Energy Systems in the Atlantic Basin

João Fonseca Ribeiro – October 2024

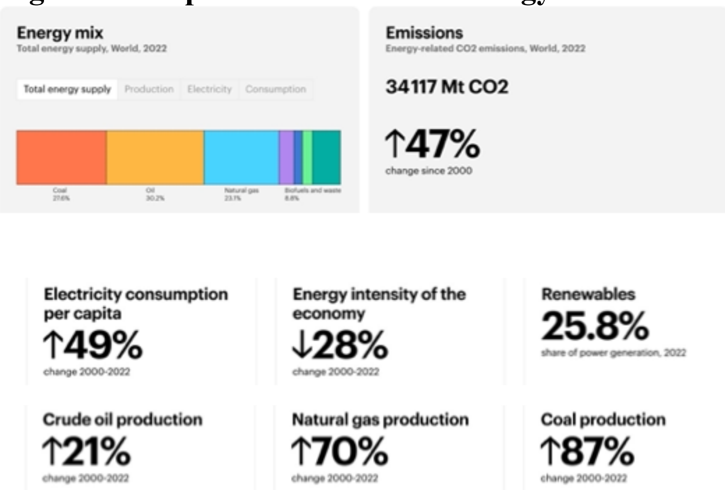
This paper presents a big-picture integrative vision of energy and related issues in the broad Atlantic Basin and to explore the potentials for pan-Atlantic cooperation, particularly in areas critical to decarbonization and where geopolitical imperatives might overlap. It offers four major focal points for consideration and main takeaways:

- Summary Overview of the Global Energy and Emissions Scenario
- Atlantic Basin Energy Systems
- Atlantic Ocean Energy Potential
- Nature-based Solutions: Opportunities and Challenges of Atlantic Land and Ocean Sinks
- Conclusions/Main Takeaways

Summary Overview of the Global State of Play

Fossil fuels consumption is continuously increasing (see Figure 1).
Public policies are slowly reversing the growing trend of fossil fuels consumption, with more visible effects from 2028 onwards (see Figure 2).

Figure 1: Snapshot of the Global Energy and Emissions Scenario in 2022

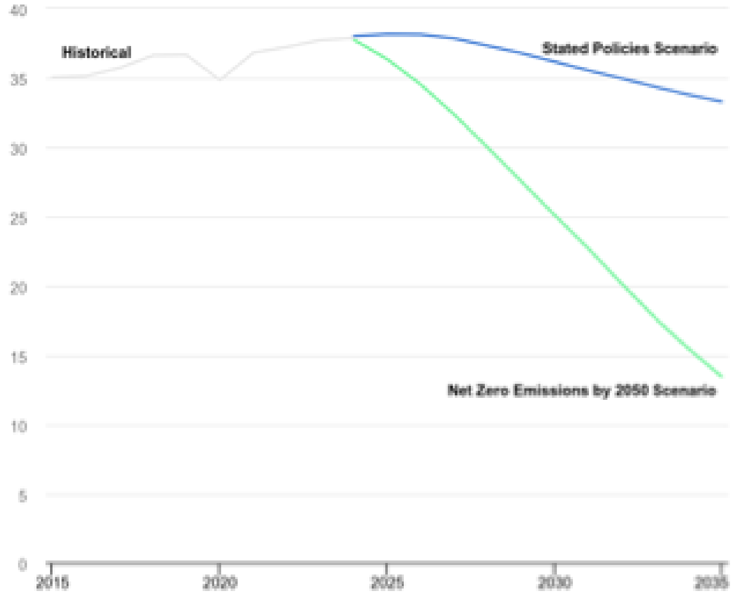


Source: IEA World Energy Outlook 2024

However, current policies are still far off the emissions trajectory needed to meet Paris Agreement (including Net Zero) commitments (see Figure 2).

The unavoidable conclusion is that mitigation measures will require much longer-term and more coherent strategies to converge with feasible Net Zero Emissions scenarios. Otherwise, the potential risk of serious disruptions is very high.

Figure 2: Global energy-related CO_2 emissions trajectory (the Stated Policies versus Net Zero Emissions by 2050 Scenarios) 2015-2035[1]



Source: IEA World Energy Outlook 2024

Nevertheless, the Atlantic Basin represents less than 20% of global energy-related CO_2 emissions[2].

Box 1: Atlantic Basin Energy-Related Emissions Snapshot

Europe (745 million people/10.18 million km2) – accounts for 3.2% of global energy-related CO2 emissions (having increased 30% in absolute terms since 2000).
The two ocean façades/coasts of (dual basin) North America (378 million people/24.7 million km2) -- account for 16.15% of global CO2 emissions (having declined 16% since 2000).
The two ocean façades/coasts of (dual basin) Africa (1.5 billion people/30.3 million km2) – account for (as in the case of Europe) 3.2% of global CO2 emissions (having also increased some 30% since 2000)
The two ocean façades/coasts of (dual basin) Central and South America (618 million people/18.3 million Km2) -- likewise account for 3.2% of global CO2 emissions (having also increased 30% since 2000).

The Atlantic is still the leading ocean basin in promoting zero emissions and the clean energy transformation.
But this process is still far too slow.

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[1] https://www.iea.org/events/world-energy-outlook-2024
[2] The 'narrow' or 'intermediate' Atlantic Basin accounts for anywhere from 15% to 20% of global energy-related CO2 emissions (see Figures 3-6, with self-elaboration). The 'broad' or 'wider' Atlantic Basin accounted for 25.75% of global energy-related CO2 emissions (see Figure 3-6, with self-elaboration). For an explanation of the various delineations in use for the 'Atlantic Basin' or the 'wider Atlantic', see Box 1: "Delimiting the Wider Atlantic", in Paul Isbell, "The Rising Strategic Significance of the Atlantic Basin: An Emerging Pan-Atlanticism", Policy Center for the New South, December 14, 2023, PB-44/23, p. 12 (https://www.policycenter.ma/publications/emerging-pan-atlanticism).

Box 2: Atlantic Basin Emissions Reduction Snapshot

The Southern Atlantic has made moves to expand the use of cleaner energies (with noticeable reductions in NOx, SOx, VOP emissions).
The Northern Atlantic has also moved to use *both* much cleaner *and zero emissions energy* (with noticeable reductions in CO2, as well as in NOx, SOx, VOP emissions).
By 2035, the Southern Atlantic's share will have risen to 25%, even as total basin demand rises 30 percent over the same time period.

Atlantic Basin Energy Systems

In order to rise to the challenge implied in the overview of the global situation outlined above, it is obvious that both innovative and strategic thinking must be brought to bear on the potential value added to the decarbonization aspirations of net zero emissions that could result from an Atlantic Basin focus and pan-Atlantic cooperation. The challenge is defined not only be the climate imperative (which has specific characteristics in the Atlantic Basin), but also by the economic, environmental and human security (and development) opportunities for all Atlantic countries – and the strategic goals of many – that could be unlocked by successful pan-Atlantic cooperation.

This is particularly promising in the realm of energy and related issues, where there exist numerous potential synergies with the areas of pan-Atlantic challenge and opportunities mentioned above. Nevertheless, many Atlantic Basin strengths – often only clear or even visible when applying an Atlantic Basin framing – often are matched by the challenge of Atlantic Basin vulnerabilities, and what they imply for the world. One example are the potentially opposing energy strengths of the Atlantic Basin: (1) fossil fuel production, particularly unconventional and 'offshore' gas and oil, on the one hand; and (2) renewable energy, decarbonization technology -- and the enormous potential of the Atlantic Ocean itself to contribute to both energy transition and the further mitigation of emissions and adaptation to climate stress through protection and restoration of marine and coastal ecosystems, on the other.

The success of the Atlantic Energy Renaissance has complicated the energy transition and the pursuit of decarbonization goals, intertwining the dynamics of energy, geostrategy, decarbonization and climate change. The focus of concern for any exploration of the potential of pan-Atlantic energy systems and cooperation should be that the former does not undermine the latter. And at the outset of the discussion, however, this does not necessarily imply the termination of the former. In this section, we draw out the major characteristics of Atlantic Basin energy, first in traditional continental terms, and then through the lens of a potential Atlantic Basin energy system (or system of systems).

However, one of the keys to circling this square -- and ensuring that fossil interests and decarbonization interests cooperate within a strategic Atlantic Basin, or pan-Atlantic, context – lies not just in the Atlantic Basin framing of the unit of analysis, but in placing the focus on the ocean itself. At the end of the day, the ocean is at the center of any Atlantic Basin system. The Atlantic Ocean is a global intersection point not only of energy investment, production, consumption and trade, but also of carbon sources and carbon sinks. There is early evidence that these two traditional Atlantic Basin strengths – carbon sources and sinks – are coming into potential conflict. Land and ocean carbon sinks are increasingly in danger of tipping point collapse -- even as we play catch-up with respect to the still enormous emissions gap, by addressing the energy sources of CO2. Such ocean-focused challenges and opportunities for pan-Atlantic energy and climate cooperation will be addressed in the subsequent sections to follow.

Box 3: Atlantic Basin Energy Systems, Continental Snapshots

The United States remains the fossil fuel center of the Atlantic Basin
Europe is the basin's leader in nuclear power and renewable energy
Latin America is the basin's leader in hydropower and biofuels
In Africa, traditional biomass still contributes a dominant share of the energy mix and has the lowest electrification rate of all the world's regions — only 26 percent of households

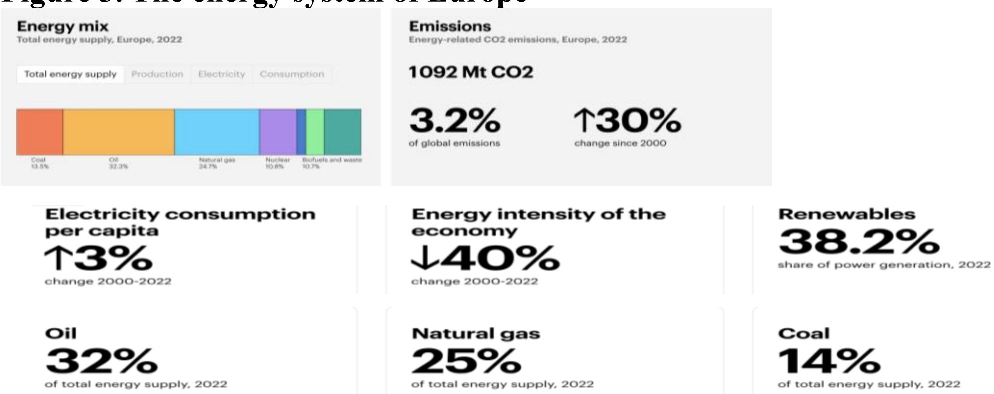
The Atlantic Basin's continental energy systems

The most obvious characteristic of the continental energy systems across the Atlantic Basin is how widely they vary. Below we deepen the bullet-point snapshot of each Atlantic Basin continent presented above in Box 3.

