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OFFSHORE WIND ROADMAP FOR COLOMBIA

Final Report

WORLD BANK GROUP

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CONTENTS

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This roadmap was commissioned and supervised by Mark Leybourne (Senior Energy Specialist, World Bank), Claudia Ines Vasquez Suarez (Senior Energy Economist, World Bank), and Roberto Luis Estevez Magnasco (Energy Specialist, World Bank).

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B LIST OF FIGURES

C ACRONYMS AND ABBREVIATIONS

AICA	Área Importante para la Conservación de las Aves
ANH	Agencia Nacional de Hidrocarburos
ANI	Agencia Nacional de Infraestructura
ANLA	Autoridad Nacional de Licencias Ambientales
AoI	Area of Interest
ASB	Áreas Significativas para la Biodiversidad
AUNAP	Autoridad Nacional de Acuicultura y Pesca
CBD	Convention on Biological Diversity
CFD	Contracts for Difference
COD	Commercial Operations Date
CRA	Corporación Autónoma del Atlántico
CREG	Comisión de Regulación de Energía y Gas
DANCP	Dirección de la Autoridad Nacional de Consulta Previa
DANE	Departamento Administrativo Nacional de Estadística
DFI	Development Finance Institution
DIMAR	Dirección General Marítima
E&P	Exploration and Production
EBSA	Ecologically or Biologically Significant Area
ECA	Export Credit Agency
EEZ	Exclusive Economic Zone
ERM	Environmental Resources Management
ESF	Environmental and Social Framework
ESIA	Environmental and Social Impact Assessment
ESMAP	Energy Sector Management Assistance Program

ESS	environmental and social standards
FENOGE	Fondo de Energías No Convencionales y Gestión Eficiente de la Energía
FIT	Feed-In Tariffs
FNCER	Fuentes No Convencionales de Energía Renovable
FOW	Floating Offshore Wind
FPIC	Free, Prior and Informed Consent
FTE	Full Time Employee
GBS	Gravity Base Structure
GEBCO	General Bathymetric Chart of the Oceans
GHG	Greenhouse Gas
GIIP	Good International Industry Practice
GWA	Global Wind Atlas
GWO	Global Wind Organization
HSE	Health, Safety and Environment
IBA	Important Bird Areas
ICANH	Instituto Colombiano de Antropología e Historia
IFC	International Finance Corporation
IFI	International Financial Institution
IMF	International Monetary Fund
INVEMAR	Instituto de Investigaciones Marinas y Costeras
IRA	Internationally Recognized Areas
IRENA	International Renewable Energy Agency
IUCN	International Union for Conservation of Nature
KBA	Key Biodiversity Areas
LCOE	Levelized Cost of Electricity
LPA	Legally Protected Areas
MADS	Ministerio de Ambiente y Desarrollo Sostenible

MME	Ministerio de Minas y Energía
MSP	Marine spatial planning
NCF	Net Capacity Factor
NCRE	Non-Conventional Renewable Energy
NEP	National Energy Plan
O&M	Operations and Maintenance
OEF	Obligaciones de Energía Firme
OEM	Original Equipment Manufacturers
OSS	Offshore Substations
OWF	Offshore Wind Farm
PNN	Parques Nacionales Naturales
PPA	Power Purchase Agreement
PS	Performance Standards
RAG	Red, Amber, Green
RCG	The Renewables Consulting Group
REMAC	Reglamento Marítimo Colombiano
SER	Association de 15nergías Renovables de Colombia
SINAP	Sistema Nacional de Áreas Protegidas
SNSM	Sierra Nevada de Santa Marta
SOV	Service Operations Vessel
SPRB	Sociedad Portuaria Regional de Barranquilla
SPRG	Sociedad Portuaria Regional de Cartagena
SPSM	Sociedad Portuaria de Santa Marta
STN	Sistema de Transmisión Nacional
TEA	Technical Evaluation
TLP	Tension Leg Platform
ToR	Terms of Reference
TP	Transition Piece

UNESCO	United Nations Educational, Scientific and Cultural Organization
UPME	Unidad de Planeación Minero Energética
UXO	Unexploded ordnance
WACC	Weighted Average Cost of Capital
WBG	World Bank Group
WEC	World Energy Council
WTG	Wind Turbine Generator

1 INTRODUCTION

The World Bank Group (WBG) launched a global initiative on offshore wind in 2019 with the objective of supporting the inclusion of offshore wind into the energy sector policies and strategies in emerging markets. This report is one of a series of offshore wind roadmap studies commissioned by the World Bank Group under the joint Energy Sector Management Assistance Program (ESMAP)- International Finance Corporation (IFC) Offshore Wind Development Program.

This Roadmap considers the potential role that offshore wind power can play in Colombia's medium and long-term energy sector development. It highlights key challenges and opportunities and provides recommendations on next steps in terms of policy formulation, planning, and development bankable projects. Two potential deployment scenarios (High and Low) have been envisioned, covering a reasonable breadth of the possible routes forward for Colombia and serve as basis for the underpinning analyses. The purpose of the scenarios is to be able to consider the effect of industry scale on cost, consumer benefit, environmental and social considerations, economic benefit and other aspects in a quantifiable way. The scenarios were not established (and have not been tested) through deep energy system modelling, which is recommended in due course

Colombia's Caribbean coastline has abundant offshore wind resources and a total technical resource potential estimated at 109 GW of offshore wind power. When considering various key environmental, social and technical constraints and drivers, the analysis reveals that there are development exploration areas approximately of 50 GW in accumulated potential (see section 4.3.7). Estimated Net Capacity Factors (NCFs) for representative project sites, which is how much electricity these could produce compared to their theoretical full potential, approach 70% - particularly in the east of La Guajira - and are among the highest in the world.

Report Structure

- Section 2: Describes the two potential offshore wind deployment scenarios used in this study
- Section 3: States the recommended actions to deliver either of these two deployment scenarios

Supporting information

- Section 4 - onwards: Provides the analysis and findings that support the recommendations and roadmap for delivering offshore wind in Colombia.

2 TWO SCENARIOS FOR OFFSHORE WIND IN COLOMBIA

2.1 Context

2.1.1 The energy trilemma

Colombia currently faces a challenge in addressing its own energy trilemma:

- **Security:** Energy security is a critical issue for any country, and whilst approximately 67% of Colombia's electricity is produced from its own hydro resources[1], over-reliance on a single energy source exposes the country to potential energy security concerns with seasonal or weather shocks. More diversity in the electricity supply is needed to increase the overall security of supply.
- **Sustainability:** In general, Colombia's use of hydro resources means that the country is in a better position than others with respect to the carbon emissions of its sources of electricity. However, to meet its updated NDC targets and implement its carbon neutrality targets by 2050, Colombia will have to develop aggressively low-carbon electricity generation. According to the findings of the "Colombia Long-term Climate Strategy E2050 to Meet the Paris Agreement"[2], electricity use across all end-use sectors would have to at least double by 2050. This will create substantial challenges and opportunities to diversify the energy mix and develop alternative non-conventional renewable generation capacity. (Section 12.5.4).
- **Equity:** The population of Colombia has excellent access to electricity with 99.77% of people having access to a basic electricity source[3]. However, electricity pricing is the main challenge going forward. Ensuring electricity pricing remains stable and affordable will be critical. Again, over-exposure to single sources of electricity can be counter-productive to stable pricing, and the potential

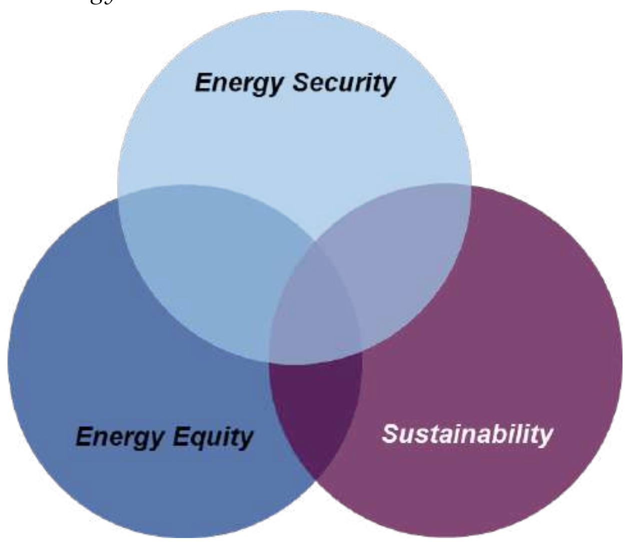
[1] Our World in Data based on BP Statistical Review of World Energy & Ember (2021); https://ourworldindata.org/energy/country/colombia

[2] Gobierno de Colombia. (2021). Estrategia climática de largo plazo de Colombia E2050 para cumplir con el Acuerdo de París. MinAmbiente, DNP, Cancillería, AFD, Expertise France, WRI: Bogotá.

[3] Our World in Data based on World Bank; https://ourworldindata.org/energy/country/colombia

increase in coal and gas power predicted will also lead to a greater exposure to global commodity pricing.

Exhibit 1 Energy trilemma



Source: RCG adapted from World Energy Council (WEC)

2.1.2 The role of offshore wind

Offshore wind has the potential to address all aspects of the energy trilemma faced by Colombia now, over the next 30 years and beyond. Offshore wind has the potential to add diversity into the energy system, at large-scale. While offshore wind can be exposed to its own seasonality (11.1.2.2) and weather-related risks, these will generally be different to those faced by other conventional renewable energy solutions such as hydroelectricity, thus increasing system reliability. Furthermore, when coupled with emerging long-term energy storage solutions such as hydrogen, exposure to these risks can be reduced further (2.2.1.1).

Offshore wind farms are located at sea, and whilst there are environmental and social risks associated with this, these should be lower than has been experienced so far in Colombia with onshore wind and hydropower, the application of well-defined Marine Spatial Planning (MSPs) and Permitting practices – especially when considering risks related to indigenous communities (6.3 and 10.4).

The cost of offshore wind is also falling, with significant benefits from large-scale deployment in mature markets such as Northern Europe now being felt globally. Indications from competitive bidding in new and emerging markets has already shown that initial costs in these markets will be lower than the earliest offshore wind markets but will also align closely to global prices for offshore wind relatively quickly, if deployed at scale and with clear policy frameworks in place. The wind resource and infrastructure in Colombia show all the right signs for a scaled-up offshore wind market to reach these competitive levels relatively quickly too (7.3, 8.3, 11.1).

Finally, offshore wind is the only technology that can efficiently and quickly displace and complement conventional large-scale generation. Offshore wind turbines are much larger in scale than onshore wind turbines, and therefore fewer are needed to meet the same demand. Coupled with higher capacity factors in the offshore environment and the excellent wind resource in Colombia's Caribbean coastline (11.1.2.2), offshore wind farms are much closer to large baseload power stations.

2.1.3 Deployment scenarios

Therefore, two potential deployment scenarios have been envisioned for Colombia's offshore wind industry:

- The **"Low" Scenario** represents a hands-off approach from the government – offshore wind is not incentivized, and the majority of renewables growth comes from other technologies. In this scenario, many challenges of the energy trilemma described earlier are unlikely to be solved by offshore wind and Colombia would need to turn to other technologies to provide a solution.
- The **"High" Scenario** represents an achievable, but accelerated growth in the development of offshore wind, where the government has followed some of the key recommendations in this report and offshore wind has been targeted as a technology to support its renewables ambitions. In this scenario, by 2050 many of the current challenges of the energy trilemma faced by Colombia are addressed by large-scale deployment of offshore wind.

2.2 Two Potential Deployment Scenarios for Colombia

The following section provides a more detailed description of the two deployment scenarios. It should be noted that these scenarios are not prescriptive pathways, nor recommended policy guidance, but rather are intended to support initial assessment of procurement pathways, volumes, and options. Building from this roadmap report, additional analysis, policy decision making, and integrated resource planning is required to design and structure the low-carbon energy pathway that is most beneficial for Colombia. Actual volumes of offshore wind installed may differ substantially from the scenarios evaluated in this section, both in terms of overall quantum and phasing across future decades.

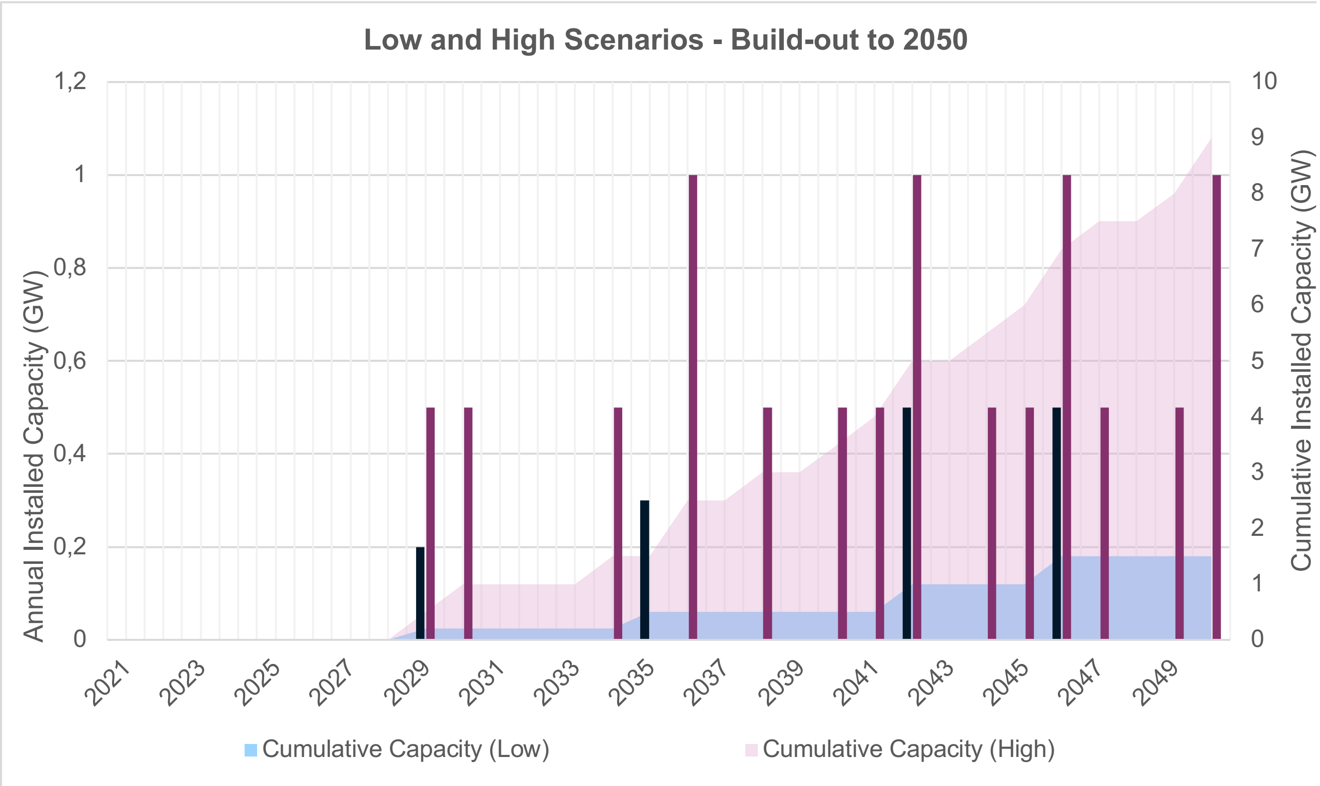
In particular, it is worth stating that the "High" scenario should not be seen as a ceiling. Should the government and other actors follow the recommendations in this report, there is potential for offshore wind to exceed this scenario.

The principal characteristics of the discussion scenarios outlined in this section are:

1. **“Low” Scenario:** The low case scenario assumes that offshore wind is developed and procured in specific situations on an individual, ‘one-off’ basis, at smaller project sizes (e.g. <500MW) and without specific establishment of a forward-looking national strategy and procurement program specific to offshore wind. The Low scenario is presumed to be achievable without a dedicated transmission expansion plan, leveraging both assumed business-as-usual reinforcements over the period and concentrating deployment closer to the load centers of Cartagena, Barranquilla, and Santa Marta.
    a. The low scenario envisions 200 MW by 2030, 500 MW by 2040, and 1.5 GW by 2050, on a cumulative basis.

2. **“High” Scenario**: The high case scenario assumes that offshore wind is developed on a commercial scale (including projects at the 1GW level) through a dedicated technology-specific procurement program. To achieve the 2030 target, additional transmission upgrades and projects, currently under consideration, will need to be evaluated and implemented. To achieve the significant volumes in the 2030-40, and especially 2040-50 period, a significant program will need to be undertaken to build the necessary transmission capacity.
    a. The high scenario envisions 1 GW by 2030, 3 GW by 2040, and 9 GW by 2050, on a cumulative basis.

Exhibit 2 Installation rate for buildout scenarios



Source: Author's analysis. N.B. Chart represents an indicative build-out for each of the low and high scenarios and actual installed capacity may be more variable depending on project sizes and market conditions.

2.2.1 Methodology - Capacity Volumes

Unlike integrated resource plans, including those developed and modeled by the Unidad de Planeación Minero Energética (UPME) and the Ministerio de Minas y Energía (MME or Minenergía) in the National Energy Plan (NEP), this roadmap report does not perform a dynamic evaluation of economic dispatch, but rather suggests ranges and rates of offshore wind capacity deployment, within the context of a complete characterization of the most likely and unconstrained development areas (see section 4) and the probable levels of effort required to inject volumes of offshore wind energy adjacent to these locations.

One of the most challenging constraints to commercial-scale offshore wind power deployment in Colombia, is the limited availability of high-voltage transmission capacity near the most important wind resource areas near Guajira and Magdalena.

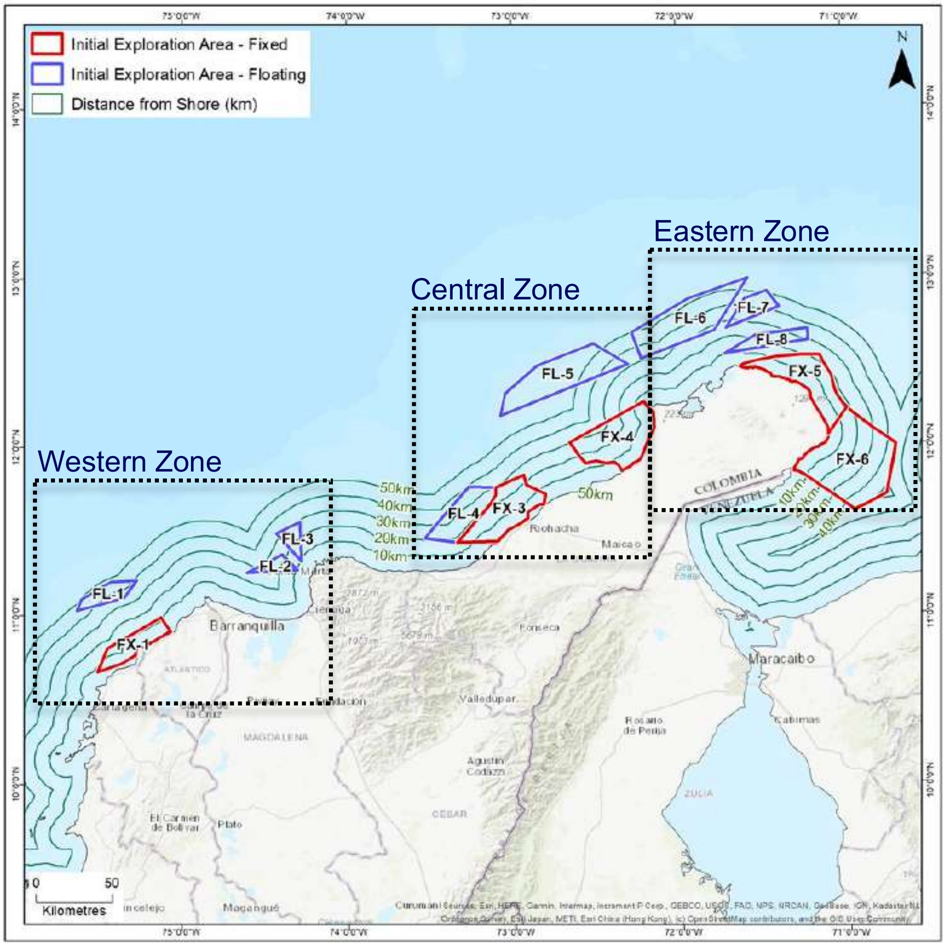
During stakeholder engagements in 2021, UPME informed that very limited existing capacity is available, and there are no locations in the Costa-Caribe region, where the wind resource is, that presently can accept commercial scale injection volumes. Over the medium term, this problem can be ameliorated by building new high voltage transmission, most likely overland and using existing right-of-ways. As part of UPME's expansion plans, two new 500kV substations (Colectora 2 and 3) are considered for 2027, which will be interconnecting the Alta Guajira with central Colombia through a HVDC line, effectively unlocking renewable project deployment in this Eastern region[4]. To unlock the high levels of offshore wind capacity envisioned in the high case scenario especially, major dedicated investments in transmission are expected to be required.

2.2.1.1 Exploration Area Definition

A holistic offshore data collection and characterization process was undertaken to identify technically attractive exploration zones that avoid major hard constraints, such as offshore marine traffic (see further discussion in section 4).

[4] UPME PLAN DE EXPANSIÓN DE REFERENCIA GENERACIÓN – TRANSMISIÓN 2017 – 2031 https://www1.upme.gov.co/Energia_electrica/Plan_Preliminar_Expansion_RGT_2017_2031.pdf

Exhibit 3 Initial Exploration Areas for Fixed and Floating Offshore Wind (Red = Fixed, Blue = Floating)



Source: Author's analysis

*Disclaimer: The borders, colors, denominations and any other information on this map do not imply a judgment on the legal status of any territory or the endorsement or acceptance of such borders.

Given the transmission limitations, projects in the Low Scenario are expected to be in modest sizes of 200-500MW to avoid the need for major transmission improvements. In the Eastern Zone, particularly at the eastern end of La Guajira, there is tremendous development potential for fixed foundation wind, which includes much more than was included in the High Scenario. Like other large-scale onshore renewables in this area, new construction of high voltage transmission lines is required to unlock this resource.

Energy storage could be used onshore, to reduce curtailment and transmission upgrade requirements, though this was not considered in the costing and in almost any case it is typical and expected that some local upgrades will be necessary. Additionally, electricity generation from an offshore wind farm can be used to produce green hydrogen. This potential route to market, combined with the shared use of infrastructure for both technologies, lead to interesting synergies with the recently approved Hydrogen Roadmap for Colombia[5] that will need to be assessed. While this study does not consider the use of offshore wind energy for hydrogen production, this may be another viable use for the energy potential in this region.

2.3 Low Scenario

The Low Scenario assumes that offshore wind is developed in specific situations and no clear, technology specific procurement program is established.

By 2030, it is assumed that one 200MW fixed-foundation project reaches commercial operation proximate to load.

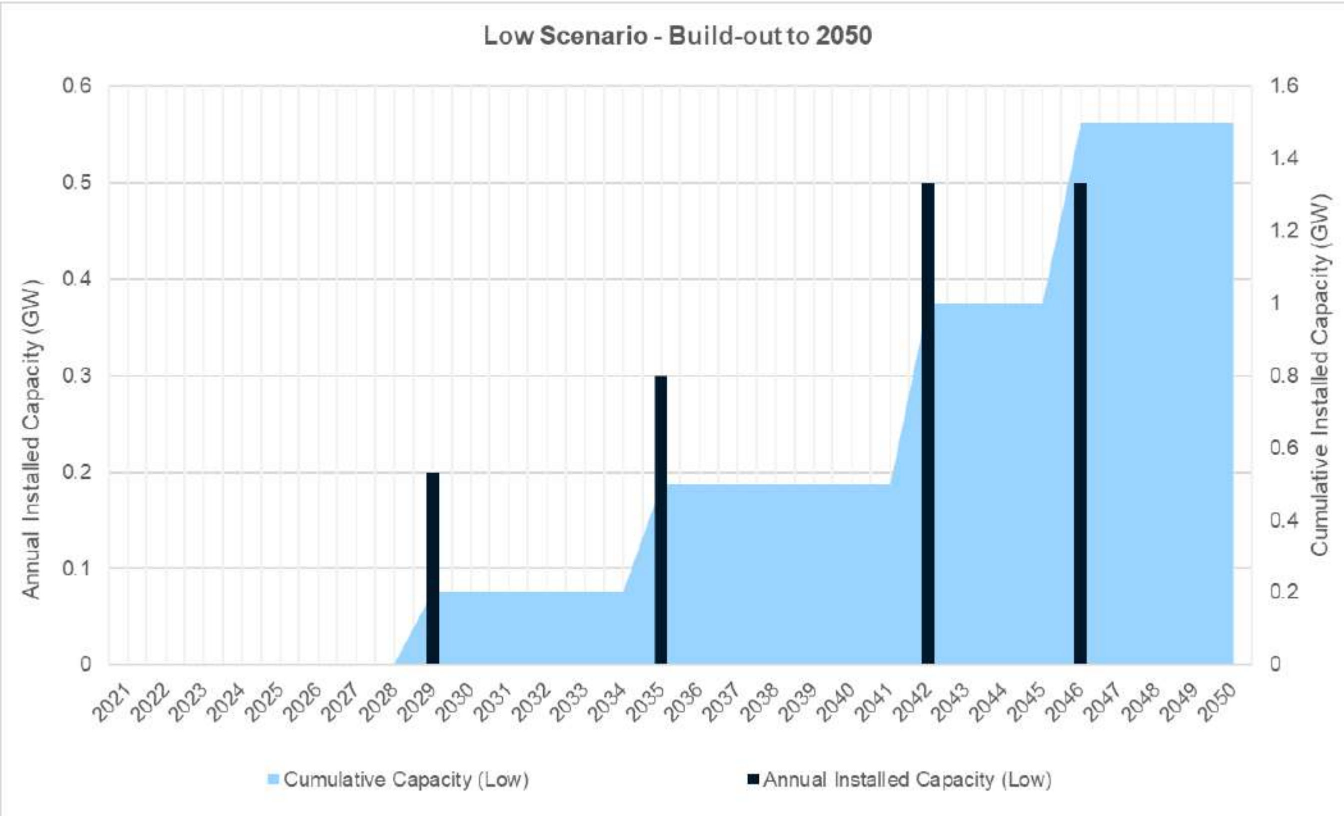
By 2040, it is assumed that an additional project of similar size will be developed near the load centers and without major transmission improvements (such as the construction of new major high-voltage lines).

By 2050, two additional larger projects are assumed to be developed without major transmission upgrades, assuming additional capacities are available during this time period. This project may interconnect in the Central Zone or Eastern Zone.

The exhibit below shows how this build-out scenario may play out in reality for installation schedules. Given the small scale of projects (cap of 500 MW) it is expected that each project can be installed in a single season. Given the lack of significant increase in projects in this scenario, the buildout is highly sporadic with no consistent buildout or gradual increase in installed capacity over time.

[5] Hoja de ruta del hidrógeno en Colombia, Minenergía 2021 https://www.minenergia.gov.co/documents/10192/24302627/Hoja+de+Ruta+H2+Colombia_Borrador.pdf

Exhibit 4 Installation rate for Low scenario



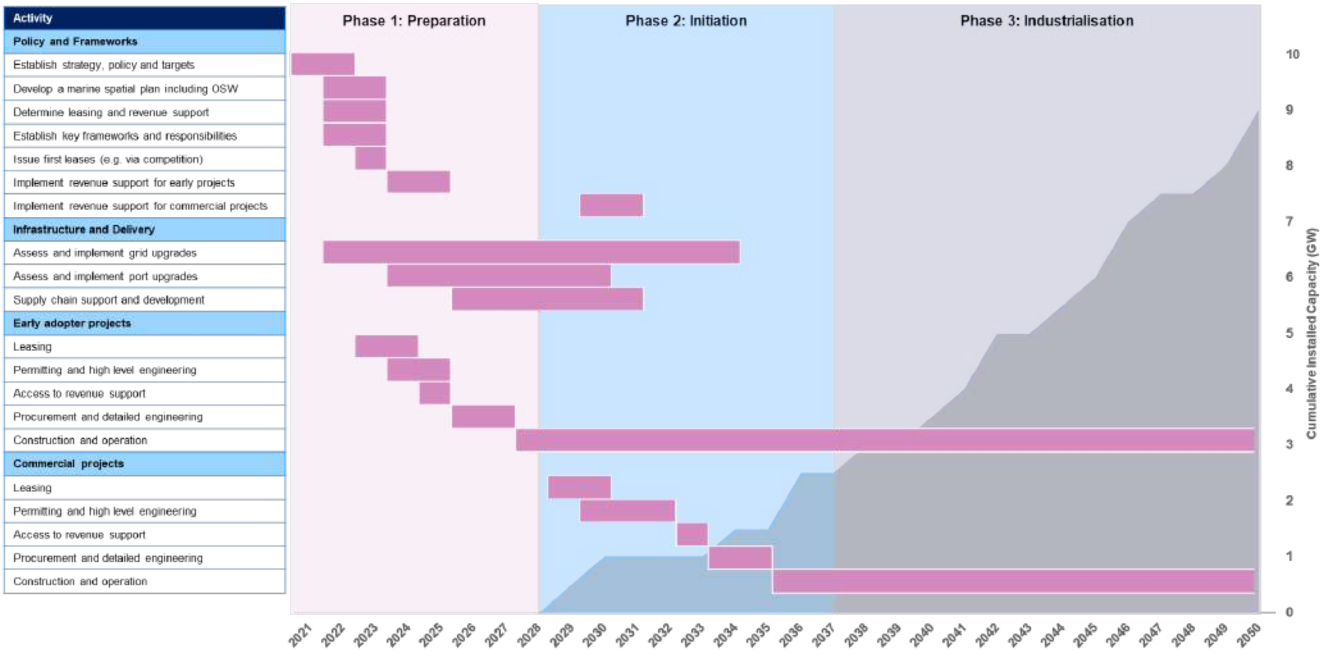
Source: Author's analysis. N.B. Chart represents and indicative build-out for the low scenario and actual installed capacity may be more variable depending on project sizes and market conditions.

2.4 High Scenario

The High Scenario assumes that offshore wind is developed on a commercial scale through a dedicated technology-specific tender. To achieve significant volumes in the 2040-2050 period, it is assumed that a major program is undertaken to build the necessary transmission capacity.

Exhibit 5 Policy implementation and development timeline for the High scenarioExhibit 5 shows the potential timeline for policy implementation and project development that would be required to fulfil the High scenario. This demonstrates the need for the 'building blocks' to be established prior to both early adopter projects and commercial projects developing in an efficient and timely manner. Development timelines of approximately 7-10 years are generally achievable for nascent markets.

Exhibit 5 Policy implementation and development timeline for the High scenario



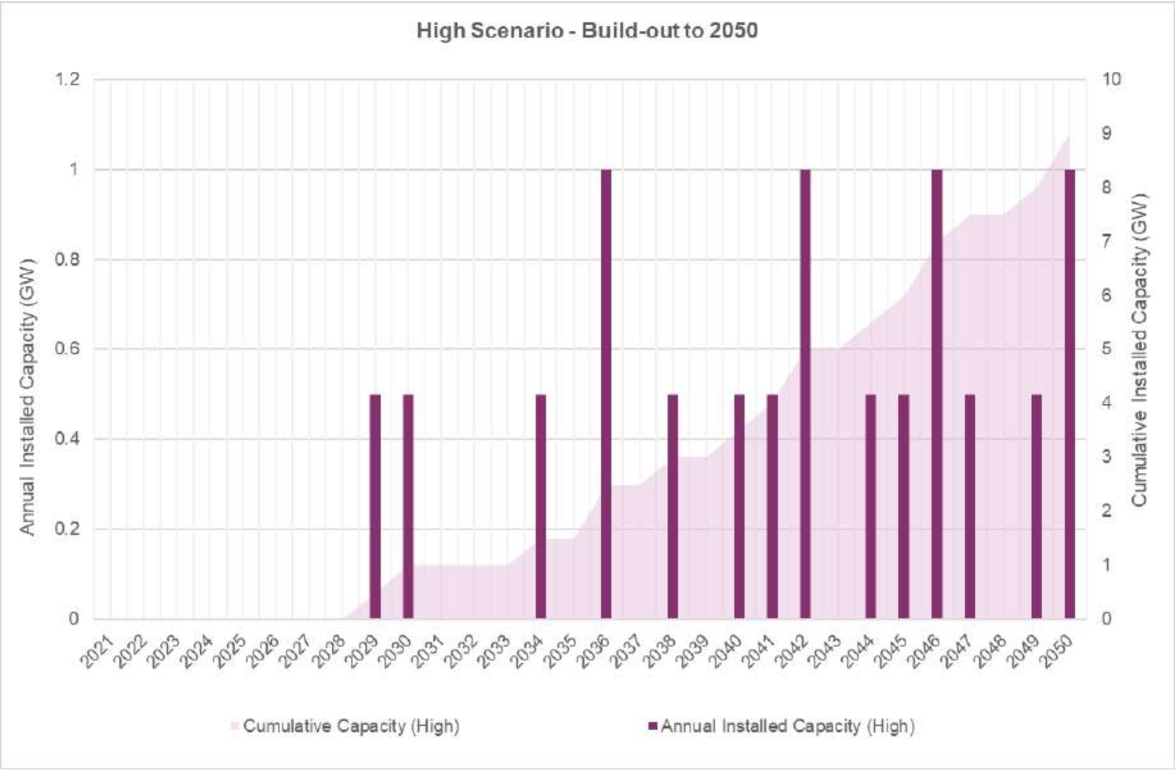
In 2030, the capacity is increased vs. the low-case scenario from 200 MW to 1 GW, indicating a larger first single project or a second medium sized project.

By 2040, 3 GW are achieved under the assumption that one large commercial-scale project (1 GW) and two smaller projects (0.5 GW), or a similar combination, achieve a commercial operation. Dedicated transmission upgrades will be required.

By 2050, the target increases by 6GW to 9GW in total. This substantial increase assumes that a significant procurement program is pursued, requiring coordinated transmission development, with possibly more floating projects connected through radial lines in the western and central zones.

The exhibit below shows how this build-out scenario may play out in reality for installation schedules. The key difference between the low scenario and the high scenario on installation rate, is that by the middle of the 2030s, enough momentum will have been established in the market to enable a more consistent installation rate, with potential for a peak by 2050.

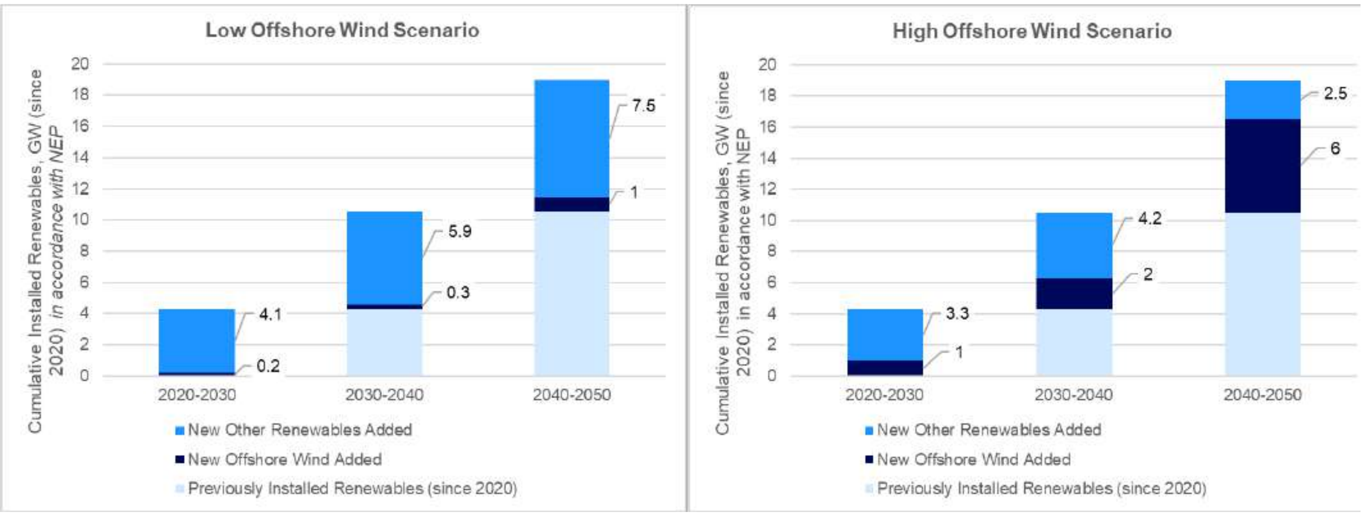
Exhibit 6 Installation rate for High scenario



N.B. Chart represents and indicative build-out for the high scenario and actual installed capacity may be more variable depending on project sizes and market conditions.

Exhibit 7 below presents the High and Low scenarios in the context of the 2020-2050 National Energy Plan. With a 19 GW target for non-hydro renewable sources by 2050 (see section 12.5.5), the charts show how offshore wind can contribute to this target and the intermediate steps in between, as well as showing the amount of other renewables would need to be installed each decade. The Low scenario shows that 5.9 GW and 7.5 GW of other renewables would need to be installed in Colombia in 2030-2040 and 2040-2050 respectively, if the 19 GW target set out in the National Energy Plan is to be achieved. The High scenario shows that offshore wind can provide the vast majority of new renewables added to the network by 2050, with only 4.2 GW and 2.5 GW of other renewables required in 2030-40 and 2040-2050 respectively. The purpose of Exhibit 7 is to simply contextualize the scenarios within the NEP targets, hence no economic analyses have been carried out to prioritize offshore wind over other sources such as onshore wind or solar PV. This will be part of section 3. Recommendations.

Exhibit 7 Low and High scenarios in the context of the NEP



Source: Author's analysis and *National Energy Plan 2020-2050*, UPME & Minenergía. Note: Each decade represents the cumulative, total forecasted installed capacity of renewable energy resources (non-hydro) according to the NEP.

2.5 Potential Implications of the Scenarios

A summary of the potential implications of the scenarios is provided below.

2.5.1 Local Supply Chain & Industry

The growth of a local supply chain will be highly dependent on policy commitments and the overall outlook for market volume. A project pipeline of multiple gigawatts is typically required to attract the type of substantial capital investment needed for state-of-the-art local supply chains that can deliver components cost-competitively.

Considering the analyses developed along sections 7, 8 and 11, the growth scenarios' impact on a supply chain in Colombia:

- **A Low growth scenario** would be insufficient to mobilize private-sector capital investment in local facilities or infrastructure for major tier-1 components, such as foundations and wind turbine blades or towers.
  - Major offshore wind components and contracts would continue to be sourced from abroad.
  - Local facilities and coastal infrastructure, such as the Port of Cartagena and Port of Barranquilla, could be used for staging and marshalling of components in this scenario.

  - Certain structures such as onshore substations and secondary steel for foundations, may also be provided by local companies. However, the bulk of components and major contracts would be sourced from abroad.
  - The analyses in section 11.2.3.1 estimate an impact of ~300 FTE years by 2030 and increasing to ~1,500 in 2050 as additional capacity is developed in the final decade. For gross economic output in Colombia, the analysis estimates ~$25 Million USD $2021 by 2030 and ~$130 Million USD $2021 by 2050.
  - The industry in Colombia would not drive the global supply chain, thus new projects would likely have to use opportunism, such as windows in construction schedules of available heavy-lift vessels to define their own construction schedule.
- **A High growth scenario**, where the market volume is anticipated to reach multiple gigawatts, should provide enough volume to organically encourage further supply chain investments for local manufacture of major components by 2050.
  - To deliver greater capacity volumes, it is anticipated that dedicated port upgrades will be required to expand staging and pre-assembly capacity.
  - However, location of major Tier 1 component manufacturing facilities in Colombia is not certain even under the high growth scenario and may require further incentive or requirement from the government during procurement/auctions, or regional market development in nearby countries outside of Colombia’s control.
  - If a build-out rate of one commercial size (500 MW+) project per year could be achieved from 2030 onwards, this could justify investment in specialist vessels dedicated to the Colombian market.
  - The analyses in section 11.2.3.1 estimate an impact of ~1,000 FTE years by 2030 and increasing to ~26,000 in 2050 as significant additional capacity is developed in the final decade. For gross economic output in Colombia, the analysis estimates ~$100 Million USD $2021 by 2030 and ~$3 Billion USD $2021 by 2050.
  - By this time, it could also be anticipated that other offshore wind markets in the region would be maturing, and in the High scenario Colombia could be a key part of a regional supply chain hub.

2.5.2 Local Environment & Society

Offshore wind has implications for biodiversity, ecosystem services, and on socioeconomic receptors[6]. However, with well-designed pre-feasibility and permitting policies, these projects can coexist with environment and society without creating unacceptable environmental harm or social disruption. This has been proven in active and planned developments globally and further research is ongoing, such as the Offshore Wind Evidence and Change program[7] by The Crown Estate, UK. A prudent development program that adequately considers these factors, potential mitigations, and consults with stakeholders of all kinds, is required to ensure optimal outcomes and reduce potential impacts. Such a program can take several years to effectively design and implement and so should be started early. See Section 6 for further detail.

- The **Low growth scenario** could be envisioned if this program is not effectively designed and thus permitting of offshore wind is slow, high risk and costly – deterring investors.
  - In the low growth scenario, Colombia's renewable energy must come from other sources which may come with other environmental impacts (e.g. additional use of land and natural resources, impacts on indigenous communities, greater impact on terrestrial ecology).
  - By 2050, it can be anticipated that offshore wind, especially in the areas selected in Colombia due to their extremely high wind speeds, would be a highly competitive technology. In the low growth scenario, the full potential for cost reduction would also not be realized as cost efficiencies on scale in the region cannot be sought. Therefore, there would be a commensurate negative impact on the cost of electricity to consumers.
  - In the low growth scenario, increased reliance on other conventional generation may be required – if so, the diversity of energy supply will not have been sufficiently addressed and energy security risks due to resource scarcity or weather events may also be increased.
- The **High growth scenario** could be envisioned if an effective permitting and regulatory framework is established to encourage and facilitate efficient approvals of major offshore wind projects.
  - In this scenario a specific offshore wind or marine renewable energy framework is established by the end of this decade, to help facilitate the development of at least 500 MW of projects per year by the start of the 2030s.