The energy system of Europe

Europe is home to a diverse group of energy producers and consumers with extensive ties to global markets. The region's energy sector has undergone profound changes following Russia's invasion of Ukraine. The war triggered an energy crisis that sent prices to record highs, European countries have put energy security at the top of their political agendas, dramatically reducing the energy imports from Russia upon which they had previously relied. They have also substantially raised their clean energy ambitions, aiming to further diversify their energy mixes while making progress towards climate targets.

Figure 3. The energy system of Europe



Source: IEA World Energy Outlook 2024

Renewable energy deployment is now at a record high, thanks to a raft of supportive policies. Yet greater efforts are needed to overcome ongoing energy challenges, such as bolstering clean energy supply chains, replacing outdated infrastructure, and achieving further energy system integration across the region. In some areas of Europe (including the Baltic and Mediterranean seas) countries are implementing Emissions Controlled Areas (ECA), although they are still far from covering all their coastal countries' respective EEZs. This ECA measure enforces maritime shipping to reduce NOx, SOx and VOP emissions, thereby increasing air quality.

Europe is indeed more advanced — particularly among the continent's key Atlantic players such as Germany, Spain, the U.K., and Scandinavia — along the road to a renewable energy and low- carbon economy than is the United States and, for that matter, the rest of the Atlantic Basin.[3]

On the other hand, Europe consumes more oil (41 percent of the primary mix), the same proportion of gas (25 percent), less coal (16 percent), and more nuclear power (13 percent) than the U.S., for example — although the German government's recent decision to halt the expansion of the country's nuclear energy program, and to plan for the eventual decommissioning of all its nuclear plants, certainly casts a cloud of uncertainty over the future of nuclear energy in Europe, even as France recommits itself to dependence on nuclear power.

The energy system of North America

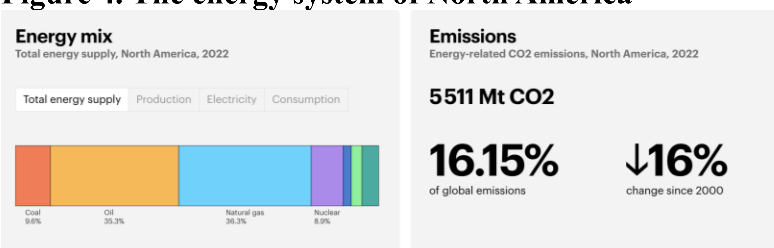
Home to two of the world's top 10 oil producers (the United States and Canada, with Mexico at No. 11) and the world's largest natural gas producer (the United States), North America plays a key role in ensuring global energy security. Meanwhile, a wave of support for clean energy deployment has accelerated sustainable transitions within the region and added to momentum globally.

The United States, the world's second largest energy producer and consumer, continues to develop its extensive fossil fuel resources and has increased oil and gas exports. At the same time, it has mobilised unprecedented levels of government support to boost clean energy industries. As a result, its energy economy is undergoing rapid changes – with renewable generation rising at a record pace.

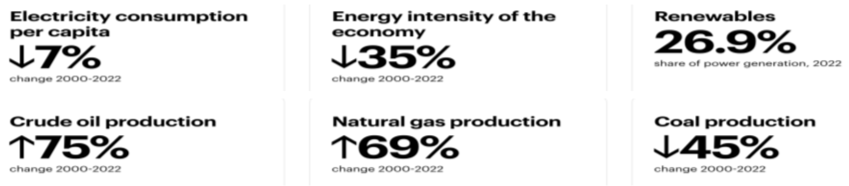
Canada, which already has notable shares of low-emissions sources in its energy mix, has also strived for a balanced approach between resource development and strengthening its environmental performance. And Mexico, whose energy mix is currently dominated by oil and gas, is substantially increasing electricity generation from renewables as demand for power grows.

It is also worth mentioning that all three North American countries long ago implemented ECA regulations over their respective EEZ, enforcing maritime shipping to the reduce NOx, SOx and VOP emissions.

Figure 4. The energy system of North America



[3] Energy and the Atlantic: *The Emergence of an Atlantic Basin Energy System* - Background Paper, Paul Isbell, Center for Transatlantic Relations. This background paper is adapted from Chapter One ("*An Introductory Exploration of the Atlantic Basin Energy System*") by Paul Isbell, Energy and the Atlantic: The Shifting Energy Landscape of the Atlantic Basin, German Marshall Fund, Washington, D.C.-Brussels, December 2012.

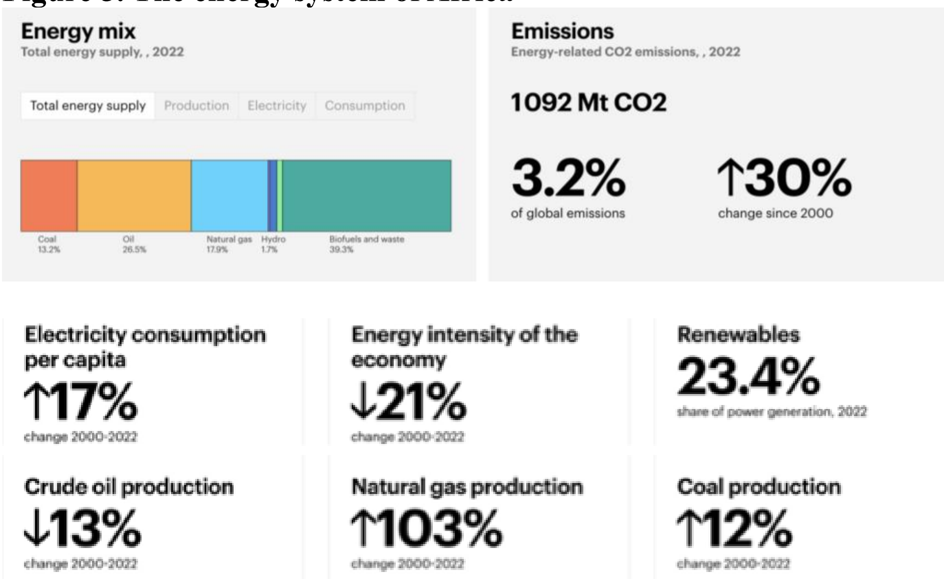


Source: IEA World Energy Outlook 2024

Energy system of Africa

Africa will be home to one-fifth of the world's population by 2030. The continent is also set to play an increasingly important role in the global energy ecosystem. Across the region, demand for energy is growing, but modern energy use per capita remains among the lowest in the world, despite ample energy resources across the continent. Africa accounts for just 6 percent of global energy use and less than 3 percent of global energy-related carbon dioxide (CO2) emissions. Boosting access to secure and sustainable energy in Africa remains essential. More than 600 million people on the continent currently live without access to electricity – and nearly 1 billion do not have access to clean cooking supplies. Supporting these ambitions will require a step-change in financing, including from the international community and the private sector. To achieve Africa's development goals, as well as energy access and climate objectives, energy spending on the continent needs to more than double by 2030, with more than two-thirds going to clean energy.

Figure 5. The energy system of Africa



Source: IEA World Energy Outlook 2024

The energy system of Central and South America

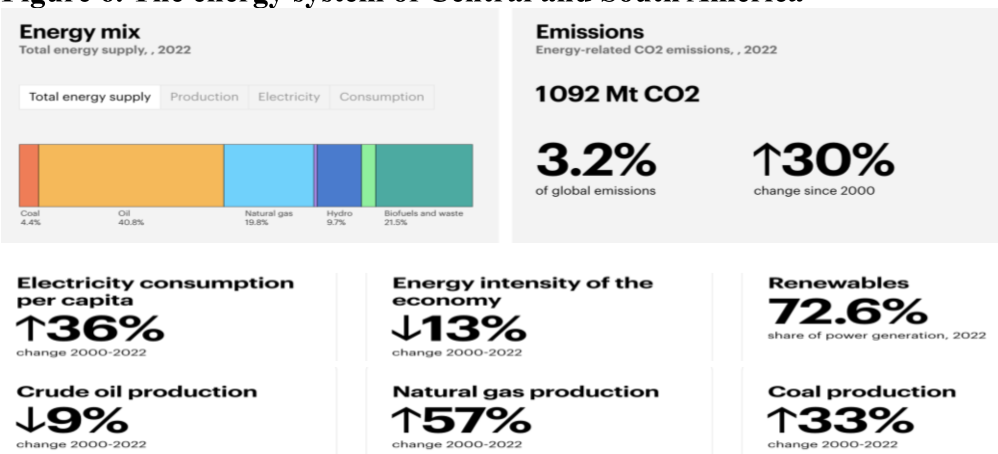
Central and South America is a region that stands out in the global energy sector. It boasts extraordinary natural resources – from oil and gas to high-quality solar, wind and hydropower – and a significant share of the world's critical minerals. It also has a history of ambitious policy making in pursuit of stronger energy security and greater sustainability that has delivered one of the cleanest electricity mixes in the world, as well as strong adoption of biofuels.

Countries in Central and South America are well-placed to leverage their clean energy potential to drive economic activity and improve the security and sustainability of energy around the world. Many countries in the region have also set ambitious climate goals. Implementing these pledges will be crucial to meeting emissions targets.

Brazil is an obvious focal point on the continent. It is the country in the Atlantic Basin with the lowest percentage of fossil fuels in the total primary energy mix. While it is true that Brazil has more low-carbon energy sources in its primary mix than almost any other country, making it the "cleanest" country in the Basin, much of this is due to the high dependence on hydropower in the electricity mix (more than 80 percent). On the other hand, Brazil's largest contribution of greenhouse gas emissions stems from deforestation and changes in agricultural and land-use patterns and, as a result, does not appear in either the country's energy mix or in its "energy emissions profile."

The continent is excessively dependent on oil (nearly half of the primary energy mix), but due to the region's relative lack of coal (only 4 percent) and nuclear power (less than 1 percent), hydroelectric power is more dominant here in the primary mix than elsewhere (more than 25 percent). In the rest of the Atlantic Basin (as in the rest of the world), hydroelectricity contributes only 5 percent to 6 percent of the primary energy mix, although it does have enormous theoretical potential in Africa, for instance. Latin America and the Caribbean is also a leader in the biofuels terrain — particularly Brazil (where ethanol is produced relatively efficiently and cheaply from sugarcane), traditionally and still often the world's leading exporter of biofuels, if sometimes now slightly behind its Atlantic Basin ally and biofuels partner, the United States. [4]

Figure 6. The energy system of Central and South America



Source: IEA World Energy Outlook 2024

An Atlantic Basin energy system?

Despite the clear diversity across the continental energy systems of the Atlantic Basin, a number of developments over the last 20 years suggest the possible existence of – or potential for – an Atlantic Basin energy system, along with the attendant challenges and opportunities

[4] Ibid.

for pan-Atlantic cooperation. This nascent development was first identified over a decade ago[5].

A number of these energy vectors were either identified as unique to the basin or as more advanced in their evolution than in the Indian Ocean or the Pacific basins – and often more so than in any of the Atlantic Basin continents, analyzed individually. At the time, this nascent Atlantic Basin energy system had already achieved significant and growing weight within the global energy economy (e.g., in terms of supply, demand, relative autonomy, and supply chain complementarity). The growth of renewables, the shale gas revolution, the boom in Southern Atlantic offshore oil, the dynamism of Atlantic liquified natural gas (LNG), and the possible emergence of gas-to-liquids (GTL), all placed the Atlantic Basin at the cutting edge of the energy future.

Box 4: An Atlantic Basin Energy System?

Some 70% of all Atlantic Basin trade in oil is intra-Atlantic Basin trade: 67% of all Atlantic Basin crude oil trade and 76% in oil products trade.
The situation is very similar in gas. Three-quarters (74%) of all Atlantic Basin trade in LNG was intra-Atlantic Basin trade.
Indeed, the Atlantic Basin could turn out to be the ideal space within which the Atlantic's many energy economies begin to abandon the chimera of "national energy independence" and pursue instead — through a conscious framing of energy policy and a deliberate recasting of energy relations within the basin — an ultimately more sustainable and, therefore, more pragmatic "collective energy security"[6].
Several mutually complementary opportunities to develop energy investment and trade linkages — all along the energy supply chain — have also appeared across the Atlantic space, particularly in the Southern Atlantic.
One example is the complementary nature of potential Southern Cone shale gas with existing South African GTL synthetic fuel technology. This potential has been revived by the new Argentine government's economic and energy strategies, conceived to massively increase the export of LNG into the Atlantic Basin and beyond.

But these dynamics and driving forces shaping energy in the Atlantic have also been recently re-confirmed: "As with the Atlantic Energy Renaissance, another key feature of Atlantic Basin energy remains in place: the high levels of intra-Atlantic interdependence in most forms of energy trade. A snapshot update of current intra-Atlantic energy trade reveals … the Atlantic Basin remains the most energy interdependent region in the world. Between two-thirds to three-fourths of the energy trade of Atlantic Basin states is 'intra-Atlantic'[7].

Moreover, pure intra-Atlantic Basin trade involves a relatively large and growing share *of both the global petroleum and liquefied natural gas markets*, lending Atlantic Basin markets a certain level of depth and functional autonomy in relation to the overarching global markets. "Even more than it did in 2015, the increased density of this energy system suggests high potential for pan-Atlantic energy cooperation – whether from the cost and efficiency

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[5] Ibid.
[6] See, for example, the Atlantic Basin Initiative's "Luanda Declaration for Sustainable Energy in the Atlantic Basin".
[7] Paul Isbell, "Energy and The Atlantic Basin: State of Play and Prospects for Pan-Atlantic Cooperation", Background Paper, Atlantic Energy Forum, October 3, 2024.

standpoint of industry or from the strategic perspective of energy and foreign policy makers"[8].

Mobilizing the untapped potential of underutilized energy trade and investment links, particularly in the Southern Atlantic, could help produce a renaissance in the Atlantic Basin, eroding the patterns of traditional economic and political dependence of the South upon the North, and moderating the risks imposed by China's inexorable global emergence, the emergence and expansion of the BRICS, and its growing influence and presence around the world, including within the Atlantic Basin.
The AEF should consider pan-Atlantic energy cooperation and the conscious shaping of the Atlantic Basin energy system in the pursuit of such strategic goals.

Atlantic Ocean Energy Potential

As mentioned above, part of the key to resolving the potential conflicts between fossil and decarbonization interests, between Atlantic Basin carbon sources and sinks, and the intensifying dilemmas of balancing climate and energy security is to be found by focusing on the Atlantic Ocean. Much attention has been rightly placed on the Atlantic Ocean's offshore energy production and potential (i.e., the shale revolution and the deep offshore oil and gas booms of the 21st century), especially across the Southern Atlantic. However, in this section (without attempting to be exhaustive), we offer a selection of the significant potentials in the Northern Atlantic of Atlantic ocean energy – both renewable and fossil.

Renewable Energy in the "European Atlantic": Potential for European Union Strategic Leverage:

An EU-wide study on offshore energy in the Atlantic Ocean[9] has investigated the potential for offshore renewable energy in the European Atlantic.

More specifically, *offshore wind, wave, tidal stream and solar photovoltaic (PV) cells* have been considered, given that other forms of offshore renewable energy (e.g., Ocean Thermal Energy Conversion, or OTEC[10]) have very limited potential in the region. The study based its analysis not only on the potential for offshore renewable energy generation based on currently-identified resources and the present "state of play", but it also identified "hot spots" (i.e., the areas with greatest potential for the different technologies, and the technical challenges facing their development).

Importantly, the so-called 'Levelised Cost of Energy' (LCOE)[11] is bound to affect this development. It is arguably the single most important metric to consider, and therefore has been analysed extensively across two-time horizons (2030 and 2050). The study covers the four technologies under focus and the entire European Atlantic space.

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[8] Ibid.
[9] J. Dubranna, R. Fofack-Garcia (FEM), C. Verrecchia, B. Rodrigues, S. Langiano (EDP NEW), J. Berque (Tecnalia), G. Iglesias, E. Laino, B. Alvarez (UCC), "Study on the offshore energy potential in the Atlantic Ocean: Final report", European Commission, July 2023 (https://op.europa.eu/en/publication-detail/-/publication/0db53974-6ca8-11ee-9220-01aa75ed71a1/language-en).
[10] Ocean Thermal Energy Conversion (OTEC) systems use a temperature difference (of at least 20° Celsius or 36° Fahrenheit) to power a turbine to produce electricity. Warm surface water is pumped through an evaporator containing a working fluid.
[11] LCOE: the price at which the generated electricity should be sold for the system to break even at the end of its lifetime.

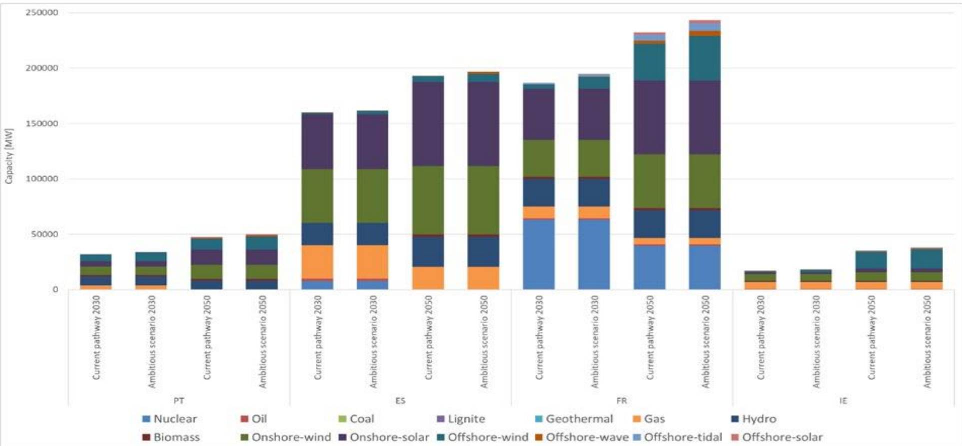
Connecting future offshore facilities to the mainland grid is another important element in the development of offshore renewable energy. Options for such connections (both radial and hybrid) were analyzed in detail, considering their pros and cons and, finally, their cost. While radial options appear less costly in general than the hybrid alternatives, hybrid projects bring additional advantages (for example in terms of security of supply).

As such, the study covered the range of challenges and barriers to the implementation of offshore renewable energy in the European Atlantic.

Five categories of non-technical implementation challenges were addressed: (1) regulatory and administrative, (2) socio-ecological, (3) economic and financial, (4) marine spatial planning (MSP) and multi-use, and (5) supply chains. This was complemented by an analysis of the national strategies to mitigate these challenges in the selected countries considered in this study (Portugal, Ireland, Spain and France). Finally, a quantitative method to rank the areas previously selected was developed; it combined a number of criteria, which take into account the LCOE and other uses of the marine space (military, nature reserves, fishing, shipping lanes, oil and gas, and communication cables), where appropriate. This method has the advantage of allowing for a homogeneous application to the fourt different technologies considered in this study with two time horizons (2030 and 2050). The findings include a quantitative classification of pre-selected areas and, as a result, the identification of prime areas for the development of offshore renewable energy in the European Atlantic.

The production scenarios include all renewable and non-renewable technologies for the Atlantic countries. The 'current pathway' and the 'ambitious scenario' differ only with regards to offshore installed capacity, and they share the same assumptions regarding electricity demand and deployment of onshore technologies, which are aligned with explicit targets in National Energy Plans or relevant long-term strategic documents.