[6] Key Factors for Successful Development of Offshore Wind in Emerging Markets (English). Washington, D.C.: World Bank Group. http://documents.worldbank.org/curated/en/343861632842395836/Key-Factors-for-Successful-Development-of-Offshore-Wind-in-Emerging-Markets

[7] https://www.thecrownestate.co.uk/en-gb/what-we-do/on-the-seabed/offshore-wind-evidence-and-change-programme/

- The development of 9 GW of offshore wind projects in the highest wind speed areas, will lead to both global and local cost reduction benefits, with buildout sufficient for regional economies of scale to take effect. In this scenario, offshore wind is therefore deemed a potentially cost-effective renewable energy solutions for the region with a LCoE of 53 USD/MWh already expected by 2040 (see section 11.1.3.2).
- In the high growth scenario, significant diversification of Colombia's electricity supply will have been achieved – with hydropower, other renewables such as onshore wind and solar, and offshore wind all contributing to the overall mix. This would have the effect of improving energy security and resilience to major weather events.
- Given the increase in space required in the marine environment for this buildout scenario, there will be a higher risk of marine environmental impacts such as those to seabirds or marine mammals. An effective MSP and permitting scheme will ensure these are adequately assessed and mitigated.

3 RECOMMENDATIONS

3.1 Introduction

This section provides initial recommendations for Colombia to develop a successful offshore wind industry. A list of 34 recommendations, organized in eight themes, are presented below. These are based on the analyses developed from Section 4 onwards, engagements with public and private sector and international case studies from the WBG report "Key Factors for Successful Development of Offshore Wind in Emerging Markets"[8]. These suggestions are not exhaustive nor prescriptive, and broadly cover market-building and de-risking themes. Further consideration, analysis, stakeholder consultation, and policy decision making are required to develop an ideal pathway for offshore wind in Colombia.

Exhibit 8 Themes for the Recommendations

Source: RCG-ERM

[8] Washington, D.C. : World Bank/ESMAP/IFC. http://documents.worldbank.org/curated/en/343861632842395836/Key-Factors-for-Successful-Development-of-Offshore-Wind-in-Emerging-Markets

3.2 Recommendations

Vision and Volume targets

1. UPME to undertake **generation planning** to provide the indicative volumes and timeline for offshore wind capacity as part of their next iteration of the indicative generation expansion plan and the transmission expansion plan as discussed in section 10.5. It is crucial to understand the role for offshore wind in the country's future energy mix to help meet local demand and electrify the economy.

2. MME to establish offshore wind **vision and capacity targets** towards 2030 and 2040, guided by the scenarios and potentials discussed on this roadmap (sections 2 and 4) and also UPME's next iteration of indicative generation plan mentioned above.

3. Government engagement and outreach to/with international offshore community to provide orientation to local practices and encourage interest in the market.

Planning, Leasing and Permitting

4. MinInterior to initiate stakeholder engagements e.g. roundtable discussions and working groups to establish open dialogues with communities that will be impacted by the development of the offshore wind industry in Colombia. Identified groups would be, among others, the ICANH, Organización Nacional Indígena de Colombia, AUNAP and the Dirección de Intereses Marítimos y Fluviales de la Armada Nacional.

5. DIMAR to lead the review of the Plan de Ordenamiento Marino Costero, Government-led **Marine Spatial Planning** (MSP), to analyze the compatibility of commercial offshore wind deployment with other sea users. So as not to delay the market, the MSP shall be pragmatic and proportionate. As a result, the MSPs shall publish priority areas for offshore wind deployment, which can serve as basis for the Seabed Leasing process and reduce permitting risks down the line. This is a comprehensive procedure that requires consultation with relevant stakeholders and coordination with the relevant authorities with knowledge about the other activities in the sea i.e. MME, ANH, MADS, INVEMAR, ICAHN , AUNAP, DAMCRA, MinInterior, etc to ensure safe coexistence. Reference is made to the Marine Spatial Plans being carried out by EU member states as per the Directive 2014/89/EU.

6. Identify **priority areas** for commercial offshore wind deployment in Colombia, guided by technical, environmental and social considerations in line with section 4 and aligned with the MSPs. This work can be led by the UPME and shall require a coordinated approach across several institutions, i.e. MME, MADS, DIMAR, INVEMAR, ICAHN , AUNAP, DAMCRA, MinInterior and the electrical sector.

7. ANLA to include the identified priority areas for commercial offshore wind deployment in the **Regionalización** exercise to understand their characterization requirements and also be able to support future evaluation teams once project plans materialize in these areas.

8. Mapping of **protected landscapes** is recommended to assist evaluating visual impact by the MinCultura and MADS with the support of research institutes and in consultation with local communities as discussed in section 6.3.3.5.

9. ANLA and MADS to publish general **Terms of Reference** (ToR) for the development of the environmental and social impact studies (ESIA) for offshore wind projects. Environmental and Social considerations in section 6, combined with learnings from onshore wind and offshore O&G project development in Colombia, are advised to be included. Additionally, a thorough gap assessment between current ToR for onshore wind energy and Performance Standards by the International Finance Corporation (IFC) is recommended, which can build on the high-level review developed in section 10.3.2.1.

10. A **pre-qualification standard** is recommended prior to initiation of a Seabed Leasing competition for the interested developers (see section 10.4). Qualifying criteria will be established for the screening of companies that have the technical and / or financial capabilities and will prevent speculative projects. This will also encourage partnership between local and international players to create the necessary capacities. Examples can be drawn from the UK Round 4 managed by The Crown Estate[9] and the US Federal Lease Auctions managed by the Bureau of Ocean Energy Management[10] (BOEM).

11. DIMAR to define and administer the **Seabed Leasing** process, which shall be coordinated with the MME and UPME and shall award leases as part of a

[9] https://www.thecrownestate.co.uk/media/3321/tce-r4-information-memorandum.pdf (pages 22 and 23)

[10] https://www.boem.gov/sites/default/files/documents/about-boem/Qualification%20Guidelines.pdf

competitive process. Developers require certainty that if they develop a site to consent, and then secure a power purchase agreement, that they can proceed to build the project. The certainty is provided by an option agreement, which grants exclusive development rights. Then once a final investment decision has been reached the developer can exercise its option to enter into a lease agreement. Rules that manage competition and terms of lease shall be published and, among others, considerations about potential area overlaps across competitors are to be clarified. Best practices can be adapted from leasing bodies in other markets. For example, good practice was in early market development in the UK, in Round 2 and updated for the Northern Ireland tender, both of which tested developer's capability and commitment. It used a scoring rubric with approx. 80 questions, each question had 5 scoring levels and % weighting to give a total score of capability and commitment. Where projects overlapped, that with the higher score was awarded.

12. DIMAR to re-evaluate the **Maritime Concession** regulation for non-conventional renewable energy sources (see section 10.3.1) in line with the planned terms of lease, both option agreement and lease agreement, for offshore wind projects. Clear interdependencies with the Seabed Leasing, ESIA and Revenue Support processes shall be defined to increase transparency in the project development steps.

13. MME to lead the work on the regulatory framework at **Decreto/Ley** level encompassing the process for offshore wind leasing, permitting, grid connection and support mechanisms in Colombia. Considerations such as the national vision and targets, applicable legislation and a role mapping across government entities shall be captured. The latter has to delimit the roles, responsibilities, limitations and scope of the actions of each of the institutions involved, to avoid possible conflicts that could lead to reprocessing between the different participating entities and creating certainty and clarity for interested market participants.

14. Streamline the access and availability of the general public to the existing **public-domain information** in the different Government entities. Specifically, it would be beneficial to have a centralized portal providing access to baseline information currently available at ANLA web library, INVEMAR's information repository on the Colombian Caribbean Coast, etc.

15. Encourage joint Government-Industry collaboration efforts to target strategic **offshore data collection**, including environmental, biodiversity and social baseline surveys, as well as geophysical/geotechnical and metocean including wind resource, to support derisking of project modelling assumptions. DIMAR,

through its research centers could greatly assist in enhancing knowledge on coastal and offshore environments. Having baseline data available helps investors de-risk early-stage development and accelerate or even compress development timescales for projects. In Colombia, pre-feasibilities have been granted, but do not imply exclusive rights nor priority towards an eventual area concession, which might be reducing the interest from investors to deploy data capture infrastructure. An example of a Joint Industry Program (JIP) is Carbon Trust's Offshore Wind Accelerator[11], in the UK.

Grid Connection and Transmission Planning

16. UPME to formulate **grid expansion** plans in alignment with the vision and capacity targets announced for offshore wind and the priority areas identified for this technology in the MSPs. Estimated costs for transmission expansions across the western, central, and eastern regions shall be considered in policy design of procurement volumes and locations.

17. **Grid connection** requests shall become an integral part of the permitting process for offshore wind projects, which shall also help prevent speculation.

Port Infrastructure

18. DIMAR and MinTransporte, through the Agencia Nacional de Infraestructura (ANI), to evaluate development and investment needs of the local port infrastructure e.g. dedicated port facilities, quayside capacity reinforcement, etc., how these investments will fit existing concession contracts and also road transportation requirements to meet the vision and capacity targets. Section 8 defines the assessment criteria to prioritize with respect to their physical capability to support fixed-bottom and floating offshore wind farm construction or manufacturing activities in Colombia over the long-term.

19. Assess potential and suitability of existing **shipyards** as staging and assembly points, fabricate offshore substation topsides and foundations, and servicing offshore supply and construction vessels. Shipyards have also proven to be important coastal infrastructure offering fabrication, staging, and assembly services for the offshore wind industry in Europe and Asia. A high-level review is captured in section 8.3.5.

20. Develop policies to encourage offshore wind **industrial clusters** to be created and evolve around selected ports. Several notable port-centered industrial

[11] https://www.carbontrust.com/our-projects/offshore-wind-accelerator-owa

clusters have developed over the last 50 years and, in relation to offshore wind, a notable example is the Port of Esbjerg[12] (Danish Energy Innovation Cluster[13]).

Supply Chain development

21. MME to enhance local supply chain development by mechanisms such as fiscal incentives. As part of this effort, review the adequacy of the Law 1715 / 2014, Proastilleros program, etc. to support a nascent offshore wind industry.

22. MME to engage with **export credit agencies** (ECAs), such as Denmark's Eksport Kredit Fonden, UK Export Finance and Germany's Euler-Hermes, who can offer trade finance and other services to facilitate domestic companies' international exports. Many countries have ECAs that provide loans, loan guarantees, and insurance to help reduce the uncertainty of exporting to other countries.

23. MinTrabajo and MME to assess the potential **transferability** of local industries e.g. fossil fuel to offshore wind. Companies in Colombia can be well positioned to take significant market shares during the development, construction and operational phases for offshore wind farms, both regionally and globally (see section 7). Quantify requirements based on the vision and targets, combined with the global market outlook, and initiate stakeholder engagements to establish a plan. Examples of similar initiatives exist in Norway, where studies have been commissioned to identify the opportunities for the local industry[14].

24. Amongst the areas evaluated to be the most ready to emerge as a potential offshore wind supply chain in Colombia are various upfront project development services, notably project development consulting and local legal and permitting advisory services (see section 7.3.1). Creating networking opportunities to identify synergies and establish **alliances** can spearhead the supply chain development for the offshore wind industry.

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[12] https://portesbjerg.dk/en/business-area/renewables

[13] https://en.winddenmark.dk/projects/energy-innovation-cluster

[14] Eksportkreditt: Offshore Wind – Opportunities for the Norwegian, 2020-13, 978-82-8368-074-4 https://www.regjeringen.no/contentassets/07635c56b2824103909fab5f31f81469/offshore-wind-opportunities-for-the-norwegian-industry.pdf

25. Industry support activities such as a robust supply chain **database** can help understand the skills of current and potential future suppliers. A supply chain readiness assessment similar to the one executed in section 7 may help understanding transferability capabilities from other industries.

Financing

26. Offshore wind projects have large capital requirements, and it is recommended to initiate contacts with experienced international financers to help the government understand lender requirements. These include international banks, development finance institutions (DFIs), international financial institutions (IFIs) and export credit agencies (ECAs). ECAs can be instrumental in mobilizing local currency and experienced international lenders, as has been the case in Taiwan.

27. Create incentives from the national government to second-tier financial entities, national funds e.g. FENOGE, or from national banking entities in order to increase participation of the Colombian banking sector in the financing of offshore wind projects with a competitive rate and terms, which resemble the conditions used by international banks.

28. Leverage **concessional finance** programs and partnerships to reduce cost of financing. Concessional financing and credit support mechanisms should be investigated to ensure project sponsor costs of financing can be structured at globally competitive levels.

Offtake and Revenue

29. MME to analyze potential support mechanisms most suitable for offshore wind projects to provide developers, lenders and investors long-term visibility and certainty on revenues, which helps them manage revenue risk and reduce LCOE. Options for offtake agreements can include Power Purchase Agreements (PPA), , Contracts for Difference (CFD) and bilateral agreements with corporate entities. Choice of mechanism may evolve over time as the industry matures.

30. MME to decide on the process to award offtake agreements, which shall include the type of support mechanism chosen and when in a project's development process it will take place. It is recommended to award these through a technology-specific revenue support competitive process timed to deliver target capacities as per the stated national offshore wind vision and target. Additionally, a two-competition model is suggested (see section 10.4), so that offtake agreements are granted as a separate process from the leasing and permitting

stages. Careful consideration of offtake tariff currency, indexation, duration and related protections in view of the local financing capacity is required.

31. MME to assess the synergies between offshore wind and **green hydrogen** generation guided by Colombia's Hydrogen Roadmap (see section 2.2.1.1) due to the potential shared use of infrastructure and the alternative route to market that electrolysis offers as opposed to electricity injection to grid.

32. CREG to evaluate the viability of awarding Firm Energy Obligations (OEF) to future offshore wind projects under the existing Reliability Charge mechanism (Cargo por Confiabilidad) (see section 5.3.1).

Health & Safety and Training

33. MinTrabajo and MME to develop Health & Safety (H&S) guidelines and training to promote the safe start of the offshore wind industry, and also relevant to the local context in Colombia. It is advised to partner with global training bodies to draw international best practices and conduct a gap analysis with the existing legislation (see section 9). Examples from the international community include the New Jersey Statetogether with the Global Wind Organization (GWO) who created The Wind Safety Training Challenge[15].

34. Review of national safety legislation and perform a gap analysis to integrate other widely adopted international standards for offshore wind H&S. Specific actions are to consider offshore wind project particularities in the next update of the Resolution 674/2012 and the ongoing work on the Offshore Safety Handbook (Manual de operaciones seguras costa afuera), due in 2022.

35. MME to facilitate training in offshore wind project development and best practices for personnel in the several governmental agencies that shall develop the regulatory framework, process applications to lease rounds, etc. Hiring and/or outsourcing advisors to handle the volume of applications and the work required has proven successful in the UK to avoid delays in processing and achieving efficient and rational outcomes.

[15] https://www.globalwindsafety.org/news/wind-safety-training-challenge-launched-in-new-jersey-to-support-offshore-growth

3.3 Technical Implementation Considerations

Exhibit 9 shows actions potentially required to achieve the Low and High capacity deployment scenarios discussed in Section 2. Further analysis will be required across all areas as part of future policy design and implementation planning.

Exhibit 9 Potential Actions to Implement the Scenarios

Consideration	Low Growth Scenario	High Growth Scenario
Grid	• It is assumed that only limited upgrades will be required in each decade, taking advantage of planned reinforcements and interconnection directly into load pockets at low relative volumes.	• Over time it is assumed that dedicated grid upgrades will be required to incorporate higher injection volumes. This is expected to include reinforcements and dedicated upgrades in the existing right-of-way between Santa Marta and Riohacha, as well as significant upgrades across the planned right-of-way into eastern Guajira in order to unlock significant offshore volumes in that area. Note that it may be possible to utilize marine HVDC as an alternative pathway for transmission expansion, though it is expected that such an approach would be less cost effective.
Port Infrastructure	• Existing ports of Cartagena and Barranquilla would be viable to support staging and marshalling operations on an as-needed basis with relatively minor investment in upgrades. • No purpose-built local port facility is required in low growth scenario, however, some investment may be necessary or upgrades	• Dedicated local port facilities could be utilized for the staging and marshalling of large offshore wind components. • Moderate investments would be required in port upgrades, primarily quayside capacity reinforcement and in some cases increasing channel depth. • Initially, port activities would likely be centered around Ports of Cartagena and Barranquilla, secondary options in Santa Marta.
Local Supply Chain	• Nearly all major tier-1 components imported from facilities abroad. • Investment in local (serial) manufacturing facilities not required • Some potential for local tier-2 and 3 component suppliers (i.e. Secondary steel structures). • Operations and Maintenance supplied locally from port areas in vicinity to offshore wind farms.	• Handful of facilities established for manufacturing and staging of components such as transition pieces or Offshore Substations (OSS) topsides • Wind turbine components such as blades and nacelles continue to be imported from specialized facilities abroad. • Wind turbine foundations imported from specialized serial production facilities abroad, but can be staged and fitted locally • Special Purpose Installation Vessels also imported from abroad.

Regulatory and Policy	• Under the low growth scenario, a long-term competitive PPA offtake program may or may not be established, and projects may be procured either on an individual bilateral basis where most economic and compatible with system expansion planning or via auction. • Establish supportive and predictable government policy with respect to offshore permitting and approvals.	• To achieve a 'high growth' pathway, it is assumed that a competitive procurement program is established dedicated to offshore wind, that maximizes competitive tension and pricing efficiency among bidders. • Establish supportive and predictable government policy with respect to offshore permitting and approvals.
Financial & Economic	• While no dedicated procurement program is established under the low scenario, it is expected that measures will be considered to maximize the cost effectiveness of planned projects, such as: o Lengthening renewables PPA tenor to 25 years or more o Leverage of concessional finance programs and partnerships to reduce WACC	• Utilizing a dedicated procurement program, it is expected that measures will be considered to maximize cost effectiveness and attractiveness of the market to international developers.
Health and Safety	• Guidance from applicable national offshore HSE Codes and Standards can form the basis for Colombia's offshore wind HSE standards. A gap analysis should be performed to integrate other widely adopted international standards for offshore wind HSE in order to form industry specific HSE standards in Colombia.	

Source: : RCG-ERM 2021

SUPPORTING INFORMATION

4 ASSESSMENT OF OFFSHORE WIND AREAS

This section details the methodology and the results for identifying potential offshore wind development zones and estimating the gross maximum offshore wind deployment potential.

4.1 Purpose

This section identifies offshore areas that could be suitable for future offshore wind deployment in Colombia. In addition to the resource potential and basic site condition characteristics, we assess the key environmental, social and human considerations that may influence location and size of future development areas as well as overall market volume potential. The consideration of constraints is an important exercise required to understand the potential scale of the offshore wind industry in the country and size of potential offshore wind development areas.

4.2 Methodology

The project team began the analysis with a desktop resource assessment of offshore wind speeds to understand the overall technically achievable power generation potential in the market. The technically achievable potential is then filtered based on various layers of physical, technical, environmental, and social constraints that determine the suitability of specific areas for offshore wind development. A GIS mapping exercise has been undertaken to visualize the key constraints and drivers for offshore wind development areas in Colombia. Datasets have been identified from public sources and displayed in a series of technical drivers and constraints maps, allowing for the identification of offshore wind development *exploration areas of interest (not final project sites)* and estimation of less constrained offshore wind capacity in Colombia.

4.2.1 Technical Potential

Technical potential refers to the maximum developable capacity for offshore wind based on key technical criteria including depth, wind speed, and national boundaries, but not including other key constraints such as marine traffic or competing uses.

Areas of technical potential have been defined based on the following wind speed and bathymetry values:

Exhibit 10 Technical Potential Criteria

Wind Speed (meters / second at 150 m)	Bathymetry (meters at mean sea level)	Foundation Type
7 – 8	Less than 70	Fixed bottom
8 – 9	Less than 70	Fixed bottom
9 – 10	Less than 70	Fixed bottom
Greater than 10	Less than 70	Fixed bottom
7 – 8	70 – 1,250	Floating
8 – 9	70 – 1,250	Floating
9 – 10	70 – 1,250	Floating
Greater than 10	70 – 1,250	Floating

Source: RCG

Industry standard approximate benchmark ranges including minimum wind speed value of 7 m/s at 150 m and a maximum water depth of 1,250 m have been used to define the technical potential. Whilst development in areas outside of these technical conditions is possible and may be viable, conditions within 0 m – 1,250 m with wind speeds higher than 7 m/s are considered a higher priority for investigation. 1,250 maximum depth was chosen for floating not for purposes of a technical limit, but based on the offshore characteristics in the vicinity of the primary interest areas.

4.2.2 Technical, Environment and Social Constraints

In addition to technical potential, the key environmental, social and technical constraints and drivers have been mapped in order to provide additional context and refine realistic deployment areas. A non-exhaustive list of the types of constraints considered is provided in Exhibit 11.

Exhibit 11 Types of constraints and criteria

Type of Constraint	Example	Criteria notes
Resource	Wind Speed	≥ 7 meters/second at 150 m hub height
Technical	Bathymetry	<70 meters fixed bottom, <1,000 meters for floating

Technical	Shipping density	Seek to avoid/buffer
Technical	Aviation and radar	Seek to avoid/buffer
Technical	Oil and Gas infrastructure	Seek to avoid active areas
Technical	Site conditions	Consider soil sediment type
Technical	Subsea cables	Seek to avoid/buffer
Technical	Pipelines	Seek to avoid/buffer
Technical	Military exercise areas	Seek to avoid/buffer
Technical	Transmission access	Consider access location
Environmental	Biodiversity areas	Seek to avoid/buffer
Environmental	Marine protected areas	Seek to avoid/buffer
Environmental	Conservation areas	Seek to avoid/buffer
Environmental	RAMSAR sites	Seek to avoid/buffer
Environmental	Other protected areas	Seek to avoid/buffer
Environmental	Migratory birds	Seek to avoid/buffer
Environmental	Important Bird Areas	Seek to avoid/buffer
Social	Cultural Heritage Sites	Seek to avoid/buffer
Social	Industrial fishing	Seek to avoid/buffer
Social	Artisanal fishing	Seek to avoid/buffer
Social	Aquaculture	Seek to avoid/buffer
Social	Tourism	Seek to avoid/buffer

Source: RCG, ERM 2021

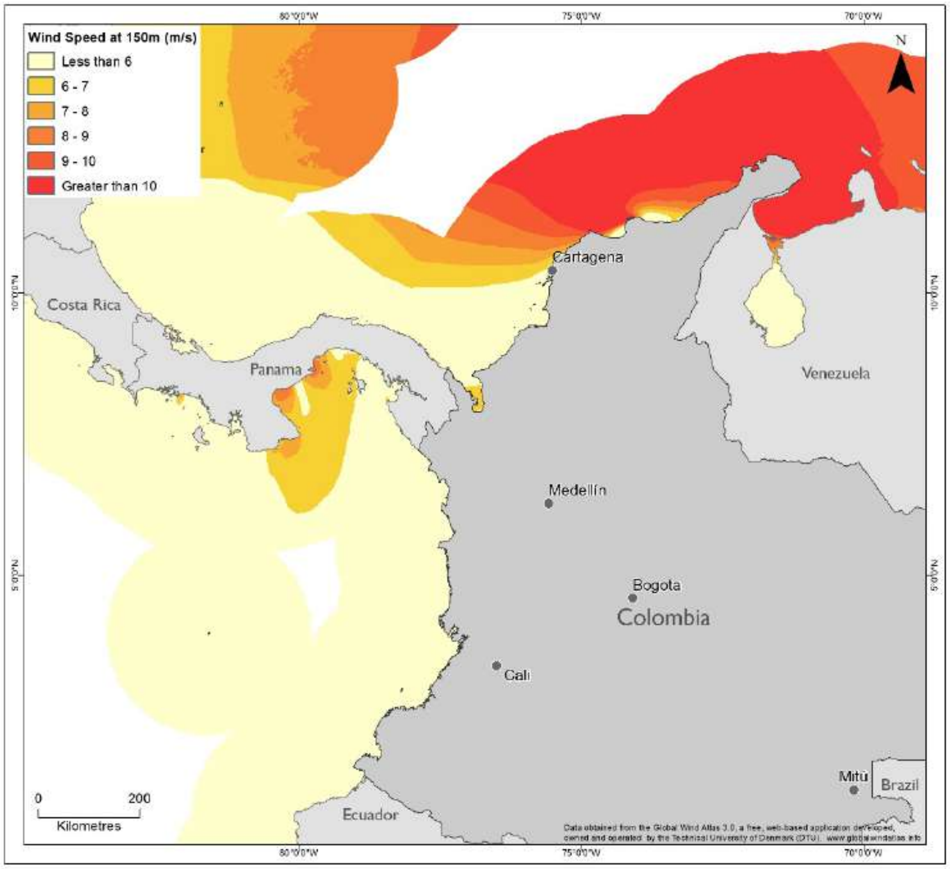
4.3 Results

4.3.1 Wind Speed

The wind resource data layer used in this analysis is sourced from the Global Wind Atlas 3.0 (GWA 3.0), an online map portal created by the Technical University of Denmark (DTU Wind Energy) and the World Bank Group. The data includes ten years (2008-2017) of mesoscale time-series modeled input data from Vortex and improved elevation and landcover data in the microscale modeling. Wind speeds measured at 150 m have been selected for this exercise as they are aligned with the potential expected hub height of offshore wind turbine generators (WTGs). Global Wind Atlas data is limited to a distance of 200 km from the shoreline.

Wind speeds off the western coast of Colombia are below 6 m/s at 150 m height. These wind speed conditions are sub-optimal for offshore wind. Wind speeds are much higher on the northern coast, reaching values of greater than 10 m/s along much of the coastline.

Exhibit 12 Offshore wind resource



Source: RCG- ERM, 2021

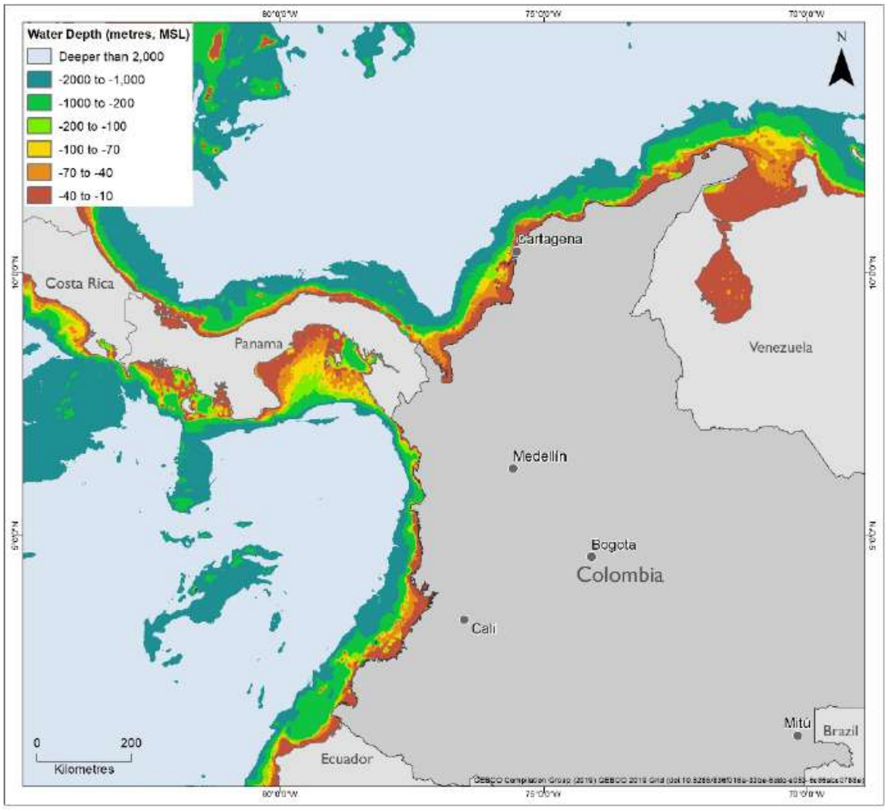
*Disclaimer: The borders, colors, denominations and any other information on this map do not imply a judgment on the legal status of any territory or the endorsement or acceptance of such borders.

4.3.2 Bathymetry & Offshore Geology

Bathymetry data was sourced from GEBCO Compilation Group (2019). The GEBCO 2019 Grid is a continuous, global terrain model for ocean and land with a spatial resolution of 15 arc seconds. It includes data sets from a number of international and national data repositories and regional mapping initiatives.

The water depths around Colombia vary significantly. Water depths are below 70 m along the majority of the coastline, however these depths drop off into the 100 m – 200 m range with increased distance to shore. Water depths continue to increase and drop below 1000 m approximately 50 km – 100 km from the coastline for much of the country. There are some shallower areas further offshore centered around the islands of Isla Isabela and San Andres.

Exhibit 13 Bathymetry



Source: RCG- ERM, 2021

*Disclaimer: The borders, colors, denominations and any other information on this map do not imply a judgment on the legal status of any territory or the endorsement or acceptance of such borders.

The project team was unable to access the requisite data for assessing offshore geology according to the categories most pertinent for offshore wind, including:

1. Subsurface geology (i.e.below surface sediment)
2. Soil profiles
3. Surface sediment types
4. Surface sediment thickness
5. Hard bottom occurrence
6. Sediment size (grain size)

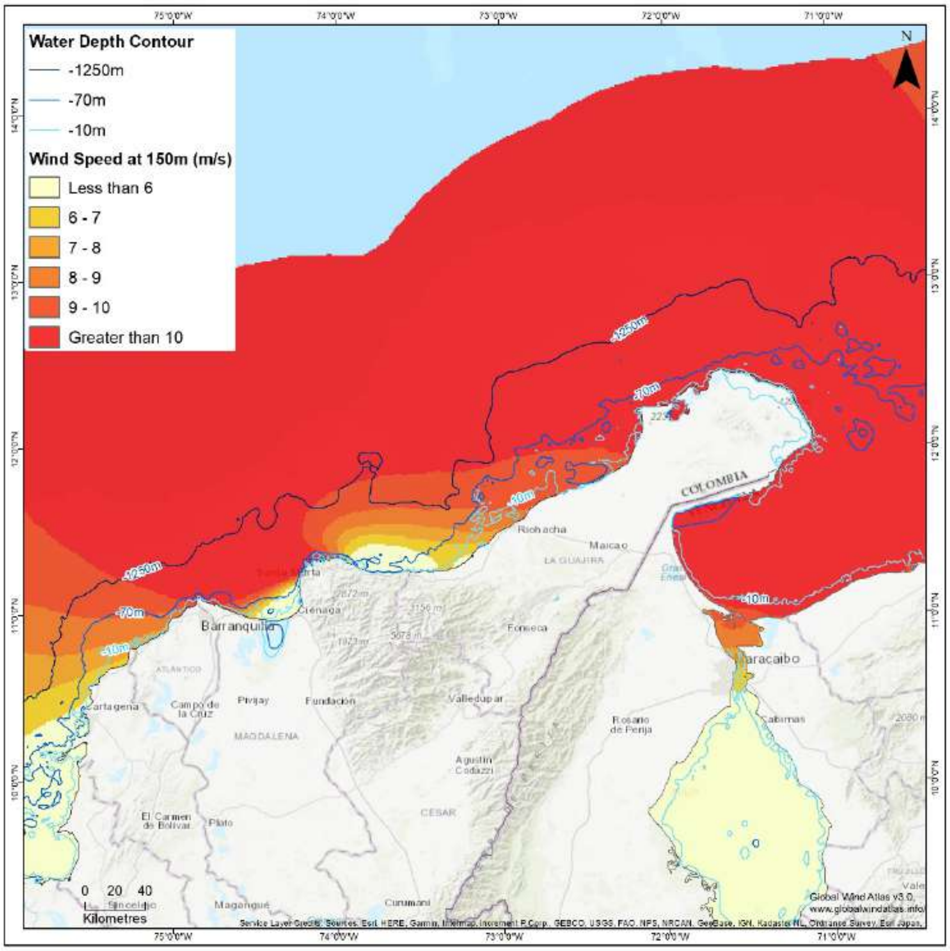
It is not understood that such data is readily available offshore Colombia outside of individual examples of surveys conducted for private purposes or activities specific to oil & gas exploration that are less applicable to the needs of an offshore wind developer.

The project team reviewed data held by *Servicio Geológico Colombiano*, as well as privately held Agencia Nacional de Hidrocarburos (ANH) data. In addition, the project team held an informal informational meeting with an offshore geo-data specialist with some limited experience conducting private investigations near Cartagena and Santa Marta. This firm's experience, at select locations, underscored the need for further offshore investigation, as challenging conditions were identified in both areas, including rocky conditions near Santa Marta and gas seams near Cartagena. Such limited observations are not necessarily broadly applicable, nor factors that necessarily preclude offshore wind deployment for either fixed or floating foundation types, however they are indicators that further study will be useful for derisking and building a clearer understanding of requirements for foundation types, project and turbine layout design, and install methods.

4.3.3 Combined technical drivers

A map showing the combined wind speed assessment and water depth counters is shown in Exhibit 14. There is no technical potential for fixed or floating offshore wind along the western coast of Colombia. This is due to wind speeds at a height of 150 m being below 6 m/s. The available technical potential is focused along the northern coastline in the Caribbean Sea, with the largest area of potential located off the region of La Guajira.

Exhibit 14 Combined Technical Drivers



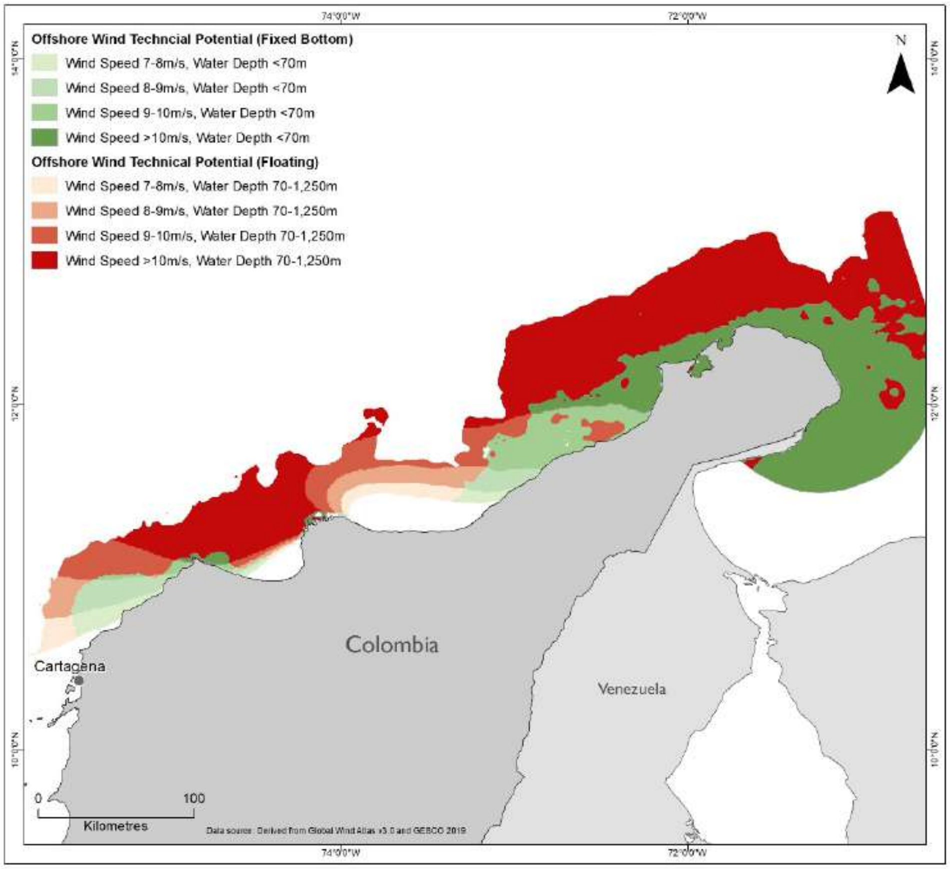
Source: RCG- ERM, 2021

*Disclaimer: The borders, colors, denominations and any other information on this map do not imply a judgment on the legal status of any territory or the endorsement or acceptance of such borders.

4.3.4 Combined technical potential

Based on the technical potential criteria defined above, Colombia has a total technical offshore wind potential of approximately 110 GW, which includes utilization of both fixed-bottom and floating offshore wind farms. The combined gross technical potential does not take into consideration any additional conflicts or constraints, as described below. Rather, the figure portrays the overall technically achievable potential based on resource availability.

Exhibit 15 Fixed & Floating Offshore Wind Technical Potential



Source: RCG-ERM

*Disclaimer: The borders, colors, denominations and any other information on this map do not imply a judgment on the legal status of any territory or the endorsement or acceptance of such borders.

It should be noted that the available technical potential is focused along the northern coastline in the Caribbean Sea, with the largest area of potential located off the region of La Guajira.

4.3.5 Constraints Analysis

In addition to technical potential, the key environmental, social and technical constraints and drivers have been mapped in order to identify potential offshore wind deployment areas and refine capacity deployment scenarios. These constraints are most influential with respect to estimating technically developable capacity. Exhibit 16 provides a list of the datasets used along with the data source.

Exhibit 16 Spatial data utilized

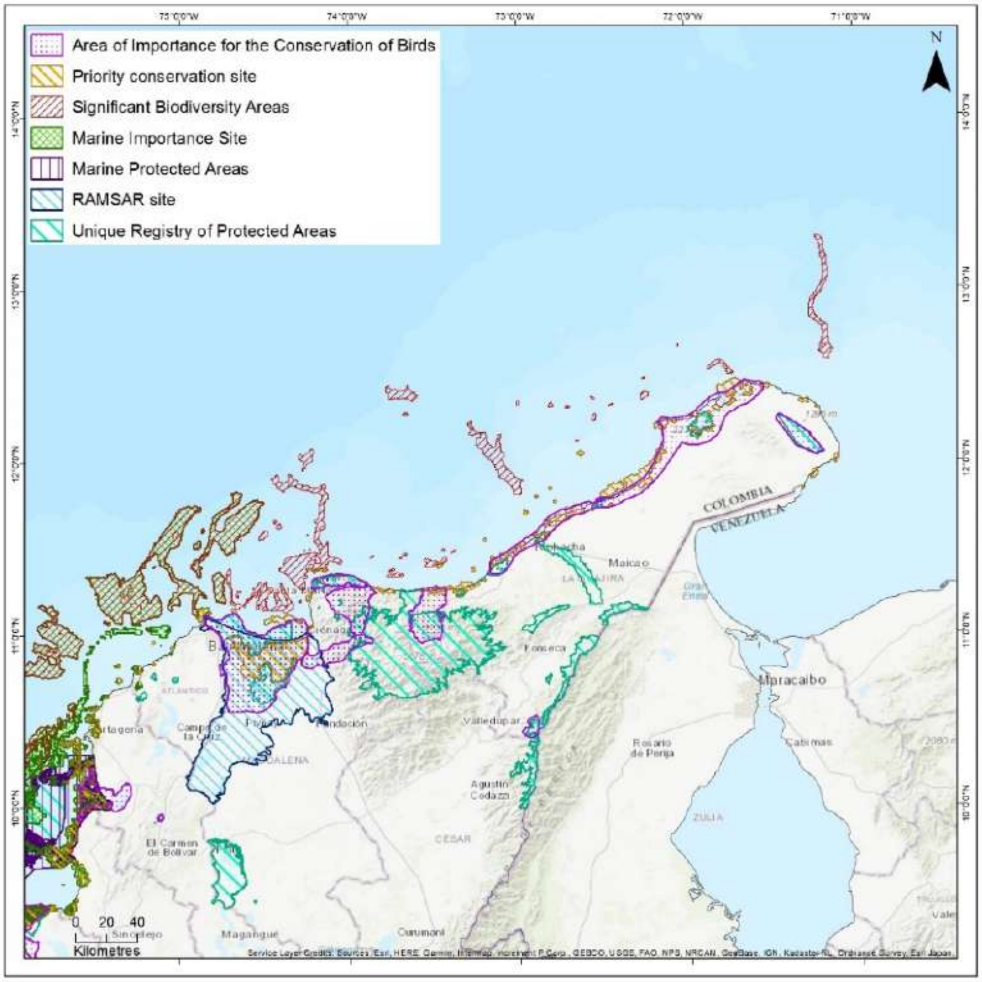
Dataset	Source
Bathymetry	The General Bathymetric Chart of the Oceans (GEBCO) 2019
Wind Speed	Global Wind Atlas 3.0
Shipping Activity	Marine Traffic (www.marinetraffic.com) International Monetary Fund (IMF's World Seaborne Trade monitoring system (Cerdeiro, Komaromi, Liu and Saeed, 2020)
Transmission infrastructure	High voltage lines dataset (ANLA) OpenStreetMap
Protected and Environmentally Sensitive Areas	Ministerio de Ambiente y Desarrollo Sostenible (MADS)
Oil and Gas Areas	Agencia Nacional De Hidrocarburos (ANH)
Submarine cables	Submarinecablemap, 2021
Port Infrastructure	National Geospatial Intelligence Agency
Significant Wave Height	E.U. Copernicus Marine Service Information
Fishing Activity	Autoridad Nacional de Acuicultura y Pesca (AUNAP) vía Instituto de Investigaciones Marinas y Costeras (INVEMAR)

4.3.5.1 Environmental constraints

Large portions of the Colombian coastline and onshore areas are designated as protected areas. In the offshore region along the country's northern coastline, there are a number of designated areas that occupy large areas of seabed. Notably, there are multiple Marine Importance Sites, Significant Biodiversity Areas and Protected Areas. The presence of these designated areas is important for potential offshore wind development. Where possible they should be avoided. However, mitigations such as seasonal construction activities may make coexistence in the areas possible. There are also multiple onshore designations along the northern coastline that need to be considered. These include RAMSAR sites, Areas of Importance for the Conservation of Birds, and Protected Areas. Maintaining an acceptable distance to these areas is important in order to prevent disruption of protected species and minimize visual impacts.

Key findings for Environmental and Social constraints are provided below. A detailed analysis of each of these Constraints is provided in Section 6.