Figure 7. Capacity assumptions in different production scenarios for the Atlantic Member States



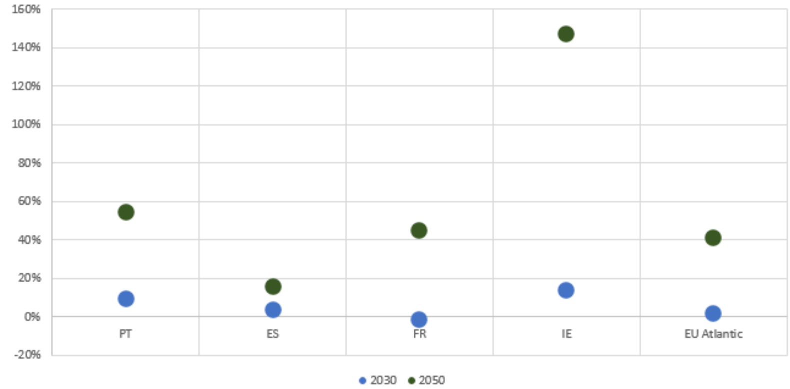
Source: "Study on the offshore energy potential in the Atlantic Ocean: Final report", EC, July 2023.

Overall capacity considers targets concerning: (1) the share of renewables in electricity consumption; (2) (an explicit target for) installed Renewable Energy Sources (RES)[12] capacity; and the phase out of existing nuclear or fossil generation technologies. Figure 7 above shows the assumed production capacities for the scenarios under study.

[12] The generation from renewable energy sources (RES) is central to the electricity generation mix in Europe, according to CEER.

Electricity demand is another key parameter for power market modelling and power flow analysis. Due to electrification in transport, heating and industry sectors, European electricity demand is expected to increase significantly by 2050. In this study, electricity demand assumptions are based on the national trends' scenario (of the TYNDP 2022 - Scenario report, s.d.), which aims to reflect the commitment of each Member State in meeting the targets set by the European Commission and National Plans. The variation of electricity demand in 2030 and 2050 is shown in figure below, relative to the demand in 2020. For the EU Atlantic Member States, the total electricity demand is assumed to increase 2% by 2030 and 41% by 2050.

Figure 8. Electricity demand variation relative to 2020



Source: "Study on the offshore energy potential in the Atlantic Ocean: Final report", EC, July 2023.

Fuel and carbon prices are key parameters for determining the merit order of power generation. In this study, fuel prices are based on the assumptions of the TYNDP Scenario Report 2020. On the other hand, CO_2 prices are based on the "*Study on the offshore grid potential in the Mediterranean region*".

Figure 9. Fuel price assumptions: Atlantic Study, ENTSO-E, EU and IEA Scenarios

Fuel	Atlantic Study (€/MWh)		Med Study (€/MWh)		TYNDP 2020 (€/MWh)		EU LTS scenarios (€/MWh)		IEA Stated policies (€/MWh)	
	2030	2050	2030	2050	2030	2040	2030	2050	2030	2050
Hard Coal	15.5	24.9	15.5	24.9	15.5	24.9	13.7	15.5	9.7	9.9
Natural Gas	24.9	26.3	24.9	26.3	24.9	26.3	37.2	46.5	24.3	27.0
Light Oil	73.8	79.9	73.8	79.9	73.8	79.9	80.6	95.6	57.2	66.7
Heavy Oil	52.6	61.9	52.6	61.9	52.6	61.9	50.4	60.0	35.6	41.7
Nuclear	1.7	1.7	1.7	1.7	1.7	1.7	-	-	-	-
Lignite	4.0	4.0	4.0	4.0	4.0	4.0	-	-	-	-
CO2 (€/ton)	28	250	28	250	27-53	75-100	28	250- 350	33	43

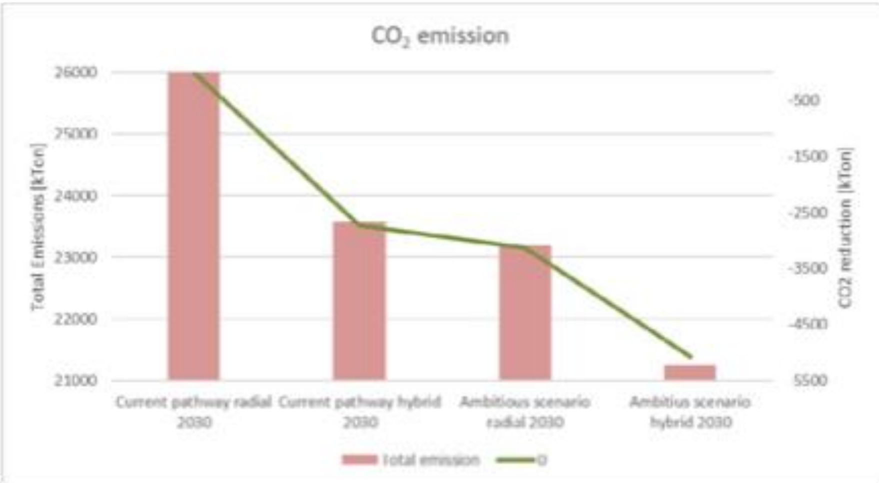
Source: "Study on the offshore energy potential in the Atlantic Ocean: Final report", EC, July 2023; also ENTSO-E, EU and IEA Scenarios.

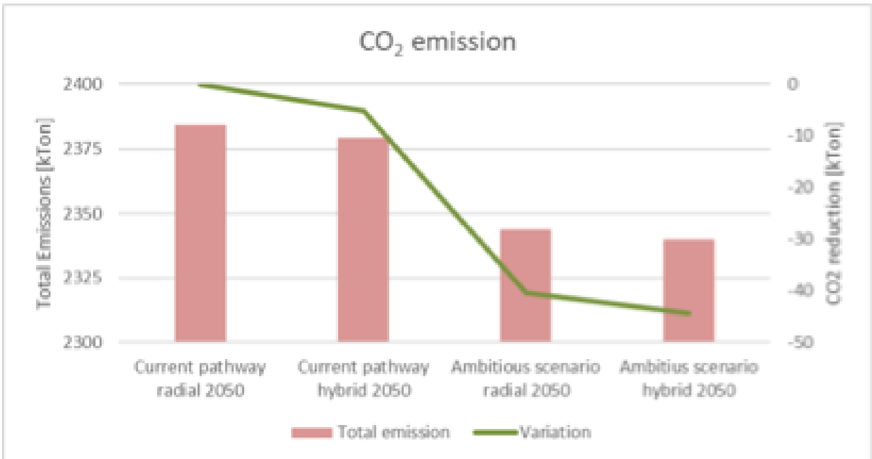
For over two decades now, Europe has been demonstrating that offshore wind turbines are a proven technology that produces clean energy and jobs from its offshore wind resources, without significant impacts to marine systems and avian species. As a result, the offshore wind market is expanding.

With respect to the 2030 scenarios, the savings in CO_2 emissions of the different production scenarios and grid options (compared with the current pathway with radial connection), the hybrid layout estimate savings are around 2700 Kton of CO_2 annually in the current pathway by replacing fossil-fuelled generation. Moreover, CO_2 savings can increase up to 5000 Kton in the more ambitious scenario, given the higher penetration of offshore energy. Interconnections in the ambitious scenario would contribute to annual CO_2 emissions savings of about 1900 kTon more annually. Considering that CO_2 emissions in 2022 on the European continent (i.e., EU plus other European countries) were approximately 1092 Mton, and focusing on the best scenario, such savings in the near-term are marginal – representing only 0.6 percent of annual CO_2 emissions on the European continent[13].

On the other hand, by 2050, the CO_2 emission savings of the different production scenarios and grid options compared with the current pathway with radial connection indicates that the hybrid layout registered savings of around 5 kTon of CO_2 annually in the current pathway by replacing fossil-fuelled generation. And CO_2 savings increased up to 40-45 kTon in the ambitious scenario.

Figure 10. CO_2 emissions savings: production scenarios and grid options vs current pathway 2030 and 2050 scenarios with radial connection





Source: "Study on the offshore energy potential in the Atlantic Ocean: Final report", EC, July 2023.

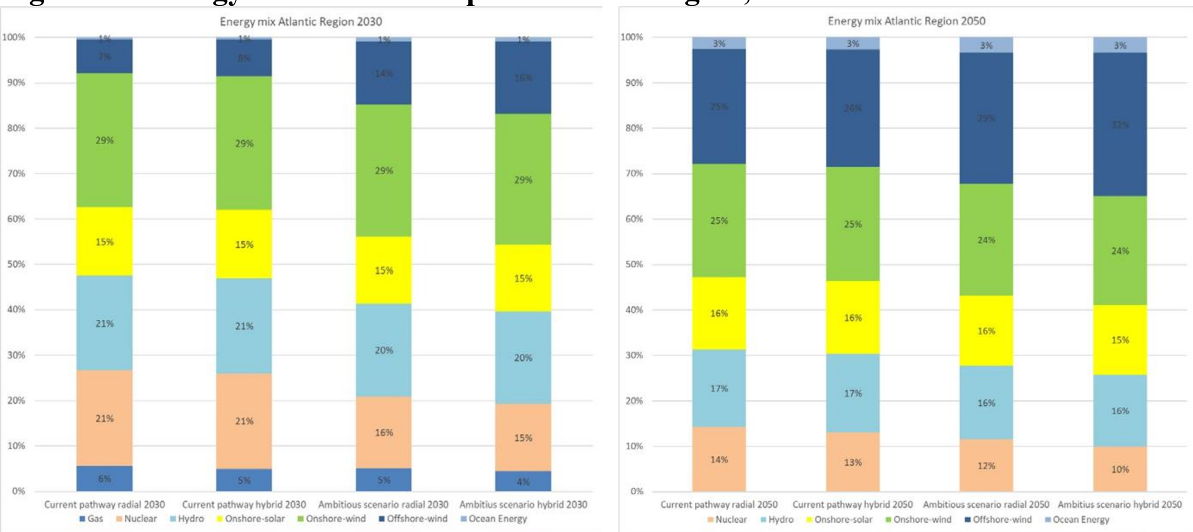
Electricity demand in the Atlantic region would be supplied by the different energy sources in 2030, for the different production scenarios and grid options. With the current pathway,

[13] Nevertheless, with respect to the four Member States of Europe's Atlantic Region it represents ……. (TO BE CONFIRMED).

offshore renewable energy would cover up to 8-9% of all electricity demand, of which 87% would be supplied by offshore-wind. The situation does not change much with the introduction of the hybrid option, as it increases by 1%. However, *under the ambitious scenario, the penetration of offshore renewables doubles up to 17%, with wind covering 14-16%.*

On the other hand, by 2050 and with the current pathway, offshore renewable energy would cover up to 29% of the whole electricity demand, of which 90% is supplied by offshore-wind. Introducing the hybrid configuration this share increases by 1%. But, again, *under the ambitious scenario, the penetration of offshore renewables increases significantly up to 32-35%.*

Figure 11. Energy mix of the European Atlantic region, 2030 and 2050



Source: "Study on the offshore energy potential in the Atlantic Ocean: Final report", EC, July 2023.