Exhibit 17 Summary of Environmental constraints



Source: RCG- ERM, 2021

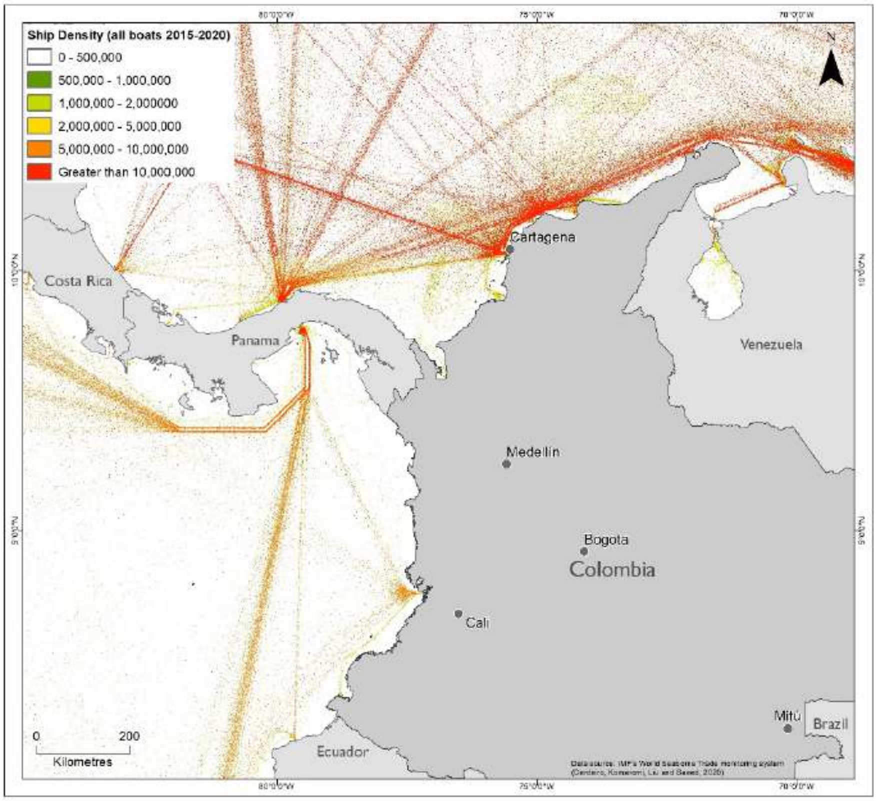
4.3.5.2 Social constraints and considerations

Shipping routes

Shipping traffic offshore Colombia presents a significant constraint to offshore wind farm development. Projects should be kept out of any designated shipping lanes or traffic separation areas, and areas of high shipping density should be avoided during site selection for maritime safety reasons. Shipping data has been sourced from both

Marinetraffic.com and the IMF's world seaborne trade monitoring system and shows the density of Automatic Identification System (AIS) tracked shipping traffic in 2020. Shipping activity offshore Colombia is significant, with the majority of vessels transiting towards and from the Panama Canal, however local traffic into Cartagena and neighboring ports also complicates nearshore offshore wind development in those regions, and was a major limiting factor in our analysis of viable areas.

Exhibit 18 Shipping constraints



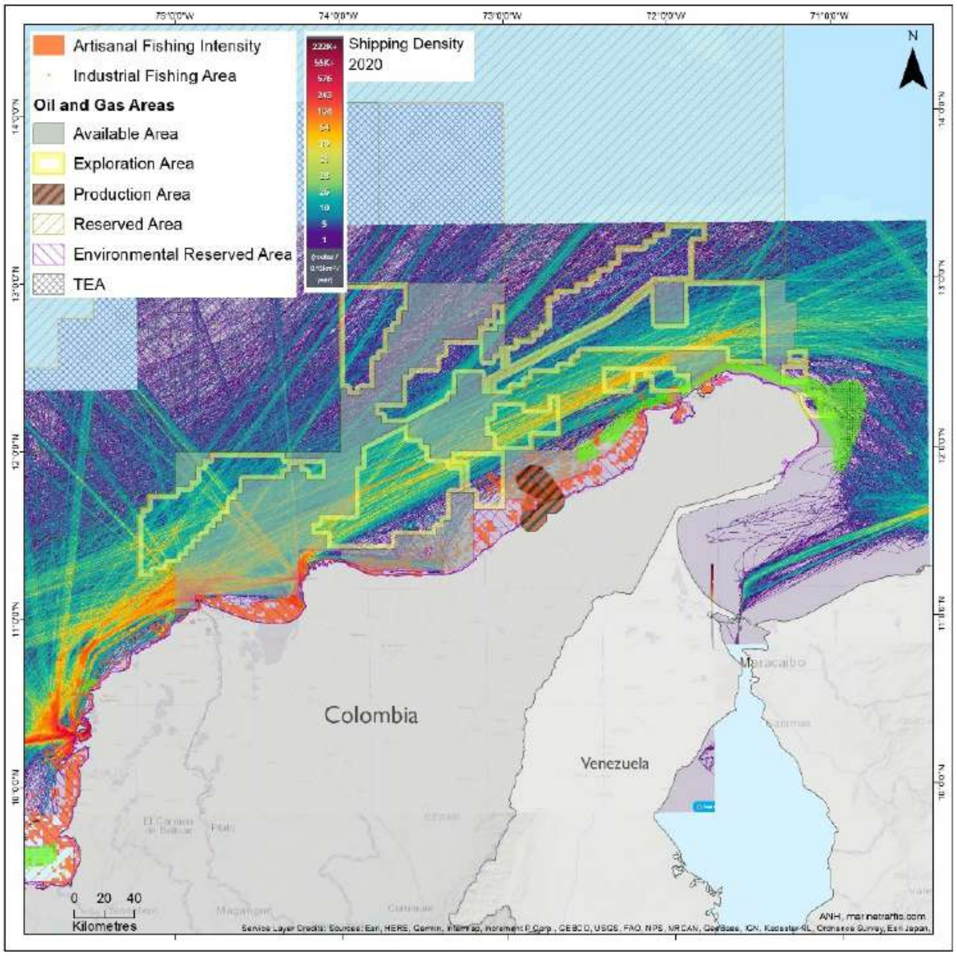
Source: RCG- ERM, 2021

*Disclaimer: The borders, colors, denominations and any other information on this map do not imply a judgment on the legal status of any territory or the endorsement or acceptance of such borders.

Commercial and artisanal fishing

Fishing activity is displayed on Exhibit 19 through industrial fishing areas and artisanal fishing areas. The western coast has moderate levels of industrial fishing activity. Fishing activity on the north coast is made up of both industrial and artisanal fishing.

Exhibit 19 Commercial and artisanal fishing



Source: RCG- ERM, 2021

Offshore Oil and Gas

There is oil and gas activity around Colombia's coast, particularly in the offshore area along the northern coastline. A production area is present off Riohacha, with several exportation areas located along the northern coast. Oil and gas activity on the western coast is less, however a number of "reserved" and "available" areas are present. Historically in European markets, coexistence with oil and gas activity has been possible, however consultation with the relevant oil and gas area owners is recommended in order to achieve this.

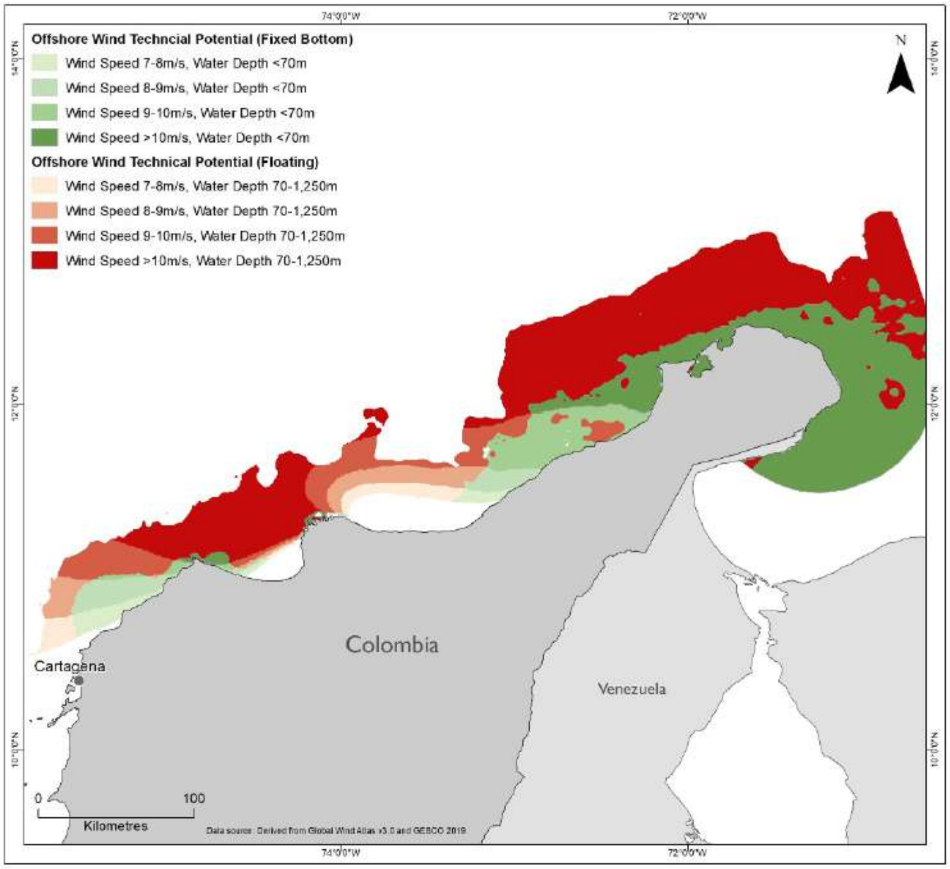
4.3.6 Site Identification – Initial Exploration Areas

Based on the results of the resources assessments as well as technical, environmental, and social constraints GIS mapping, the project team narrowed down areas of interest for potential fixed and floating offshore wind development.

4.3.6.1 Regions of Interest

The primary regions of interest for fixed-bottom and floating offshore wind are shown in Exhibit 20. The following section refines potential areas of interest within these regions, based on the results of the GIS constraints analysis.

Exhibit 20 Zones of interest



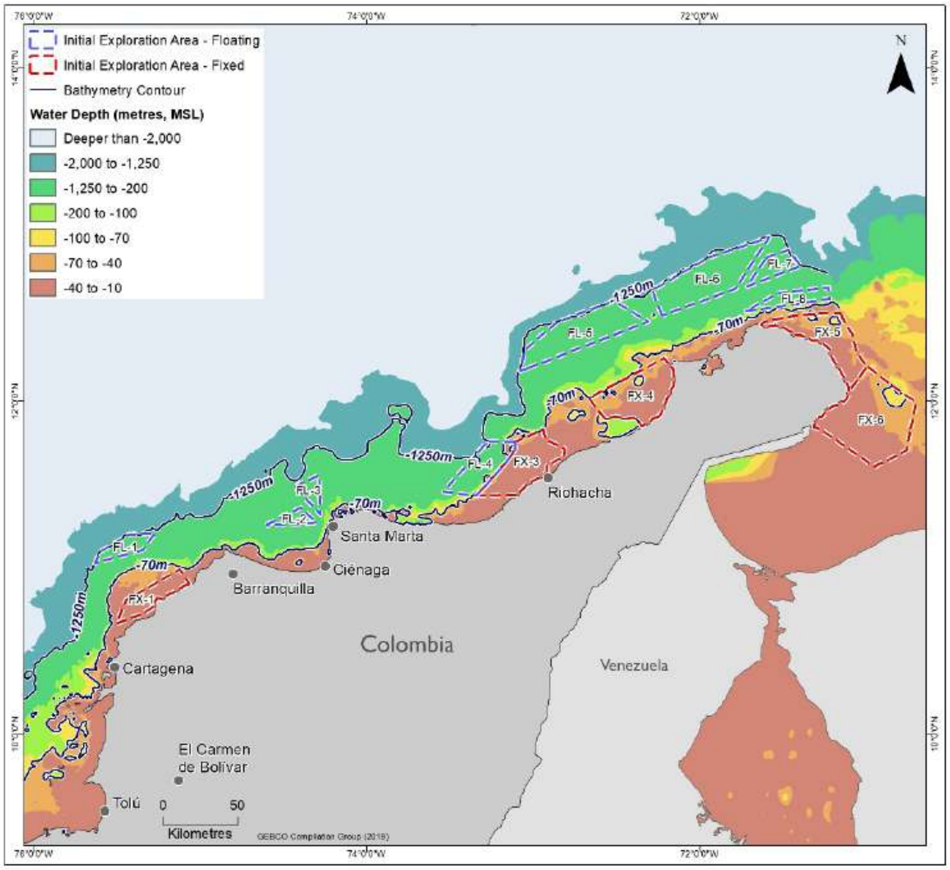
Source: RCG- ERM, 2021

*Disclaimer: The borders, colors, denominations and any other information on this map do not imply a judgment on the legal status of any territory or the endorsement or acceptance of such borders.

4.3.6.2 Exploration Zones of Interest

Based on the results of the resources and constraints GIS analyses, the project team has identified six (6) areas that may be compatible for fixed-bottom project sites (FX) and eight (8) areas that may be compatible for potential floating project sites (FL). It should be noted that these zones are based on the initial GIS screening results undertaken for this roadmap study and require further consultations with stakeholders in Colombia to assess viability for offshore wind lease areas or development zones. The zones selected in Exhibit 21 reflect those with a reduced number of technical, environmental or social constraints, however all zones have unique constraints that will require deeper investigation.

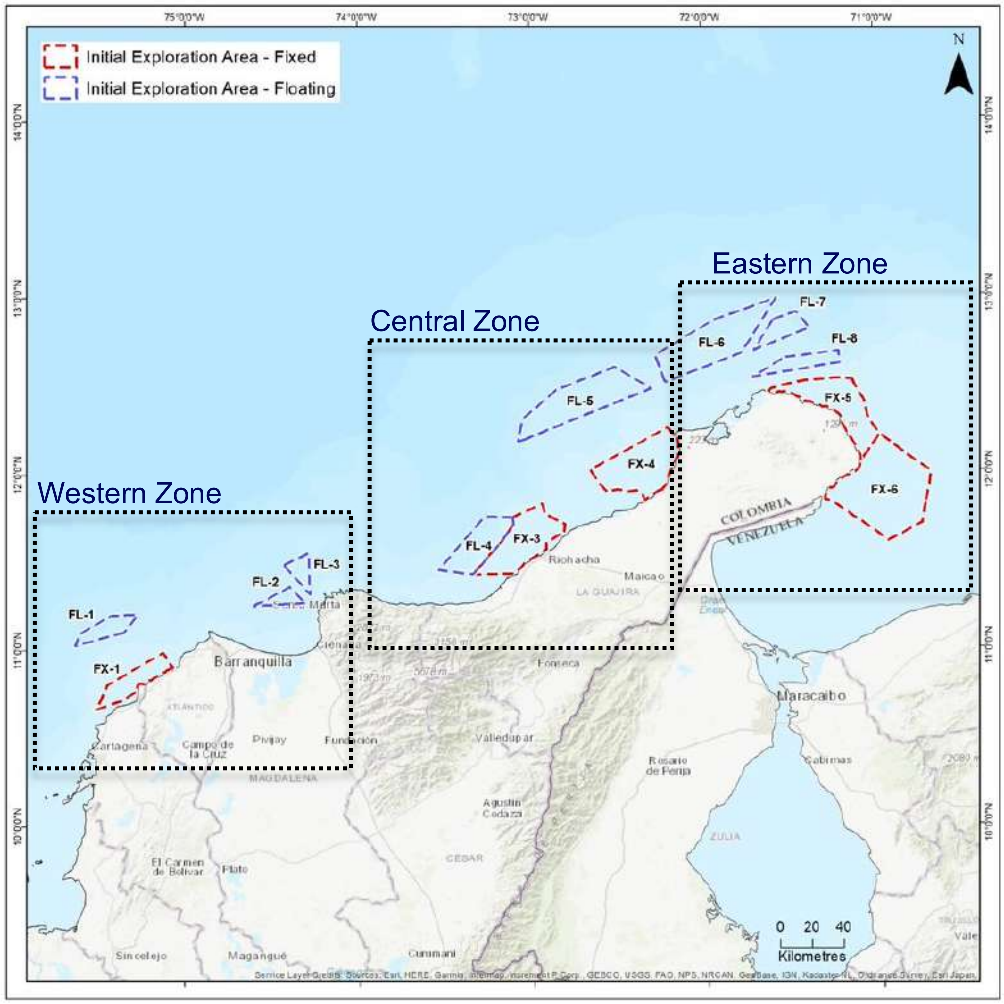
Exhibit 21 Areas of Interest - with bathymetry and wind resources



Source: RCG- ERM, 2021

*Disclaimer: The borders, colors, denominations and any other information on this map do not imply a judgment on the legal status of any territory or the endorsement or acceptance of such borders.

Exhibit 22 Zones of Interest- Overview Map

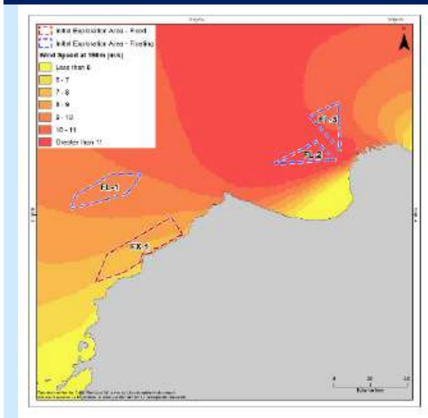
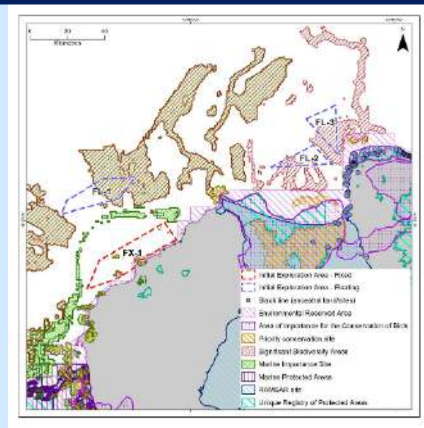
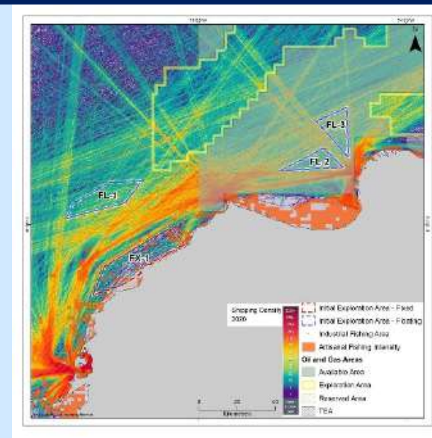


Source: RCG- ERM, 2021

Each of the 14 considered exploration zones have specific challenges and opportunities. In the following pages, we summarize the main technical drivers, as well as some of the identified environmental and social constraints. This analysis is non-exhaustive and is intended only to identify the key drivers and constraints in the potential deployment areas. Further stakeholder engagement would be required to fully understand the constraints and consultation requirements specific to each deployment area. For this analysis, we have dived the area into three regions:

- Bolivar, Atlántico, and Magdalena Departments – Western Zone
- La Guajira, Central Zone
- La Guajira, Eastern Peninsula, Eastern Zone

SUMMARY TABLE (Western Zone)
Bolivar, Atlántico and Magdalena

Drivers	Select Environmental Constraints	Select Social Conflicts
		

Source: RCG- ERM, 2021

Bolivar, Atlántico and Magdalena Departments

The Bolivar and Atlántico departments are home to Cartagena and Barranquilla, respectively. These cities are both large commercial, industrial and power demand centers, and also have strong coastal infrastructure in place to potentially support offshore wind construction, manufacturing, operations and maintenance. The river Magdalena also provides an important maritime artery for the country. See more details in Section 7 & 8.

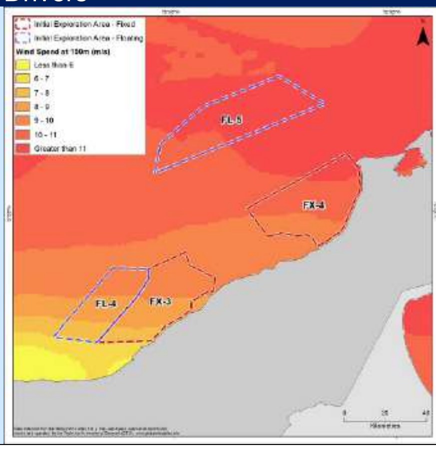
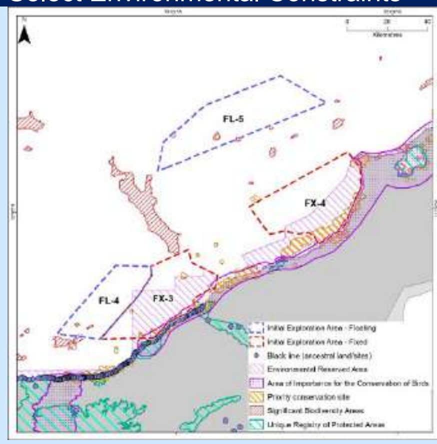
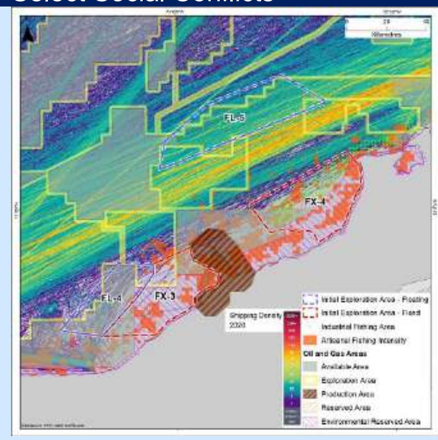
The primary drivers in the regions are the wind resource as well as proximity to potential future grid interconnect points. Although the wind resources are only modest in the Cartagena zones identified when compared to areas to the east, they are still commercially viable wind speeds. The major constraints to consider for the fixed-bottom areas of potential identified include potential overlap with artisanal fishing, as well as sensitive environmental and social areas, which would need to be assessed with relevant stakeholders. For the identified floating offshore wind areas identified, the major constraint is existing shipping routes and shipping traffic.

Bolivar, Atlántico and Magdalena Summary

Drivers	Constraints
Wind resource	Artisanal fishing
Proximity to future transmission	Biodiversity

Demand centers	Offshore Commercial shipping traffic Conservation areas Wildlife and habitats

SUMMARY TABLE (Central Zone)
La Guajira – Central

Drivers	Select Environmental Constraints	Select Social Conflicts
		

Source: RCG- ERM, 2021

La Guajira (Central)

The primary drivers in the central part of the La Guajira region are strong wind resources as well as proximity to an existing 220kV transmission right-of-way (that would need further reinforcement to accommodate offshore wind). The identified development areas are also large in terms of area, theoretically allowing for large commercial projects. There is also limited impact from existing shipping lanes for either the identified fixed-bottom or floating offshore wind sites. However, social constraints such as visual impact to indigenous communities as well as environmental constraints with respect to biodiversity and conservation sites are considerations in the region and may restrict overall deployment potential.

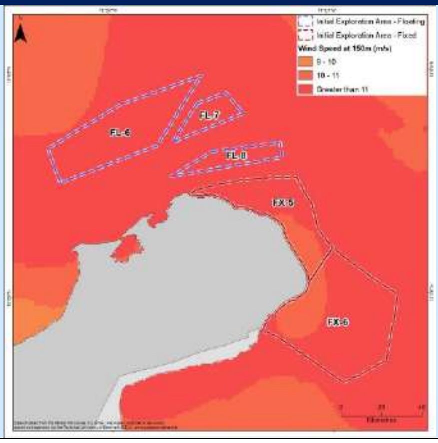
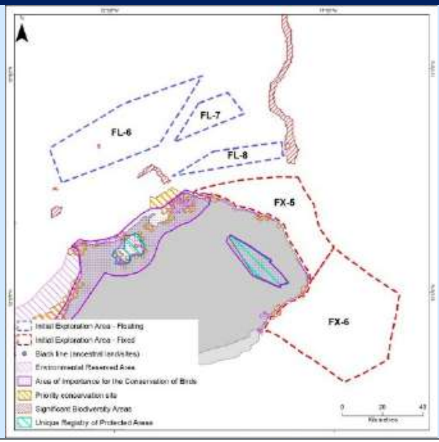
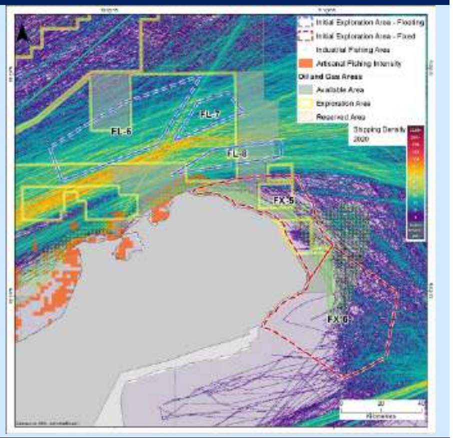
La Guajira (Central) Summary

Drivers	Constraints
Wind resource	Indigenous community visual impacts
Proximity to existing transmission ROW and an operating thermal plant (Termoguajira)	Artisanal fishing Biodiversity
Size of potential wind areas	Conservation areas Wildlife and habitats

	Offshore Commercial shipping traffic

Source: RCG

SUMMARY TABLE (Eastern Zone)
La Guajira- Eastern Peninsula

Drivers	Select Environmental Constraints	Select Social Conflicts
		

Source: RCG- ERM, 2021

La Guajira (Eastern Peninsula)

The eastern peninsula of Colombia, located in the eastern part of the La Guajira department and bordering Venezuela, hosts the strongest wind resources in the region and some of the best wind resource that can be found anywhere in the world. Offshore wind development areas are also larger in size given the relative lack of environmental and social conflicts as compared to other areas of interest. The main constraint to consider in the Eastern Peninsula sites is the future development of power transmission lines. The area is remote from any high or medium voltage infrastructure or load pockets and planned construction of high voltage lines is intended to serve only onshore renewables. Additional considerations also include engagement with existing marine users both with respect to artisanal and industrial fishing in the area. This area has the lowest overlap with protected environmental areas (excluding impacts of onshore transmission).

La Guajira (Eastern Peninsula) Summary

Drivers	Constraints
Strongest wind resources	Transmission proximity
Size of potential wind areas	Fishing

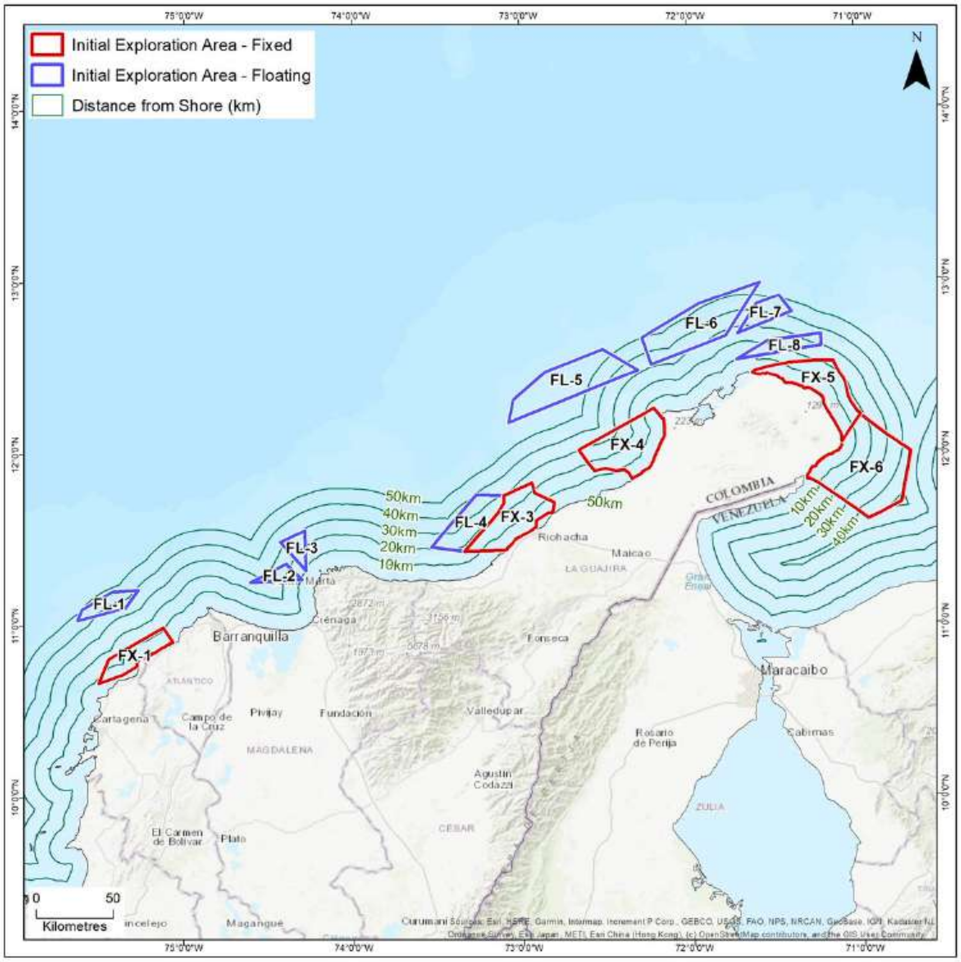
	Oil and Gas exploration areas
	Offshore Commercial shipping traffic

Source: RCG

4.3.6.3 Visual Impact

Visual impact from offshore wind farms is a subjective consideration for siting of offshore wind deployment areas. Specific requirements vary market-to-market and are typically the result of extensive engagement with local stakeholders. In some markets, offshore wind farms are located near-shore and can be easily viewed from shore. In other markets, however, wind farms areas are intentionally sited over 20 miles offshore specially to avoid visual impact. Given these disparities, we did not limit areas of interest to any specific distance from shore for this study. However, in Exhibit 23, we have included distance from shore for each of the identified areas.

Exhibit 23 Visual impact - distance from shore of exploration areas



Source: RCG- ERM, 2021

4.3.7 Offshore wind deployment potential

The potential development zones identified in this study are estimated to have a gross offshore wind deployment potential of ~50 GW.

The exhibit below details the areas in square kilometers for potentially feasible offshore wind development zones as well as a nominal reference capacity for each zone. We have divided the analysis into fixed-bottom and floating offshore wind. These figures represent the estimated gross development potential based.

Exhibit 24 Results table – Offshore wind deployment potential in Areas of Interest

Site ID	Area (km2)	Nominal reference capacity (MW)
FX-1	550	2,200
FX-3	1,150	4,600
FX-4	1,400	5,600
FX-5	1,200	4,800
FX-6	2,500	10,000
Fixed Bottom Potential	**6,800**	**27,200**
FL-1	350	1,400
FL-2	200	800
FL-3	200	800
FL-4	800	3,200
FL-5	1,550	6,200
FL-6	1,550	6,200
FL-7	350	1,400
FL-8	400	1,600
Floating Wind Potential	**5,400**	**21,600**

Reference Capacity Potential (MW)	**~50,000**

Source: Author's estimate. Based on a nominal power density assumption of 4MW/km^2 per WBG ESMAP.

The analysis has yielded prospective offshore deployment areas that total approximately 12,500 sq kilometers potentially developable area. Using power density assumptions consistent with next generation wind turbines, these areas are assumed to have a gross capacity potential of approximately 50 GW.

Note: This spatial analysis does not consider Colombia's target of increasing protected areas by 30 percent by 2030. Even with an increase in the size of protected areas, given the large offshore wind areas of interest identified, and relatively conservative assumption of power density, there will be sufficient space to allow the delivery of either growth scenario presented in this roadmap.

5 TRANSMISSION INFRASTRUCTURE

This section provides an analysis of the existing power market structure, Colombia's national transmission system, and the consideration for offshore wind power to gain transmission access.

5.1 Purpose

Connecting to the national transmission infrastructure and the process for gaining access to future planned transmission capacity will play a key role in facilitating offshore wind investments and help drive the overall market volume potential. This section assesses Colombia's existing transmission infrastructure in addition to the current plans for expanding transmission over the next decade.

5.2 Methodology

The project team analyzed publicly available reports from Unidad de Planeación Minero Energética (UPME) to understand the current transmission capacity and planned upgrades. In addition, the project team also had direct consultation with UPME as part of the project's Inception Mission. This consultation provided the team the opportunity to ask detailed questions and clarifications directly from the agency. The results of these analyses are provided below.

5.3 Results

5.3.1 Power market summary

The deregulation of the Colombian energy sector began in 1994 (among a wave of privatizations across the energy sectors of many South American countries) with the passing of Laws 142 and 143, following a period of major national blackouts in 1992 and 1993. These Laws, based on the 1991 constitution, transformed the power sector from a state monopoly to a competitive market. As part of this deregulation process the regulatory agencies were created with the objective of the definition of the energy policy; regulation; and control. This regulatory framework combined market-led growth with government planning and oversight.

Electricity Law and market structure

The Electricity Law (Law 143/94) sets the rules for generation, transmission, interconnection, distribution and trade of electricity and creates the Wholesale Electricity Market (WEM), which came into operation in July 1995. As a general rule, contracts for the provision of electricity when competition is possible are freely negotiated, while contracts with end users are regulated.

Electricity Law also establishes unbundling rules, restricting horizontal and vertical integration of utility companies. The companies constituted after the publication of this Law are only allowed to carry out, at the same time, complementary activities such as generation-trading or distribution-trading and are forbidden to simultaneously perform the activities of generation-transmission, generation-distribution, transmission-distribution and transmission-trading. Regarding horizontal integration, according to Resolution CREG 128/96 and its amendments, a single company may not own more than 30% of the generation (firm energy), 25% of distribution and/or 25% of trading. These norms do not establish limits for transmission horizontal integration as in many countries in the region.

The Electricity Law defines two categories of end-users: non-regulated and regulated users. Users can choose to become non-regulated if their consumption is above 55 MWh/month or 0.1 MW. The Law also establishes a cross-subsidy between different types of users. Users within the areas classified as poor and/or using low amounts of energy are entitled to receive electricity and natural gas at subsidized tariffs. These subsidies are almost entirely funded by users living in areas considered as being relatively wealthy and those who use more energy (i.e. commercial and industrial users).

Colombia is the only electricity market based on price offers in Latin America (other markets such as Argentina, Chile and Brazil feature a marginal cost pricing). This means spot prices are settled, in an hourly basis, in a daily bidding process where generators offer one price per day (for each generation unit) and availability per hour. Hydro resources are not optimized centrally (i.e. hydro generation depends on the willingness of the generator to bid).

In 2006 a new regulatory scheme (Resolution 071/2006) was introduced to encourage the expansion of the installed capacity to meet future demand and to ensure the reliability of the system at efficient prices. The scheme allocates to new and existing power plants Firm Energy Obligations (OEFs), which are commitments to supply energy during periods of severe droughts at fixed prices ("Scarcity Price"). The generator who wins an OEF receives a stable annual remuneration (the "Reliability Charge") for up to 20 years (providing signals and incentives for investments in new generation resources). Generators supplying energy under an OEF are paid the Scarcity Price up to their committed quantities, and receive the spot price on any additional quantities. See "1.3 Generators' sources of income" for further detail.

In 2014, Law 1715 was passed aiming to promote the development and use of unconventional sources of energy, mainly renewable energy, in order to achieve sustainable development, reduce greenhouse gas emissions, ensure the country's energy supply and promote efficient energy management. This Law establishes the legal framework and instruments required to take advantage of unconventional resources and renewable energy, while promoting investment, research and development of clean technologies for energy production, energy efficiency and demand response. Main measures included: (i) access of renewable self-generators to the transmission and distribution grid to deliver their surplus; (ii) development and use of distributed energy resources ; (iii) the creation of the Unconventional Energy and Efficient Energy Management Fund (FENOGE) to finance renewable energy projects; and (iv) fiscal incentives such as: income tax deduction of 50% of investment value for up to 50% of taxable income for up to 5 years; VAT exemption for renewable energy equipment and services; import duty exemption for renewable energy equipment not produced locally and accelerated depreciation of up to 20% per year for renewable energy investments. In order to access to these benefits the projects must be certified by the Environment and Sustainable Development Ministry. For the moment, the regulation has not implemented feed-in tariff mechanisms. The country has a target of 6.5% generation from Non-Conventional Renewable Energy (NCRE) sources by 2020, excluding large hydro, but hydro potential could delay the development of the NCRE market, despite the legislation supporting them .

Resolution N° 40,791/2016 establishes a new long-term contracting mechanism (complementary to the Reliability Charge) aiming to allow a better incorporation of NCRE projects to the grid (that weren’t developed under the other schemes). Power generators would be awarded with standardized annual energy contracts for a period of up to 20 years. Regulation considers all technologies (both conventional and renewable) with capacities larger than 10 MW, in order to classify for the auction projects must contribute to the reduction of GHG emissions, complement hydro resources and help to enhance national energy security.

5.3.1.1 Generators

Power generation takes place in a free competitive environment, in which Generators can sell energy to other power generators, to trading companies and to non-regulated users, through contracts or in the spot market.

Generators connected to the National Interconnected System (SIN) operate at a frequency of 60 Hz and are classified as:

Classification	Criteria
Generators	>20 MW

Minor plants	<20 MW
Self-generators	agents that produce electricity to fulfill their needs
Co-generators	Agents that produce electricity and thermal energy as part of the productive activity, to fulfill its own consumption or to supply to a third party.

Source: Author's analysis

There are 95 (PARATEC, 2022) registered power generators participating of the WEM. However, as of July 2018, the top-5 generators concentrated ~75% of the total installed capacity of ~17 GW. The main players in generation are provided in Exhibit 25.

Exhibit 25 Main players in power generation

Company	Control	# of Plants	Installed Capacity (2018)				Market share
			MW	Hydro	Thermal	Others	
Emgesa	Grupo Energia de Bogota / Enel	27	3,529	88%	12%	0%	20%
EPM	Medellín municipality	43	3,484	87%	12%	1%	20%
Isagen	Brookfield	7	2,989	81%	9%	0%	17%
Celsia	Grupp Argos	22	1,865	50%	61%	3%	11%
Termocandelaria Power Limited	Vince Business Corp, Moneda Internacional, Bancard International Investments and SCL Energia Activa	5	1,232	0%	100%	0%	7%

Source: Author's analysis, adapted from XM.

5.3.2 Existing transmission system

Transmission comprises the physical transportation of electricity through the National Transmission System (STN) operating at more than 220kV. Operators must provide open access to customers on a non-discriminatory basis, while receiving regulated revenues. The latter is set by the Energy and Gas Regulatory Commission (CREG), who fixes tariffs every five years through revenue cap regulation. Power producers, distributors and traders are responsible for the collection of the transmission remuneration.

Exhibit 26 Map of transmission infrastructure in Colombia

Source: UPME, 2019 PLAN DE EXPANSIÓN DE REFERENCIA GENERACIÓN – TRANSMISIÓN 2019 – 2033

The Mining and Energy Planning Unit is responsible for the planning, coordination and approval of the STN' expansion. Since 1999, the expansion has been executed through free competition mechanisms (i.e. public tenders where existing and new companies participate). New concession contracts are awarded to the bidder that offers the lowest present value of the proposed income profile over the 25-years contract term. The STN comprises ~15,000 km of transmission lines (mostly 230 kV) and covers almost 40% of the national territory, where the largest number of users are located. The remaining demand (non-interconnected zones) is typically supplied by small local electricity power plants that operate on liquid fuels.

Although there is some private participation in transmission, the bulk of operations are controlled by the Government of Colombia. As explained previously, there is no limit for horizontal integration in transmission.

Exhibit 27 Main players in transmission

Company	Legal entities	Control	Transmission Network (Km)				Market share
			200 kV	230 kV	500 kV	Total	
ISA	Transelca and Intercolombia	Government of Colombia	1812	7951	2489	12252	80%
Grupo Energia de Bogota	EEB	Bogota municipality	20	1514	0	1534	10%
Empressa Publicas de Medellin (EPM)	EPM, CENS, ESSA	Medellin municipality	843	278	46	1167	8%
Celsia	EPSA	Grupo Argos	0	291	0	291	2%

Source: adapted from UPME

5.3.3 Planned upgrades and extensions

UPME´s expansion plan for transmission and generation (Plan de Expansión de Referencia Generación Transmisión 2020-2034)[16] has considered the entrance of Offshore Wind projects in the very long-term analysis 2035-2050, approximately 2000 MW, 4.7% of the total energy matrix, considering that the Capex is still too high to be competitive in the Colombian Market.

In order to ensure a sufficient supply of electricity to consumers, UPME carries out an annual review to assess and plan for expansion of transmission in the country and define priorities in the short, medium and long-term. UPME considers future projects and projections of electricity demand growth as well as approved new projects that will require transmission and grid connection. The 2019-2033 planning assumes the generation additions summarized in Exhibit 28.

Exhibit 28 Summary of approved generation capacity additions – Caribbean area

Department	No. of Projects	Capacity (MW)
Atlántico	15	1084
Bolívar	10	365

[16] UPME Plan de Expansión de Referencia Generación Transmisión 2020-2034. http://www.upme.gov.co/Docs/Plan_Expansion/2021/Volumen2_Generacion.pdf

Guajira	16	1888
Cesar	6	929
Magdalena	1	99
Córdoba – Sucre	16	528
Total	*64*	*4,896*

Source: Adapted from UPME Plan de Expansión de Referencia Generación Transmisión 2019 – 2033

Exhibit 29 lists the projects that are currently being incorporated into UPME's transmission expansion plan through 2034.

Exhibit 29 Projects with transmission approval

Project	Capacity (MW)	Technology
El Paso Solar	68	Solar
Pescadero-Ituango	1200	Hydro
Chemesky	99	Wind
La Loma Solar	170	Solar
Tumawind	198	Wind
Windpeshi 1	195	Wind
Parque Beta	280	Wind
Escuela de Minas	55	Hydro
Casa Eléctrica	176	Wind
Termo EBR	19	Thermal
TermoProyectos (Estación Jagüey)	19	Thermal
El Tesorito	200	Thermal
Miel II	116	Hydro
Termosolo 1	148	Thermal
Termosolo 2	80	Thermal
Cierre De Ciclo De Las Unidades 1	241	Thermal
Termo Caribe 3	42	Thermal
Termovalle	40	Thermal
Termoyopal G3	50	Thermal
Termoyopal G4	50	Thermal
Termoyopal G5	50	Thermal
Parque Alpha	212	Wind

Source: Adapted from UPME Plan de Expansión de Referencia Generación Transmisión 2019 – 2033

In anticipation of these awarded projects, UPME has planned targeted transmission expansion projects. Exhibit 30 shows some of the recently planned transmission expansion Projects announced by UPME.

Exhibit 30 Recently planned transmission expansion projects

Project	Date

La Loma 500 kV	January 2019
Subestación Cereté 110 kV	January 2019
Caracolí 110 kV	February 2019
Chinú – Montería – Urabá 220 kV	March 2019
Subestación Norte, Nueva B/quilla 110 kV	March 2019
Tercer Transformador Valledupar 220/34.5 kV	March 2019
Tercer Transformador El Bosque	June 2019
Tercer Transformador Sogamoso 500/230 kV	November 2019
Cuestecitas – Riohacha – Maicao 110 kV	December 2019
Segundo Transformador Ocaña 500/230 kV	June 2020
La Loma 500 / 110 kV	September 2020
Conexión Ituango 500 kV	September 2020
Copey – Cuestecitas 500 kV	November 2020
Copey – Fundación 2 220 kV	November 2020
Refuerzo Costa 500 kV (Cerro – Chinú – Copey)	February 2021
Subestación La Marina STR	November 2021
San Juan 220 / 110 kV	December 2021
Bolívar – Sabana 500 kV	June 2022
El Rio 220 kV	June 2022
Toluviejo 220 kV	June 2020
Subestación Guatapurí 110 kV	September 2022
Nueva Montería – Rio Sinú 2 110	September 2022
Subestación Colectora 500 kV y líneas asociadas	November 2022
La Loma – Cuestecitas 2 500 kV	December 2023
La Loma – Sogamoso 500 kV	December 2023

Source: Adapted from UPME Plan de Expansión de Referencia Generación Transmisión 2019 – 2033

5.3.4 Implications for offshore wind

Offshore wind will need to compete with the planned growth of land-based renewables over the medium and long-term in order to secure transmission capacity. This competition will be particularly acute in the La Guajira region, where a number of renewable energy projects are planned, and several more are likely to results from upcoming tenders. Currently, there is no available capacity in La Guajira to connect small, medium, or large amounts of offshore energy to the national transmission infrastructure, and all planned expansions capacities have been assigned to other projects. As such, limitations in transmission infrastructure and competition for future access will have a substantial impact on offshore wind growth scenarios for Colombia.

6 ENVIRONMENTAL & SOCIAL CONSIDERATIONS

This section provides detail on the environmental and social considerations that must be taken into consideration for the development of an offshore wind industry in Colombia.

6.1 Purpose

In this section, we consider the environmental and social considerations that will influence the future development of Colombia's offshore wind market. Observations on the different considerations will allow stakeholders (government entities, project developers and financial entities) to identify the type of environmental and social restrictions, the regulations aimed at protecting environmentally sensitive areas, and the participation of communities in the development of the offshore wind industry.

Poorly sited offshore wind projects have the potential to give rise to environmental or social impacts. These risks can be minimized by avoiding areas of high sensitivity which can identified through marine spatial planning processes, informing the selection of areas for seabed leasing. Risks can be further managed and mitigated by embedding Environmental and Social Impact Assessment (ESIA) to Good International Industry Practice (GIIP) into the permitting process. Environmental and Social considerations are also highly relevant to financing. Lenders' performance standards (including those of the World Bank and International Finance Corporation) require ESIA to GIIP to have taken place and for potential impacts on social, biodiversity and other environmental receptors to have been taken into account during project development.

6.2 Methodology

As a first step, we identified the relevant environmental and social variables that may influence the development of offshore wind projects in Colombia. The information summarized in Exhibit 31, which presents the main restrictions, categories and arguments based on the environmental and social context of the Colombian Caribbean, particularly the departments of Atlántico, Bolívar, La Guajira and Magdalena. These departments were chosen because the frequency and intensity of wind adjacent to their coastline is attractive for the development of this type of project.

The determination of the categories and the classification of the impact considered the sensitivity, fragility and vulnerability of the social and environmental aspects relevant for the development of offshore wind projects. The argumentation and relevance is the result of the impact classification based on the following criteria:

Exhibit 31 Red, Amber, Green (RAG) evaluation criteria

Color	Criteria
Red	An environmental or social consideration that is very likely to impact or influence the development of offshore wind projects in the Colombian Caribbean.
Amber	An environmental or social consideration that is likely to limit or influence the development of offshore wind projects in the Colombian Caribbean.
Green	An environmental or social consideration that is not likely to limit or influence the development of offshore wind projects in the Colombian Caribbean.

Source: ERM and RCG

These categories were defined based on experience in the preparation of environmental impact studies for offshore projects, knowledge of the area by the professionals on the work team, ecosystems and communities identified, and national regulations in force. Likewise, this document is aligned with the best environmental and social practices stipulated by the Environmental and Social Framework (ESF) of the World Bank, the International Finance Corporation (IFC), as well as UNESCO and the International Union for Conservation of Nature (IUCN) good practice guides.

The analysis of the environmental and social context and the results of the impact classification integrated the areas of interest located between the coastal strip and the Exclusive Economic Zone (EEZ)[17]. The environmental and social data show that there is a greater probability of affecting sites of interest, significant biodiversity areas (presence of birds), near the coastal zone of the Colombian Caribbean, sites of cultural interest (heritage character), socioeconomic activities (artisanal fishing, industrial fishing, tourism, ports, and communications).Therefore, a separation distance from the coast should be considered to avoid affecting these areas and reduce the risks of offshore wind projects by coastal processes (sediment movements, coastline currents, erosion by oceanic circulation).

The analysis has focused on identifying possible areas of environmental and social restriction in the Colombian Caribbean, with the purpose of providing project

[17] Law No. 10 of 1978, which establishes regulations on the Territorial Sea, Exclusive Economic Zone and Continental Shelf, establishes that the Exclusive Economic Zone (EEZ) corresponds to the 200-mile strip of sea along the exclusive line for the exploitation of living and mineral resources.

developers with relevant elements for the development of the pre-feasibility and feasibility stages of offshore wind projects.

A list of the key stakeholders for environmental and social considerations is provided in Section 12 of this report.

Considerations

For each potential environmental, social, and human consideration identified, the project team considered the following:

- The extent the consideration applies to the most likely offshore wind developments
- The relevant areas in the Colombian Caribbean,
- Regulatory legal framework, including the role of regional corporations,
- How the issue is defined in the law and applied in practice,
- Defined similar issues have been addressed in other offshore wind markets
- Set out options for how the Colombia can address the key issues, and
- Relevant experience in the approach of Environmental Studies for offshore projects (hydrocarbon sector) in the Colombian Caribbean.

World Bank Environmental and Social Framework Environmental and Social Standards

The environmental and social considerations evaluated are aligned with the World Bank Environmental and Social Framework (ESF), including the need to carry out the evaluation and management of risks and environmental and social impacts for all offshore wind projects. The ESF applies to all new World Bank investment project financing and enables the World Bank and prospective borrowers to better manage environmental and social risks of projects and to improve development outcomes. It consists of 10 core environmental and social standards (ESS) as follows:

Exhibit 32 World Bank Group ESF environmental and social standards (ESS)

Standard	Subject
ESS1	Assessment and Management of Environmental and Social Risks and Impacts
ESS2	Labor and Working Conditions
ESS3	Resource Efficiency and Pollution Prevention and Management
ESS4	Community Health and Safety
ESS5	Land Acquisition, Restrictions on Land Use, and Involuntary Resettlement

ESS6	Biodiversity Conservation and Sustainable Management of Living Natural Resources
ESS7	Indigenous Peoples/Sub-Saharan African Historically Underserved Traditional Local Communities
ESS8	Cultural Heritage
ESS9	Financial Intermediaries
ESS10	Stakeholder Engagement and Information Disclosure

Source: RCG-ERM, adapted from World Bank Group

6.3 Results

In the environmental and social context, several areas of interest for offshore wind project developers have been identified. The principal environmental and social considerations are defined in below. Constraints are aligned with World Bank Environmental and Social Standards ESS1 and ESS6 where relevant.

The areas with marine components most likely to be affected or that influence the development of offshore wind projects are: National Natural Parks (PNN), RAMSAR Sites, Significant Biodiversity Areas (ASB), Key Biodiversity Areas, Important Bird Conservation Areas (AICAS), Civil Society Nature Reserves, natural areas (corals, grasslands, mangroves and nesting beaches), artisanal fishing areas, areas for the exploitation of fishing resources, particularly fishing grounds located between 1 and 12 nautical miles, submerged cultural heritage, immovable cultural heritage (fortifications), intangible cultural heritage (sacred sites), tourist and recreational activities developed in places near the coastal zone, the network of submarine cables installed on the seabed and offshore blocks located offshore.

The areas most likely to be a limitation or to affect the development of offshore wind projects, based on the location of potential sites for offshore wind energy development, are: registered maritime routes and embarkation and disembarkation sites, coastal industrial fishing and industrial fishing carried out in the Exclusive Economic Zone.

National legislation requires developers to obtain the respective environmental license for the development of this type of project, which requires the performance of the respective Environmental Impact Studies that include, among other aspects, information on the biotic, abiotic and socioeconomic components of the area of influence. However, to date the Autoridad Nacional de Licencias Ambientales (ANLA) has not formulated generic Terms of Reference for offshore wind projects for the environmental licensing process, so the ANLA is currently issuing specific Terms of Reference for each offshore wind project that officially requests them.

Exhibit 33 Summary of Environmental and Social Constraints

Constraint	Category	Constraint Category	Constraint Category
Protected areas and Key Biodiversity Areas	Environmental	**R**	Environmentally designated sites of regional, national, and international significance. Affects both nearshore and offshore sites, but more likely to impact nearshore sites.
Critical and natural habitats	Environmental	R	Coastal habitats such as nearshore flats and mangroves and offshore seagrass beds and coral reefs. Affects both nearshore and offshore sites, but coastal habitats more likely to impact nearshore sites
Sensitive marine species (priority diversity values)	Environmental	R	Dolphins, sperm whales, whales, manatees, sharks, turtles, and other species Sensitive to survey and construction activities, including threatened species. Affects both nearshore and offshore sites, but more likely to impact nearshore sites.
Birds and bats	Environmental	R	Habitats for resident and migratory bird species, particularly nearshore feeding grounds and high-tide roost sites which support internationally important populations of threatened species. Particularly important for nearshore sites.
Artisanal fishers	Social	R	Areas for the exploitation of fishery resources (usually close to the coastal zone) Fishing grounds located between 1 and 12 nautical miles
Commercial Fishing grounds	Social	A	Registered maritime routes and embarkation and disembarkation sites located near the coastal zone. Industrial fishing zones near the coastal zone (shallow water shrimp). Industrial fishing zones (from 5 nautical miles to the Exclusive Economic Zone).
Aquaculture	Social	A	Coastal aquaculture and mariculture of fish, shellfish, and seaweed. Particularly important for nearshore sites.
Landscape, seascape	Social	A	Visual impact of wind turbines on nearby heritage features or natural settings (negative); and on communities (positive/ negative). Particularly important for nearshore sites.
Ships and navigation routes*	Technical	R	Shipping routes, anchoring areas, and transshipment area. Affects both nearshore and offshore sites.
Historical and cultural heritage	Social	R	Underwater cultural heritage, immovable cultural heritage (fortifications), intangible cultural heritage (sacred sites). Heritage located near the coastal zone.
Tourism activities	Social	R	Cruises, recreational tourism (sun and beach), cultural, historical, religious, ethnic, ecological, and ecotourism with an ethnic focus, including its value chain. Important activities in places near the coastal zone.
Communication infrastructure	Social	R	Submarine cable network (safety area of 1/4 nautical mile or 500 meters on each side)
Oil and gas infrastructure operations	Social	R	Offshore blocks with Exploration and Production-E&P contract and Technical Appraisal-TEA contract - Located offshore
Military exercise Areas*	Technical	R	Military bases, firing ranges, exclusion zones, military no-fly zones.

			Firing ranges can also include UXO. Affects both nearshore and offshore sites.
Aviation*	Technical	A	Physical obstruction and aviation radar signal distortion caused by wind turbines and blade rotation. Particularly important for nearshore sites.

Source: RCG-ERM 2021

Note: Constraints marked * are not considered to be environmental or social constraints according to World Bank ESS definitions but are included here as technical constraints that will need to be addressed in project development.

The identified area of interest (AoI) in Section 4 intersects with areas of high ecological and biological importance for the conservation of key species and ecosystems such as Vía Salamanca Island Park, Ciénaga Grande de Santa Marta, Sawairu Integrated Management Regional District seagrass, Tayrona National Park, among others, which support populations of migratory, endemic and internationally important birds, sensitive ecosystems that are found in shallow coastal waters and, therefore, are especially vulnerable to the development of near-shore wind projects.

The wind industry has been implementing different mitigation measures to allow the development of wind farms near designated areas, such as modifying the operation of wind turbines, flashing lights, identification of key feeding and breeding areas in order to avoid collisions of birds and changes in their behavior and migratory routes, procedures such as soft start or Ramp up have also been implemented to limit acoustic disturbances on marine mammals and fish during the construction and operation phases.

However, in Colombia it is necessary to develop a regulatory framework aimed at issuing Environmental and Social Guidelines and Terms of Reference to guide the preparation of Environmental and Social Studies (and associated assessment) taking into account the particular characteristics of this type of offshore wind projects and the most sensitive and important environmental and social areas in the sites that due to their wind conditions are of greatest interest for their location, so as to ensure prevention, control, mitigation and/or compensation measures in accordance with the possible effects that the projects may generate.

6.3.1 Environmental Constraints

6.3.1.1 Critical and priority habitats and legally protected areas

Colombia possesses a large number of coastal marine habitats and ecosystems such as coastal lagoons and wetlands, coral reefs, seaweeds, mangroves, rocky and sandy beaches, coastal upwelling areas and various types of seabed (Alonso et al., 2008a). The country has ratified the Convention on Biological Diversity (CBD) through National Law 165 (1994), which formed the basis of the National Biodiversity Policy, including the consolidation of a National System of Protected Areas (Sistema Nacional de Áreas Protegidas, SINAP).

Marine mammals are important in the biodiversity of the Caribbean and play fundamental roles in ecosystems. The Colombian Caribbean is home to a high diversity of marine mammals, such as dolphins, sperm whales, and manatees, among others. Currently, 29 species of marine mammals have been registered, that is, 83% of the species registered in Colombia, and 24% of the species registered worldwide (Ávila & Giraldo 2022).

The SINAP classifies the areas into two main groups, public and private. Among the public areas, the most important at the national level is the National Natural Park System (which, in turn, are divided into National Park, Natural Reserve, Unique Natural Area, Flora Sanctuary, Fauna Sanctuary and Parkway) and the Protective Forest Reserves, Regional Natural Parks, Integrated Management Districts, Soil Conservation Districts and Recreation Areas; among the private areas are the natural reserves of civil society.

These categories of marine protected areas, are aligned with the IUCN management categories and should therefore be considered as restricted areas for the development of offshore wind projects in compliance with IFC-PS6. For the Colombian Caribbean, eight (8) areas with a high level of restriction were identified, of which only two intersect with the identified areas of interest. If the project deems it necessary, it will be possible to request the subtraction of protected areas when for other reasons of public utility and social interest there are plans to develop uses and activities that are not permitted within a protected area, in accordance with the legal regime of the management category. More specific analysis should be performed for the EIA of individual projects.

Exhibit 34 Legally protected areas in Colombia with marine or coastal components

Legally Protected Area	Total declared area (ha)
Bahia Portete Kaurrele National Park	14,08
Pastos Marinos Sawairu Integrated Management Regional District*	67,177
Musichi Integrated Management Regional District	1,494
Delta del Rio Rancheria Integrated Management Regional District	3,609
Los Flamencos Fauna and Flora Sanctuary	7,034
Tayrona National Park	19,309
Isla de Salamanca Nature Monument*	56,592
Los Corales del Rosario y San Bernardo National Park	123,455

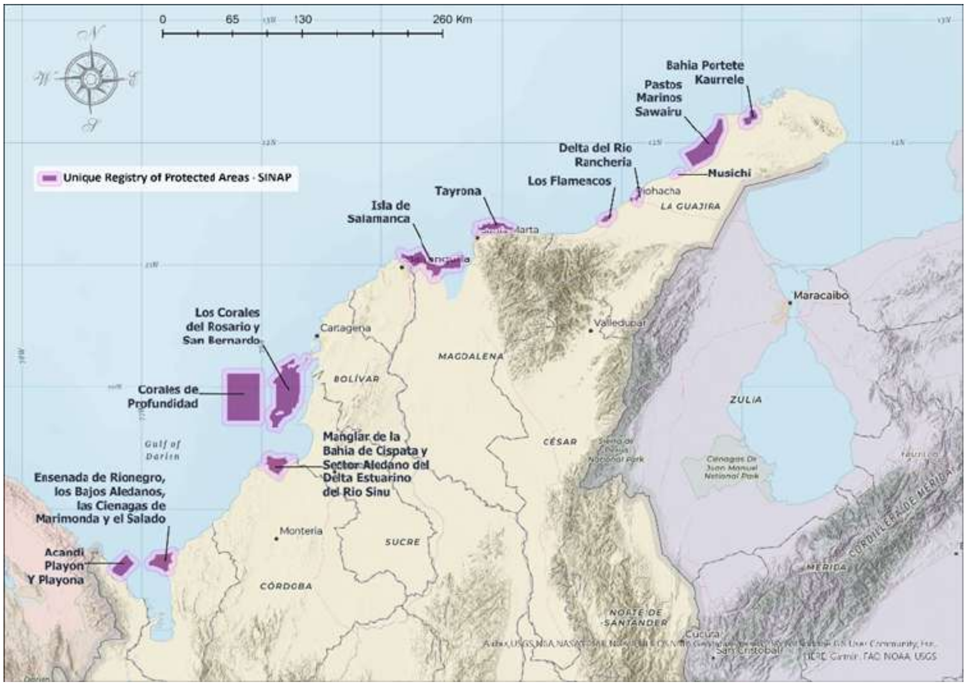
Corales de Profundidad National Park	142,192
Manglar de la Bahia de Cispata y Sector Aledano del Delta Estuarino del Rio Sinú Integrated Management Regional District**	27,838
Ensenada de Rionegro, los Bajos Aledanos, las Ciénagas de Marimonda y el Salado Integrated Management Regional District**	30,758
Acandi Playon Y Playona Fauna Sanctuary**	26,233
Seaflower Specially Protected Area (Cartagena Convention) **	6,506,649

Source: https://www.protectedplanet.net/country/COL*legally protected areas that intersect with the areas of interest identified for tis type of project

** These protected areas are located in departments with less potential for the development of offshore wind projects

The exhibit below shows the legally protected areas in Colombia's coastal and marine zones.

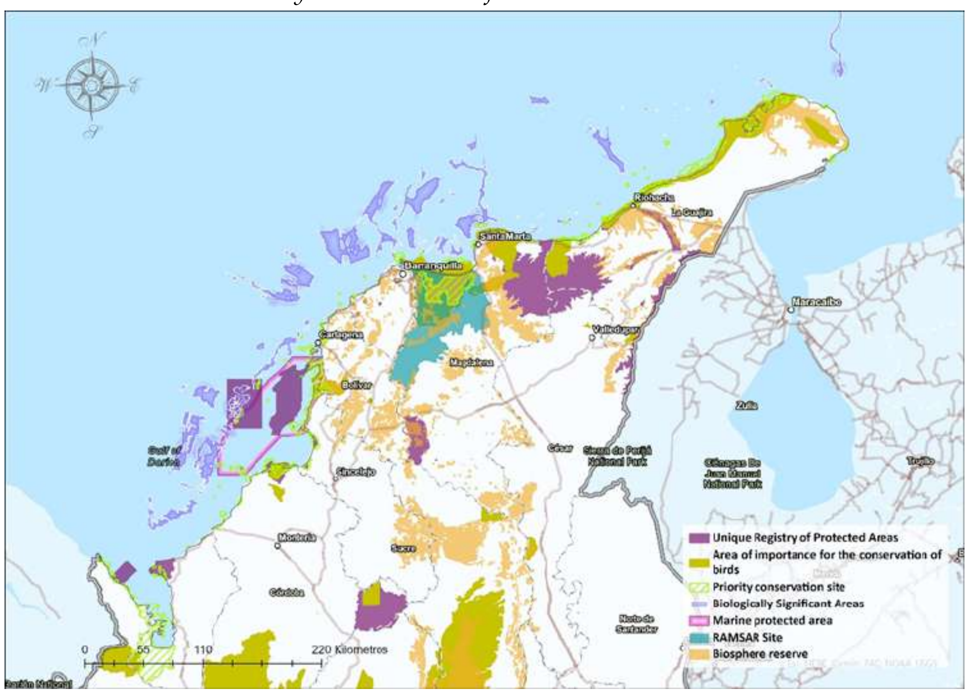
Exhibit 35 Legally protected areas in Colombian Caribbean coast



Source: Open data portal of the environmental sector. Environmental Information System of Colombia-SIAC

Additionally, there are other categories of environmentally sensitive areas different from those that are part of the SINAP, such as the strategic ecosystems: RAMSAR sites (Convention on Wetlands of International Importance), Mangroves, coral reefs, seagrasses, wetlands, tropical dry forest, among others, and the complementary conservation and sustainable development strategies: Forest Reserve Law 2, buffer zones in areas of the National Park System, biosphere reserves, peace forests, AICA (Important Bird Areas), and areas considered UNESCO-MAB World Heritage Sites, areas considered UNESCO-MAB World Heritage Sites and areas of scientific interest or with conservation priorities contemplated by the National Natural Parks of Colombia and/or research institutes such as the Marine and Coastal Research Institute José Benito Vives de Andres (INVEMAR)

Exhibit 36 Environmentally sensitive areas of the Colombian Caribbean



Source: ERM-RCG,2021

Regarding the RAMSAR sites identified for the areas of interest, the Magdalena River Estuarine Delta System, Ciénaga Grande de Santa Marta, Ramsar Site no. 951 (CGSM-Ramsar), has existed since 1998 with an area of 5286 km² and a perimeter of 579.8 km (Ministry of Environment, Housing and Territorial Development, 2009). It has also been categorized as AICA, a site of key importance for biodiversity and AZE-Zero Extinction areas; this is a coastal estuarine system with several lagoons and rivers, and includes the largest mangrove area of the Caribbean coast of Colombia. It is the most important area in the Colombian Caribbean for waterfowl, marine mammals, fish, and reptiles. This Ramsar site has also been designated as an Important Bird Area.

In addition, the Guajira coastal wetland complex was identified as an AICA, located in northern Colombia on the western margin of the Guajira Peninsula, which is a transition zone between the arid plains of La Guajira and the Caribbean Sea, where marine habitats, wetlands, marshes, swamps, peat bogs, marshes, swamps and other bodies of fresh or brackish water, permanent or seasonal, are located (Díaz and Guerra 2003). A total of 145 bird species have been recorded, most of which are aquatic birds, for a large community of land birds associated with the dry scrublands of the Caribbean coast and sea turtles[18].

The following biosphere reserves were identified for the AoI: the Ciénaga Grande de Santa Marta (SGSM), Vía Salamanca National Park, SGSM Flora and Fauna Sanctuary, and the Sierra Nevada de Santa Marta (Sierra Nevada de Santa Marta, Tayrona, and Los Flamencos Parks). The park is located within the Magdalena River Estuarine Delta System, Ciénaga Grande de Santa Marta, it overlaps with the Flora and Fauna Sanctuary, its surrounding area has been internationally declared a RAMSAR site, in 2000 it was categorized as a UNESCO Biosphere Reserve, and nationally it has been catalogued as an Important Bird Conservation Area (IBAs).

Exhibit below lists the KBAs (Key biodiversity areas)/IBAs identified for the Colombian Caribbean, with presence within the AoI, these areas present environmentally sensitive terrestrial and/or marine ecosystems of high importance whose main function is the conservation of the planet's biodiversity and the sustainable use of resources.

Exhibit 37 KBAs / IBAs in Colombia with marine or coastal components

KBA	Area (ha)	KBA Triggers	
		Threatened Species	**Priority Biodiversity / Congregations**
AICA Complejo de Humedales Costeros de la Guajira (KBA/IBA)	218,756	Sapphire-bellied Hummingbird – *Amazilia lilliae*, threatened marine/aquatic reptiles - *Caretta, Eretmochelys imbricata, Dermochelys coriacea, Chelonia mydas, Crocodylus acutus.*	Important area for migratory waterbirds. Holds the majority of the distribution area of the non-breeding population of American Flamingo (P*hoenicopterus ruber ruber*) in Colombia. The Sapphire-bellied Hummingbird (A*mazilia lilliae*) is a Critically Endangered, Colombian endemic, mostly restricted to well-preserved mangrove habitat.
Parque Nacional Natural Tayrona (KBA/IBA)	21,276		Huge diversity of bird species and mammal species, including bats. Large number of bird species that area threatened, restricted-range/endemic or biome-

[18] Rueda-Almonacid 2002; Castaño-Mora 2002; BirdLife International, 2021

			restricted. Concentrates the majority of tropical costal ecosystems, including coral reefs and seagrasses, in a small area.
Reserva de Biosfera RAMSAR Ciénaga Grande, Isla de Salamanca y Sabana Grande (KBA/IBA, AZE- Zero Extinction areas)	251,656	Sapphire-bellied Hummingbird – *Amazilia lilliae*, Bronze-brown Cowbird - *Molothrus armenti*	Most important area in the Colombian coast in the Atlantic for waterbirds, especially for migratory waders and anatids (ducks, geese, etc.). Concentrations of waterbirds and Blue-winged Teals *Spatula discors*. Important numbers of migrating Buff-breasted Sandpipers (C*alidris subruficollis*) and resident Northern Screamers (*Chauna chavaria*), both of which are globally Near-Threatened. This is a AZE site that concentrates nearly the whole world population of the Sapphire-bellied Hummingbird (*Amazilia lilliae*). Important spawning area for many fish species and for other threatened species, such as the American Manatee (*Trichechus manatus*) and the American Crocodile (*Crocodylus acutus*).
AICA Valle de San Salvador (KBA/IBA)	58,000	Blue-billed Curassow *Crax alberti,* Sapphire-bellied Hummingbird *Amazilia lilliae,* Santa Marta Antpitta *Grallaria bangsi,* Rusty-headed Spinetail *Synallaxis fuscorufa*	The valley has been identified as a priority area for conservation due to the richness of fauna and flora found there (FPSNSM 2000). The San Salvador Valley covers primary habitat areas, along an altitudinal gradient, that have been lost in other areas of the Sierra Nevada de Santa Marta.
AICA Región Ecodeltáica Fluvio-Estuarina del Canal del Dique (KBA/IBA)	42,952	Northern Screamer - *Chauna chavaria*	An assessment of the mangrove areas on the coasts south of Bolívar and north of Sucre where *Lepidopyga lilliae* possibly exists is recommended
AICA Zona Deltáica-Estuarina del Río Sinú(KBA/IBA)*	10,000	Three species are in some category of threat at the national level according to Renjifo et al. (2002)	This area includes the old and current delta of the Sinú River, with its corresponding estuarine environment dominated by mangroves. Here are the best preserved

		and six present a restricted range of distribution according to Stiles (1998). Very numerous nesting colonies of White Ibis (*Eudocimus albus*), Red Heron (*Agamia agami*) and many other herons are found throughout this area. In the bay of Cispata there is a stable population of the Tucuxi dolphin. Additionally, a reintroduction and installation program of artificial caiman nests (*Crocodylus acutus*) is being carried out.	mangroves in the Colombian Caribbean and one of the most extensive. In this region there is a complex mosaic of habitats that include mangroves, swamps, mud flats, streams, sandy marine and riparian beaches, fragments of dry forest and freshwater wetlands.
Reserva de Biósfera Seaflower(KBA/IBA)*.	350,000	White-crowned Pigeon - *Patagioenas leucocephala,* San Andres Vireo - *Vireo caribaeus,* Thick billed Vireo - *Vireo crassirostris,* Jamaican Oriole - *Icterus leucopteryx*	The differences in the geological formation of the islands generate a great diversity of fauna and flora species, some threatened species.

Source: http://www.keybiodiversityareas.org/ and http://www.birdlife.org

* These KBAs / IBAs are located in departments with less potential for the development of offshore wind projects.

Marine mammals in the Caribbean of Colombia are at risk due to threats related to fishing, hunting/capturing and maritime transport activities, mainly in coastal areas, being the Gulf of Urabá, Gulf of Darién, Gulf of Morrosquillo, in front of Barranquilla, Ciénaga Grande de Santa Marta and the Gulf of Coquivacoa are the areas with the greatest exposure to risk in the Caribbean (Avila & Giraldo 2022)[19], therefore, it is important to take this condition into account when defining the exploration area and the management measures, for this type of projects

[19]Avila, I., & Giraldo, A. (2022). Risk areas for marine mammals in Colombia. Journal of Tropical Biology, 70(1), 96-113. https://doi.org/10.15517/rev.biol.trop..v70i1.48553.

Ecologically or Biologically Significant Areas (EBSAs) are special areas that support the healthy functioning of the oceans and the many services it provides. The Conference of the Parties (COP 9) to the Convention on Biological Diversity adopted the following seven scientific criteria for identifying EBSAs uniqueness or rarity; Special importance for life history stages of species; Importance for threatened, endangered or declining species and/or habitats; Vulnerability, fragility, sensitivity or slow recovery; Biological productivity; Biological diversity; and Naturalness. The identification of EBSAs and the selection of conservation and management measures are the responsibility of States and relevant intergovernmental organizations, in accordance with international law (including the United Nations Convention on the Law of the Sea). The criteria do not include quantitative thresholds, but in principle have much in common with the definition of Natural Habitats and the World Panel of Experts (WBG/IFC) Critical Habitat criteria, and could therefore be an important high-level planning consideration for offshore wind energy development. In the area of interest, the Magdalena and Tayrona ocean floor was identified as the main EBSA.

Exhibit 38 Significant EBSAs in the Areas of Interest

EBSA	Significance
Fondos oceánicos de Magdalena y Tayrona	Unique habitat in the Caribbean region as well as in the world, where the species *Madracis myriaster* is the main structuring species of the deep corals waters. A high richness, diversity and endemic species are associated with submarine canyons and seamount geoforms, including over 100 species of fishes, echinoderms, mollusks, crustaceous, cnidarians and bryozoans.

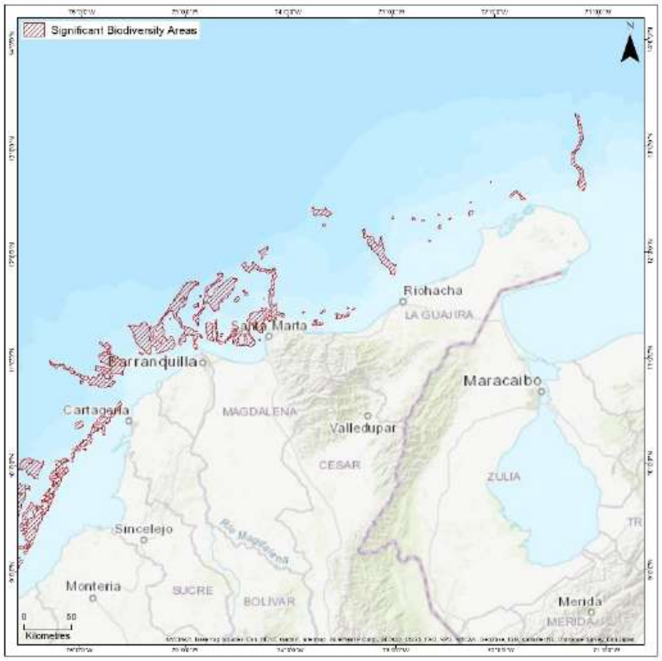
Source: RCG-ERM, 2021

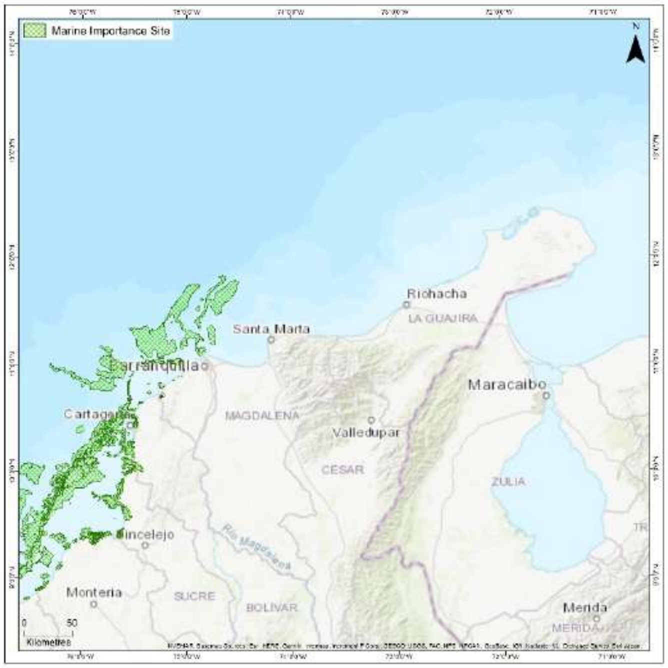
The installation of wind turbine bases and submarine cables can disturb the seabed and temporarily increase suspended sediments in the water column, which in turn leads to a decrease in water quality and could possibly affect bottom-associated marine species such as benthos, corals, sponges and seagrasses, as well as have an impact on areas identified as fishing grounds. Additionally, the installation of offshore structures could generate localized erosion of the seafloor due to changes in water movements; the location of operational turbines may alter the daily circulation of birds and bats (e.g., from feeding sites to roosts or breeding areas), and may pose a barrier to the migratory patterns of certain animal species (Drewitt and Langston, 2006, Masden *et al*. 2009).

It is likely that some of the priority biodiversity values existing in these areas are sensitive to the impacts associated with the development of offshore wind energy. Taking into account that in Colombia there are no terms of reference for the offshore wind sector, in other sectors, although there are no exclusions, as in the case of the hydrocarbon sector, it is recommended that these areas be subject to differentiated management at the moment of planning the sector's activities, so the same could apply to wind projects. When planning projects of this type, it is necessary to consider the proximity to places of high biodiversity value in the region, as well as to take into account national and international protected areas (such as marine protected areas),

areas of importance such as IBAs/AICAS/KBAs/AZE/Ramsar (wetlands of international importance), known places of concentration of gregarious species, and unique or threatened ecosystems. Additionally, it is suggested to plan the construction, installation and dismantling of structural components taking into account sensitive periods for the life cycle of the species identified in the area of interest (IFC, 2015).

Exhibit 39 Important Biodiversity and Marine Importance Areas



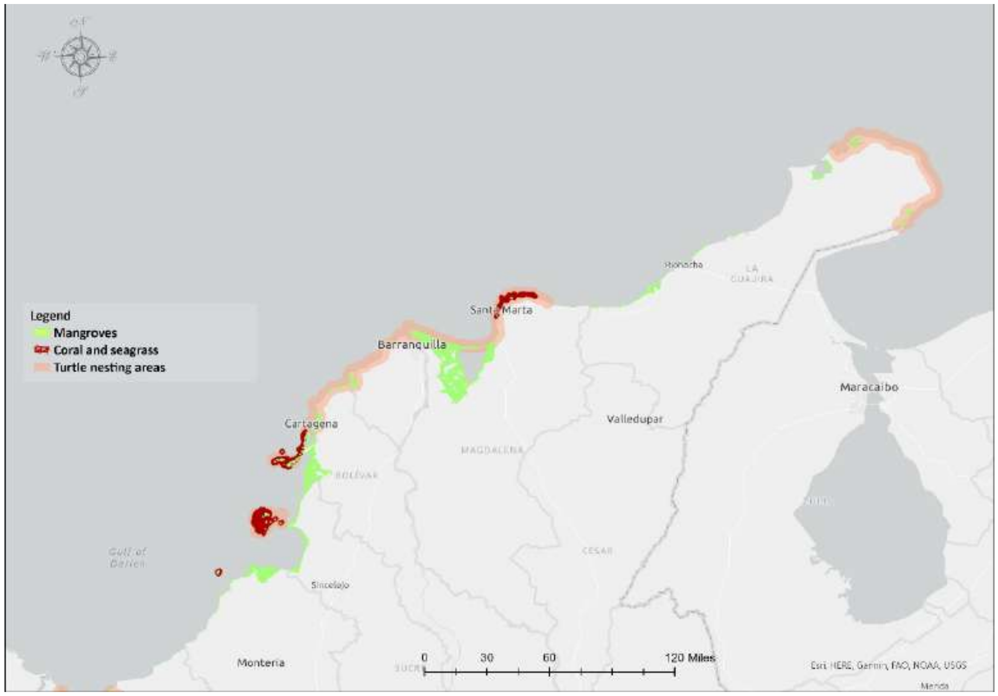


Source: INVEMAR, 2016

6.3.1.2 Sensitive marine species and habitats (priority diversity values)

According to their geologic, hydrographic, climatic, and biological features, the coastal and oceanic realms of Colombia can be subdivided into 18 natural marine ecoregions, nine in the Caribbean (Díaz & Acero 2003) . Such a variety of conditions leads to a great diversity of habitats and ecosystems, and the great majority of tropical marine habitats is well represented in Colombia (Díaz & Acero 2003; Uribe *et al.* 2020). Amongst the most threatened marine and coastal habitats are coral reefs, seagrass beds and mangrove forests, all with a presence in the project's area of influence (Uribe *et al.* 2020).

Exhibit 40 Sensitive marine species



Source: INVEMAR; 2021; Allen Coral Atlas maps,2021; WCMC, 19999.

Colombian coral areas and associated ecosystems are mostly located up to 30 m deep (Uribe *et al.* 2021). In the Caribbean Sea, most important and larger coral areas are in the Gulf of Darién, especially near the coast between Cartagena and the islands off San Bernardo del Viento, and in deeper waters in the center of the Caribbean Sea, including the Seaflower area. The oceanic reefs of the Archipelago of San Andrés and Providencia (Seaflower PA) are among the most extensive reef systems of the Atlantic, occupying approximately 760 km^2 (Díaz & Acero 2003; Uribe *et al.* 2021). Other significant areas of coral are found just off Ciénaga Grande, Isla de Salamanca y Sabana Grande and Tayrona KBAs, and in Bahia Portete. The major part of the coral reefs is included within Legally Protected Areas (LPAs) and Internationally Recognized Areas (IRAs), including EBSA (ASU, 2021).

Mangroves are amongst the biologically most productive ecosystems in the world and play an important role in the sustainability of fisheries, protect the shoreline against erosion, and provide an important resource of wood (Díaz & Acero 2003). Caribbean coast, the forests are smaller and fringe intertidal flats at the mouths of major rivers. Mangroves, comprised mainly of *Rhizophora mangle*, *Avicennia germinans*, and *Laguncularia racemose*, cover approximately 863 km2 of the Colombian Caribbean coast. In the Caribbean region, mangroves are mainly present between Manglar in Ciénaga Grande, Isla de Salamanca y Sabana Grande KBA. While the large majority of these habitat patches falls within LPAs and IRAs, The mapped areas of mangroves sourced from the Global Mangrove Distribution, Aboveground Biomass, and Canopy Height (2019).

Five species of seagrasses have been recorded in Colombian waters, of which *Thalassia testudinum* and *Siryngodium filiforme* are the most abundant. Most continuous areas of this habitat are present in Los Corales del Rosario y San Bernardo National Park, San Andrés Archipelago (Seaflower PA), and especially (almost 80%) along the shore and in the shallow portion of the continental shelf off the Guajira Peninsula (Pastos Marinos Sawairu PA and Complejo de Humedales Costeros de la Guajira KBA). The largest majority of the area occupied by seagrass in Colombia is comprised within PAs or IRAs; however, the mapped area of seagrass sourced from UNEP-WCMC.

Breeding areas for sea turtles extend along nearly the whole Colombian Caribbean coast, from the Gulf of Darién (Brazo Leon Río Atrato area) to Guajira Peninsula (Eckert & Eckert 2019). The Caribbean coast and surrounding islands also host important feeding grounds for sea turtles in places such as the Guajira Peninsula and the San Bernardo Archipelago (Eckert *et al.* 2020). Recent research has also confirmed that Loggerhead, Green and Hawksbill Turtles use the Seaflower LPA and IRA for breeding and foraging (Ramirez-Gallego & Barrientos-Muñoz 2020). In regard to cetaceans, the Guiana Dolphin has a patchy distribution along a major part of the Colombian Caribbean Sea coast from the Sinú river estuary to Guajira province (Borobia *et al.* 1991; Caballero *et al.* 2007). It is mostly associated with brackish waters, estuarine conditions and other shallow, sheltered coastal waters (Borobia *et al.* 1991; IUCN 2017).

Multiple direct and indirect effects on ecosystem processes and functions are expected following Offshore Wind Farm (OWF) installation (Gill, 2005). These can be linked to the delivery of ecosystem services, physical changes to the habitat from the installation of turbines and other structures, changes in hydrodynamic regime (Matutano *et al.*, 2016), benthic habitat loss or gain and the provision of shelter from fishing and predation (Gill, 2005; Miller et al., 2013; Wilson *et al.,* 2010). Indirect effects, linked to the direct effects, include modification to processes and functions, for example, complex epibenthic communities colonize turbine substructures forming artificial reefs, which can alter biodiversity and community structure, influencing processes and functions (Hooper *et al.*, 2005; Schleuning *et al.*, 2015).

Some marine species are sensitive to survey and construction activities. These species are, in general, those that are particularly sensitive to underwater noise, vibration, or smothering or loss of seabed habitat. Developers should consider the likely presence of dolphins, manatees, sharks, turtles, and some schooling fish species. Marine mammals are particularly sensitive to underwater noise. The degree of sensitivity varies according to species and the frequency and duration of noise. Some species are also susceptible to collision risk from vessels. Species may be disturbed by construction or operational noise, or by the presence of wind towers, or by boats and maintenance activity; animal behavior (e.g., calling rhythm, feeding, relaying, movements) may change in ways that reduce foraging or mating ability (reducing fecundity and/or animal health), or may increase chronic stress levels leading to reduced animal health. Wind facilities can also have positive effects, wind installations can serve as marine protected areas if navigation and commercial fishing are restricted within their boundaries (Kraus et al., 2019).

During operation, cables transmitting the produced electricity will also emit electromagnetic fields. This could affect the movements and navigation of species that are sensitive to electro- or magnetic fields, which includes fish species, particularly elasmobranchs and some teleost fish and decapod crustaceans, and sea turtles. However, marine animals could be affected by the underwater noise generated during the construction and operation of wind turbines. Any effects of the noise will depend on the sensitivity of the species present and their ability to adjust to it (Koeller et al, 2006; Thomen *et al,* 2006; Gill *et al*., 2009).