In conclusion, with respect to costs and estimated costs for grid reinforcement, all scenarios require considerable investments in offshore power generation and connection to the onshore grid. The total CAPEX of integrating 14.5 GW by 2030 in the current pathway scenario is around 40.3-40.6 billion €, whereas to integrate 27.8 GW by 2030 in the ambitious scenario is around 68-69 billion € (depending on the grid option). This study reveals how floating offshore wind would absorb 40-70 per cent of the investments in offshore power generation (depending on the scenario) by 2030. To achieve the RES integration of 76 GW in the current pathway scenario 2050 an investment of 144-145 billion € is required, but this increases to 180-182 billion €, depending on the grid option, to integrate the 96.5 GW in the ambitious scenario.

North America, Ocean Energy and Strategic Leverage

<u>Canada: Oil E&P in the Extended Continental Shelf</u>

On July 26, 2018, Newfoundland and Labrador announced a development agreement for the Bay du Nord oil discovery in the Flemish Pass basin, located about 500 km offshore[14]. This development agreement is significant because the Flemish Pass Basin is outside Canada's 200 mile nautical limit (370 km). Four offshore production platforms are already located roughly

[14] https://www.cer-rec.gc.ca/en/data-analysis/energy-markets/market-snapshots/2019/market-snapshot-atlantic-offshore-oil-production-law-sea.html#fn1

350 km away from St John's, approaching the nautical limit. In April 2018, BP Canada was granted an approval to drill an exploration well 300 km offshore from Nova Scotia. BP Canada has also applied to drill a well in the Orphan Basin, 350 km east of Newfoundland. According to Article 82 of the United Nations Convention on the Law of the Sea (UNCLOS) Canada would need to pay royalties to the International Seabed Authority (ISA) for producing oil outside the nautical limit. However, under UNCLOS no international royalties are due during the first 5 years of oil production. Annual payments of 1% begin after the 6th year of production and increase by 1% per year until the 12th year. Thereafter, payments remain at 7%. The ISA will distribute payments or contributions-in-kind to other UNCLOS member countries, according to the treaty.

<u>United States: Offshore Wind Potential Supported by Biodiversity Interests</u>
The United States has vast offshore wind energy resources in the Atlantic Ocean, with over 1300 GW of clean electricity generation potential identified by the National Renewable Energy Laboratory (NREL).

Atlantic offshore wind power is one of country's largest untapped renewable energy sources and has great potential to replace fossil fuel emissions and protect wildlife and people from the dangers of climate change, while also creating significant economic and workforce development opportunities, diversifying the energy portfolio, and producing lower and more stable energy prices especially through long term contracts.

The U.S. Department of the Interior launched an offshore renewable energy leasing program in 2010, began leasing areas in federal waters of the Atlantic Ocean for offshore wind development in the summer of 2013, and has announced a significant amount of acreage set for auction in 2014.

All energy development has some effect on wildlife, and offshore wind power has significantly fewer negative effects than many of its alternatives. As demonstrated by many studies and reports, including the State of Rhode Island's Ocean Special Area Management Plan, offshore wind power can be developed in an environmentally-responsible manner, with strong wildlife protections guiding the selection of project locations and requirements for best management practices in pre-development, construction, operations, and decommissioning activities.

Crucially, in a strategic sense, environmental groups like the National Wildlife Federation recognize the critical importance of the ocean, and that:

- Climate change is the single greatest threat facing the nation's wildlife.
- Carbon pollution from burning fossil fuels to generate electricity and power the transportation system is the primary contributor to climate change.
- Wind energy currently generates only five percent of America's electricity.

The National Wildlife Federation works in partnership with affiliates and other key partners to build and demonstrate support for appropriately-sited offshore wind power, ensuring that strong wildlife protections and continued research and monitoring of possible effects upon wildlife and fisheries guide the pursuit of this much-needed clean energy source for the U.S. On this foundation, the National Wildlife Federation supports environmentally-responsible development of offshore wind power projects in the Atlantic as a critical component of achieving a clean energy future for America that is needed to protect wildlife populations and their habitats across all states from the dangerous effects of climate change.

Such biodiversity interests have called on the U.S. Department of the Interior to move a leasing and permitting process forward for offshore wind power in the Atlantic Ocean that ensures strong and effective protections for wildlife populations during the pre-development, construction, operations, and decommissioning stages. This must include:

- comprehensive environmental review;
- coordination with state, local, and tribal governments;
- meaningful stakeholder engagement;
- transparency of process;
- comprehensive endangered species assessment and protection; environmental monitoring; respect for existing responsible ocean uses;
- adaptive management planning and mitigation of effects upon wildlife and fisheries
- the U.S Congress to pass critical incentives—such as an investment or production tax credits—needed to jumpstart an American offshore wind energy industry.
- Atlantic coast Governors and other state leaders to take actions necessary to ensure that environmentally-responsible offshore wind power plays a major role in their energy future.

Offshore wind development is rapidly expanding along the Atlantic coast of the United States, especially from Massachusetts to North Carolina. This is a new use of U.S. marine waters, requiring substantial scientific and regulatory review by NOAA Fisheries.

The first U.S. offshore wind power project came online for commercial operation in late 2016. As with this first project, U.S. developers are expected to leverage European offshore wind technology, industry experience, and industrial capacity in early projects. Beiter et al. (2016) defined a scenario assuming that the U.S. offshore wind industry can leverage the recent European offshore wind technology and industry experience while addressing important physical, regulatory, and economic differences influencing U.S. projects. The cost-reduction pathway under this scenario applies projected cost reductions developed for European projects within the time frame from 2015 to 2027 and assumes sufficient domestic deployment and supply chain maturity to support these cost reductions in the United States during the analysis period.

In 2017, the National Renewable Energy Laboratory (NREL) produced a study for assessing the economic potential of offshore wind in the U.S. from 2015 to 2030[15]. The results presented in this study were intended to inform a broad set of stakeholders to enable an initial assessment of offshore wind as part of energy development and energy portfolio planning. It provided information for federal and state agencies and planning commissions usage to inform initial strategic decisions about offshore wind development in the U.S.

This study found that estimated reductions in levelized cost of energy (LCOE) over the next decade coincide with relatively high levels of levelized avoided cost of energy (LACE) in some U.S. regions. By 2027, a considerable amount of economic potential was estimated in the U.S. Atlantic coast, more specifically for the Northeast and the eastern shore of Virginia (see table below).

[15] Philipp Beiter, Walter Musial, Levi Kilcher, Michael Maness, and Aaron Smith, "An Assessment of the Economic Potential of Offshore Wind in the United States from 2015 to 2030", National Renewable Energy Laboratory, Prepared under Task No. WE16.CA02.

Table 1. Available Capacity, U.S. Atlantic Coast, and Economic Potential by State, 2027

State	Economic Potential (in gigawatts [GW])
Maine	65
Massachusetts	55
Rhode Island	16
Virginia	4
New Hampshire	2
New York	1
Connecticut	1

Source: NREL "An Assessment of the Economic Potential of Offshore Wind in the United States from 2015 to 2030"

Some general observations in this study include:

- Offshore wind sites with economic potential are located predominantly in the Northeast and eastern shore of Virginia;
- Across all regions, the number of sites with a positive net value (or a value close to a positive net value) increase over the time period considered;
- State policies have driven offshore wind development recently (e.g., in New York and Massachusetts); these policies may play a key role when assessing the economic viability of offshore wind but are not considered in this analysis;
- Further technology improvements are needed to achieve the cost reductions of this assessment.

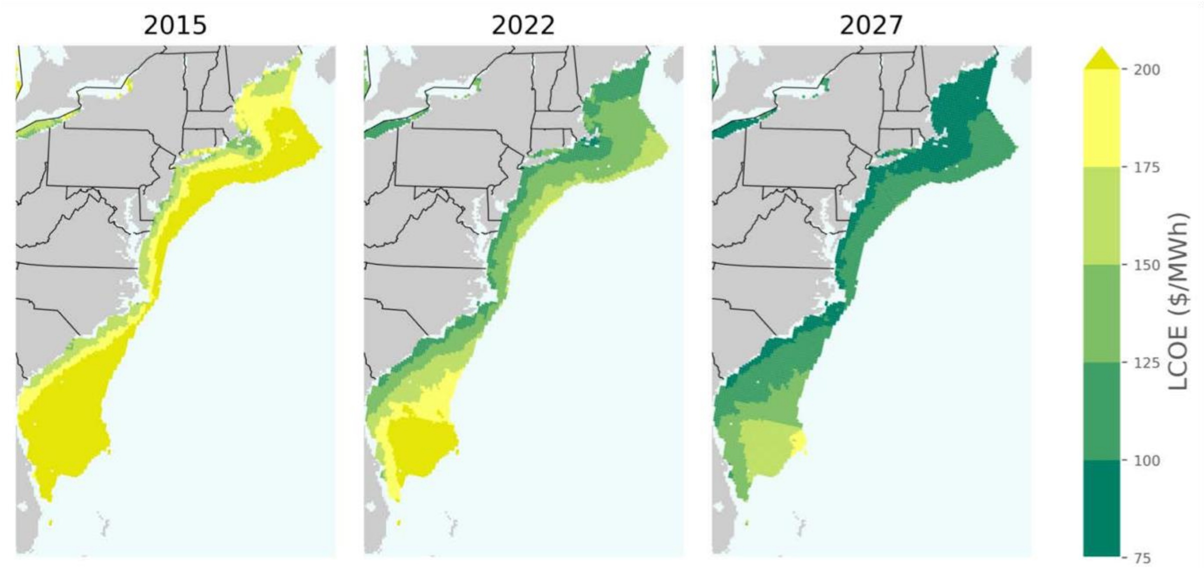
The study also revealed that a total of approximately 2,060 GW of offshore wind technical resource potential were estimated by Musial et al. (2016) for all major U.S. coastal regions (excluding Alaska). In comparison, a total of 82 GW of land-based wind was installed in the U.S. by the end of 2016 (American Wind Energy Association [AWEA] 2017).