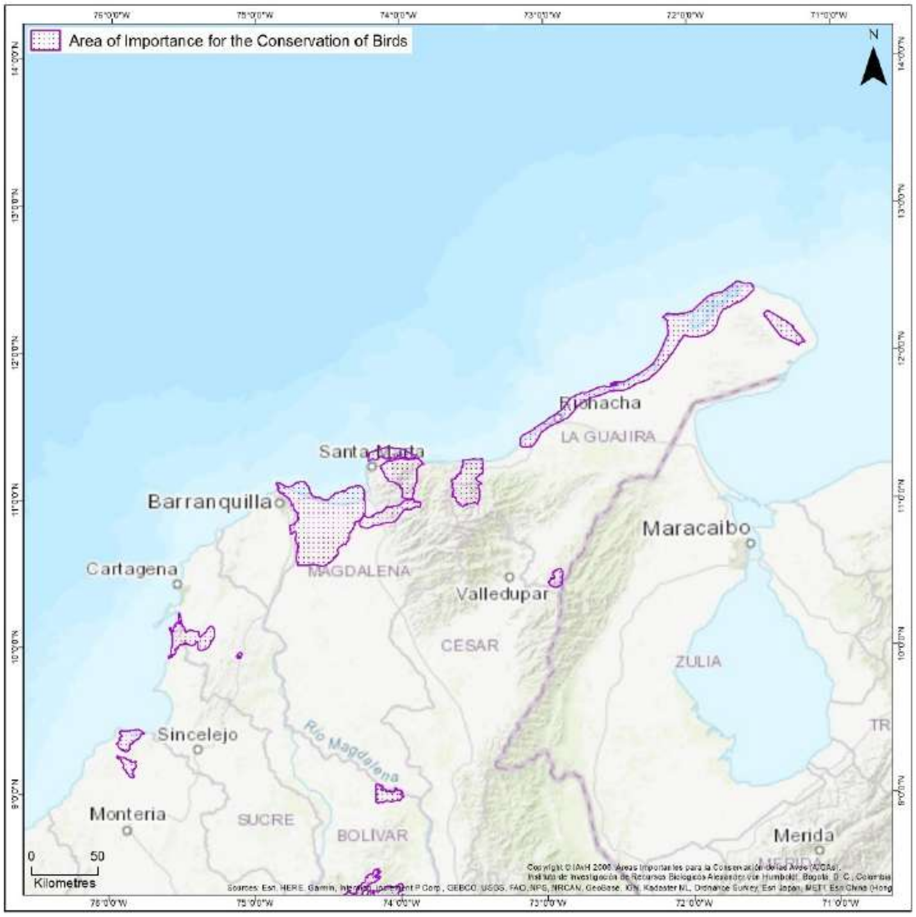
According to the above, it is necessary to take into account in the development of offshore wind projects, marine spatial planning and ESIA to avoid and mitigate the impacts that may be the result of the development of these projects, to increase market confidence and to comply with funder requirements.

6.3.1.3 Migratory birds and bats

Colombia hosts a huge number of resident or migratory waterbirds (225 species) and 98% of the migratory waterbirds from the Nearctic occur in the country (Naranjo & Bravo 2006; Arzuza *et al.* 2008). Several of these species are threatened at the global or at the national level (Troncoso 2002; Rodríguez-Gacha & Morales-Rozo 2016). The largest concentrations of waterbirds in Colombia are recorded during winter (November-January), due to the wintering or stopover of a large number of migrants (Naranjo *et al.* 2006; Ruiz-Guerra *et al.* 2008).

Nearly half of Colombia's waterbird species are found along Colombia's Caribbean coast, where are concentrated during the winter. Ducks and geese (Anatids) comprise more than three-quarters of these. Wading birds, flamingos, ibis, ardeids, storks, Limpkin (*Aramus guarauna*), pelicans, cormorants, frigates, gulls, terns and skimmers are also abundant (Ruiz-Guerra et al. 2008).

Exhibit 41 *Areas of importance for the conservation of birds*



Source: Alexander von Humboldt Biological Resources Research Institute (IAvH)

Nearly all Anatids and most part of the waders concentrate in Ciénaga Grande, Isla de Salamanca y Sabana Grande, a Ramsar wetland and LPA. The KBA/IBA Complejo de Humedales Costeros de la Guajira is the second most important area for waders along the Caribbean coast and the most important site in winter for the remaining groups of waterbirds (Ruiz-Guerra *et al.* 2008). Importantly, this area also hosts more than 6% of the whole South American Caribbean population of American Flamingo (*Phoenicopterus ruber* (LC)), a species considered as Endangered at the national level (Troncoso 2002; Renjifo *et al.* 2016; Rodríguez-Gacha y Morales-Rozo 2016).

The hazards presented to birds by the construction of offshore wind farms (OWF) remain primarily: the barrier they present to movement, loss of habitat and collision risk. Most studies to date have used radar and thermal infrared monitoring as well as range-finding and visual observations to confirm that most of the more abundant and especially large bodied birds show major avoidance to offshore windfarms, minimizing the probabilities of collision. Slightly extended migration distances are unlikely to have consequences for these species. Effects on breeding interrupted during their commuting flights remain less well studied, but avoidance of conflict is easily achieved by siting offshore wind turbines well away from important concentrations of breeding seabirds and their respective feeding areas (Fox *et al*. 2006; Jensen *et al*. 2016); And in poor visibility conditions, large numbers of birds could collide OWF attracted by their illumination. One of the most useful mitigation measures to avoid this type of impact is to replace the continuous light with an intermittent one (Huppop *et al*, 2006).

Several species of bats are present along the Colombian Caribbean coast and in general their interaction with wind farms on land is a concern. Similar considerations will be applicable to offshore wind projects, although this is likely only to be relevant for nearshore projects.

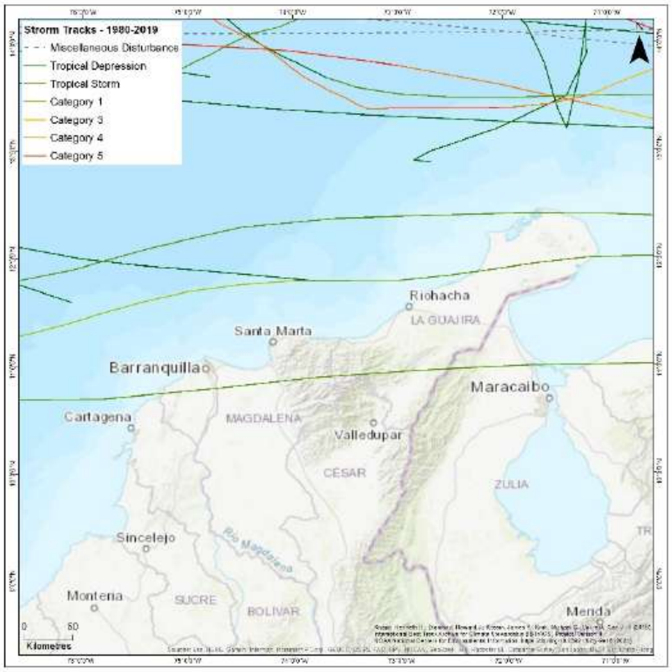
Many potential negative effects of offshore wind farms can be reduced within the planning process, by avoiding important recruitment habitats and by timing construction activities outside of important breeding seasons. Obviously, such measures should be based on real knowledge on the distribution and population status of local species and habitats. Given the high dependency of the obtained conclusion on local environmental conditions, a fundamental issue for the sustainable development of OWF is the availability of reliable seafloor and habitat maps and information on population connectivity and learn from other industries to inform risk assessments and the effectiveness of mitigation measures (wind energy, seismic surveys and floating oil platforms). According to the potential negative effects of OWF, is necessary the marine spatial planning to inform the higher capacity scenario and in all cases ESIA to GIIP to avoid these types of impacts.

6.3.2 Extreme Weather

The potential for severe weather events and the probability of the occurrence of extreme conditions also impacts the development of offshore wind farms in a region. Among the most pertinent extreme weather conditions considered for offshore wind farm development are: (1) major hurricanes that have a probability of delivering wind and wave conditions that exceed design conditions for the structure, and (2) earthquakes creating seismic conditions that cause unstable ground conditions and degradation of soil strength, which can lead to failure of major offshore wind farm components. Nevertheless, the probability of extreme weather events does not prohibit offshore wind farm development in a region. Rather, it influences various decisions with respect to mitigation, including the technology, design and engineering of the offshore wind farm.

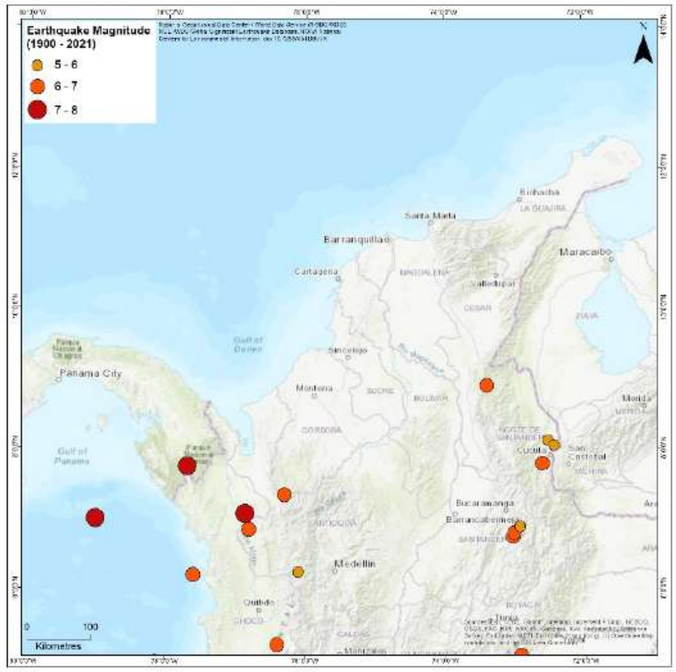
Exhibit 42 Extreme Weather

Hurricane tracks in Colombia 1980-2019



Source: NOAA National Centers for Environmental Information, 2021

Earthquake events in Colombia



Source: National Geophysical Data Center / World Data Service (NGDC/WDS), NOAA, 2021

Based on a historical assessment of extreme weather events in Colombia, it is unlikely that extreme weather risks would detour offshore wind development in the Areas of Interest identified in this study. Although unanticipated extreme weather events may occur over the lifecycle of the offshore wind farms, the probability that these events would significantly exceeding design conditions to the extent that they may causes structural and mechanical failures remains tolerably low.

6.3.3 Population Context and Socioeconomic Conditions

Projections by the National Administrative Department of Statistics (DANE) as of June 2017, indicate that the Caribbean region is composed of a population of 10.7 million inhabitants, (Banco de la República, 2017). In relation to ethnic composition, 15.7% of the population considers itself Afro-descendant, 6.8% indigenous and 77.5% has no ethnic affiliation.

The region's ethnic communities develop socioeconomic, cultural and religious practices in the continental and marine-coastal areas; In particular, the Wayuu indigenous people in the coastal zone of the La Guajira Peninsula (Cabo de La Vela, Bahía Portete, Puerto López and other sites of cultural interest) and the Kogui, Arhuaco, Wiwa and Kankuamo indigenous peoples in the foothills of the Sierra Nevada de Santa Marta (SNSM) perform ceremonies and rituals in the coastal strip between La Guajira and Magdalena. The Community Councils and non-ethnic communities living in the coastal zone also take advantage of marine resources through artisanal fishing, a socioeconomic activity that contributes significantly to their food security.

Exhibit 43 Location of the collective territories of the ethnic communities

Source: National Land Agency

The main economic activity in the region is agriculture and livestock farming, which includes planting food crops and raising cattle, pigs, cattle, goats, and other minor species; however, fishing is one of the most important activities, given the strategic location of the Caribbean region (1,932 km of coastline). Manufacturing activity in the region is concentrated mainly in the departments of Atlántico, Bolívar, and Magdalena, given the port facilities that facilitate imports and exports. The Caribbean and its diversity allow for the development of tourism activities with a cultural, historical, ecotourism, religious and recreational focus -sun and beach- (Observatorio del Caribe Colombiano).

6.3.3.1 Ships and navigation routes

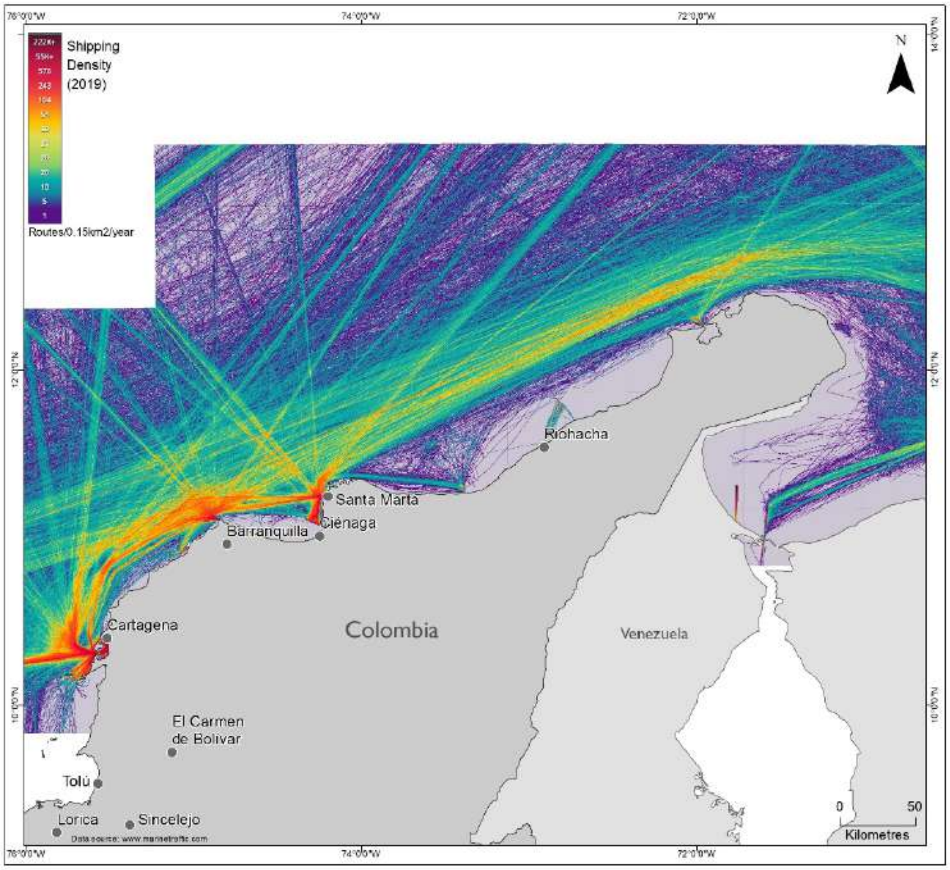
There is significant marine traffic offshore Colombia that is driven to a large extent by vessels transiting Colombian waters enroute to and from the Panama Canal (see Exhibit 44). These vessels include very large cargo vessels which have limited maneuvering capability and require a reasonable buffer between physical hazards. The ‘New Panamax’ class container cargo ships, for instance, can reach an allowable length of approximately 1,200 ft (366 meters) and a width of 160 ft (49 meters). Some jurisdictions such as the UK recommended that for navigational safety reasons, there be a buffer of 3.5 nautical miles in order to avoid collisions.

Spatial conflicts between offshore wind farm areas and shipping navigation routes will thus have a substantial impact on the citing and development of offshore wind farms in Colombia. The conflict is particularly acute with floating offshore wind farm siting, as these development areas are further offshore in Colombia and in more direct conflict with current shipping navigational routes. However, it is also a consideration closer to shore as there is also dense marine traffic entering and leaving the ports of Cartagena and Barranquilla, for instance.

The impact between offshore wind farms and shipping navigation spatial conflicts must be carefully considered amongst various stakeholders at the onset of offshore wind farm planning. It is recommended that the Government of Colombia and DIMAR engage to discuss potential vessel re-routing options (if applicable in final areas of development interest) to help facility safety measures and the coexistence of both industries.

All ships participant in OSW development, construction, O&M must fulfil MARPOL requirements and present the correspondent certifications.

Exhibit 44 Marine traffic and shipping density



Source: Map data sourced from marinetraffic.com with permission

*Disclaimer: The borders, colors, denominations and any other information on this map do not imply a judgment on the legal status of any territory or the endorsement or acceptance of such borders.

6.3.3.2 Artisanal fishing

Artisanal fishing is one of the main economic and social activities of the northeastern coastal margin of the Colombian Caribbean. Between the departments of La Guajira and Magdalena, most fishermen are members of 22 registered organizations[20] and

[20] INVEMAR. 2020. Identificación de zonas promisorias para pesca artesanal en el área del Plan Maestro de Protección y Restauración del Parque Nacional Natural Tayrona, Caribe colombiano. Convenio de cooperación No. 275 de 2020 AUNAP – INVEMAR. Santa Marta D.T.C.H.

alternate fishing with other activities such as tourism, agriculture, cattle ranching, construction, commerce and services. They use different fishing gear, including hand lines, gillnets, pots, and longlines. The activity is generally carried out in boats with 40 HP outboard motors (INVEMAR, 2020). Based on environmental studies for offshore projects in the departments of Atlántico and Bolívar, ERM has identified 42 fishing associations[21] that carry out their activities between 0 and 15 nautical miles and at depths between 1 and 400 meters. The boats used range between 6-10 m in length (length) and 1-2 m in beam (width), with outboard motors between 5 and >70 HP. The fishing gears used are hand line, gill nets and longline (ERM, 2017).

Exhibit 45 Artisanal Fishing Areas

Source: INVEMAR, 2021

It is relevant to consider that Decree 2256 of 1991 classifies marine fishing into 3 categories: 1) coastal fishing: when it is carried out at a distance of no more than one nautical mile from the coast, 2) inshore fishing: when it is carried out with vessels at a distance of no less than one mile and no more than twelve (12) nautical miles from the coast, and 3) offshore fishing: when it is carried out more than 12 miles from the coast. The exhibit above shows the artisanal fishing sites registered in the Geographic Viewer of Fishing Grounds of the Instituto de Investigaciones Marinas y

21 ERM. 2017. Archaeological Diagnosis. Environmental Impact Study for the Exploratory Drilling Area of the Sin Off-7 Block, confidential client. Bogotá-Colombia

Costeras José Benito Vives de Andres (INVEMAR), according to the consultation carried out online (September 2021).

Environmental studies of marine projects should identify, through a participatory exercise with artisanal fishermen, the categories of fishing (coastal, inshore and offshore), fishing routes and fishing grounds to know at least the areas where their economic activities are carried out, their characteristics and dependence on them, with a view to having sufficient information to identify and evaluate potential impacts and formulate the corresponding management measures and prevent, among others, possible conflicts between the parties due to the location of the projects.

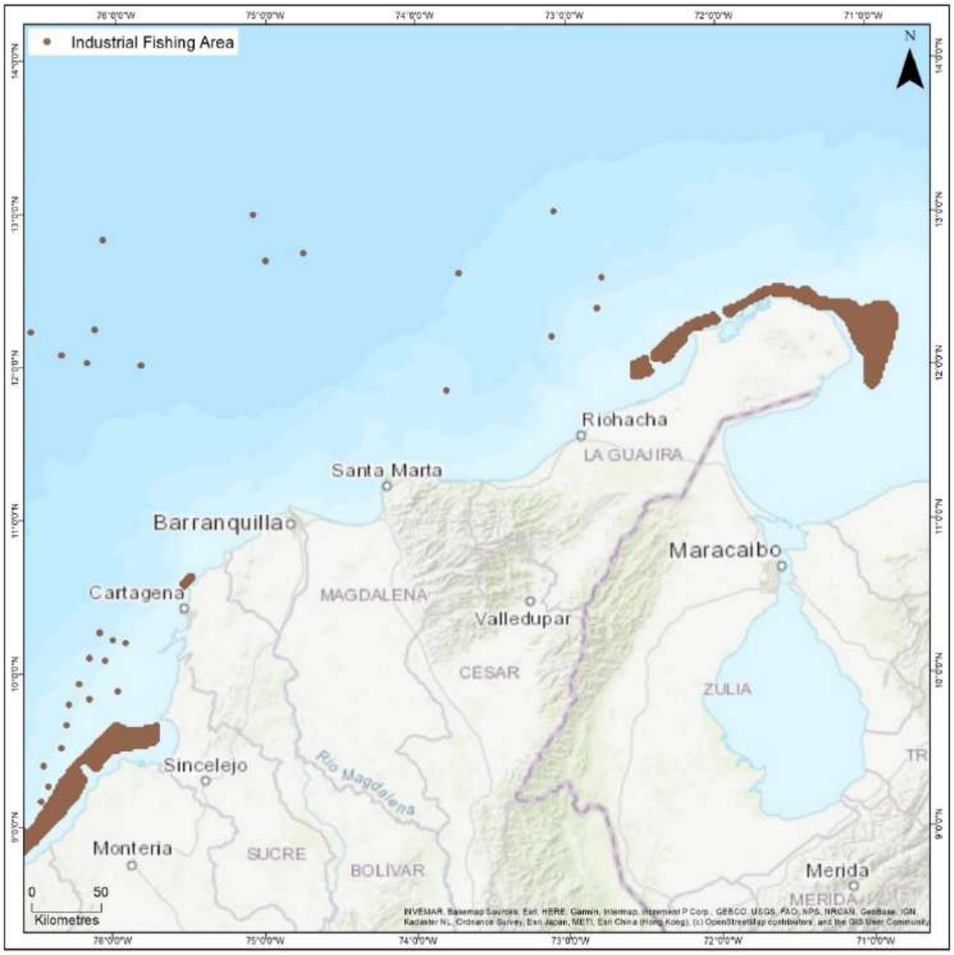
6.3.3.3 Industrial fishing

The Autoridad Nacional de Acuicultura y Pesca (AUNAP) indicates in their studies that industrial fishing in Colombia has developed key fisheries in resources such as: Shallow-water shrimp, deep-water shrimp, white fishing, lobster, purse seine tuna and longline, which are distributed in the Caribbean, Pacific and insular territory (San Andrés, Providencia and Santa Catalina). In the Colombian Caribbean, there are 4 types of industrial fisheries: 1) tuna with home ports in the cities of Barranquilla and Cartagena, 2) white fishing with home ports in Cartagena and San Andrés, 3) shallow-water shrimp based in Cartagena and Tolú, and 4) conch and lobster with ports on the island of San Andrés.

Tuna fishing is carried out within the limits of the Exclusive Economic Zone at a distance of 20 nautical miles from the coastline. The landings, according to the available information, are mainly conformed by the tuna group, shallow water shrimp. Regarding the white fishery, specifically shallow water shrimp, there is a fleet with 2 navigation routes, leaving from Cartagena towards the Gulf of Morrosquillo and La Guajira, and another, leaving from Tolú towards the fishing zone in front of the Gulf of Morrosquillo. As indicated, white fishing is carried out in the northern zone, including maritime jurisdiction of the department of La Guajira, between Manaure and Castilletes, where it is characterized by fishing from a depth of 15 meters to 50 meters and from 5 nautical miles from the coast (INVEMAR, 2011- 2012: 88).

The areas with the highest traffic by these vessels include Cabo Tiburón-Punta Arboletes, Punta Arboletes-Punta Rincón, Punta Rincón-Galeras, Punta Galeras-Mouth of the Ciénaga Grande de Santa Marta-Cabo San Agustín, Cabo San Agustín-Punta Carrizal and Punta Carrizal-Colombia-Venezuela land boundary. The exhibit below shows the industrial fishing grounds registered in INVEMAR's Geographic Viewer of Fishing Grounds.

Exhibit 46 Commercial fishing zones



Source: INVEMAR, 2021

The planning of offshore wind projects should consider the navigation routes of industrial fishing vessels and their embarkation and disembarkation points. As part of the environmental studies, it is suggested that an informative process be carried out with the AUNAP and the industrial fishing companies with the support of the Dirección General Marítima (DIMAR).

6.3.3.4 Aquaculture

Aquaculture is practiced throughout the country, but the main production areas are species dependent. The range of cultured species allows aquaculture production in all climatic regions of Colombia. The main species include shrimps, tilapia, cachama, and trout; but only shrimp production occurs in coastal areas.

Marine shrimp. The country's main producing zones of marine shrimp are located in the Atlantic coast departments, such as Bolívar, Córdoba, Atlántico, Magdalena and la Guajira. In 2001, the area dedicated to shrimp culture was approximately 3 816 hectares of water surface area. Production infrastructure is located in coastal areas, mangrove zones or salty marshlands. Water is always pumped either directly from the sea, marshes (coastal lagoons) or from fresh or brackish water drainage canals located in estuarine zones.

6.3.3.5 Landscape and seascape

The character and features of a specific landscape or seascape may have a physical or aesthetic social value, which can be impacted by the placement of a wind farm.

Landscapes and seascapes stretch along the Colombian Caribbean coast. Just to mention a few: in the northern tip of Colombia, La Guajira department, Cabo de la Vela is an unrivaled geographical feature with several tourist attractions. This region has the lowest level of rainfall in the country, which causes it to have desert conditions. Unique seascapes include beaches such as Playa Dorada and Ojo de Agua, which have the perfect conditions for kite surfing. From Cabo de la Vela, it is possible to get to Punta Gallinas, a magical place with golden dunes and rocky cliffs. Towards the southwest are the protected seascapes within the Tayrona National Park, which include several beautiful beaches such as: Cabo San Juan, Cañaveral, Arrecifes, La Piscina, Castilletes, and Playa Cristal. More to the west is the Ciénaga Grande de Santa Marta.

The visual impact of a wind farm can be positive or negative for observers. Visual intrusion clearly is more important for the nearshore. In Colombia there is a great diversity of landscapes and many are declared for scenic areas, and aesthetic qualities.

In other jurisdictions, landscape and seascapes are often protected by legislation, and developers must follow official guidance on how the assessment of impacts from offshore wind farms should be carried out, often involving wide consultation and visual representations (photomontage).

Options for Colombia include mapping of protected landscapes with the help of the competent authorities, consultation with local communities, clarification of requirements and restrictions for placing offshore wind farms within protected landscapes, and drafting of guidance and regulations for developers to consider landscape and seascape aspects within the licensing process, including the preference of local communities for wind farm siting.

6.3.3.6 Historical and cultural heritage

The guidelines of the Colombian Institute of Anthropology and History (Instituto Colombiano de Antropología e Historia, ICANH) and the regulations on underwater cultural heritage (Law 1185 of 2008, Decree 763 of 2009, Law 1675 of 2013 and Decree 1698 of 2014); as well as the terms of reference of the ANLA for the preparation of Environmental Impact Studies of offshore hydrocarbon exploratory projects have determined the scope of the approach to archaeological heritage. Seismic explorations and exploratory drilling of offshore projects developed through exploration and production (E&P) and technical evaluation (TEA) contracts, assigned by the National Hydrocarbons Agenda (Agencia Nacional de Hidrocarburos, ANH) in the last 10 years; as well as port interventions, have provided the parameters and actions for addressing the archaeological potential in this type of projects.

Based on sources of secondary information, the exhibit below shows the diagnosis of the archaeological potential in the Colombian Caribbean, considering 2 criteria: 1) oceanographic characteristics in relation to the possibility of finding submerged archaeological remains and, 2) historical information on possible shipwrecks. It is recommended that the promoters of offshore wind projects establish, according to the type of interventions of each project, if there is a potential impact on underwater cultural heritage and, consequently, validate and verify the data on underwater cultural heritage with DIMAR and ICANH, in order to prevent the possible impact on heritage.

Exhibit 47 Shipwreck identified in the Colombian Caribbean

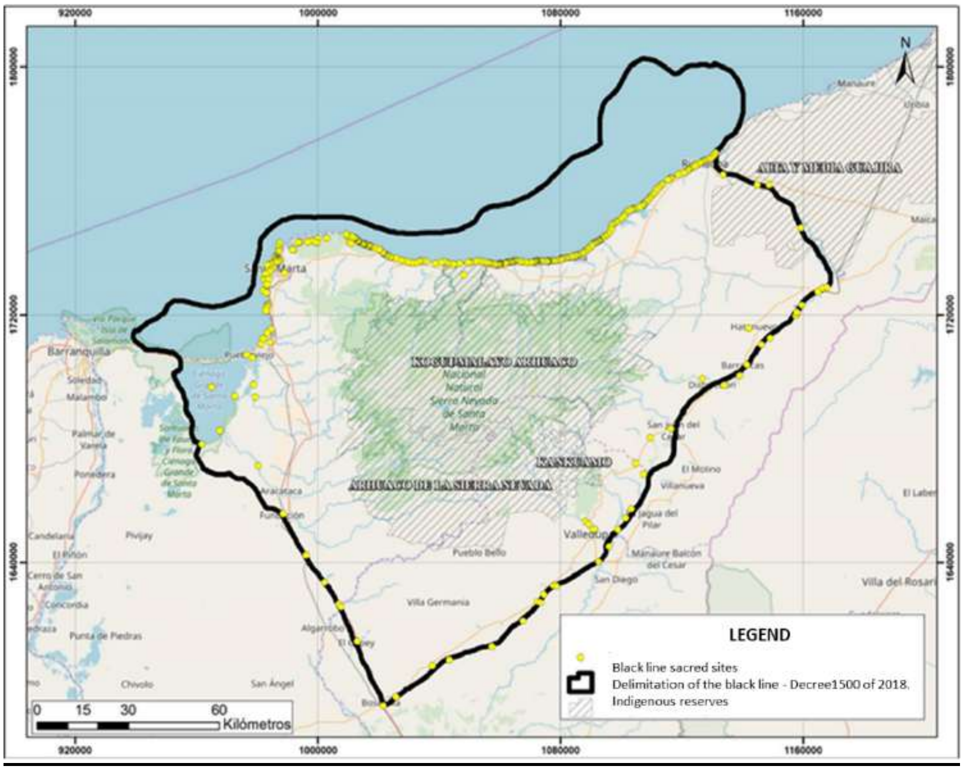
Source: ERM. Archaeological Diagnosis. Environmental Impact Study for the Exploratory Drilling Area of the Sin Off-7 Block, 2017. The figure identifies the only major underwater archaeological find that has been discovered in the Colombian Caribbean and which is located within the area of interest.

It is important to highlight that Cartagena is also characterized by the fortresses and walls declared by the United Nations Educational, Scientific and Cultural Organization (UNESCO) as World Heritage of Humanity. Among the fortifications near Cartagena, the following stand out: 1) Battery of Angel San Rafael located on Tierrabomba Island, which is part of the defensive complex of the Bocachica channel in the Bay of Cartagena, 2) Castle of San Luis de Bocachica located on Tierrabomba Island, 3) Fort San Fernando located on Tierrabomba Island, in front of the Battery of San Jose, protecting the passage through the Bocachica navigation channel (considered one of the Hispanic military constructions in the New World), 4) San José Battery located on an islet neighboring the island of Barú and, 5) Santa Cruz de Castillo Grande Fort, which is part of the facilities of the National Navy Officers' Naval Club. It is expected that the development of offshore wind projects will not affect the fortifications given the regulations for their protection and safeguarding; however, this should be an element to be evaluated in the development of environmental studies.

In the context of intangible cultural heritage, the System of ancestral knowledge of the indigenous peoples of the SNSM was recognized and included in the representative list of intangible cultural heritage through Resolution 3760 of 2017. According to the delimitation of the Black Line recognized in Decree 1500 of August 06, 2018, the government will guarantee the protection, spiritual, cultural and environmental value and will establish measures and guarantees for its effective protection. In Exhibit 48, the sacred sites that delimit the Black Line are represented, including point 348 called Nibué - Seynuriwa (maritime spaces above the 200 m isobath).

Considering the environmental and cultural sensitivity of the areas delimited by the Black Line, it should be suggested to generate alternative designs for the location of offshore wind projects. If the alternative is located in the area of the Black Line, the developer must request the determination of the appropriateness and timeliness of prior consultation in accordance with the criterion of direct impact in the Project's Area of Influence from the Directorate of the National Prior Consultation Authority (DANCP) and, based on the administrative act issued, proceed or not with the development of the consultative process and/or Free, Prior and Informed Consent (FPIC). Likewise, the developer must carry out the procedure the same procedure for other ethnic communities (other than the indigenous peoples of the SNSM), due to a possible direct impact on fishing, transit, ecotourism, and landscape activities, among others.

Exhibit 48 Sacred sites in Colombia



Source: ERM, 2018.

6.3.3.7 Tourism activities

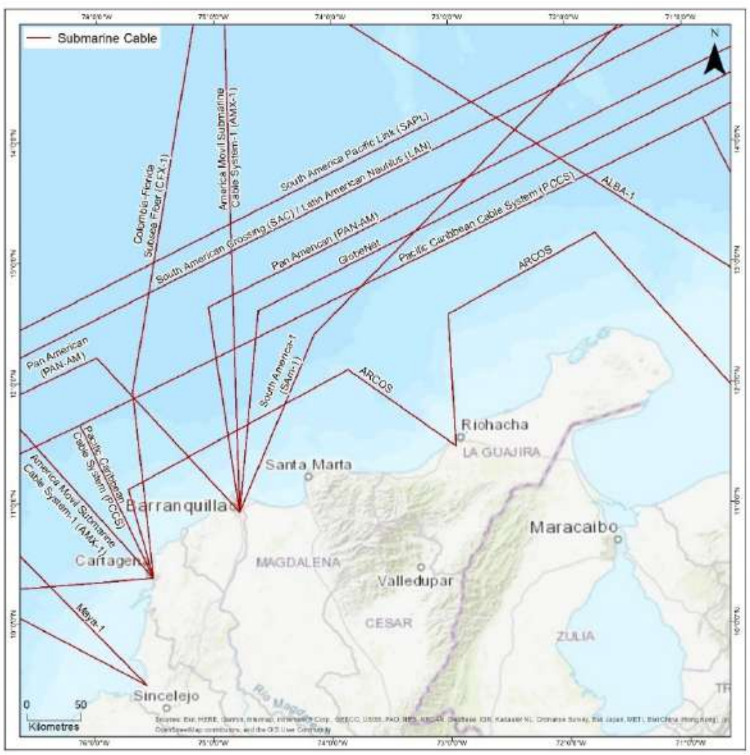
The Colombian Caribbean is a leader in tourism, with Cartagena, San Andrés, and Santa Marta as the main destinations for domestic and international tourism (cruise ships). The Colombian Caribbean has 1,932 kilometers of coastline for recreational tourism -sun and beach- (Ardila, 2005) and other types of tourism: cultural, historical, religious, ethnic, ecological, and gastronomic. Parques Naturales de Colombia records that in La Guajira, cultural and ecological tourism is promoted in the Bahía Portete - Kaurrele National Natural Park and Los Flamencos Fauna and Flora Sanctuary. In the department of Magdalena, the Tayrona National Natural Park offers a diversity of beaches bordered by mangroves and forests for hiking, snorkeling and diving.

Between the departments of Atlántico and Magdalena, the Salamanca Island Park allows tourists to appreciate mangrove forests, marshes and beaches, and in Bolívar, the Corales del Rosario and San Bernardo National Natural Park is cared for by local communities, mainly Afro-Colombian, who develop ecotourism, education and environmental awareness programs with an ethnic focus. It is recommended that offshore wind project developers characterize the areas of the Colombian Caribbean coastal strip to identify the frequency of tourism and the economic dependence of the communities, including their value chain to avoid the impact associated with possible socioeconomic displacement.

6.3.3.8 Communication infrastructure

Colombia has a 42,000 kilometers fiber optic network installed on the seabed[22]. The TeleGeography platform records the map of submarine cables worldwide. Specifically in the Colombian Caribbean, at the date of preparation of this document (September 2021), 10 submarine fiber optic cables are identified that allow communication in the region: (ARCOS (purple), Colombian Festoon, South America-1 (SAm-1), Pacific Caribbean Cable System (PCCS), GlobeNet, Pan American (PAN-AM), South American Crossing (SAC), America Movil Submarine Cable System-1 (AMX-1), Colombia-Florida Subsea Fiber (CFX-1), AURORA Cable System, Caribbean Express (CX), Maya-1 and San Andres Isla Tolu Submarine Cable (SAIT).

Exhibit 49 Submarine communications cables



[22] Colombia already has nine Submarine fiber optic cables. Retrieved from https://www.mintic.gov.co/portal/inicio/Sala-de-Prensa/Noticias/8920:Colombia-ya-tiene-nueve-cables-submarinos-de-fibra-optica

Source: RCG-ERM, 2021, adopted from submarinecablemap, 2021.

The Dirección General Marítima (DIMAR) through Resolution 204 of 2012 "whereby safety areas are established along the laying of submarine cables in Colombian jurisdictional waters", stipulates that the safety area extends to 1/4 nautical mile (500 meters) on each side of the cables, restricting the anchoring of vessels, trawling, and the development of any type of maritime activity that maintains total or partial contact with the seabed. It is suggested that the promoters of offshore wind projects previously identify with DIMAR, the type of infrastructure installed to prevent its possible affectation.

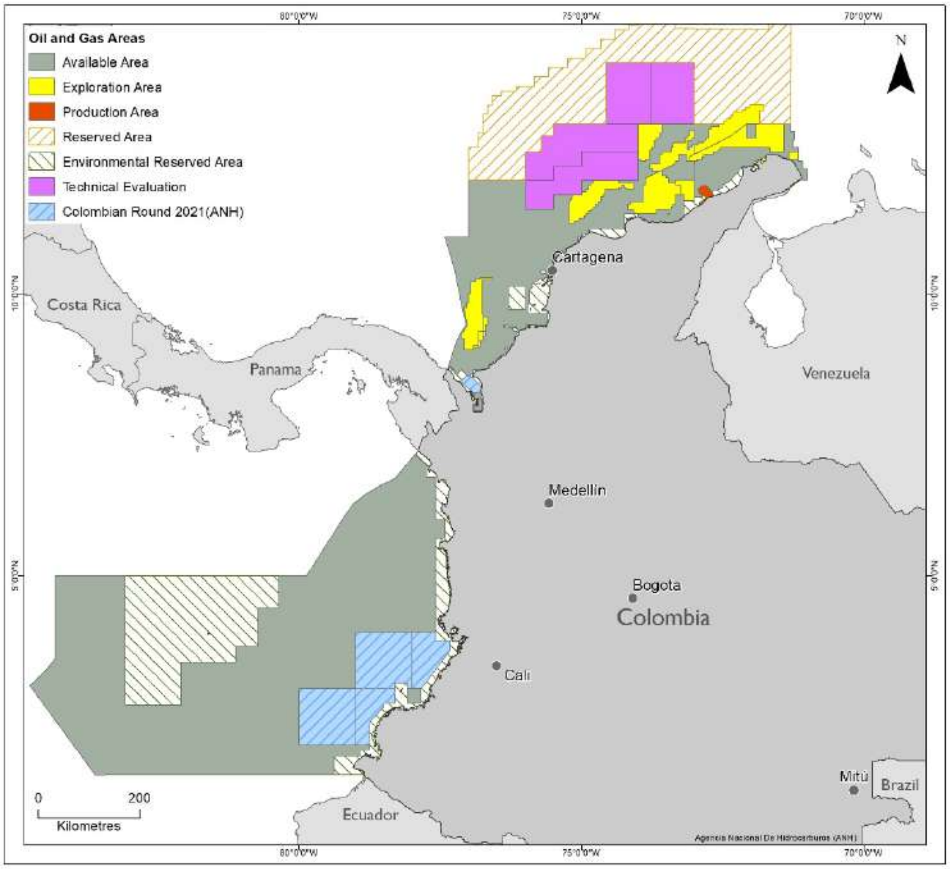
6.3.3.9 Oil & Gas infrastructure

The Agencia Nacional de Hidrocarburos (ANH), the authority to manage the hydrocarbon reserves owned by the Colombian Nation in accordance with Decree Law 4137 of 2011, assigned in the "Colombia Round 2014" the offshore areas for the contracting of hydrocarbon exploration and exploitation activities.[23].In the Colombia 2014 Round, the ANH offered 5 blocks that integrate the 24 offshore blocks with current contracts. The contracts formalized in 2014, Blocks COL 1, COL 2, COL 6 and COL 7 have a Technical Evaluation -TEA contract, Blocks COL 3, COL 4, GUA OFF 1, GUA OFF 3, GUA OFF 10, RC- 10 and RC -12 have an Exploration and Production (E&P) contract and the Tayrona Block is in the Exploration and Exploitation (E&E) stage. The background in the discoveries of natural gas accumulation in the Colombian Caribbean Sea, in the Guajira Block, specifically in the Chuchupa A and Chuchupa B platforms operated by Chevron Petroleum Company in Association with ECOPETROL and the recent discovery in the Orca-1 exploratory well of the operator Petrobras (first discovery in deep waters of the Caribbean in 2014).

It is important that the investors of offshore wind projects take into consideration the location of the Blocks concessioned by the ANH in their prefeasibility stage. The port facilities used for the development of the E&P and TEA activities may offer logistic support during the development of the onshore activities, as well as the mitigation measures used in this type of projects that may be related to and prevent the impacts generated by the offshore wind farm industry.

[23]Resolution No, 866 of August 19, 2014 "By which areas within the competitive procedure Colombia Round 2014 are declared deserted" [online]. [accessed December 06, 2016]. Available at <URL: http://www.controlz.com.co/rondacolombia2014/images/archivos/ListaDefinitiva/Resolucion%20declaracion%20de%20desiertas%20areas.pdf>

Exhibit 50 Offshore oil and gas blocks



Source:ANH, 2021

*Disclaimer: The borders, colors, denominations and any other information on this map do not imply a judgment on the legal status of any territory or the endorsement or acceptance of such borders.

6.3.3.10 Military exercise areas

Military activities, such as vessel maneuvering exercises, firing practice, low-fly training, and testing of ammunition and other technologies are in most cases not compatible with offshore wind farms and pose a hard constraint.

The high level of uncertainty regarding military exercise and activity areas could constrain the development and operation of prospective offshore wind development sites. It is not clear what the legal requirements are regarding military exercise areas and offshore wind development, but in practice, developers should conduct early consultation with the military as they have a significant role in decision-making, and the issues regarding offshore wind sites are addressed on a case-by-case basis.

In other jurisdictions the military has established exclusion zones, site-specific restrictions, and no-restriction zones for offshore wind development.

Options for Colombia include early liaison with the military to determine compatibility, particularly with the DIMAR and the Dirección de Intereses Marítimos y Fluviales de la Armada Nacional. Consultations shall aim to the definition of development restrictions to avoid spatial conflict with offshore wind development.

6.3.3.11 Aviation

Offshore wind turbines pose a risk to the aviation sector by way of physical obstruction, radar interference, and potential negative effects on the performance of communication and navigation systems[24]. In this context, areas around air traffic control centers (radars), airports, aerodromes, and air traffic zones can pose soft or hard constraints for developers.

Numerous aviation-related sites exist along the Colombian Caribbean coast serving the larger urban centers, and these could be a constraint for nearshore wind development. Civil Aviation Authority of Colombia is a semi independent agency of the Colombian Ministry of Transport. AeroCivil deals not only with civil aviation, but with general aviation as a whole, excluding military aviation which falls under the Colombian Air Force branch of the Military Forces of Colombia. This agency is responsible for developing plans, programs, regulations, and standards, and providing flight management and aviation safety. It also manages several airports and aviation support infrastructure. It is a legal requirement to consult them.

[24] Policy and Guidelines on Wind Turbines—CAP764, Civil Aviation Authority, February 2016, available online at https://publicapps.caa.co.uk/docs/33/CAP764%20Issue6%20FINAL%20Feb.pdf,

7 SUPPLY CHAIN ANALYSIS

This section presents an analysis of Colombia's existing supply chain, evaluates its readiness to support major component and services packages for the offshore wind industry, and identifies a preliminary (non-exhaustive) list of potential domestic suppliers.

7.1 Purpose

A domestic supply chain can be critical to spurring economic benefits across various segments of the domestic supply chain and services sectors. In this section, we assess the in-country capabilities of Colombia for activities required during project development and construction; including the existing "readiness" of the supply chain in Colombia for major offshore wind components, supply contracts, and the potential to support a future offshore wind industry.

7.2 Methodology

For the purpose of this assessment, the project team categorized the different stages of an offshore wind project, development, and construction, including supply contract/agreement for Tier-1 offshore wind components and foundations. A list of the typical contracts, and supply agreement of major components for offshore wind projects is shown below.

Exhibit 51 Services and major equipment's supply agreements

Agreement Package	Types of Contract
Project Development Services	Wind resource assessment
	Environmental Impact study consultant.
	Project management service contract
	Engineering consulting
	Owner´s engineering contract
	Legal advisory agreement
	Geophysical and Geotechnical surveys
Wind Turbine Generator	Blades
	Nacelle, hub and assembly
	Towers

Balance of Plant	Monopile foundations
	Jacket foundations
	Gravity Base foundations
	Floating foundations
	Transition Pieces
	Secondary steel
	Export Cables
	Inter-array Cables
	Offshore substation
	Onshore Substation
Transport and Installation	Wind Turbine Installation Vessels
	Heavy Lift Vessels
	Feeder Barges
	Submarine Cable Laying vessels
Operations and Maintenance	Crew Transfer
	Inspection (above water and sub-sea)
	Maintenance and Repairs

Source: RCG

7.2.1 Description of Major Components

This section provides a description of the major Tier-1 components for an offshore wind farm as well as other relevant contract packages. The analysis also notes specific areas where there may be Tier 2 opportunities to supply global Original Equipment Manufacturers (OEMs) such as wind turbine OEMs.

7.2.1.1 Project Development Services

Activities including wind resource assessment, front-end engineering and design, project management, procurement, and legal and financial advisory.

7.2.1.2 Wind Turbine Generator

The Wind Turbine Generator (WTG) is the heart of any utility-scale wind generation project. For offshore projects in particular, the huge size of WTG components and market consolidation in the past several years have combined to ensure that just three original equipment manufacturers (OEMs) –Vestas, Siemens Gamesa (SGRE), and General Electric (GE) – have assumed a dominant position in the global market, excluding China. Assuming WTGs are procured from one of these three main suppliers, a likely supposition given their experience and energy cost advantages, WTG components will be produced by the relevant OEM at their existing fabrication facilities worldwide. The propensity to establish a local fabrication facility depends on a variety of factors. First and foremost, the WTG OEMs will seek confidence in the future market size – which requires a sufficient and reliable pipeline of projects. In addition to this, the expense of component transportation, existing factory capacity, any domestic manufacturing policy requirements, and the state of the existing global supply chain at large, will also be considered before WTG OEMs establish local presence.

The Wind Turbine Generator itself is typically comprised of three (3) components: Nacelle and Hub, Blades, and Towers. Each of these are described in more detail below.

7.2.1.3 Wind Turbine Generator Blades

As more wind farms are installed around the world every year, wind turbine blades have increased substantially in size and are set to continue doing so in the coming decade. In the mid-2000s, blade size was typically between 30-50m for industry-standard onshore turbines rated between 1.5 and 5MW capacity. By 2015, the largest offshore wind turbine blades measured between 60 and 80 meters in length. Today, cutting-edge blades on new WTG models like GE's Haliade-X model, currently rated for 12MW but planned for 14MW offerings by 2024, has a blade length of 107m. These increases in size have contributed significantly to cost declines from offshore wind energy, but the size of the massive blades can pose logistical challenges for a global supply chain. Particularly for offshore wind, which can sustain larger blade sizes, these logistical challenges are important for factory siting and other production decisions. Many onshore wind turbine blade fabrication facilities, like those listed below, would need investment in new infrastructure and refurbishment in order to fabricate, load, and transport blades compatible with offshore wind development.

7.2.1.4 Nacelle, hub and assembly

Nacelles offer some of the most complex, multifaceted opportunities for domestic supply chain buildout of any WTG component due to the number of smaller industrial components that make up the nacelle interior. While finding or building a foundry large enough to handle the casting that makes up the nacelle exterior may be a substantial limiting factor, countries with relatively less developed domestic supply chains that are planning for large offshore wind capacities with domestic supply capability, most notably the United States, have already been able to achieve a high degree of domestic content in nacelle components.

7.2.1.5 Towers

More so than blades, towers strong synergies in transitioning production capacity from onshore to offshore towers, though additional requirements like anti-corrosion coating and increased diameter require careful understanding for manufacturers who intend to service the offshore market. In addition to these additional requirements, the larger component size of offshore wind tower components poses logistical challenges for tower fabrication that takes place far from shore or near infrastructure with stringent underpass height requirements. Sufficient quayside loadout capacity is required for efficient positioning of an offshore wind tower production facility, necessitating both ease of access to a port of sufficient width and depth to accommodate the relevant transport vessels and sufficient staging areas to work with the towers on land. Any plausible site for development of such a facility will have to demonstrate favorability on these characteristics to attract credible investment commitments from tower fabricators.

At present, Colombia has no domestic onshore or offshore tower manufacturing capabilities. Tower production is largely automated and would require substantial initial capital investment, however training and labor cost would not pose a major challenge for any prospective tower production facility.

As transport costs are meaningful for towers, any new facility that could cut transport time and associated costs would likely present an improvement on future cost of wind farm construction. However, the capital requirement is such that any investment decision for local greenfield facilities would require a visible offshore wind pipeline of several gigawatts (GW) worth of advanced stage projects.

7.2.2 Balance of Plant

Materials necessary for all other physical infrastructure needed to anchor a WTG to the seabed and interconnect to the grid make up the balance of plant. These varied but complementary industries present notable opportunities to leverage existing industrial capacity and expertise to drive growth in the Colombian offshore wind industry and a growing role in the regional supply chain.

7.2.2.1 Foundations

Foundations are responsible for anchoring the WTG and tower structures to the seabed. These structures are typically steel structures that are driven into the seabed layers. The specific type of foundation structure (as described below), is influenced by a number of factors, including the seabed characteristics (e.g. soil types and properties), water depth, wind-wave loadings, probability of extreme weather events, as well as the necessary load resistance to the dynamic forces of the wind turbine generator itself. To-date, single member tubular structures called monopiles have been the most prevalent type of offshore wind turbine foundation for offshore wind farms. Jackets, typically three (3) or (4) legged lattice structures, are also common and tend to be used in areas with greater water depths (typically 50-70 meters) and subject to more onerous loading conditions. Floating foundation types have also achieved critical viability milestones for offshore wind turbines in recent years, and unlock the potential for offshore wind projects in waters deeper than 60m (though there are a handful of floating technologies for shallower water).

7.2.2.2 Monopiles

The most widely installed foundation type with a record of cost efficacy is the monopile, a large tubular structure weighing up to 2,000 tons and made up of sections of rolled steel welded together to form a single, massive pile. Monopiles are ideal for offshore wind farms in water depths of 20-50m and can be designed to withstand extreme loading events, including hurricanes. However, the large size of the structure, and in particular the diameter of rolled steel sections, limits the number of suppliers capable of producing them. The monopiles required for today's offshore wind farms can exceed 10 meters (30 feet) in diameter. There are few machines globally that are capable of rolling steel to this diameter. The machines that do exists are custom made and require high upfront capital investment.

7.2.2.3 Jackets

Jacket foundations are fixed-bottom lattice structures used in waters too deep for conventional monopiles but not deep enough to necessitate a floating foundation, or where soil or structural loading conditions are particularly challenging. Jacket-type structures can consist of various configurations of cross-braced welded steel tubular members, each a few meters in diameter. As compared with monopiles, the steel rolling process is not as specialized because the individual tubular piles are smaller in diameter. However, the labor requirement for fabrication is generally higher for jackets than monopiles, as the welding of the various braces in the structures tends to be manually performed by skilled craftsmen as opposed to automated (although some jacket yards have invested in automated welding equipment for the jacket braces and nodes in recent years).

7.2.2.4 Gravity Based

Gravity Base Structure (GBS) foundations are used in shallow waters to achieve stability without piling by attaching the WTG to a massive weighted concrete base that uses its own mass to remain upright. GBS structures have been used only in limited applications for commercial-scale offshore wind farm to-date; however, they have been used in offshore oil and gas in the North Sea for several decades.

GBS structures offer viable alternatives to other fixed-bottom concepts in areas where the use of a piled structure (such as monopiles or jackets) is either technically risky due to presence of subsea boulders, the soil strength is weak, or there are onerous environmental regulations and restrictions against driving piles (i.e. during marine wildlife migration seasons). GBS solutions also offer a less complicated offshore construction operation. GBS concepts can typically be semi-submerged and transported via tugs, eliminating the need for more expensive Heavy Lift Vessels to lift and maneuver heavy structures. Nevertheless, the primary drawbacks of GBS foundations are the volume of material (typically concrete) required in each structure, the weight of the structure, and limited opportunities for assembly-line production and economies of scale. Moreover, given the massive weight of the foundations, quayside bearing capacity must be strong enough to accommodate the enormous structures.

7.2.2.5 Floating Foundations

Floating offshore wind (FOW) technology will not be able to fully rely on the supply chain of fixed-bottom offshore wind, particularly for the foundations. However, FOW will be able to rely on the supply chain of other industries such as shipbuilding, oil and gas, and civil infrastructure projects. Globally, floating technologies derives from a long history of floating structures for the oil and gas industries and even longer marine sector knowhow in terms of shipbuilding techniques. There are three main types of FOW substructures: Semi-Subs or floaters (including barges), spar buoys, and tension leg platforms (TLPs). These substructure types are defined by their different approaches to achieving structural stability, each with its own pros and cons.

Floating offshore wind technology is developing from technology demonstration through to pre-commercial (100 – 200 MW) and future large commercial-scale projects (>500 MW).

As FOW platforms are floating structures, they are required to be compliant and registered with the relevant regulatory authorities, such as DIMAR.

All offshore wind temporary floating devices should fulfill requirements of resolution DIMAR 240 of 2021. However, regulation for definite floating devises is still pending.

7.2.2.6 Transition Piece

Transition Pieces (TP) are structures that have typically been used to connect the WTG and tower structure to the foundation substructure. They ensure verticality of structure, tower and WTG, as well as provide access for maintenance and the cable connections. TPs consist of a thick-walled steel tube, approximately 5 or more meters in diameter, and a length of up to approximately 20 meters. In addition to the main structure, the TP also requires several secondary steel fixtures, including ladders, handrails, and other appurtenances.

7.2.2.7 Subsea Cables

Beyond foundations, the balance of the plant is the infrastructure required to transform power generated at each individual turbine into a form that makes it exportable to and usable on the wider electric grid. This usually involves three critical pieces of offshore, new-build infrastructure: the inter-array cables connecting all the turbines in the array to an offshore substation, the offshore substation itself, responsible for transforming power collected on the inter-array cables to a higher voltage for export, and a high voltage export cable for running power from the offshore substation to a substation already interconnected with the grid onshore.

Developers and EPC companies must comply with the current DIMAR regulation for submarine cables.

7.2.2.8 Inter-Array Cables

Inter-array cables are medium-voltage cables running between the turbines that make up an offshore wind farm, and the offshore substation that transforms the power to a higher voltage for export. Array cables have become higher voltage as turbine size and power production have grown considerably, with 66kV lines now in regular use at larger projects.

7.2.2.9 Export Cables

Export cables are larger and heavier than array cables, running from the offshore substation to the point of connection to the grid on land. Where interconnection is nearby, alternating current is traditionally used for its greater stability, while direct current with a transformer is employed for projects with export cable length >80 km.

7.2.2.10 Offshore Substations

Offshore substations (OSS) are large structures designed to transform power from array cable links to a higher voltage for export. Each substation consists of both a topside and a foundation. The construction, transportation and installation methods and requirements for offshore substations are similar to that of large offshore oil and gas platforms. As such, many companies experience with construction, transport and installation of large oil and gas platforms and topsides have transferrable skill sets. To-date, the global market trend for offshore wind substations has been towards large fabricators based in Europe, who have experience in delivering these bespoke structures for European offshore wind farms. Some of the largest European suppliers of offshore substations includes include Bladt, Harland & Wolff, Smulders, and others with a history of work in the offshore oil and gas industry.

7.2.2.11 Onshore Substations

Onshore substations are a necessary component of any complete wind generation facility, as the export cable must be connected into the grid via a substation so that it can be transformed to the appropriate voltage for transmission.

7.2.3 Transport, Installation and Operations Vessels

Transportation of the large offshore wind components and structures from the production facility, quayside, storage site or staging areas to the offshore wind farm construction site requires a range of vessel capabilities, all of the companies involved in the process must comply with DIMAR resolution 794 (2020) and 240 (2021). Marine operations can require these use of vessels tugboats, dumb barges, lift-boats (Jack-Up Vessel) or feeder barges. These vessels are typically available from supporting marine civil infrastructure projects or offshore oil and gas operations. However, the size of offshore wind farm components, including the foundations, blades, and nacelles, often require specialized purpose-built vessels, with higher crane capacity (hook height and maximum weight lift) than is typically required for other marine operations. These specialized vessels would be sourced from existing offshore wind markets and they would need to be compliant with local regulations for foreign flagged vessels. Once the wind farm is operational, Operations and Maintenance (O&M) of the structures also requires different types of vessels required for crew and equipment transport. Many of these vessels draw on existing offshore industrial capabilities, including those from oil and gas, while others are tailored specifically for work in offshore wind. Exhibit below describes the relevant vessel types.

Exhibit 52 Required Vessels for Offshore Wind Development by phase, type, and purpose.

Development Phase	Vessel Type	Purpose	Key features
Pre-Construction	Survey Vessel	Conducts surveys to assess site conditions and determine where to place turbines.	Has survey equipment. Can either be purpose-built for offshore wind or a multi-purpose vessel with survey equipment
Construction	Foundation installation vessel	Places turbine foundations on ocean floor.	Depends on type of foundation; a heavy-lift crane is generally required to lift the foundation off the vessel.
Construction	Scour protection vessel	Lays rocks around the site and turbine foundations to prevent erosion.	Ability to carry a large number of rocks and place them precisely on the ocean floor.

Construction	Cable-laying vessel	Lays cables along the ocean floor to carry electricity from site to shore.	Has cable-laying equipment. Does not need to be specialized for offshore wind.
Construction	Wind turbine installation vessel	Installs turbines on top of foundations.	Typically, a jack-up vessel. Needs a large amount of clear deck space and a tall, heavy capacity crane to install turbine components.
Construction	Feeder vessel	Transports turbine components from port to site.	Ability to transport heavy turbine components.
Operations and Maintenance	Crew transfer vessel	Transports technicians from port to turbines.	Small, fast vessel. Ability to push up against turbine so crew can climb onto turbine.
Operations and Maintenance	Service operations vessel	Houses technicians and transports them between turbines.	Ability to house a large number of technicians for several weeks and transfer them to turbines.
Decommissioning	Decommissioning uses the same variety of vessels as construction to take turbines apart.		

Source: Table reproduced from US Government Accountability Office (GAO)[25]

7.2.4 Operations and Maintenance

Operations and Maintenance (O&M) includes the routine monitoring, offshore inspection, repairs and maintenance of each component of the system. O&M requirements, including frequency and types of inspections (i.e. above water or subsea), are informed by offshore regulations. They are also influenced by OEMs and equipment warranties. Audits or inspections may be required by public authorities during the O&M phase to ensure safe operations are carried out. Above-sea inspections are often carried out an annual basis and can involve a manned inspection or an unmanned inspection using Unmanned Aerial Surveillance equipment such as drones. Subsea inspections are done less frequently and can involve the deployment of Remote Operated Vehicles (ROVs) or divers to inspect subsea structures and cables.

O&M supply chain requirements include local storage areas for backup equipment as well an appropriate fleet of crew transfer vessels. Crew Transfer Vessels (CTVs) are typically utilized for short distance trips. For windfarms further from shore, Service Operations Vessels (SOVs) that have capacity for crew sleeping quarters and more

[25] United States Government Accountability Office Report GAO-21-153/ “Offshore Wind Energy: Planned Projects May Lead to Construction of New Vessels in the U.S., but Industry Has Made Few Decisions Amid Uncertainties. December 2020. See table 2, page 11.

equipment storage capabilities are required. Although there is some transferability from the offshore Oil and Gas sector, generally the industry relies on purpose-built vessels.

O&M suppliers must comply with the available regulation for the execution of works at sea.

7.2.5 Decomissioning

As the project approaches the end of its design life, consideration will be given to:

- Extending the operational life of the existing WTGs
- Repowering the project by replacing or substantially overhauling the WTGs, utilizing the existing foundations, electrical infrastructure and grid connection (where technically feasible)

Life extension and repowering are subject to the granting of the necessary consents to continue operating the project beyond its planned lifespan. Where these options are not technically or economically feasible, or where permits are not granted to continue operating the project, it will be decommissioned.

The environmental and social impacts arising from the decommissioning process are usually considered as part of the ESIA and the project will be designed to ensure that the decommissioning activities do not have a significant environmental or social impact, or that such impacts can be appropriately mitigated. A further ESIA will likely be undertaken prior to decommissioning once the decommissioning process (and the components to be removed and those to be left in-situ) us known. This ESIA will be informed by surveys of the environmental conditions present at the time. A detailed Decommissioning Plan is normally developed for approval as part of the permit application process. The plan typically includes program and sequence, proposed decommissioning option for each component, assessment of environmental impacts, verification surveys, post-decommissioning monitoring and management of the site, project, health and safety and environmental management and details of stakeholder consultation undertaken on the plan.

The Decommissioning Plan is subject to regular review and update during the life of the project to take account of evolving technological solutions and industry best practice and any decisions with regard to life extension or repowering.

7.2.6 Criteria for Assessment

Each component in the offshore wind farm supply chain was taken separately and analyzed across four (4) criteria of assessment for readiness and in a weighted scoring process to produce a numerical ranking by component-based individual criteria. All components are ranked on each of the four criteria from 1 to 4, with the composite score calculated by weighted addition of the individual scores. In all cases, 4 denotes the highest level of readiness, and 1 denotes the lowest.

Track record in wind industry

The first criterion evaluated was the experience in services for the wind industry. Ratings 1 were given for components for which no Colombian company has experience. Ratings 2 were given for components that at least one Colombian firm has supplied for an onshore wind project of less than 100 MW capacity. If one company has experience supplying the component to a larger onshore wind project the component is scored as a 3, and two or more such firms result in a 4 scoring. The rating criteria and associated Red, Amber, Green (RAG) color scale is provided below.

Exhibit 53 Assessment of track record in wind industry

Criterion	Score	Description
Track record in wind energy	1	No experience
	2	Experience in supplying onshore wind farm components (<100 MW)
	3	One company with experience supplying onshore wind farm components (>100MW)
	4	Two or more companies with experience supplying commercial onshore wind farms (> 100MW)

Source: RCG analysis

Capability in parallel sector

The second criterion is capability in a parallel sector. Ratings 1 were given for components for which Colombia has no companies with parallel sectoral experience. Ratings 2 were given for components produced by companies with parallel experience in offshore oil and gas or onshore wind. Ratings 3 and 4 refer to companies in parallel sectors, but with barriers to market entry for offshore wind. A 3 denotes possible market entry with high barriers, where a 4 denotes lower barriers to entry.

Exhibit 54 Assessment of capabilities in parallel sectors

Criterion	Score	Description
Capability in parallel sector	1	No relevant parallel sector experience
	2	Parallel sector experience in offshore oil and gas or onshore wind
	3	Companies in parallel sectors that can enter market (w/ high barriers to investment)
	4	Companies in parallel sectors that can enter market (w/ low barriers to investment)

Source: RCG analysis

Benefit of using local supply chain

The third criterion is the benefit of sourcing a component from the Colombian supply chain as opposed to internationally. Ratings 1 were given for components where there is no benefit from local production. Ratings of 2 were given for components that can be produced in Colombia with moderate benefits but no substantial impact on project costs or risk. Ratings of 3 were given for components that can be sourced from outside of Colombia, but only by taking on significant added cost and risks. Ratings of 4 were reserved for components it would be impossible or highly unlikely to source outside the domestic supply chain.

Exhibit 55 Assessment of benefits to using local supply chain

Criterion	Score	Description
Benefits of local supply chain for Colombia offshore wind projects	1	No benefits in supply Colombian projects from Colombia
	2	Some benefit in supplying Colombian projects from Colombia, but no significant impact on costs or risks
	3	Work for Colombian projects can be undertaken from outside Colombia, but only with significant increased cost and risk
	4	Work for Colombian projects must be undertaken locally

Source: RCG analysis

Investment Risk. The fourth criterion is the investment risk, which focuses on the amount of certainty in future offshore wind growth required for investment, the size of the required investment, and the potential for investments to de-risk further by serving additional markets beyond the offshore wind. Ratings of 1 were given for components that require long-term market visibility and an offshore wind pipeline of 1 GW or greater. This has typically been a capital investment threshold for large OEMs and other Tier-1 suppliers. Ratings of 2 were given for components that also require long-term market visibility and certainty, but investments tend to be made as initial projects near Final Investment Decision. Ratings of 3 were given for investments smaller than $50 million with the potential to serve other small sectors. Investments smaller than $10 million that could also serve other large sectors were rated as 4.

Exhibit 56 Assessment of investment risks

Criterion	Score	Description
Investment Risk	1	Capital investment requires long-term market visibility with pipeline of projects >1 GW
	2	Capital investment requires market visibility and some projects to be at or near Final Investment Decision (FID)

	3	Low investment threshold (<$US 50 million), that can also meet demand from other small sectors
	4	Low investment threshold (<$US 10 million), that can also meet demand from other large sectors

Source: RCG analysis

7.2.7 Readiness Score - Weighing Criteria

The criteria are rated on the 1 (least ready) to 4 (most ready) scale in the Red Amber Green (RAG assessment). The project team then applied a weighted scoring to produce a numeric value to assess readiness of the major supply chain components. A composite score for each component was calculated by a weighing the assessed readiness level against the weighted values as show in Exhibit 57.

Exhibit 57 Supply chain readiness assessment factor weights

Criterion	Score	Description
Readiness Score - Weighing Criteria	1	Benefits of using local supply chain
	2	Investment Risk
	3	Capability in parallel sector
	4	Track record in wind industry.

Source: RCG analysis

As depicted in the table above, a previous track record in wind energy was deemed as the most important factor for assessing overall readiness for the existing supply chain. While the cost benefits of using the local supply were considered to have a relativity lower impact on the overall readiness of the supply chain.

Formula for assessing numeric readiness score of supply chain

Score from RAG analysis x Weighted Value = = Composite Readiness Score

Based on the project team’s methodology, the highest “readiness” scores any area of the supply chain could achieve would be a score of 40. The lowest numeric weighted score an area of the supply chain could receive would be a 1. The analysis results following on the next page.

7.3 Results

The results of the supply chain analysis and numeric ranking are shown in Exhibit 58. A discussion of the results follows.

Exhibit 58 Scoring results of supply chain readiness assessment

Contract or Supply Package	Service or Component	Criteria (1-4)*				Scoring
		Track Record in Wind	Capability in Parallel Sector	Benefits of Using Colombia Supply	Investment Risk	Weighted Score (1-40)**
Development Services	Project Management Consulting	3	3	3	4	32
	Engineering Consulting	2	2	2	4	24
	Legal, Consenting, Regulatory Consulting	4	4	4	4	40
	Geophysical and Geotechnical Surveys	1	2	3	4	21
WTG (Tier-1)	Turbine Blades	1	1	2	1	11
	Nacelle, hub, assembly	1	1	2	1	11
	Towers	1	1	2	1	11
Balance of Plant	Monopiles	1	1	2	1	11
	Jacket foundations	1	2	2	2	16
	Gravity Base foundations	1	3	3	2	20
	Floating foundations	1	1	3	2	14
	Transition Pieces	1	1	3	3	16
	Secondary steel	1	3	2	4	23
	Offshore Export Cables	1	2	2	3	18
	Inter-array Cables	1	2	2	3	18
	Offshore substation	1	3	3	2	20
	Onshore Substation	3	3	4	3	31
Transport and Install	Wind Turbine Installation Vessels	1	1	3	1	12
	Heavy Lift Vessels	1	2	3	3	19
	Feeder Barges	1	2	3	4	21
	Submarine Cable laying vessels	1	2	3	3	19
Other	Raw Materials (Steel)	1	3	2	4	23

*1 is lowest readiness level. 4 is highest.

** 1 is lowest readiness ranking. 40 is highest.

7.3.1 Discussion of Results

Amongst the areas evaluated to be the “most ready” to emerge as a potential offshore wind supply chain in Colombia are various upfront project development services, notably project development consulting and local legal and permitting advisory services. Additionally, the supply chain potential for onshore substations is ranked very high, given parallel sector experience as well as a strong cost benefits inherent from procuring the onshore substations locally. A summary of the results sorted by highest level of readiness to lowest is provided in Exhibit 59.

Companies listed below can provide some services, machinery, elements, some manufactures like Siemens, Schneider, ABB, have local manufacture for major components of substations, there is availability of steel companies with off shore work experience in other economic sector, so Colombia government must support these companies, machinery manufacturers with I+D projects that will allows them to acquire knowledge and experience to be able to provide the services are required for the construction of offshore park in all of the phases including development, generate policy with tax incentives that make investment in improvement attractive so that they are prepared for the arrival of these projects and investors..

From the research area, strengthen national consulting companies, so that they can establish alliances, projects, etc. that allow them to offer design engineering services from the development stage.

Exhibit 59 Sorted Results of Supply Chain Readiness Assessment

Component	Weighted Score (1-40)*
Highest readiness level (>30)	
Legal, Consenting, Regulatory Consulting	40
Project management consulting	32
Onshore substation	31
Medium readiness level (20-30)	
Engineering Consulting	24
Secondary steel	23
Geophysical and Geotechnical Surveys	21
Feeder Barges	21
Gravity Base foundations	20
Offshore substation	20
Low readiness level (<20)	
Heavy Lift Vessels	19
Submarine Cable laying vessels	19

Inter-array Cables	18
Offshore Cables	18
Jacket foundations	16
Transition Pieces	16
Floating foundations	14
Wind Turbine Installation Vessels	12
Turbine Blades	11
Nacelle, hub, assembly	11
Towers	11
Monopiles	11

Source: RCG analysis

*1 is lowest readiness level. 4 is highest.
** 1 is lowest readiness ranking. 40 is highest.

To enable local Supply Chain growth, governments play a key role to put in place policies and frameworks that give suppliers confidence to invest and establish their own pipelines. Moreover, they should consider local supply in the context of a competitive regional and global market, as an individual national market like Colombia will not be large enough to sustain a competitive local supply chain alone[26],

7.3.2 Additional Assessment of Supply Chain

7.3.2.1 Wind Turbine Generator Components Supply Chain

With respect to supplying major Tier-1 components, a lack of comparable onshore wind development in Colombia to-date has limited opportunities for a transferrable local supply chain, particularly with respect to the major wind turbine components such as blades and nacelles. However, it can be anticipated that as the onshore wind industry expands in Colombia, there will be some potential for prospective Tier 2 and 3 OEM suppliers to supply the offshore wind supply chain.

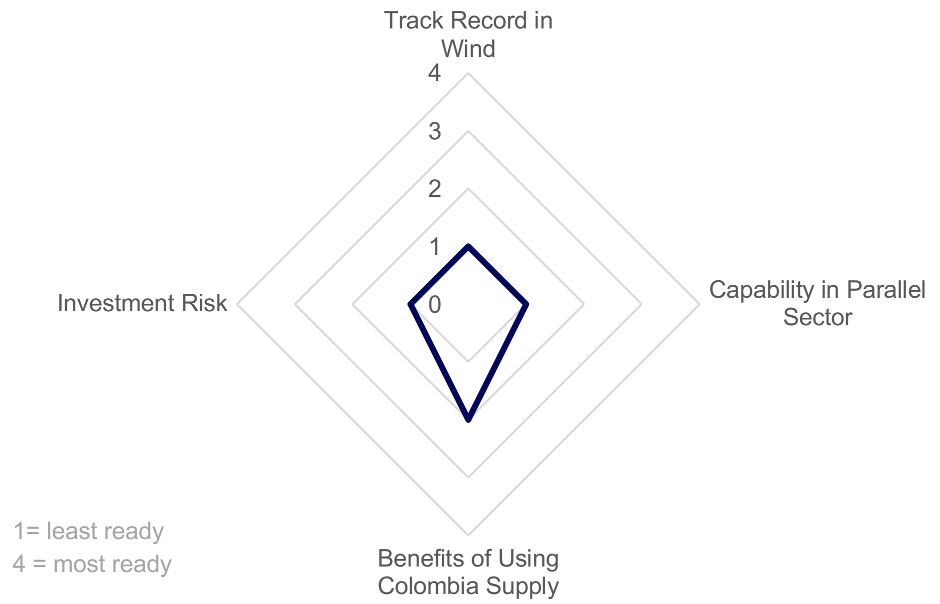
Nacelles

Colombia is home to over 40 metalworking companies with direct or indirect experience that would allow for conversion to nacelle component manufacturing with relatively low barriers to entry. The most serious barrier to the development of local Colombian nacelle and hub assembly capacity, aside from market visibility and a bankable project pipeline, is existing nacelle production and assembly facilities in the

[26] Washington, D.C. : World Bank/ESMAP/IFC. http://documents.worldbank.org/curated/en/343861632842395836/Key-Factors-for-Successful-Development-of-Offshore-Wind-in-Emerging-Markets

region. As nacelles depend on a web of internal components in a complex supply chain, OEMs may be cautious to pursue an entirely new set of component suppliers for an existing assembly factory.

Exhibit 60 Nacelle components supply readiness assessment



Source: RCG

Exhibit 61 Potential local supply chain companies – nacelle components

Local companies with potential transferrable skills:
• Bay, Ltd. • Acerias de los Andes, Ltda. • Fundiciones Industriales SAS. • Ficep Group. • Compañia General de Aceros S.A.

Source: RCG

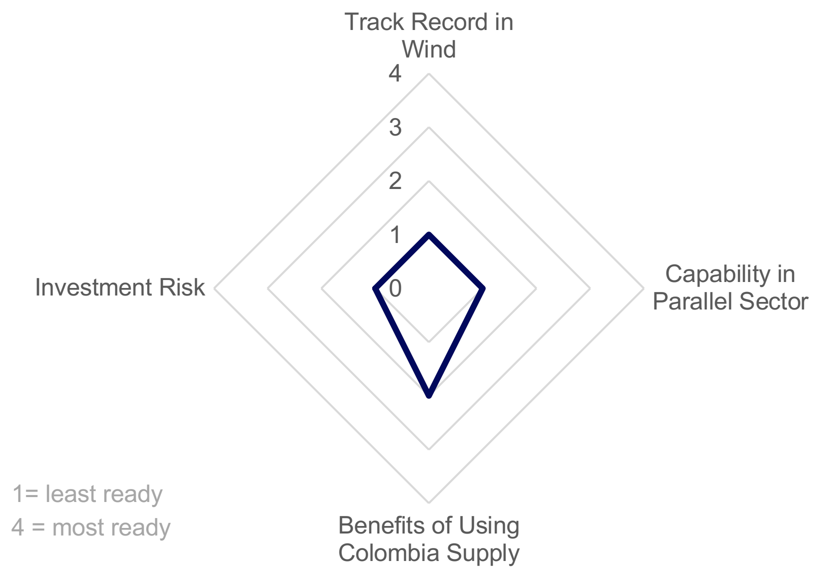
Balance of Plant Components

For the Balance of Plant requirements – including supply of the offshore wind turbine foundations, offshore substations, as well as subsea cabling, the supply chain is a medium to low level of readiness. As in many nascent offshore wind markets, a supply chain for local monopile foundations remains elusive due to the major capital requirements and upfront investment risks. Additional areas of the supply chain such as manufacturing jacket foundations and transition pieces can draw upon existing facilities that support offshore oil and gas platform fabrication. However, given the moderately high investment requirement, these facilities would also require a high degree of market visibility before investments are made.

Monopiles

Although multiple local firms may have experience and capabilities with rolling tubular steel structures in Colombia, the large size of monopiles required to support today's wind turbine generators requires bespoke facilities with customized steel-plate rolling machines. The cost of this investment creates a significant barrier to entry for this segment of the supply chain. The monopiles required for offshore wind farms often exceed 10 meters (30 feet) in diameter. Existing steel rolling yards seldom have this capacity, as it far exceeds requirements for oil and gas platforms, piles, or other marine structures. The capital requirement for a monopile fabrication yard is also high and requires a bankable project pipeline to justify the investment. Nevertheless, several local firms have been identified with experience in rolling steel. As the pipeline of offshore wind projects develops in Colombia, these suppliers may seek to invest, either solely or via partnerships / JVs, in dedicated monopile rolling facilities.

Exhibit 62 Monopile radar chart assessment



Source: RCG

Exhibit 63 Potential local supply chain companies – monopiles

Local companies with potential transferrable skills:
• Sidenal • Sidoc S.A. • Ternium Colombia S.A.S.

• ACESCO Colombia S.A.S.
• COPACERO S.A.S.

Source: RCG

Jacket Foundations

Jacket foundations require less specialized or purpose-built equipment than monopile foundations and utilize the same design and fabrication techniques as the jackets used for offshore oil and gas platforms. As such, jacket foundations may be open to domestic producers with lower barriers to entry. However, domestic fabrication yards would still need to invest modestly in reconfiguring their yard layouts to facilitate assembly line serial jacket production techniques. The market outlook for jacket structures would also have to support this investment. However, globally jacket structures have a significantly lower market share than monopiles, and recently many major global offshore wind jacket manufacturers have shifted their focus to producing monopile foundations.

Exhibit 64 Jackets radar chart analysis

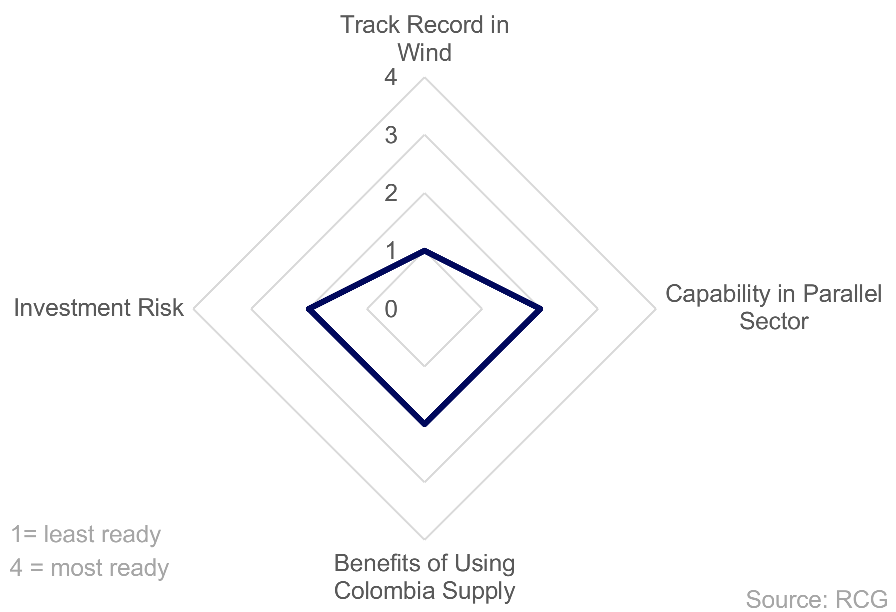


Exhibit 65 Potential local supply chain companies – jackets

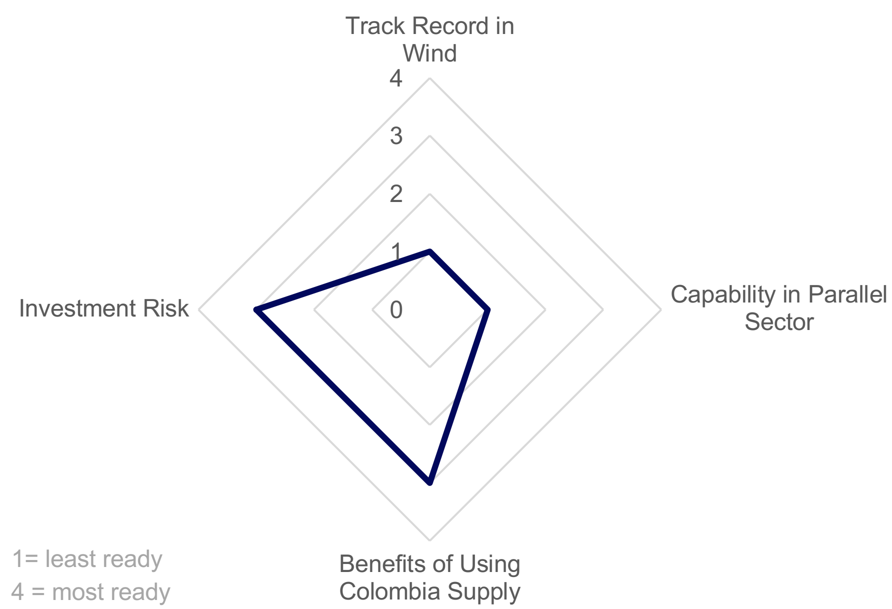
Local companies with potential transferrable skills:
• Bay, Ltd. • Ternium Colombia • Astilleros Unidos S.A.

Source: RCG

Transition Pieces

The transition piece component for foundations can represent a possible opportunity to develop a supply chain during the relatively early development stage of the industry, as these facilities typically require less market visibility and a smaller pipeline of bankable projects to justify investment. There can also be several logistical benefits to developers of utilizing local supply chain in Colombia with respect to transition piece supply. These include potential labor costs savings and coordination with delivery schedules as well as potential de-risking overseas component delivery delays impacting construction schedules.

Exhibit 66 Transition Piece Radar Chart



Source: RCG

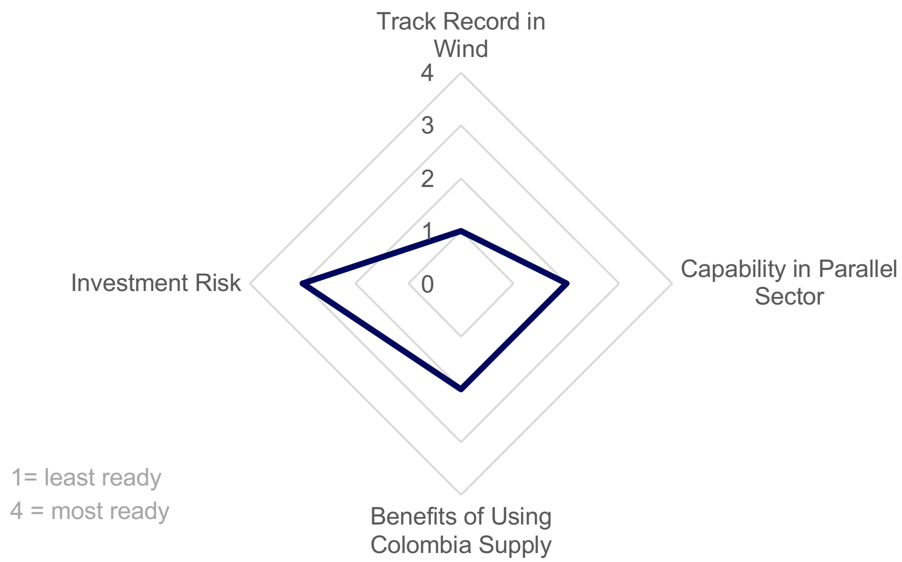
Exhibit 67 Potential local supply chain companies – Transition piece

Local companies with potential transferrable skills:
• Bay, Ltd. • Acerias de los Andes, Ltda. • Fundiciones Industriales SAS. • Ficep Group. • Compañia General de Aceros S.A.

Cabling (Inter-array)

High Voltage subsea export cables are highly specialized and may be difficult to construct locally. While technically possible to develop the capability, it is not expected that the local supply chain will construct inter-array cables in Colombia.

Exhibit 68 Radar Chart for Inter-array cables



Source: RCG

Exhibit 69 Potential local supply chain companies – subsea cables

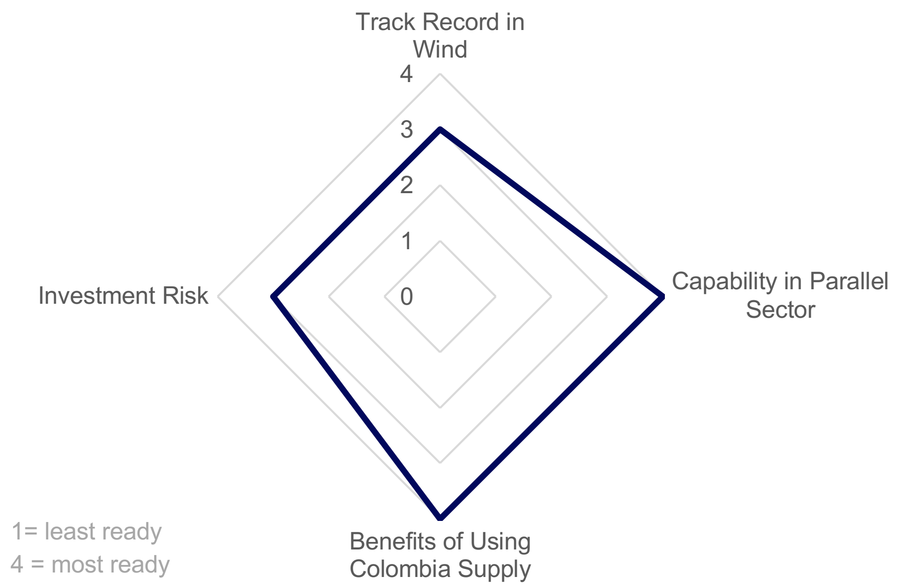
Local companies with potential transferrable skills:
• Centelsa • Procables • Nexans

Source: RCG

Onshore Substations

The onshore power substation receives power from the export cable and converts it to be fed into the onshore transmission system. These are often procured locally and there are benefits to the projects using local suppliers to directly contract with. From a local content perspective, however, most of the components needed will be manufactured overseas. Several companies with experience that would be transferrable to support the offshore wind industry are identified below.