U.S. Atlantic Coast

The Levelized Cost of Energy (LCOE) Spatial Distribution in 2015, along the Atlantic Coast was estimated to range from approximately $125– 270/MWh in the Northeast, $145–315/MWh in the mid-Atlantic regions,[30] and $150–385/MWh in the Southeast, respectively. These ranges decrease to $95–180/MWh (Northeast), $110–210/MWh (mid-Atlantic), and $115–260/MWh (Southeast) by 2022, respectively. By 2027, the LCOE range in the Northeast was estimated to decline to $80–130/MWh (Northeast), $85– 150/MWh (mid-Atlantic), and $90–185/MWh (Southeast).

The Atlantic Coast has some of the lowest LCOE sites across U.S coastal areas. These sites are generally near shore and in relatively shallow waters. Some of the lowest-cost sites are located in Massachusetts, Maine, Rhode Island, and New York. As shown in Figure 12, areas of relatively low LCOE extend far from shore in Massachusetts, New Hampshire, Maine, and Rhode Island because of shallow waters. Along the coast of Florida, LCOE tends to be significantly higher as a result of relatively low wind speeds (see Musial et al. 2016).

Figure 12. Atlantic Coast Spatial LCOE Distribution (2015–2027)

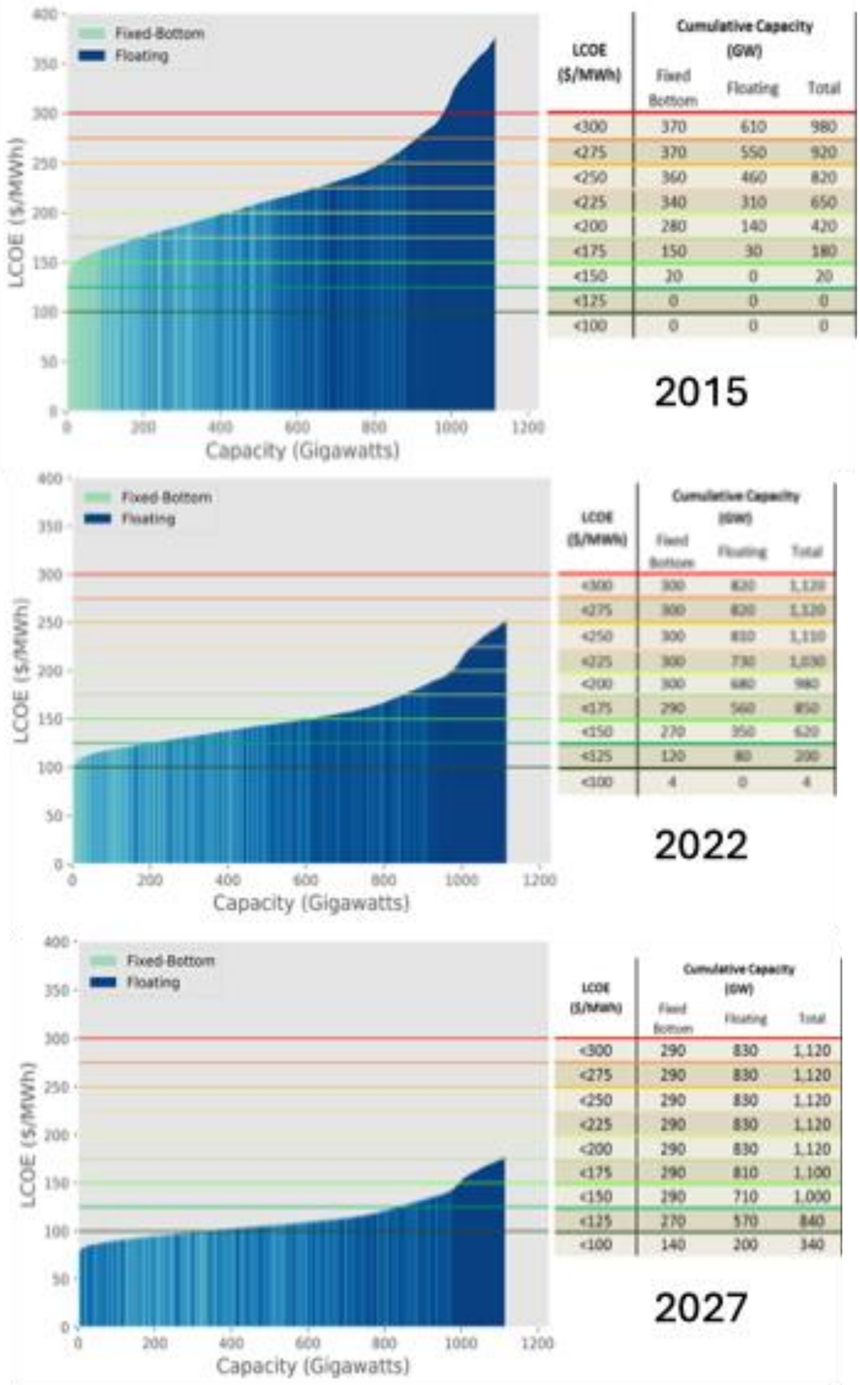


Source: NREL "An Assessment of the Economic Potential of Offshore Wind in the United States from 2015 to 2030"

Figure 13 (below) shows a set of U.S. Atlantic Coast offshore wind supply curves for 2015, 2022, and 2027. The adjacent tables indicate the available capacity at different levels of LCOE in increments of $25/MWh.

The U.S. Atlantic Coast possesses a total offshore wind technical resource of approximately 1,100 GW. This is the largest resource potential among all U.S. coastal areas (excluding Alaska). Yet, in 2015, there was no offshore wind capacity below LCOE levels of $100/MWh. By 2022, nearly 4 GW of capacity was available below $100/MWh, and by 2027 approximately 340 GW of capacity reaches costs below $100/MWh. In the same timeframe, the share of floating offshore wind sites increases from 0 percent at LCOE levels of <$150/MWh in 2015 to nearly 60 percent at LCOE levels of <$100/MWh in 2027. By 2027, the Northeast region alone will comprise more than 260 GW of the 340 GW of capacity at LCOE levels below $100/MWh in 2027. Approximately 200 GW of this amount are located off the coast of Maine, Massachusetts, and Rhode Island. It should be noted that in the Atlantic Coast region, approximately 74% of the sites favour floating wind technology as the least-cost solution by 2027.

Figure 13. U.S. Atlantic Coast offshore wind energy supply curve



LCOE ($/MWh)	Cumulative Capacity (GW)		
	Fixed Bottom	Floating	Total
<300	370	610	980
<275	370	550	920
<250	360	460	820
<225	340	310	650
<200	280	140	420
<175	150	30	180
<150	20	0	20
<125	0	0	0
<100	0	0	0

2015

LCOE ($/MWh)	Cumulative Capacity (GW)		
	Fixed Bottom	Floating	Total
<300	300	820	1,120
<275	300	820	1,120
<250	300	810	1,110
<225	300	730	1,030
<200	300	680	980
<175	290	560	850
<150	270	350	620
<125	120	80	200
<100	4	0	4

2022

LCOE ($/MWh)	Cumulative Capacity (GW)		
	Fixed Bottom	Floating	Total
<300	290	830	1,120
<275	290	830	1,120
<250	290	830	1,120
<225	290	830	1,120
<200	290	830	1,120
<175	290	810	1,100
<150	290	710	1,000
<125	270	570	840
<100	140	200	340

2027

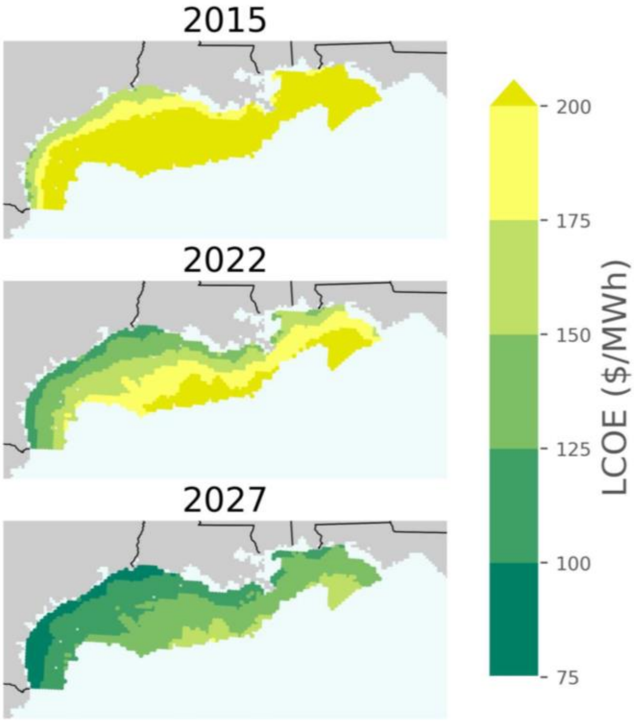
Source: NREL "An Assessment of the Economic Potential of Offshore Wind in the United States from 2015 to 2030"

U.S. Gulf Coast

On the other hand, the Levelized Cost of Energy (LCOE) Spatial Distribution in the U.S. Gulf Coast (also part of the Atlantic Basin) offshore wind resource studies conducted by NREL in 2016 calculated the technical offshore wind resources for each state and found that the Gulf states had among the highest quantity of offshore wind resource in the U.S. However, the quality of that resource was found to be lower as most of the sites are below an 8-m/s average wind speed (Musial et al. 2016a). Nevertheless, the resource assessment shows that Florida, Louisiana, and Texas rank second, third, and fourth nationally in terms of total offshore wind resource, with significant area in shallow water. Shallow water may be an advantage to help sites in some of these areas achieve competitive LCOE levels.

Figure 14 depicts the spatial distribution of LCOE in the Gulf Coast region between 2015 and 2027. In 2015, LCOE ranges from $140 to $385/MWh, led by locations in Texas and Louisiana. By 2022, this range declines to $105–260/MWh. By 2027, this range declines further to $90– 185/MWh. The influence of water depth and distance from shore seems clearly distinguishable in the Gulf Coast with the highest-cost sites farther from shore. The Gulf states all have areas where LCOE drops below $125/MWh. In particular, Louisiana and Texas both have significant resources below $100/MWh by 2027.