Exhibit 70 Onshore substation radar chart



Source: RCG

Exhibit 71 Potential local supply chain companies – onshore substation

Local companies with potential transferrable skills:
• Proelectrica • Sacys Industrial • Quanta • HMV Ingenieros • EMS • Milem-red Solvers • ISA • GEB • Grupo Cobra • Seselec

8 PORTS INFRASTRUCTURE

This section assesses Colombia's port infrastructure and evaluates its potential to support construction and manufacturing of offshore wind farm components.

8.1 Purpose

In this section, we assess Colombia's port infrastructure with regard to supporting offshore wind. The assessment is focused along the northern shoreline, in the Caribbean Sea, as offshore wind potential is higher in this region compared to that off the Western coastline in the Pacific Ocean. Ports are heavily concentrated around Barranquilla and Cartagena, but potential facilities are well distributed along the coast. Consideration is given to both conventional fixed-bottom and floating wind infrastructure requirements as well as ports capable of supporting marshalling, manufacturing, construction and stevedoring (loading or discharging).

8.2 Methodology

The assessment methodology was established around the port requirements for construction of both fixed-bottom and floating wind projects and took into consideration the trajectory of component sizes and dimensions over the next decade. To assess existing ports along Colombia's north coastline, the project team gathered publicly available data for each port and also conducted a high-level assessment of the level of investment each port facility might require in order to increase capabilities towards a fully functioning offshore wind port (either a manufacturing or construction port).

Exhibit 72 Criteria for assessing the level of required investment

Investment range		Justification	Weight
\$0 - \$10 million	●○○	Established porting facility, there are no severe constraints associated with this port, investment is estimated to be minimal	3
\$10 - \$50 million	●●○	Some constraints are found at the port, but with reasonable levels of investment the facility can overcome these.	2
> \$ 50 million	●●●	Port has limited features and/or a large volume of investment is required to overcome a multitude of constraints	1

** Please note that levels of investment are high-level only and have not been qualified through actual financial commitment required at ports. Further analysis is required to determine true investment level.*
Source: RCG

Different requirements were established for manufacturing and construction ports as performed works differentiate significantly. All criteria are described in the following subchapters. To quantify the viability of ports, we have employed a Red, Amber, Green (RAG) system which provides a coarse rating of how capable each port either is, or will be, in servicing offshore wind developments. Different weights have also been applied to each criterion in the RAG system. It is important to note that this assessment does not take into consideration environmental and social impacts when redeveloping port facilities for offshore wind projects. Such assessment would require further analysis to determine impacts and could be a future optional appraisal that could include a more detailed financial analysis to determine the actual level of investment required.

8.2.1 Existing ports overview

Colombia has a coastline of over 3,100 km and an established port infrastructure with 14 designated ports distributed along the country's coastline in both the Caribbean Sea and Pacific Ocean. It worth noting that a few of the designated ports serve as coal export terminals, and that this number does not include inland ports facilitating fishing that have shallow channels, as these ports would not be capable of supporting offshore wind development. Although the analysis includes just one fishing port, Port of Turbo, showcasing the port's unsuitability to server the offshore wind sector.

Most of the identified ports are located along Colombia's coastline in the Caribbean Sea, in the Northern areas of the Bolivar, Atlántico, and Magdalena departments. Only two ports, the port of Buenaventura (container terminal) and the port of Tumaco (seaport), are located along the country's West coastline in the Pacific Ocean.

Colombia has 11 seaports and 4 container terminal ports, of which the largest terminals are located in Barranquilla, Buenaventura and Santa Marta. Colombian ports are owned and managed by a mix of state-owned and private enterprises, with all coal export terminals being privately owned.

Location of potential offshore wind suppliers

Given a concentration of shipping and maritime commercial activities around Cartagena and Barranquilla, as well as offshore oil and gas activities in Magdalena around Santa Marta, the port and coastal infrastructure in these regions is highly developed and has been further assessed in the sections below. Additional supply chain capabilities have also been assigned a “readiness level” quantity in Section 10 of this report, which covers potential component suppliers.

Coastal infrastructure in the Bolivar, Atlántico, and Magdalena departments would be geographically well suited to support offshore wind developments given their proximity to the sites identified. Port facilities around Santa Marta, in particular, have also been recently promoted to help support growth in Colombia’s offshore oil and gas activities. And thus may also be considered to support offshore wind.

8.2.2 Port assessment criteria

The criteria used to assess both manufacturing and construction ports are defined in this section.

Manufacturing ports

- Manufacturing ports, broadly, require larger areas for production halls, storage space, assembly and loading areas. Thus, ports with sufficient supply of surface area are well-placed to meet the requirements of offshore wind developments. Manufacturing ports should also be well-connected by means of an efficient transport infrastructure.

Construction ports

- Construction ports, on the other hand, require less space. This is the main difference between the two types of offshore wind ports assessed in this report. Construction ports must accommodate the delivery, handling and storage of materials and components for subsequent loading onto vessels. These ports must be capable of facilitating storage of foundation and transition pieces as well as assembly of wind turbine’s towers. Loadout of components is highly dependent on the capacity of the vessel deployed per project, but usually occurs in batches of four to six foundation or turbines.

The current assessment does not review suitability of Colombia’s ports to perform operations and maintenance (O&M) activities, as port requirements are less sensitive and the selected criteria are far less stringent when compared to manufacturing and construction activities. Distance to project site plays the largest role in determining viability of O&M ports, as distance will greatly influence cost and selection of maintenance strategy. Such assessment could be a future optional appraisal as developers identify the most suitable O&M ports for their projects.

8.2.3 Manufacturing port requirements

As previously mentioned, manufacturing ports serve activities related to production of the wind turbine foundations, the turbine towers and blades. Broadly, a fixed-bottom foundation manufacturing facility requires a substantial amount of space, around 40 hectares (or 400,000 m^2) for a 500 MW. However, floating wind manufacturing port facilities require even more space, of around 60 hectares, given the large dimension of the floating foundation structures in the market today.

Blade or turbine tower manufacturing facilities require a space between 20 hectares and 30 hectares, while nacelle manufacturing requires around 10 hectares.

The largest component of an offshore wind development is the offshore substation. This component is usually built as either a single unit or two units at a time, requiring similar space as a nacelle manufacturing facility.

Nonetheless, we anticipate a limited number of components to be domestically produced at least until the end of 2030, with the majority of components most likely being imported for the initial projects. Therefore, the current assessment represents a high-level assessment of whether or not each identified port would be suitable to serve as a manufacturing facility in the long-term.

8.2.4 Construction port requirements

Construction ports, as mentioned previously, accommodate the delivery, handling and assembly of components received in batches which are temporarily stored before loadout to installation and offshore construction support vessels.

The required space for such port activities is significantly lower than that required by manufacturing ports, requiring at least 8 hectares (80,000 m^2) for fixed-bottom projects and 11.5 hectares for floating wind developments.

As construction ports will be evaluated using a RAG system, the assessment criteria for the quayside draught / length, available laydown area and channel depth can be seen in Exhibit 73. Further details covered in the following pages define RAG rating and forward a narrative which will supplement each port's rating.

Exhibit 73 Criteria for assessing Colombia's port capabilities for construction

Parameter	Red	Amber	Green
Quayside Draught	< 7 m (fixed) < 10 m (floating)	7 – 10 m (fixed) 10 – 13 m (floating)	> 10 m (fixed) > 13 m (floating)
Laydown Area	< 60,000 m^2 (fixed)	< 60 - 80,000 m^2 (< 6 – 8 hectares)	> 80,000 m^2 (fixed)

Parameter	Red	Amber	Green
	< 85,000 m^2 (floating)	(fixed) < 85 – 115,000 m^2 (8.5 – 11.5 hectares) (floating)	> 115,000 m^2 (floating)
Quayside Length	< 100 m	100 - 200 m	> 200 m
Channel Depth	< 6 m	6 - 10 m	> 10 m
Bearing capacity	< 10 t/m^2	10 - 30 t/m^2	30 - 50 t/m^2

Source: RCG

Exhibit 74 Weights per criteria used to assess port capabilities

Parameter	Weightings
Quayside Draught	4
Laydown Area	3
Quayside Length	1
Channel Depth	2
Bearing capacity	-

Source: RCG

Exhibit 75 Weights per RAG used to assess port capabilities

RAG	Weightings
Green (highest readiness level)	3
Amber	2
Red (least readiness level)	1

Source: RCG

The selected criteria for this assessment are different for fixed-bottom and floating wind developments. Floating foundations require predominantly deeper draught quaysides since platforms are typically mated with the wind turbines at port or very close to port facilities and then towed out to site. Space requirements for the laydown area required for offshore wind components, free laydown space, warehouse space and in the case of floating (wet storage accommodation) are based on high-level assumptions around component dimensions for a 500 MW project utilizing 15 MW wind turbine units.

The project team has knowledge of the typical lengths of offshore wind construction vessels. Vessels are more likely to be at the upper range in length for larger componentry forecast for upcoming projects as wind turbine capacity continue to increase. Quayside lengths (where data allows) have been taken as the maximum berth length available and not a total length of the available berths / quaysides. Please note that the following data provide the number of available berths / quayside where data allows.

The draught of most of jack-up vessels, active in the offshore wind sector, is deemed to be below 10 m. Therefore, the channel depth is a conservative criterion. Due to availability of public data, load bearing capacity of laydown areas and quaysides has not been fully evaluated.

8.3 Results

The project team assessed 16 potential ports. A summary is provided in Exhibit 76, which assesses the suitability of each port to serve as either manufacturing or construction port, or potentially as both. Note that the selected ports do not consider suitability of location, but all - except for the facilities in Antioquia department - are located close to prime offshore wind research areas. A map of the port locations is provided later in this section, and each port is coloured corresponding the RAG system.

8.3.1 Summary of manufacturing and construction ports

In Exhibit 76, note that the acronym "FBOW" denotes suitability for Fixed-Bottom Offshore Wind and "FOW" stands for Floating Offshore Wind.

Exhibit 76 Summary of construction and manufacturing ports for offshore wind projects in Colombia

#	Port	Suitability for Construction	Suitability for Manufacturing	Justification	FBOW	FOW
1	Port of Turbo Pisisi (Under construction)	Suitable with minor upgrades	Suitable with minor upgrades	• Ownership: Government • Location: Turbo, Antioquia • Deep channel and quayside waters (16 m) • 4 linear berths totaling 760 m • 44 hectares of patios that will be available to serve as storage space for container and general cargo. • Significant opportunity to adjust the design of the port to serve as both manufacture and construction activities of an offshore wind farm.	☑	☑
2	Contecar, Mamonal	Suitable with minor upgrades	Suitable with minor upgrades	• Ownership: Private - Grupo Puerto de Cartagena • Location: Bay of Cartagena, Bolivar • Deep channel waters (12.5 m) • Deep quayside waters (16.5 m) • 4 linear berths totaling 660 m • 6 berths totaling 970 m • 40 hectares • 29 hectares of repurposed land that currently serves as container terminal and RoRo activities • Minor upgrades will be required to the bearing capacity of the quayside. • Good port facilities	☑	☑

#	Port	Suitability for Construction	Suitability for Manufacturing	Justification	FBOW	FOW
3	Terminal Maritimo Muelles El Bosque - CCTO	Suitable with minor upgrades	Suitable with minor upgrades	• Ownership: Private - Operador de Terminal de Contanedores de Cartagena S.A.S • Location: Bay of Cartagena, Bolivar • Deep channel waters (12 m) • Deep quayside waters (14.5 m) • 3 linear berths totaling 660 m • 22 hectares of patio area facilitating container and RoRo activities, including five warehouses of 0.7 hectares that are used as silos. • Minor upgrades would likely be required to the bearing capacity of the quayside. • Good port facilities	☑	☑
4	Cartagena SPRC - Magna	Suitable with minor upgrades	Suitable with some upgrades	• Ownership: Private - Grupo Puerto de Cartagena • Location: Bay of Cartagena, Bolivar • Deepest channel waters (20.5 m) when compared to other ports in Colombia • Single 700 m berth with water depths of 15.5 m • Four additional berths of 190 m in length each that are used as cruise terminals. • 15 hectares of patio area facilitating container and general cargo activities • Some upgrades may be required to increase the bearing capacity of the quayside. • Good port facilities	☑	☑
5	Port of Santa Marta	Suitable with minor upgrades	Suitable with some upgrades	• Ownership: Private - Sociedad Portuaria de Santa Marta (SPSM), • Location: Santa Marta, Magdalena • Deep channel waters (14 m) • One 150 m long berth with a draught of 17.37 m. • Six berths ranging from 105 – 240 m and having water depths of 5.18 – 11.58 m. • 33 hectares of which 13 hectares are patios servicing container and general cargo activities, including 2.4 hectares that are used as coal export terminals. • Minor upgrades will be required to increase bearing capacity. • Good port facilities	☑	☑
6	Port of Barranquilla	Suitable with minor upgrades	Suitable with some upgrades	• Ownership: Government • Location: Barranquilla • Deep quayside waters (12 m) and relatively deep channel waters (10.5 m) • 6 linear berths, totaling 1,058 m • 94 hectares • 20 hectares of coal terminal that could be redeveloped to serve construction. • At least 5 tons/m^2 of bearing capacity, some upgrades might be required. • Some investment required to upgrade existing infrastructure in order to server as manufacturing port.	☑	☒

#	Port	Suitability for Construction	Suitability for Manufacturing	Justification	FBOW	FOW
7	Port of Brisa	Suitable with some upgrades	Suitable with major upgrades	• Ownership: Government • Location: Mingueo and Dibulla, La Guajira • Deep channel and quayside waters (18 m) • Two 360 m long berth which extends into the sea. • More than 20 hectares of patio available to be leased. • Mega purpose-built port infrastructure which approved in 2010. Construction started in 2013. However, construction of phase 3 which would bring five additional docks for handling containers and general cargo, stopped as a result of the coronavirus pandemic. • Moderate investment will be required to expand / redevelop existing berth and increase bearing capacity of storage area. • Significant investment will be required to redevelop port facilities for manufacturing purposes. • Poor port facilities, as the port is currently used as a coal export terminal.	☑	☑
8	Port of Tolu	Suitable with some upgrades	Suitable with major upgrades	• Ownership: Private - Compañía de Puertos Asociados S.A. (COMPAS S.A.) • Location: Tolu • Relatively deep quayside waters (12.5 m) • Two linear docking berths totaling 410 m • 43.5 hectares of available patio of which 2 hectares are used to export coal. • Moderate investment will be required to redevelop existing quayside to serve offshore wind projects, expanding its length and increasing its bearing capacity. • Significant investment required to redevelop existing port infrastructure so as to serve as manufacturing port. • Below moderate port facilities as there are some machineries that facilitate coal loading activities.	☑	☒
9	Port of Bahia	Suitable with some upgrades	Suitable with major upgrades	• Ownership: Private – Four partners including International Finance Corporation, a World Bank Group member. • Location: Bay of Cartagena, Bolivar • Colombia's youngest built port as construction of port's first phase completed in 2015. • A 300 m long pier having a draft of 18 m. The partners plan to expand the pier adding another 300 m to it. • 27 hectares of patio facilitating container storage and general cargo activities. • Moderate investment will be required to increase bearing capacity of existing quayside and storage area to serve as construction port • Significant investment will be required to redevelop existing port facilities to serve as manufacturing port for offshore wind projects.	☑	☑

#	Port	Suitability for Construction	Suitability for Manufacturing	Justification	FBOW	FOW
				• Moderate port machinery in place.		
10	Port of Buenavista	Suitable with major upgrades	Suitable with major upgrades	• Ownership: Private – Three partners: Yara Colombia, COMPAS, Saam Puertos • Location: Bay of Cartagena, Bolivar • The port is located close to the Mamonal industrial zone • Moderate channel depth (9 m) • A 221 metres long quayside having a draught of 10.2 m • 6.5 hectares of patio with storage yards of 2.8 hectares • Major upgrades required to bearing capacity of quayside and storage area • Major investment will be required to expand the port's area and modify to serve either manufacturing or construction. • Limited quayside equipment.	☑	☒
11	Port of San Andres Island	Suitable with major upgrades	Not suitable for manufacture	• Ownership: Government • Location: San Andres Island, Caribbean Sea • Four linear quays totaling 450 m in length with an 8-metre draught • 23 hectares of patio that are used for container storage as well as dry bulk cargo storage • Major upgrades required to channel and quay depth • Moderate upgrades required to bearing capacity of quayside and storage area to serve as construction port. • Limited port equipment	☑	☒
12	Port of Turbo Antioquia	Not suitable for construction	Not suitable for manufacture	• Ownership: Government • Location: Turbo, Antioquia • This port is a fishing port situated inland. • Shallow channel and quayside depth (5.6 m) • Maximum quayside length of 9 meters • Limited space of storage area as the port is mainly used by fishing vessels. • This port is not suitable to serve neither the manufacturing nor the production phase of an offshore wind project.	☒	☒

Source: RCG

Table legend

Symbols	Comment
☑	Selected port can be used for the development of offshore wind projects.
☑	Selected port can be used for the development of offshore wind projects, but some constraints exist.
☒	Selected port can not be used for the development of offshore wind projects.

Source: RCG

Exhibit 77 Summary of coal terminals that can support either manufacturing or construction of offshore wind projects in Colombia

#	Port	Suitability for Construction	Suitability for Manufacture	Justification	FBOW	FOW
1	Puerto Nuevo (formerly Port of Prodeco)	Suitable with major upgrades	Suitable with major upgrades	• Ownership: private – Prodeco • Location: Ciénaga, Magdalena • This private port is located close to the port of Drummond. • Deep water channel (20.3 m) • Deep operational quayside draught (18.4 m) • Two 301 metres long loading berths • 20 hectares of patio used as stockpiling yards and coal handling. • Significant upgrades required to quayside bearing capacity and storage area to serve both manufacture and construction phases. • Very limited port facilities and equipment as the port is used solely as a coal export terminal.	☑	☑
2	Port of Bolivar	Suitable with major upgrades	Not Suitable for manufacture	• Ownership: private – Cerrejón Coal Company • Location: Bahia Portete • Deep channel waters (19 m) • A 300 m long berth, having a 16.7 m draught • 60 hectares of total area with 30 hectares being used as coal export terminal. • Moderate upgrades will be required to increase the bearing capacity of the quayside. • Significant upgrades required to increase bearing capacity of storage area as well as to redevelop existing hectares • Poor port facilities as the port is focused on coal export activities.	☑	☑
3	Port of Drummond	Suitable with major upgrades	Not Suitable for manufacture	• Ownership: private – Drummond • Location: Ciénaga, Magdalena • Largest coal export terminal in Colombia • No quayside in place, but the port has a berth which extends 310 meters in the sea having a draught of 16 m • Significant investment required for the redevelopment of the port, expanding current berth and increasing the bearing capacity of both quaysides and coal's storage area. • Very limited port facilities and equipment.	☑	☑
4	Port of Pozos Colorados	Suitable with major upgrades	Not Suitable for manufacture	• Ownership: private - Ecopetrol • Location: Santa Marta, Magdalena • Shallow channel depth (7.6 m) • A 152 meters long berth which extends in the sea with a draught of approximately 14 m. • The port could only be repurposed to facilitate the construction phase of an offshore wind project. • Significant upgrades will be required to channel depth as well as to construct a suitable quayside and storage area. • Very limited facilities, equipment and transport links.	☑	☒

Source: RCG

8.3.2 Port assessment readiness results

The project team utilized a weighted scoring methodology (described in Exhibit 73, Exhibit 74, and Exhibit 75) to produce a numeric value and rank the overall readiness of the ports to support either fixed of floating offshore wind developments. The results are shown in Exhibit 78.

Exhibit 78 Port Assessment Results Table

Port Name	Fixed bottom				Floating				Main Port Activity	Investment Level Required	Final Score
	Quayside Draught	Laydown Area	Quayside Length	Channel Depth	Quayside Draught	Laydown Area	Quayside Length	Channel Depth			
Port of Turbo Pisisi (Under Construction)	G	G	G	G	G	G	G	G	Container, General Cargo	● ○ ○	78
Contecar, Mamonal	G	G	G	G	G	G	G	G	Container, RoRo	● ○ ○	78*
Terminal Maritimo Muelles El Bosque	G	G	G	G	G	G	G	G	Container, General Cargo	● ○ ○	78*
Cartagena SPRC - Magna	G	G	G	G	G	G	G	G	Container	● ● ○	76
Port of Santa Marta	G	G	A	G	G	G	A	G	Container, General Cargo	● ● ○	74
Port of Barranquilla	G	G	G	G	A	G	G	A	Container, General Cargo	● ○ ○	71
Port of Brisa	G	G	R	G	G	G	R	G	Coal Terminal	● ● ●	70
Port of Tolu	G	G	G	G	A	G	G	G	General Cargo, Coal Terminal	● ● ●	69*
Port of Bahia	G	G	G	G	A	G	G	G	General Cargo, RoRo	● ● ●	69*
Port of Buenavista	G	R	G	A	A	R	G	A	General Cargo	● ● ○	51
San Andres Island	A	R	G	A	R	R	G	A	Container	● ● ●	39
Port of Turbo Antioquia	G	R	R	R	R	R	R	R	Fishing	● ● ●	36
Coal & Oil Terminals											
Port of Bolivar	G	G	G	G	G	G	G	G	Coal Terminal	● ● ●	74
Port of Drummond	G	R	R	G	A	R	R	G	Coal Terminal	● ● ●	49
Puerto Nuevo	G	R	R	G	R	R	R	G	Coal Terminal	● ● ●	44
Port of Pozos Colorados	R	R	A	R	A	R	A	R	Oil Terminal	● ● ●	33

** Please note that the available quayside length was used to rank ports that got the same final score.*

Source: RCG

8.3.3 Discussion of results

Several ports facilities have been identified and evaluated favorably with respect to their physical capability to support fixed-bottom or floating offshore wind farm construction or manufacturing activities in Colombia over the long-term.

The highest ranked port in terms of the readiness evaluation criteria is the Port of Turbo Pisisi, which is currently under development as a multi-use facility. However, its remote location in relation to the prospective offshore wind farm development areas renders this port relatively unlikely to be a prime candidate to support offshore wind activities. Given their proximity, the Port of Cartagena, Port of Barranquilla, and Port of Santa Marta all contain facilities that could be utilized more readily to support construction and manufacturing of offshore wind components.

The Port of Cartagena comprises the largest port on Colombia's Caribbean coast, and several facilities were identified that could be capable of supporting offshore wind activity with modest investments. The port facilities are situated in and around a protected bay, the Bay of Cartagena, which boast water depths of approximately 14 meters, which is sufficient channel depth for large transport and installation vessels as well as potentially large floating foundation structures. The facilities also have sufficient quayside length for receiving and loading vessels. There are no identified overhead impediments such as bridges or other obstructions that would hinder large components from entering and exiting the Port.

Three (3) major terminal facilities that comprise the Port of Cartagena were evaluated. Contecar and Mamonal are located outside of the bay and currently serve primarily as container terminal. Within the bay, two facilities Maritimo Muelles El Bosque (CCTO), and Manga (SPRC) also serve as cargo facilities as well as cruise ships docks. All of these facilities have the physical characteristics required to support construction and major manufacturing activities with little to modest upgrades, and have been ranked high in terms of their ”readiness level”. The Port of Cartagena is also favorable located in proximity to several of the identified wind energy deployment sites.

Exhibit 79 Aerial Image of Port of Cartagena

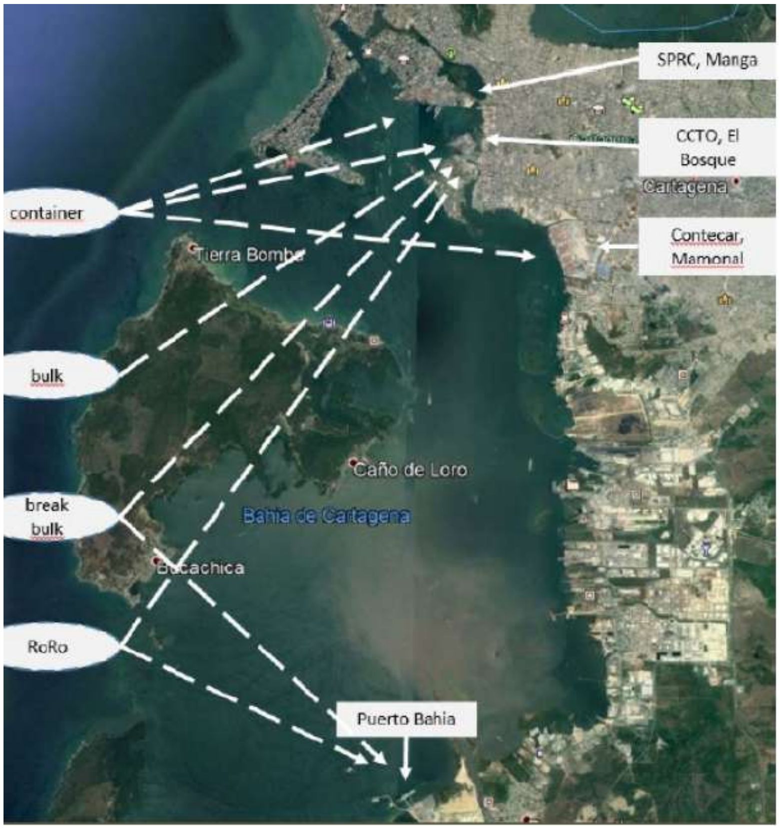


Image Source: Logistics Cluster - Logistics Capacity Assessment[27]

The Port of Barranquilla, located approximately 75 miles to the east of the Port of Cartagena, consists of a several mostly privately-owned port facilities that are located along the banks of the Magdalena River. The port facilities include a large multi-purpose terminal and a large container terminal operated by Sociedad Portuaria Regional de Barranquilla (SPRB), as well as an additional multi-purpose terminal operated by Coremar. These sites are amongst the largest coastal port facilities in the country in terms of land area and quayside length, and could be suitable to support construction, staging and, with modest upgrade, manufacturing for fixed-bottom offshore components and supporting construction operations.

The main constraint for the Port of Barranquilla is the channel depth. A spout at the mouth of the river Magdalena reduces the water depths to 9 meters, and it must be routinely dredged to maintain the water dept of 11 meters required to accommodate cargo ships. There could potentially be limitations with many (but not necessarily all) of today's floating offshore wind foundation structures, which require deeper channel depths for construction and assembly.

[27] Open access logistics database source. www.dcla.logcluster.org

Further south, there is additional development of new port facilities along the Magdalena River. The Pumarejo Bridgehas a height restriction of 45 meters and is not expected to hinder access but may need to be considered This would prevent certain large components such as jacket foundations for wind turbine generators or substations from being transported vertically from quayside to the development area. However, the sites could still be used for construction, manufacturing and staging of various other components.

Exhibit 80 Aerial Image of Port of Barranquilla

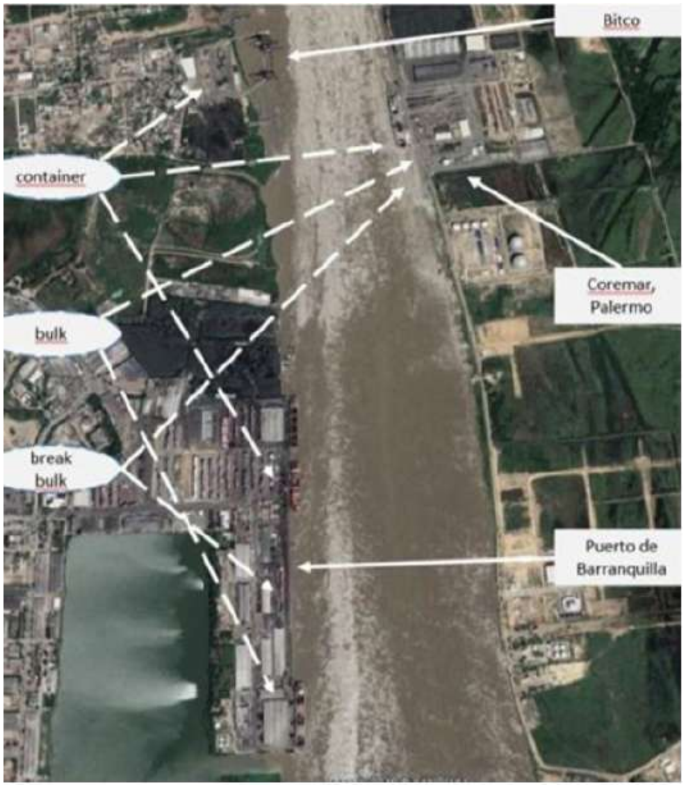


Image Source: Logistics Cluster - Logistics Capacity Assessment[28]

Port of Santa Marta facilities are currently used for a variety of commercial activities including cargo and containers loading as well as importing and exporting / discharging various commodities. The Port or Santa Mart area is an inlet comprised of seven different berths with quayside lengths spanning from 105 – 240 meters long each. The channel depth is sufficiently deep at 14 meters and the berth draught is 17 meters, which is also favorable for offshore wind. One of the key advantages of the Port of Santa Marta is its proximity to many of the prospective offshore wind development zones. However, the major constraint with the Port facilities at Santa Marta are the quayside length. Of the seven (7) berths, several have insufficient

[28] Open access logistics database source. www.dcla.logcluster.org

quayside length required for offloading large components of offshore wind structures. Moreover, although overall laydown space is overall sufficient, much of this is occupied by existing infrastructure, notably grain and commodity silos and warehouses. Re-purposing these facilities to support construction and especially manufacturing of offshore wind farm components would likely require more significant investment than alternatives at the Port of Cartagena.

Exhibit 81 Aerial Image of Port of Santa Marta

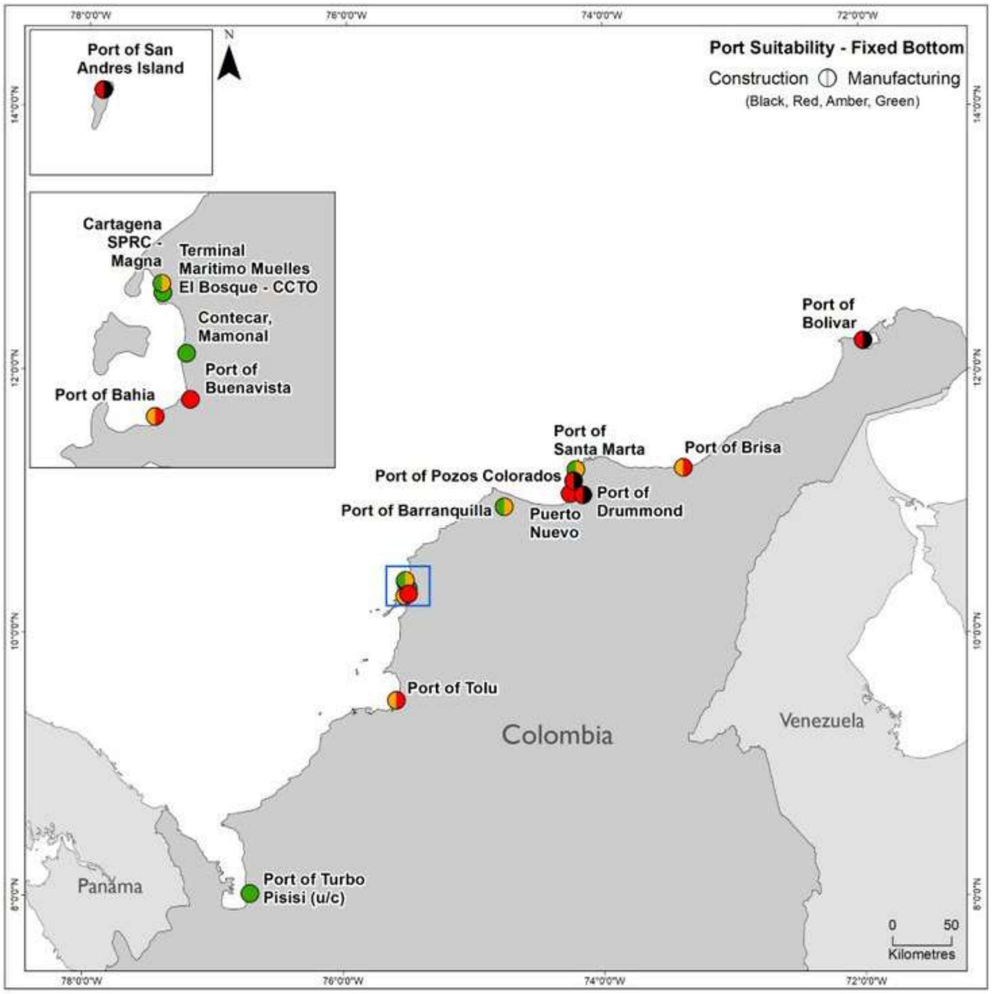
Image Source: Logistics Cluster - Logistics Capacity Assessment[29]

8.3.4 Map of potentially viable ports

Exhibit 82 displays port suitability for construction or manufacturing for fixed-bottom bottom offshore wind developments, applying the results of the RAG analysis.

[29] Open access logistics database source. www.dcla.logcluster.org

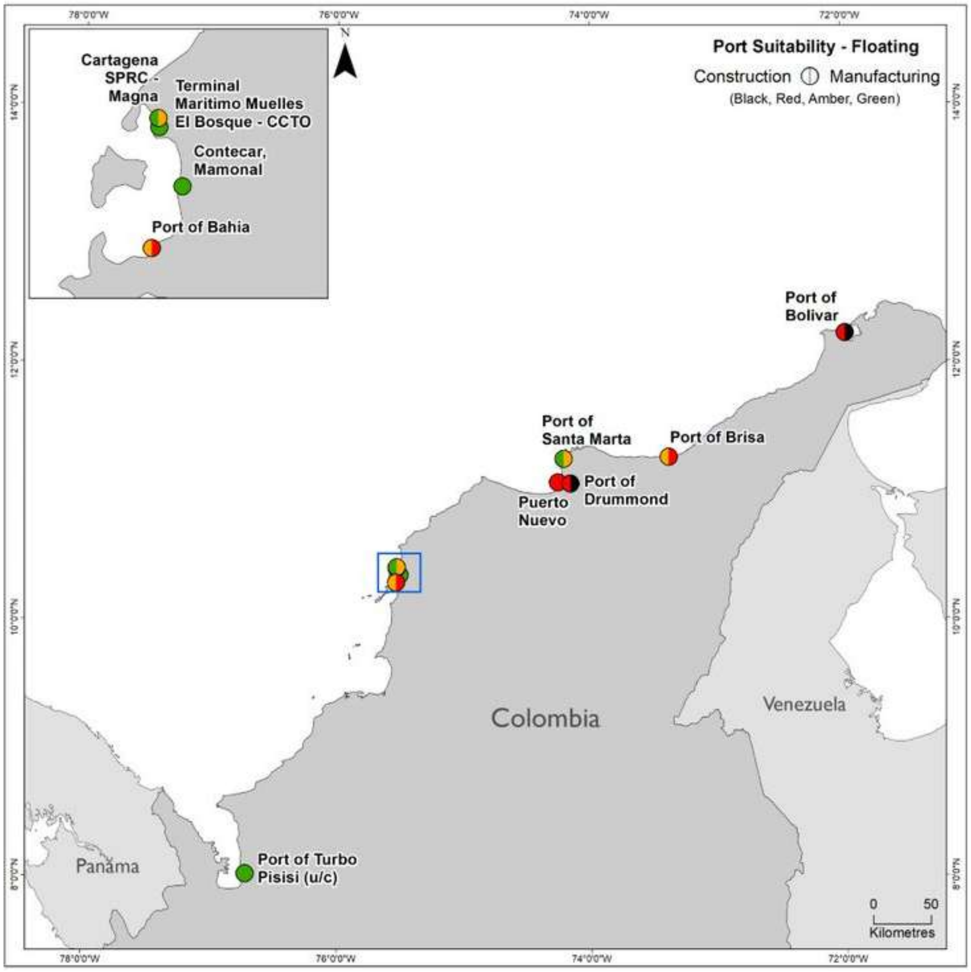
Exhibit 82 Map of Port Suitability for Fixed-Bottom Construction or Manufacturing



Source: RCG analysis as per section 8.2.2, based on National Geospatial Intelligence Agency information. Color scale references previous tables, with Green representing suitable with minor upgrades, yellow representing suitable with some upgrades, red representing suitable with major upgrades, and black representing not suitable.

The following map displays port suitability for construction or manufacturing for floating offshore wind developments, applying the results of the RAG analysis.

Exhibit 83 Map of Port Suitability for Floating Construction or Manufacturing



Source: RCG analysis as per section 8.2.2, based on National Geospatial Intelligence Agency information. Color scale references previous tables, with Green representing suitable with minor upgrades, yellow representing suitable with some upgrades, red representing suitable with major upgrades, and black representing not suitable.

8.3.5 Shipyards

In addition to ports, shipyards have also proven to be important coastal infrastructure assets as well as a link in the global offshore wind supply chain. In many cases, shipyard owners have successfully leveraged their expertise in welding and fabricating other complex multi-layer structures to transition to the offshore wind industry, offering fabrication, staging, and assembly services. Prominent shipyards in Europe and Asia have successfully adapted their core shipbuilding competencies to reliable fabrication of offshore substations – including both topside decks and modules as well as foundation structures.

As the supply chain in Colombia matures, shipyards may emerge either as manufacturing hubs for certain components or as staging and assembly hubs.

In 2020, the Colombian government approved the PROASTILLEROS (decree 1156/2020) which aims to promote new domestic construction of commercial operations vessels by eliminating import tariffs on the goods and raw materials imported to Colombia for industrial use building commercial vessels. To foster similar new production in renewable energy, the Colombian government could consider an extension of the decree waiving tariffs on materials required for the construction of offshore wind.

Below is a GIS depiction of the local Colombian shipyards within a reasonable range of the proposed offshore wind development zones. These shipyards are further color coded by their suitability for offshore wind support operations given existing equipment, facilities (available land) and previous track record of each shipyard.

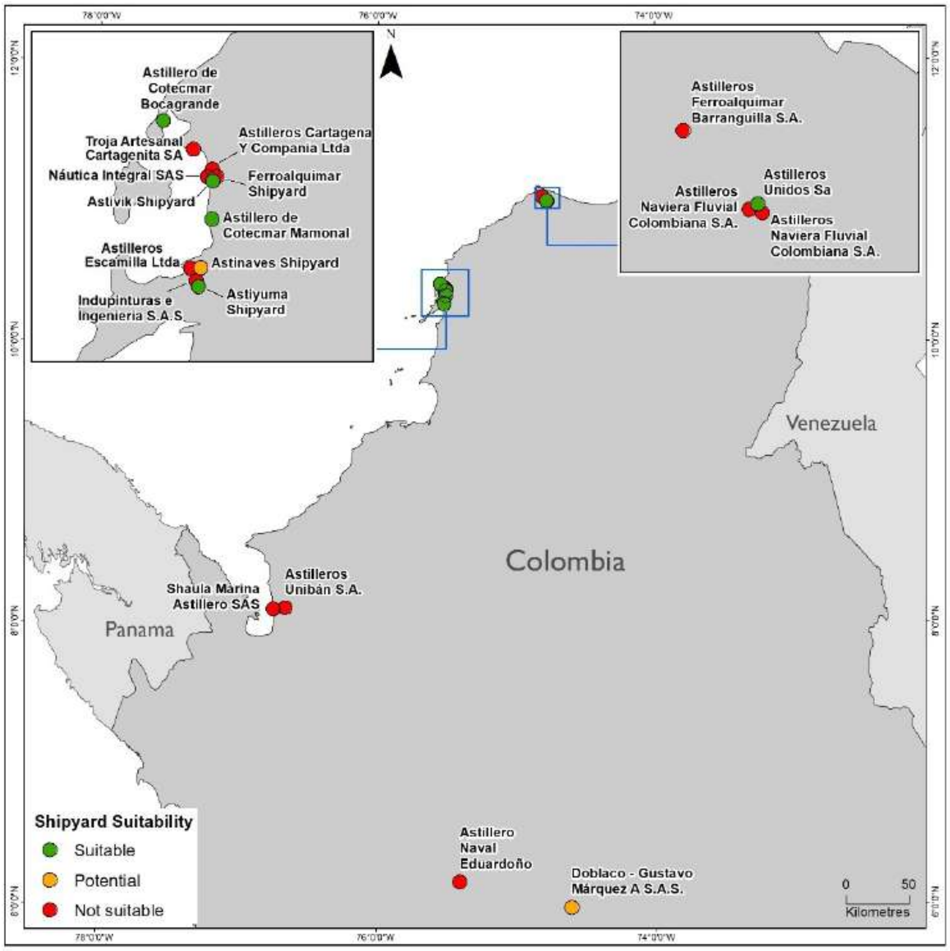
There are 32 currently operational shipyards along Colombia's coastline in the Caribbean Sea and Pacific Ocean, as shown below. Of these 32 shipyards, 22 are located along the southwestern half of Colombia's Caribbean coastline, with 11 situated in Cartagena proper. It is worth noting only a small number of the identified shipyards in Cartagena are suitable and have the capability to support the offshore wind sector manufacturing topside modules and/or foundations for offshore substations.

Exhibit 84 Colombia's shipyards by region and type of activities

Region	# Shipyards	Type of activities
Caribbean (Bolivar, Atlántico, Magdalena)	18 (11 in Cartagena)	• Construction of small boats, pleasure boats and fiberglass fishing, slabs, semi-rigid boats, motorboats • Repair of feeder vessels and medium vessels • Design and construction of medium ships
Antioquia (Medellin and Turbo)	4	• Manufacture of polyester boats, fiberglass, slabs, ferries for passengers and cargo, inflatable and semi-rigid boats
Costa Pacifica (Valle del Cauca and Choco)	6	• Manufacture of motorboats and boats, fiberglass boats, recreational and sports boats
Bogota / Cundinamarca	4	• Manufacture of catamarans, patrol boats, aluminum boats, floating docks

Source: ProColombia

Exhibit 85 Shipyards along Colombia's Caribbean coastline



Source: RCG analysis, 2021.

Three of these shipyards—Cotecmar, Astivik and Ferroalquimar—operate following established international standards (ISO 9001:2008, ISO 9001:2015) for major maritime industrial work. However, Ferroalquimar's facilities are not capable of supporting the offshore wind sector as the company focuses only on providing repair and maintenance services for boats of up to 3,000 tons and had only one 300-ton marine travelift at its docks. On the contrary, Cotecmar and Astivik operate three shipyards (Cotecmar has two) that could potentially serve Colombia's emerging offshore wind industry by providing a range of services including fabrication of both topsides and foundations. Astivik has a proven track record providing services to the offshore oil and gas sector in Colombia, including servicing vessels used in this sector (offshore supply vessels and jack-up rigs). Should these shipyards prove insufficient for the industry's needs, a remote possibility until the market has matured significantly, the Astiyuma shipyards, also in Cartagena, could be mobilized to produce offshore substation topsides and foundations. Astiyuma has a long track record of oil and gas control module and pipeline manufacturing, as well as other heavy industrial fabrication.