Figure 14. U.S. Gulf Coast spatial LCOE distribution (2015–2027)

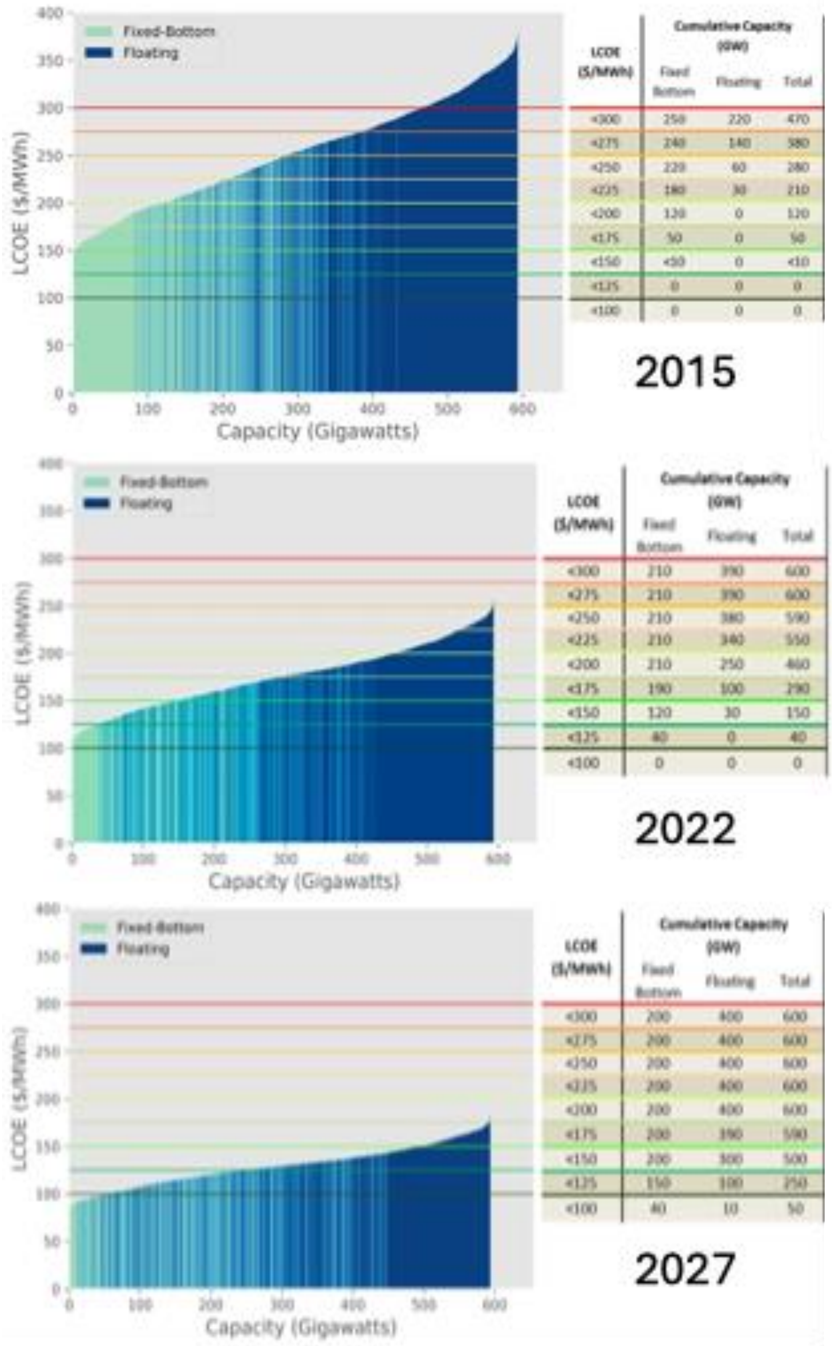


Source: NREL "An Assessment of the Economic Potential of Offshore Wind in the United States from 2015 to 2030"

With nearly 600 GW of technical offshore wind energy resource potential, the Gulf Coast is the second largest coastal region after the Atlantic Coast region. In 2015, nearly 3 GW of capacity were estimated to be available at LCOE levels less than $150/MWh and approximately 50 GW are available at LCOE less than $175/MWh.

Fixed-bottom technology is predominant among least- cost sites. In 2015, as Figure 15 below reveals, fixed-bottom technology comprised nearly all of the capacity at LCOE levels below $200/MWh. Over time, as floating technology costs decrease, the share of floating technology increases. In 2027 the same figure shows that in 2027, 75 percent of the sites that are below an LCOE of $100/MWh are still fixed-bottom sites.

Figure 15. Gulf Coast offshore wind energy supply curve (2015-2027)



2015

LCOE ($/MWh)	Cumulative Capacity (GW) Fixed Bottom	Floating	Total
<300	250	220	470
<275	240	140	380
<250	220	60	280
<225	180	30	210
<200	120	0	120
<175	50	0	50
<150	<50	0	[illegible]
<125	0	0	0
<100	0	0	0

2022

LCOE ($/MWh)	Cumulative Capacity (GW) Fixed Bottom	Floating	Total
<300	210	390	600
<275	210	390	600
<250	210	380	590
<225	210	340	550
<200	210	250	460
<175	190	100	290
<150	120	30	150
<125	40	0	40
<100	0	0	0

2027

LCOE ($/MWh)	Cumulative Capacity (GW) Fixed Bottom	Floating	Total
<300	200	400	600
<275	200	400	600
<250	200	400	600
<225	200	400	600
<200	200	400	600
<175	200	390	590
<150	200	300	500
<125	150	100	250
<100	40	10	50

Source: NREL "An Assessment of the Economic Potential of Offshore Wind in the United States from 2015 to 2030"

In 2021, the Biden administration announced efforts to reach 30 GW of offshore wind energy capacity by 2030. The U.S. Department of Energy's Wind Vision Report quantified the benefits from up to 22 GW of installed offshore wind by 2030 and 86 GW by 2050. In fact, the Wind Vision scenarios show that by 2050, offshore wind energy could be available in all coastal regions nationwide.[16]

Coastal areas represent large population centers hosting nearly 40 percent of the U.S. population. They are also proximal to vast offshore wind resources. Offshore wind farms can help supply their energy needs with many advantages, including potential domestic economic

[16] https://windexchange.energy.gov/markets/offshore

development benefits. Those resources will help the U.S. transition to renewable energy, with the country working toward a goal of installing 30 GW of offshore wind energy capacity by 2030 and 15 GW of floating offshore wind energy capacity by 2035.

The U.S. offshore wind energy industry is poised for exponential growth, with many large installations in various stages of planning, development, and operation. This growth will require an expansion of the domestic supply chain and workforce.

In fact, according to the U.S. Department of Energy's Offshore Wind Market Report, the U.S. offshore wind energy industry has, as of May 2023, a total of almost 53 GW of potential generating capacity in the development and operational pipeline. Two operational plants on the U.S. East Coast (off Rhode Island and Virginia) provide 42 MW of wind energy. And 18 projects in the U.S. offshore pipeline have reached the permitting phase, and 13 states have set their own offshore wind energy goals, totaling over 112 GW by 2050.

Carbon Sinks: Common Atlantic Basin Challenge, Unique Pan-Atlantic Opportunity

Nature-based Solutions: Opportunities and Challenges of Atlantic Land and Ocean Sinks

The Intergovernmental Panel on Climate Change (IPCC) uses earth system models to project climate change. These projections inform critical political, social and technological decisions. However, if we cannot accurately model the marine carbon cycle then we cannot truly understand how Earth's climate will respond to different emission scenarios[17].

It is relevant to mention that the ocean holds 60 times more carbon than the atmosphere[18] and acts as a "carbon sink" that absorbs about 31 percent of the CO2 emissions released into the atmosphere, according to a study published by NOAA and international partners in science[19] (including 30 percent of carbon dioxide emissions from human activities). This means the ocean is key to understanding the global carbon cycle and thus our future climate. As atmospheric CO2 levels increase, so do the CO2 levels in the ocean. When CO2 is absorbed by seawater, a series of chemical reactions occur causing the seawater to become more acidic. This phenomenon is commonly referred to as ocean acidification.

Ocean acidification threatens the fundamental chemical balance of ocean and coastal waters across the globe. Therefore, long-term monitoring and scientific analysis of ocean carbon are critical to determine if ocean uptake of CO2 will keep pace with emissions, and how to best anticipate, mitigate, and adapt to potential future changes. Effective stewardship of these important data is also essential.

Current research shows[20] that zooplankton, tiny animals near the base of the ocean food chain, are likely to be the biggest source of uncertainty in how we model the marine carbon cycle. Accurately measuring their impact on the cycle could add an extra 2 billion tons to current models' assumptions about annual carbon uptake by the ocean. That is more carbon than the entire global transportation sector emits.

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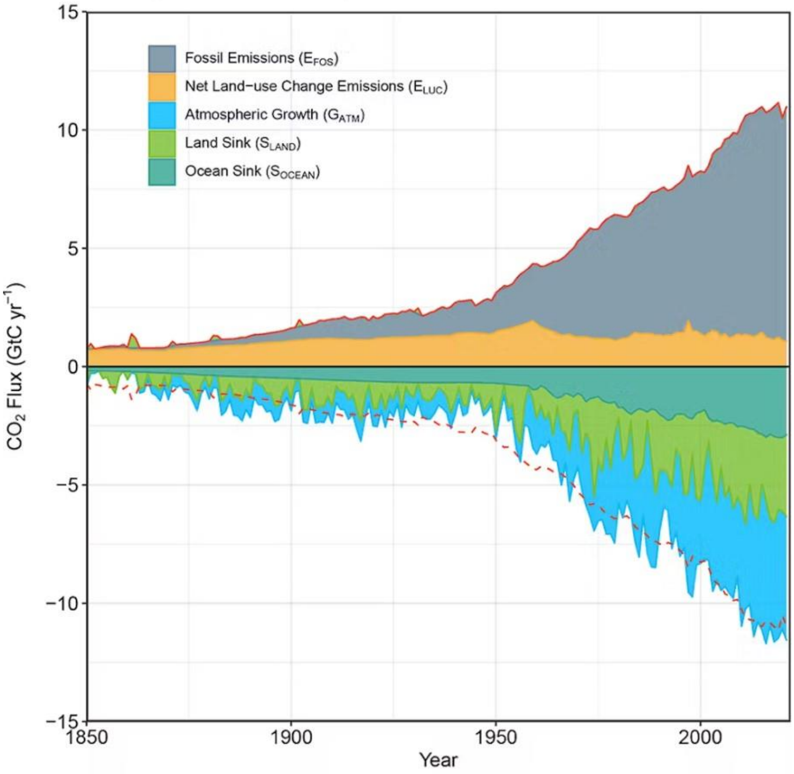
[17] https://www.csiro.au/en/news/All/Articles/2023/June/oceans-absorb-emissions
[18] Ibid.
[19] https://www.ncei.noaa.gov/news/quantifying-ocean-carbon-sink
[20] Zooplankton grazing is the largest source of uncertainty for marine carbon cycling in CMIP6 models Tyler Rohr, Anthony J. Richardson, Andrew Lenton, Matthew A. Chamberlain & Elizabeth H. Shadwick (https://www.nature.com/articles/s43247-023-00871-w)

Figure 16. Carbon Dioxide Sources and Sinks



Source: Global Carbon Budget 2022, Friedlingstein et al, CC BY. Note: the ocean (dark green) is a major carbon sink that partly offsets emissions in the global carbon budget.

Roughly 10 billion tons of carbon are being released into the atmosphere each year. But the ocean quickly absorbs about 3 billion tons of these emissions, leaving our climate cooler and more hospitable. If we price carbon at the rate the IPCC believes is needed to limit warming to 1.5℃, this adds up to over A$3 trillion worth of emission reductions accomplished naturally by the ocean every year.

However, the size of the ocean carbon sink has changed in the past, and even small changes can lead to big changes in the atmosphere's temperature. Thus, we understand the ocean acts as a thermostat for our climate. But what controls the dial? Extensive geological evidence suggests microscopic marine life could be in control. Phytoplankton photosynthesize and consume as much CO_2 as all land plants.

When phytoplankton die, they sink and trap much of their carbon deep in the ocean. It can remain there for centuries to millennia, locked away safely out of contact with the atmosphere.

Any changes to the strength of this biological carbon pump will be felt in the atmosphere and will change our climate. Some have even proposed enhancing this biological pump by artificially fertilizing the ocean with iron to stimulate phytoplankton. It is possible this could sequester as much as an extra 20% of our annual CO_2 emissions.

Taken together, the planet's oceans, forests, soils, and other natural carbon sinks absorb about half of all human emissions. However, as the Earth heats up, scientists are increasingly concerned that those crucial processes are breaking down. *Trees and land absorbed almost no CO_2 in 2023*. Is nature's carbon sink failing? The collapse of carbon sinks has not been factored into climate models – but it could rapidly accelerate global heating[21]. None of these models have factored in losses such as the wildfires in Canada last year that amounted to six months of US fossil emissions[22]. Two years ago, Siberia also lost the same amount of carbon.

In 2023, the hottest year ever recorded, preliminary findings by an international team of researchers show the amount of carbon absorbed by land has temporarily collapsed[23]. The results indicate that forest, plants and soil – as a net category – absorbed almost no carbon. For the ocean-based algae-eating zooplankton, melting sea ice is also exposing them to more sunlight – a shift scientists say could keep them in the ocean depths for longer, disrupting the vertical migration that stores carbon on the ocean floor.

Weaknesses are appearing in the resilience of the Earth's systems. In particular, massive cracks in land/terrestrial ecosystems are causing them to lose their carbon uptake and storage capacities. However, the oceans are now also showing signs of instability[24]. The 2023 breakdown of the land carbon sink could be temporary: without the pressures of drought or wildfires (which provoke forest 'die-back'), land would return to absorbing carbon again. But the 2023 carbon sink breakdown demonstrates the fragility of these ecosystems, with massive implications for the climate crisis.

Reaching net zero is impossible without nature. In the absence of technology that can remove atmospheric carbon on a large scale, the Earth's vast forests, grasslands, peat bogs and oceans are the only option for absorbing human carbon pollution, which reached a record 37.4bn tons of CO2 in 2023. At least 118 countries are relying on the land to meet national climate targets. But rising temperatures, increased extreme weather and droughts are pushing the ecosystems into uncharted territory (e.g., forest die-back).

The kind of rapid land sink collapse seen in 2023 has not been factored into most climate models. If it continues, it raises the prospect of rapid global heating beyond what those models have predicted. Another process which is absent from the climate models is the basic fact that trees die from drought. This is observed and none of the models have drought-induced mortality (forest die-back) in their representation of the land sink. The fact that the models are lacking these factors probably makes them too optimistic.

The flow of carbon through the land and ocean remains one of the least understood parts of climate science. While human emissions are increasingly simple to measure, the sheer number and complexity of processes in the natural world imply that there are important gaps in our understanding.

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[21] https://www.theguardian.com/environment/2024/oct/14/nature-carbon-sink-collapse-global-heating-models-emissions-targets-evidence-aoe
[22] Andrew Watson, University of Exeter.
[23] Piyu Ke, Philippe Ciais, Stephen Sitch, Wei Li, Ana Bastos, Zhu Liu, Yidi Xu, Xiaofan Gui, Jiang Bian, Daniel S. Goll, Yi Xi, Wanjing Li, Michael O'Sullivan, Jeffeson Goncalves de Souza, Pierre Friedlingstein, and Frédéric Chevallier, "Low latency carbon budget analysis reveals a large decline of the land carbon sink in 2023", National Science Review, nwae367, https://doi.org/10.1093/nsr/nwae367, October 22, 2024 (https://academic.oup.com/nsr/advance-article/doi/10.1093/nsr/nwae367/7831648?login=false).
[24] Johan Rockström, Director of the Potsdam Institute for Climate Impact Research; comment at an event during New York Climate Week in September 2024.

The consequences for climate targets are stark. Even a modest weakening of nature's ability to absorb carbon would mean the world would have to make much deeper cuts to greenhouse gas emissions to achieve net zero. The weakening of land sinks – which has so far been regional – also has the effect of cancelling out nations' progress on decarbonization and progress towards climate goals, something that is proving a struggle for many countries.

In Europe, France, Germany, the Czech Republic and Sweden have all experienced significant declines in the amount of carbon absorbed by land, driven by climate-related bark beetle outbreaks, drought and increased tree mortality. Finland, which has the most ambitious carbon neutrality target in the developed world, has seen its once huge land sink vanish in recent years – meaning that despite reducing its emissions across all industries by 43 percent, the country's total emissions have stayed unchanged.
On the other side of the Atlantic Basin, US is not yet experiencing such declines.

The issue of natural sinks has never really been thought about properly in political and government circles. It has been assumed that natural sinks are always going to be with us. The truth is: they are not deeply understood, and they might not always be with us. What happens if out natural sinks, which we have always relied on, stop working because the climate is changing?

In recent years, several estimates have been published on how the world might increase the amount of carbon that its forests and natural ecosystems – including the ocean -- absorb. But many researchers claims the real challenge is protecting the carbon sinks and stores we already have by halting deforestation, cutting emissions, and ensuring that both the land sinks and the oceans are as healthy as possible.

The Intergovernmental Panel on Climate Change (IPCC) uses earth system models to project climate change. These projections inform critical political, social and technological decisions. However, if we can't accurately model the marine carbon cycle then we cannot truly understand how Earth's climate will respond to different emission scenarios[25].

To conclude, there is a need to tackle the large strategic issue: fossil fuel emissions across all sectors. One cannot just assume that unhealthy natural sinks will remove CO2, because they will not work in the long term if neglected.

Pan-Atlantic cooperation should focus on the protection and restoration of Atlantic Ocean carbon sinks (e.g., marine and coastal ecosystems).

Conclusions
In less than 25 years, the global population has grown by approximately 30%, reaching 8 billion people, significantly increasing the number of energy consumers. During this same period, per capita electricity consumption rose by about 50%, while the global economy reduced its energy intensity by 28%, indicating a substantial improvement in energy access worldwide. Despite these advancements, more than 600 million people, particularly in Africa, still lack access to electricity, underscoring the persistent challenges of energy equity and inclusion in the global energy transition.

[25] https://www.csiro.au/en/news/All/Articles/2023/June/oceans-absorb-emissions

The Atlantic Basin represents a critical region in the global energy landscape, characterized by diverse energy systems and significant opportunities for advancing clean energy transitions. Fossil fuels remain the predominant energy source globally, with mitigation strategies insufficient to meet the Paris Agreement's Net Zero Emissions targets. Although the Atlantic Basin accounts for less than 20% of global CO_2 emissions, its strategic position and interdependencies highlight its importance in addressing energy and climate challenges.

Regional energy systems within the basin vary widely. North America is a key fossil fuel producer with increasing investments in renewable energy. Europe leads in renewable integration and nuclear energy deployment, though challenges remain in infrastructure modernization and cross-border cooperation. Africa faces low energy access and heavy reliance on biomass yet possesses untapped renewable potential essential for sustainable development. Central and South America exhibit strong reliance on hydropower and biofuels, with Brazil showcasing notable achievements in clean energy integration, albeit alongside significant emissions from deforestation and land-use changes.

The Atlantic Ocean offers immense potential for renewable energy, particularly offshore wind, which could supply up to 35% of the region's electricity demand by 2050 under ambitious scenarios. However, realizing this potential requires substantial investments in offshore grid infrastructure and hybrid systems to optimize efficiency and emissions reductions. The region's natural carbon sinks, particularly marine and coastal ecosystems, play a pivotal role in mitigating climate impacts by absorbing approximately 31% of anthropogenic CO_2 emissions. Yet, these systems face increasing threats from ocean acidification and ecosystem degradation, necessitating enhanced monitoring, restoration, and protection efforts.

Strategic pan-Atlantic cooperation is essential to harmonize energy production, trade, and decarbonization objectives. Collaborative policies must address regulatory, financial, and ecological challenges while leveraging the basin's unique resources and interdependencies. A balanced approach is required to align fossil fuel production with renewable energy goals, ensuring the sustainability of energy systems and the preservation of critical carbon sinks. Through coordinated efforts, the Atlantic Basin has the potential to lead in global sustainability and contribute significantly to achieving long-term climate and energy targets.