Barranquilla is home to four shipyards of which only one, Astilleros Unidos, has the ability to support fabrication of large components, offshore substation foundations and topsides. This shipyard could also be used as a staging and assembly point for fixed-bottom projects in the region of Atlántico as the company has extensive experience in manufacturing and assembling steel structures.

Similarly, the region of Antioquia is also home to four shipyards, two located at Turbo and two at Medellin. Out of these four shipyards, only the Doblaco – Gustavo Márquez shipyard could support offshore wind projects. However, this shipyard is located more than 300 km from the mouth of the Magdalena River in the Caribbean Sea. As the remaining three shipyards have limited equipment to support the offshore wind sector, projects in the region of Antioquia could face challenges during the construction and execution phases.

9 HEALTH AND SAFETY

This section provides a review of applicable Health and Safety (H&S) guidance and regulation in Colombia and provides a high-level overview of offshore wind requirements.

9.1 Purpose

Health and safety management and regulation is a vital aspect for the development of any project in Colombia, and therefore relevant for the sustainable and responsible offshore wind industry. The aim of this section is to conduct a high-level review of the applicable occupational health and safety legislation in Colombia, in order to understand how it aligns with general work requirements and its application to offshore wind energy operations.

9.2 Methodology

The evaluation of occupational health and safety (H&S) requirements has been based on the project team's experience as consultants in this area, both at the national and international level, and takes into account special considerations for offshore wind energy projects.

The review of existing information on this topic has identified the occupational health and safety frameworks in Colombia that are applicable to all industrial sectors, including the oil and gas sector, which is one of the most demanding and controlled at the national level. Specific regulations applicable to the offshore aspects of oil and gas operations would have significant relevance for offshore wind development. It is important to emphasize that Colombia is a country that in the last decade has established a great volume of norms in Health and Safety at Work, which makes it a reference in Latin America and one of the countries with the greatest regulations on the topic.

9.2.1 Applicable Standards

9.2.2 National guidance

Developers of offshore wind projects shall consider the existing regulatory framework for the offshore Oil & Gas sector in Colombia. This must include a comprehensive knowledge and understanding of the Unified Decree of the Labor sector, compendium of all applicable regulations, which is complemented by some specific rules aiming to strengthening of the national framework for the prevention of occupational accidents and related diseases.

Likewise, relevant international standards or good practices that must be taken into account will be referenced, so that developers can evaluate from the beginning of the operation the scope of their health and safety management system. The system shall take into consideration the nature of the work and the dynamics of the legal compliance on the topic for the safe implementation of required activities.

Although there is no specific regulation for the offshore wind sector, the legal framework for occupational health and safety in Colombia must be followed. As a starting point, the Regulatory Decree of the labor sector, in chapter 6 establishes the general implementation requirements for any organization in terms of safety and health. In addition, Resolution 0312 of 2019 specifies the implementation requirements for any organization according to its level of risk and number of employees, bearing in mind that a person with a license in occupational health and safety must direct the development and implementation of the Occupational Health and Safety Management System SG-SST.

The following table summarizes the main requirements currently in force that must be met.

Exhibit 86 Main Occupational Safety and Health Regulations in force in Colombia 2021

Subject	Document	Summary
Occupational Health and Safety Management Systems.	Decree 1072 of 2015. General Regulatory Framework for the Labor Sector. Chapter 6.	The implementation of the Occupational Health and Safety Management System (OSHMS) is mandatory. Companies, regardless of their nature or dimension, must implement an OSHMS. It covers issues related to legal non-compliance in the area of occupational health and safety.
Minimum Occupational Safety and Health Standards	Resolution 0312 of 2019. Establishes the minimum standards of the OSH Management System and abolishes Resolution 1111 of 2017.	The minimum standards correspond to the set of norms, requirements and procedures of mandatory compliance by employers and contractors. They describe the basic and indispensable requirements of technical, administrative capacity, financial, and patrimonial nature that must be

		established, verified and controlled for the operation, and development of activities in the OSH Management System. It contemplates legal consequences of the non-compliance in the area of occupational health and safety.
Contingency plan	Resolution 256 of 2014. Establishes the regulations for the training of fire brigades.	The brigade shall be made up of at least 20% of the working population.
Technical criteria in offshore hydrocarbon exploitation	Resolution 40295 of 2020. Establishes technical criteria for offshore hydrocarbon exploration and exploitation projects in Colombia.	The Resolution established the mandatory technical requirements for operations within the framework of contracts signed with the Agencia Nacional de Hidrocarburos (ANH), related to drilling activities, well intervention and offshore hydrocarbon production under the seabed in shallow, deep and/or ultra-deep waters, seeking to promote the development of such activities in a safe, sustainable and responsible manner.
Protected areas	Decree 2372 of 2010. Regulating Decree Law 2811 of 1974, Law 99 of 1993, Law 165 of 1994 and Law 216 of 2003, in relation to the national system of protected areas.	The aim of this decree is to regulate the National System of Protected Areas, the management categories that comprise it and the general procedures related to it and the nature of activities that can be compatible with the conservation goalls in each case.
Registration to the Labor Risks General System.	Decree 1072 of 2015. Regulatory Framework of the Labor Sector	Establish the mandatory registration of all workers to the General Labors Risk Systems
COVID-19	Resolution 777 de 2021	The criteria and conditions for the development of economic, social and state activities are defined and the Biosafety Protocol for the execution of these activities is adopted.
Health emergency.	Decree 1026 of 2021	Instructions regarding the sanitary emergency generated by the COVID - 19 Coronavirus pandemic, and the maintenance of public order, selective isolation with individual responsible distancing and safe economic reactivation is decreed
Physical load (Biomechanics)	Resolution 2400 of 1979	Provisions on housing, hygiene and industrial safety in work establishments. It describes the obligations of employers, and workers about, hygiene services in the workplace, waste disposal, and workers' camps, among others.
Natural disasters	Presidential Decree 1081 of 2015. Regulatory Framework for management of emergencies.	General measures are adopted for the development of the disaster risk management plan for public and private entities in the framework of Art. 42 of Law 1522 of 2012.
Electric Power	Resolution 5018 of 2019.	The Technical Annex provides guidelines on Occupational Safety and Health in the Processes of Generation, Transmission, Distribution and Commercialization of Electric Energy

Occupational medical evaluations	Resolution 2346 of 2007.	Regulates the practice of occupational medical evaluations and the management and content of occupational medical records.
	Circular 022 of 2021	Non-requirement of SARS - Cov -2 (Covid 19) testing by the employer to workers and job applicants.
Handling of low, medium, high and extra high voltage electrical energy.	Resolution 90708 of 2013.	Describes the technical regulation for electrical installations RETIE, among other topics.
Sanitary measures	Law 9 of 1979	Define the sanitary measures for the protection of the environment, water supply, occupational health, and sanitation, among others.
Notification and Investigation of Occupational Accidents	Resolution 1401 of 2007.	Regulate the investigation of occupational incidents and accidents.
Personnel transport	Law 769 of 2002.	Establish the National Land Traffic Code and other relevant provisions.
	Resolution 1.565 of 2014	Establish the methodological guide for the preparation of the Strategic Road Safety Plan.
Environment and sustainable development.	Decree 1076 of 2015.	Establish the general framework for Environmental Management and Sustainable Development.
Work for underage children	Resolution 1796 of 2018.	Defines the employer's responsibilities with respect to underage workers and other provisions. Provides a list of hazardous activities that due to their nature or working conditions are harmful to the health and physical or psychological integrity of minors under 18 years of age.
Employer's responsibilities	Decree 2663 and 3743 of 1950. Substantive Labor Code	Establish the code of justice in relations between employer and worker.
Intra-workplace, extra-workplace and individual factors (Psychosocial Risk).	Law 1010 of 2006	Establish the measures adopted to prevent, correct and sanction labor harassment and other harassment within the framework of labor relations.
	Resolution 2646 of 2008	Establishes regulations and defines responsibilities for the identification, evaluation, prevention, intervention and permanent monitoring of exposure to psychosocial risk factors at work and for the determination of the origin of pathologies caused by occupational stress..
Chemical Risk	Decree 1496 of 2018	Approves the Globally Harmonized System of Classification and Labeling of Chemicals and other chemical safety provisions are.
High-risk tasks - Work at heights	Resolution 1409 of 2012	Establish the Safety Regulation for fall prevention in work at heights..
High Risk Tasks - Confined Spaces	Resolution 0491 of 2020	Establishes the minimum requirements to ensure the safety and health of workers working in confined spaces.

Source: RCG-ERM, 2021

9.2.3 International guidance

In addition to the regulations associated with HSE that currently exist in Colombia, we suggest that other regulations be considered, which are available internationally (UK and around the world). These regulations are specifically focused on offshore wind projects, for which we suggest that the authorities take into account, as part of the guidelines associated with HSE aspects for the development of offshore wind projects.

Exhibit 87 Relevant Health and Safety Legislation and Guidance Documents (UK / Worldwide)

Project Stage/Area Document Summary	Project Stage/Area Document Summary	Project Stage/Area Document Summary
Design safety/ emergency response Inspection Emergency response	DNVGL-ST-0145, Offshore Substations for Windfarms	General safety principles, requirements, and guidance for platform installations associated with offshore renewable energy projects (substations).
Design inspection	DNVGL-ST-0119, Floating Wind Turbine Structures	Principles, technical requirements, and guidance for design, construction, and inspection of floating wind turbine structures.
Design construction	DNVGL-ST-0126, Support Structures for Wind Turbines	General principles and guidelines for the structural design of wind turbine supports.
Design construction	DNVGL-ST-0437, Loads and Site Conditions for Wind Turbines	Principles, technical requirements, and guidance for loads and site conditions of wind turbines.
Design	IEC 61400, Wind Turbine Generator Systems	Minimum design requirements for wind turbines.
Design operation maintenance	EN 50308: Wind Turbines—Protective Measures—Requirements for Design, Operation, and Maintenance	Defines requirements for protective measures relating to health and safety of personnel (commissioning, operation, and maintenance).
Various	G+ Good Practice Guidelines and Safe by Design Workshop Reports	Good practice guidance intended to improve the global H&S standards within offshore wind farms and workshop reports that explore current industry design and investigate improvements.
Health & safety	RenewableUK Health & Safety Publications	Various H&S guidelines for offshore wind farms, including emergency response guidelines.
Construction Safety	CAP 437, Standards for Offshore Helicopter Landing Areas	Criteria required in assessing the standards for offshore helicopter landing areas.

Source: Adapted from World Bank 2021. Offshore Wind Roadmap for Vietnam. World Bank. Washington, DC. License Creative Commons Attribution CC BY 3.0 IGO

9.3 Results

From the information described above, it can be concluded that although there are no specific regulations for offshore wind projects, the general occupational health and safety regulations from other industries are applicable to these projects. In particular, general regulations of sectors working in offshore operations such as Oil & Gas can establish the reference requirements and responsibilities for any organization undertaking an offshore project at a high level. It is important to note that these regulations are intended to align with the government's goal of preventing accidents and occupational diseases in the national territory.

Experience from other offshore wind markets has shown that project developers have implemented a combination of international regulations, standards and guidelines along with any national guidelines in place for the country of operation, rather than creating brand new guidelines for the offshore wind market. For example, UK offshore wind farms will follow CDM guidelines and will also use DNVGL-ST-0145/0119/0126, along with other ISO standards and guidelines.

Colombia's current national legislation is quite complete and continuously updated. Currently, there is no knowledge on the part of the government about the generation of specific documents for the offshore wind industry, given the wide range of existing norms; however, any new legal requirements that the Colombian government may decree in this regard should be taken into account.

The approach that has been followed in other countries (such as the UK) is to use offshore O&G regulations as a starting point and use these, together with international offshore wind regulations, to ensure best practice to minimize health and safety risks in the design and operation of offshore wind farms.

In view of the Government's strong interest in promoting alternative energy projects in the national territory, the government would be in the best position to engage with the different project developers at an early stage in order to obtain a better understanding of the different international standards and regulations that will apply to offshore wind projects. Likewise, the support of the Ministerio de Trabajo in Colombia should be considered in order to broaden knowledge of any legal requirements regarding occupational health and safety in Colombian territory.

It should be emphasized that the project developer is responsible for ensuring that the project has the necessary personnel and financial resources to implement the legal occupational health and safety considerations for the project.

10 REGULATORY FRAMEWORK

10.1 Purpose

This chapter discusses the requirements of a regulatory framework to deliver a successful offshore wind market, and considers the options for Colombia's approach based on its existing frameworks and the experience in established, international offshore wind markets.

Throughout this chapter, frequent reference is made to the World Bank Groups' Offshore Wind 'Key Factors' report.[30] For further information, readers should consult the relevant sections of that report, in parallel to reading the sub-sections of this chapter.

10.2 Requirements for Offshore Wind Frameworks

Offshore wind projects combine the scale of large hydro and the complexity of offshore hydrocarbon extraction, making them entirely different from onshore wind or solar PV. Government support and proactivity is essential to develop a successful new sector and deliver the high rewards that offshore wind can bring.

In Colombia, where the planning and development of non-conventional renewable (NCR) energy, such as onshore wind and solar PV, is heavily private sector led, a different approach by the government will be required for offshore wind to help manage risks, plan strategically, and reduce costs.

10.2.1 Project Scale and Cost

The recent, dramatic, global cost reductions in offshore wind have largely been a result of increased turbine rating and project scale. The low-cost projects that are currently being developed are usually at a gigawatt scale and will use wind turbines that are rated at least 15 MW each. One of these 1 GW offshore wind projects will typically require a capital expenditure (CapEx) of between US$2.5 – 3.0 billion; an

[30] Key Factors for Successful Development of Offshore Wind in Emerging Markets. World Bank/ESMAP/IFC. 2021. Washington, D.C. http://documents.worldbank.org/curated/en/343861632842395836/Key-Factors-for-Successful-Development-of-Offshore-Wind-in-Emerging-Markets

order of magnitude difference from the onshore wind projects currently being developed in La Guajira.

10.2.2 Development Time and Milestones

Developing a gigawatt scale project takes a large, coordinated public and private sector effort over many years and with high costs. For example, to develop a typical 1 GW project may take between 7 to 10 years (see a typical project development timeline Figure 2.3 in the Key Factors report[31]) and cost up to US$ 100 million. This development expenditure (DevEx) is a high-risk investment; there are points in the development process where the project may not proceed, meaning that a wind farm is not built, and the DevEx investment is lost. The development process is, therefore, a series of activities and milestones intended to reduce risk and increase the certainty that the project will be successfully developed. It is this certainty and understanding of risk that enables private investors to commit the huge sums required to develop a project.

Similarly to other energy projects, there are four major milestones in an offshore wind project's development cycle;

- Seabed lease or concession
- Environmental and social permit approval
- Grid connection agreement
- Offtake agreement

For offshore wind, all four milestones usually represent some form of agreement between the private developer and the government, or public body. These milestones may be achieved separately or, in some markets, be bundled together; there are numerous ways for how and when these agreements can be made, and some examples of different approaches are provided in this section.

10.3 Current Frameworks in Colombia

This section summarises the current regulatory frameworks applicable to offshore wind development in Colombia.

10.3.1 Seabed Leasing

While the earliest stages of offshore wind project development are feasible without a designated lease area, the pathway to operational capacity—and the investment

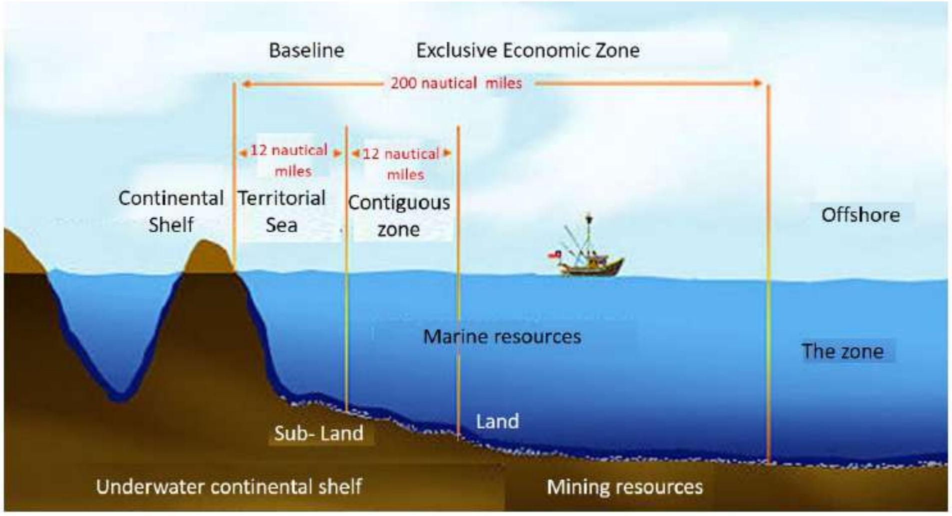
[31] Washington, D.C.: World Bank/ESMAP/IFC. http://documents.worldbank.org/curated/en/343861632842395836/Key-Factors-for-Successful-Development-of-Offshore-Wind-in-Emerging-Markets

certainty needed for procurement and installation to move forward—will eventually require that a developer receive permission to pursue development activities associated with a specific site. This confirmation of the legal right to pursue development activities on the designated site is known as the awarding of site control. In Colombia, pre-fesibility activities have been granted, which do not imply site concession (exclusive rights) nor priority to securing a lease in due course.

RELEVANT MARITIME LAWS IN COLOMBIA

According to international standards, maritime spaces are internal waters, the territorial sea, the contiguous zone and the exclusive economic zone, distributed as illustrated below,

Exhibit 88 Maritime Spaces



Source: https://nauticajonkepa.wordpress.com/

In accordance with article 101 of the Constitution of Colombia:

“The subsoil, the territorial sea, the contiguous zone, the continental shelf, the exclusive economic zone, the airspace, the segment of the geostationary orbit, the electromagnetic spectrum and the space where it operates are also part of Colombia, in accordance with International Law or with Colombian laws in the absence of international standards”.

The normative origin of maritime spaces is found in public international law, specifically in three conventions of 1958:

- Geneva Convention on the Continental Shelf
- Geneva Convention on the Territorial Sea and the Contiguous Zone
- Geneva Convention on the Continental Shelf

Subsequently, in 1982, the United Nations Convention on the Law of the Sea (UNCLOS) updated and codified these international regulations, which entered into force in 1994. Although this convention can be considered international practice, Colombia has not ratified this Convention and therefore it is not part of the treaty. However, Law 10 of 1978 and Decree 1436 of 1984, made maritime spaces consistent with international standards.

The first article of Law 10 of 1978 indicates that Colombia exercises full sovereignty over the territorial sea up to 12 nautical miles. The First Article states that:

- ***First Article.*** The territorial sea of the Colombian Nation over which it exercises full sovereignty, extends beyond its continental and insular territory and its internal waters to a width of 12 nautical miles or 22 kilometers 224 meters. National sovereignty also extends to the space located above the territorial sea, as well as to the bed and subsoil of this sea.

The normal baseline to measure the width of the territorial sea will be the low-water line along the coast in accordance with the fourth article of Law 10 of 1978.

Regarding the exclusive economic zone (EEZ), articles 7, 8 and 10 of Law 10 of 1978 indicate:

- ***Seventh Article***. Establish, adjacent to the territorial sea, an exclusive economic zone whose outer limit will reach 200 nautical miles measured from the baselines from which the width of the territorial sea is measured.
- ***Eighth Article***. In the area established by the previous article, the Colombian Nation shall exercise sovereign rights for the purposes of exploration, exploitation, conservation and administration of the living and non-living natural resources of the bed and subsoil and of the superjacent waters. Likewise, it will exercise exclusive jurisdiction for scientific research and for the preservation of the marine environment.
- ***Tenth Article***. The sovereignty of the Nation extends to its continental shelf for the purposes of exploration and exploitation of natural resources.

Law 10 of 1978 is silent in relation to the contiguous zone. UNCLOS indicates that the extension of the contiguous zone can be set by the State up to 24 nautical miles from the base line from which the width of the territorial sea is measured. In this space of "reduced sovereignty”, the State can exercise the right to prevent any violation of tax, customs, immigration or health laws.

Part VII of the UNCLOS includes the definition and regulations applicable to the Adjacent Zone, also known as the ‘high seas’. No State can exercise sovereignty on the high seas and the general principle of freedom applies.

In summary, Colombia can generate or allow the generation of offshore wind energy both in its territorial sea and in the exclusive economic zone (and even in its internal waters), that is, up to 200 nautical miles (370.4 kilometers) counted from the baseline of low tide along the coast.

DIMAR PROCESSES

The Dirección General Marítima (DIMAR) is the National Maritime Authority that executes the Government's maritime policy and is responsible for the regulation, direction, coordination and control of maritime and fluvial activities. Its jurisdiction is exercised over the internal maritime waters, the territorial sea, the contiguous zone, the exclusive economic zone, the seabed and subsoil, adjacent waters, littorals, including beaches and low tide lands, ports, islands, islets and keys, and over the Magdalena, Guainía, Amazonas, Orinoco, Meta, Arauca, Putumayo, Vaupés, Sinú, Atrato, Patía, Mira and Canal del Dique rivers.

DIMAR's competence to authorize seabed concessions derives from its nature as National Maritime Authority over 'maritime activities', which are defined in article three of Decree 2324 of 1984. According to this article, maritime activities are the systems of exploration, exploitation and prospection of the natural resources of the marine environment, the placement of any type of structures, fixed or semi-fixed works in the marine soil or subsoil, and regulate, authorize and control the concessions and permits in the waters, low tide lands, beaches and other goods of public use of the areas under its jurisdiction.

The key resolutions related to seabed leasing and resource measuring authorizations follow below.

Concessions for coastal infrastructure development

DIMAR Resolution 794

The rules related to concessions in infrastructure development projects of non-conventional renewable energy sources (hereinafter, FNCER) are found in the 'REMAC 5: Protection of the marine and coastal environment', which compiles a total of 19 rulings of the DIMAR. The rules regarding the concession of FNCER projects in maritime spaces are relatively recent as they were included to REMAC 5 through DIMAR Resolution 794 of November 20, 2020, adding Title 10 to Part 3.

According to Article 169 of Decree 2324 of 1984, maritime concessions (which includes FNCER projects in maritime areas) must exhaust the following procedure:

> *"Article 169. Requirements for granting maritime concessions. In the processes of coastal maritime planning, the requirements for the granting of maritime concessions in charge of the General Maritime Directorate are the following:*

a) Submit application to theHarbour Master, in person or electronically, which must contain the full name and identification number, if it is a merchant accredit the respective commercial registration, if it is a legal entity the entity will consult the certificate of existence and legal representation in the Registro Único Empresarial (RUES).

b) Plans of the location and boundaries of the land or area in which the concession is requested, with the projected constructions or existing infrastructure, if any, duly georeferenced, according to the parameters established by the General Maritime Directorate.

c) Technical studies of hydrographic and oceanographic conditions of the area of influence of the project.

d) Descriptive report of the project including type of works, construction method and work schedules, as well as a detailed description of the object and activity to be developed within the area requested in concession in magnetic media.

e) Environmental license or environmental management plan, as applicable, issued by the Autoridad Nacional de Licencias Ambientales (ANLA), Regional Autonomous Corporation or the Environmental Secretariat of the Special Districts, according to their jurisdiction, stating that the exploitation or construction for which the concession is requested is not contrary to the rules of conservation and protection of the natural resources existing in the area[32].

f) Certification issued by the District or Municipal Mayor's Office, Governor's Office of the Department of the Archipelago of San Andres, Providencia and Santa Catalina or the corresponding Curator's Office, stating that the land on which the project is to be built complies with the land use regulations defined in the Territorial Management Plan.

g) Concept issued by the Vice-Ministry of Tourism or the Secretariat of Tourism of the Special Districts, in which it is stated that the exploitations or constructions that are intended to advance do not interfere with the programs of tourist development of the zone.

h) Certification issued by the Ministry of Transportation stating that there is no port facilities project on the land or area to be concessioned.

i) *Determinación de Procedencia y Oportunidad de Consulta Previa* issued by the Dirección de la Autoridad Nacional de Consulta Previa (DANCP) , on the presence or not of ethnic communities in the area of the project.

[32] In paragraph 10.3.2.1 the level of alignment of the ESIA with international standards is described

> j) Payment corresponding to the value of the procedure.
>
> Paragraph 1. When the project is located near or in protected areas where there are archaeological heritage assets or Assets of Cultural Interest, the Preventive Archaeology Program and/or Archaeological Management Plan, as the case may be, approved by the Instituto Colombiano de Antropología e Historia (ICANH), and/or the Authorization to intervene in an Asset of Cultural Interest of the National Scope by the Ministry of Culture, shall be required[33].
>
> Paragraph 2. Term for the issuance of certifications in maritime concession proceedings. The authorities that must issue certification within the process of granting a maritime concession in charge of the General Maritime Directorate will have a maximum term of sixty (60) calendar days to issue the corresponding response, counted from the receipt of the request by the individuals or the National Maritime Authority".[34]

Likewise, Article 5.3.10.2 of REMAC 5 states that there are four stages for obtaining the concession of the area where the FNCER project will be developed, as follows. In the preliminary stage: (i) documents are submitted to request the concession, in the pre-feasibility stage (ii) a procedural order is issued ordering the submission of certifications and documentary support, in the publicity stage (iii) the project is advertised in accordance with Article 171 of Decree Law 2324 of 1984 and in the feasibility stage (iv) DIMAR grants the concession through an administrative act if there are no technical or legal impediments.

The concession request is made before the corresponding First Category Port Captain (*Capitán de Puerto de Primera Categoría*) according to the location of the project. Currently this part of the procedure is under revision with the intention to centralize all requests through DIMAR's headquarters. DIMAR Resolution 794 of 2020 details the documentation and the various certifications that must be provided to DIMAR to request the concession and according to article 5.3.10.6. if any of the entities issues an unfavorable certification to the project, the same must be filed by administrative act, which may be appealed through governmental and judicial channels.

It must be considered that by virtue of the concession the work for the construction of the FNCER project is authorized on the maritime space determined by administrative act. These constructions are subject to the safety, hygiene and aesthetic conditions determined by the regulatory plans or the provisions of the DIMAR. In addition, at the expiration of the concession term, the constructions are

33 In paragraph 10.3.2.1 the level of alignment of the ESIA with international standards is described.

34 According to this article, the concession request is made directly and does not mention the need for a public call for bids, which is why it should be understood that the state contracting regime does not apply to this type of concessions.

reverted to the Nation, as is proper of all concessions. Finally, in accordance with Article 176 of Decree 2324 of 1984, the concession becomes null and void for the reasons stated:

> *"Article 176.Causes of invalidity. The concessions to build shall become null and void in the following cases:*
>
> 1.When no Deed is granted within the term stipulated in the preceding article.[35]
>
> 2. When the constructions have not been erected within the term set forth in the respective resolution.
>
> 3. When the construction is not in accordance with the plans that have been approved.
>
> 4. When the construction is given a destination different from that determined in the concession.
>
> 5. When the reasons or circumstances that originated the concession have been considerably modified.
>
> 6. When the ordered policies are not established in a timely manner.
>
> The facts referred to in this article shall be reported by the respective Harbourmaster to the General Maritime and Port Directorate, which shall issue the respective resolution".

Finally, in addition to Title 10 of Part 3 of REMAC 5, other titles may also be relevant for the development of offshore FNCER projects. For example, Title 4 establishes criteria and procedures to modify granted concessions. Title 5 establishes criteria and procedure for the reversion of the constructions subject of the concession and Title 7 has provisions regarding the publicity of the concession applications.

Resource Measuring Authorization

DIMAR Resolution 240

The Resolution DIMAR 240 of March 26, 2021 regulates the procedure and mandatory requirements for compliance by individuals or public entities that are interested in obtaining authorization for the temporary [non-permanent] installation of fixed foundation or floating infrastructure, for the collection of needed data for advancing project design. This authorization covers the monitoring of climatic, environmental, physical, and coastal marine scientific research information, in areas

[35] The interested party in the concession must notarize the policy that guarantees the observance of the obligations contracted within ten days following the date on which the administrative act granting the concession becomes enforceable.

of maritime waters, maritime beaches and / or low tide lands under the jurisdiction of the DIMAR.

This authorization will have a maximum validity of one (1) year, extendable only once. Interested parties shall request said authorization from DIMAR accrediting the following documents:

1) Detailed description of the purpose of the data collection, areas to occupy, as well as the type of elements and materials of the infrastructure needed to acquire the information, avoiding the use of materials that present any potential environmental risks,
2) Stability study of the proposed infrastructure, which must comply with safety and environmental protection criteria,
3) When the proposed infrastructure is located on beaches, a concept issued by the district or municipal authority or the Department of San Andrés and Providencia, as appropriate, indicating whether the temporary infrastructure is compatible with the regulations about land use defined by the municipality or district in its Land Use Plan,
4) Map of the sector or area object of the request, and the projected location for the proposed infrastructure elements with reference to the National Geocentric Frame of Reference (MAGNA-SIRGAS), Official Datum of Colombia,
5) Certificate of Viability issued by the competent environmental authority. In case of requiring an Environmental License or approval of the Environmental Management Plan, the sponsor must submit the Preventive Archeology Program for review and approval by the Colombian Institute of Anthropology and History, in accordance with article 131 of Decree 2106 of 2019[36],
6) Photocopy of the Citizenship Certificate of the applicant (natural person) or a valid Certificate of Existence and Representation (legal person),
7) Current documentation of the vessels to be used, in the event that events or activities are carried out in maritime waters, and
8) Receipt documenting payment of the corresponding amount for the procedure as defined by the General Maritime Directorate according to Law 1115 of 2006.

Once said documentation has been filed with DIMAR, the Coastal Area of the Harbor Master's Office of the jurisdiction will be responsible to issue the Technical Concept within a term of 20 business days, after inspection of the area object of the authorization request. The Technical Concept will be attached to the DIMAR administrative act that authorizes or denies the authorization request, which will include the respective terms, obligations, and conditions for data collection.

[36] In paragraph 10.3.2.1 the level of alignment of the ESIA with international standards is described

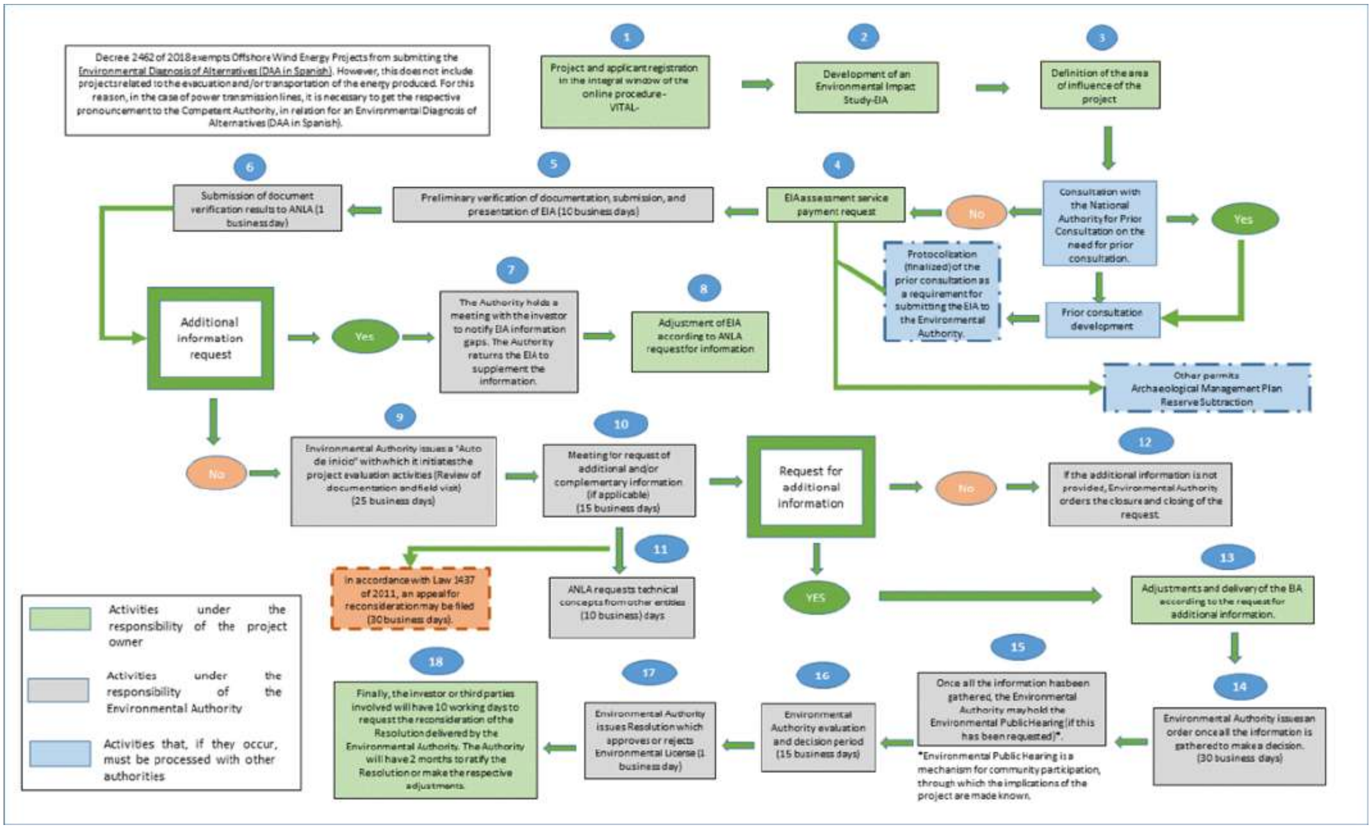
Once the validity of the authorization has expired or the data collection completed, in a term not exceeding 15 business days, the infrastructure must be removed in accordance with the environmental guidelines and other obligations contained in the authorization of the DIMAR. Likewise, the collected meteorological and oceanic data will be delivered to DIMAR.

10.3.2 Environmental Licensing and Permitting

Although the Colombian State through the Autoridad Nacional de Licencias Ambientales (ANLA) has not yet formulated generic Terms of Reference for offshore wind projects, the following considerations describe the current legislation and procedures for licensing Renewable Energy Projects on land in the understanding that the licensing of offshore wind projects will follow a similar process.

Though Resolution 1312 of August 11, 2016, the MADS adopts the Terms of Reference for the preparation of the Environmental Impact Study (EIA), required for the processing of the environmental license of projects for the use of continental wind energy sources. The Registry of Projects in the Comprehensive Online Processing Window - VITAL is the filing mechanism provided by ANLA to request the Environmental License, and / or carry out the modification of the environmental license and other environmental instruments. According to the ANLA, registration on the VITAL platform is the first step that the interested party must take to apply for the Environmental License, even before requiring specific Terms of Reference for the offshore wind project.

Exhibit 89 Environmental licensing process in Colombia



Source: RCG-ERM 2021

According to what is established in the national regulations, generation projects do not need an environmental diagnosis of alternatives (DAA), but for the energy transmission lines and substations is required to present the DAA.

- With support in the Terms of Reference ToR-09, the sponsor shall consider the following: **Preliminary procedures**: Previous studies, filing of subtraction of reserves and / or lifting of ban (if applicable), identification of SINAP and SIRAP areas, and notification to the Instituto Colombiano de Antropología e Historia (ICANH), in relation to the preventive archaeology process.
- **Definition of the Area of Influence (AI)**: The AI must be formulated with primary and secondary information (qualitative and / or quantitative) about the environmental and social conditions of each Project. Its definition is a fundamental input to identify and assess the preliminary environmental and social impacts. The General Methodology for the Preparation and Presentation of Environmental Studies (ANLA, 2018) establishes that the AI must consider the abiotic, biotic and socioeconomic environments.

- **Biophysical Component**: For the different biophysical aspects, in addition to fieldwork to collect primary information, the EIA shall include information from national, local and departmental entities related to issues of special management areas (protected areas, areas subject to a special legal regimes, fishing grounds, and artisanal and industrial fishing routes). It shall also consider other projects nearby, overlapping projects, routes, shipping companies, number and type of vessels passing through the area, current regulations on maritime traffic and projects, presence of submarine cables, and licensed / unlicensed blocks.
In addition, the process must consider relevant policy documents, laws, decrees, and resolutions at the national level; regional agreements and resolutions; departmental level agreements and executive decisions at the municipality or district level. The respective authorizations and permits for the activity in the Project's Area of Influence must be advanced before the DIMAR, and the MME..
- **Socioeconomic Component**: Considering the defined Area of Influence, the sponsor must request a certification of ethnic communities within the AI from DANCP. The procedure is specifically referred as *Determinación de Procedencia y Oportunidad de Consulta Previa*. Depending on the response, the sponsor will proceed with the development of the Consultative process and / or Free, Prior and Information Consent (FPIC) within the framework of the participation and socialization process, stipulated in ToR 09. When the Prior Consultation process proceeds, the sponsor will follow the provisions of Presidential Directive No. 10 of 2013 and Presidential Directive No. 8 of 2020, which define the stages of the consultative process as:

    1) Determination of origin of the Prior Consultation,
    2) Coordination and preparation,
    3) Pre-consultation,
    4) Prior Consultation, and
    5) Follow-up of agreements and closing.

    Particularly with non-ethnic communities (rural communities and government authorities), the sponsor must establish a participation plan that includes at least three (3) scenarios:
    1) share information on the technical characteristics, activities and scope of both the Project and the EIA to be prepared,
    2) generate participation spaces during the preparation of the EIA, in which information is presented and feedback is received on the project and its implications, specifically on the impacts and environmental management measures for the different stages (pre-construction, construction, operation and decommissioning). Likewise, the participants should be encouraged to identify other impacts and management measures not contemplated in the EIA;

and include them in the impact assessment and in the Environmental Management Plan, and
3) socialize the results of the EIA, prior to filing it with the Environmental Authority.

In case of identifying Territorial Units (villages and / or townships) within the Area of Influence, the sponsor will prepare a comprehensive socioeconomic characterization considering the following components:

1) demographic (history and occupation of the territory, population dynamics, demographic trends, population structure, settlement patterns, migrant population, etc.),
2) spatial (quality and coverage of public and social services),
3) economic (type of economic activities, ownership structure, production processes, programs and projects, characteristics of the labor market, trends in employment, etc.),
4) cultural (non-ethnic communities, ethnic communities, settlement patterns, cultural changes, uses and customs, cultural heritage, etc.),
5) archaeological (procedures before the Instituto Colombiano de Antropología e Historia ICANH, field activities and analysis of results),
6) political organization (political-administrative characteristics of the units territorial), institutional and community presence (public institutions, private organizations, mechanisms for the participation of the population, community organizations, etc.),
7) development trends (socio-economic analysis of the area supported by the results of each component), and
8) if applicable, information on the population subject to resettlement.

For the development of the archaeological component, the developer will consider the guidelines of Decree 1698 of 2014, which requires the definition and approval of a Preventive Archeology Program prior to any underwater interventions or intrusive activities on the ocean bottom, for purposes other than the investigation of submerged cultural heritage. Said program must guarantee the safe exploration and prospecting of the intervention area and in the event of finding Submerged Cultural Heritage assets, it will take the necessary measures for their preservation. ICANH must establish the requirements for such programs.

10.3.2.1 Level of alignment between International Standards and ESIAs

To generally understand the level of alignment between the typical Terms of Reference for the preparation of the ESIA (required for the processing of the environmental license of projects onshore wind energy) and the Performance Standards (PS) related to the IFC, a general assessment of gaps between both regulations is presented. For this evaluation, four (4) categories were considered: i) Aligned, ii) Partially aligned, iii) Not aligned and iv) Not applicable.

It should be noted that Colombia does not have specific terms of reference for offshore wind energy projects at current, so the following analysis is based on typical terms of reference for onshore wind energy projects.

In general terms, it can be observed that the PS are partially aligned with Colombian regulations. Of the total number of subsections identified for each PS, about 20% of these are considered to be aligned with Colombian regulations (terms of reference for ESIAs).

Exhibit 90 Alignment of each section of the PS with Colombian typical terms of reference

Section of the Standard	Alignment Category	Gaps identified in the terms of reference for onshore wind energy projects
Performance Standard 1 - Assessment and Management of Environmental and Social Risks and Impacts		
1.1 Environmental and social assessment and management system	Partially Aligned	Completion of the risk analysis
1.2 Policy	Not Aligned	No comprehensive policy is developed
1.3 Risk and Impact Identification	Partially Aligned	Complementation of the risk analysis with respect to the impact analysis and definition of areas of influence. Inclusion of climate change analysis, business and human rights, vulnerable and disadvantaged groups, people with disabilities, impacts and management plans by third parties and supply chains, and environmental audits.
1.4 Management Programs	Partially Aligned	
1.5 Organizational Capacity and Competence	Partially Aligned	
1.6 Monitoring and evaluation	Partially Aligned	
1.7 Stakeholder Participation	Aligned	
1.8 External Communications and Grievance Mechanism	Not Aligned	Design of the mechanism for handling complaints and claims, from the beginning of the project.
Performance Standard 2 - Labor and Working Conditions		
2.1 Human resources policies and procedures	Partially Aligned	Definition of policies and procedures from the beginning of the project.
2.2 Working conditions and terms of employment	Aligned	

2.3 Labour organisations	Partially Aligned	Generation of a comprehensive policy that allows the development of procedures aligned to the IFC's PS.
2.4 Non-discrimination and equal opportunities	Partially Aligned	
2.5 Reduction in workforce	Partially Aligned	
2.6 Workforce protection	Partially Aligned	
2.7 Health and safety at work	Aligned	
2.8 Supply Chain	Partially Aligned	Development of policies and procedures for monitoring contractors.
Performance Standard 3 - Resource Efficiency and Pollution Prevention		
3.1 Resource efficiency	Partially Aligned	Development of a sustainable natural resource management program aligned with the MASS.
3.2 Greenhouse Gas Emissions	Not Aligned	The identification and characterization of greenhouse gases is not developed.
3.3 Pollution Prevention - Emissions and Discharges	Aligned	
3.3 Pollution Prevention - Ecosystem Identification	Aligned	
3.3 Pollution prevention - Responsibility for historical soil contamination	Partially Aligned	Identification of current projects and potential soil disturbance from the implementation of the project.
3.4 Solid waste management	Aligned	
3.5 Hazardous Materials Handling	Partially Aligned	Completion of the description of the handling of materials generated in case of replacement / maintenance and/or dismantling.
3.6 Pesticide use and handling	Not Aligned	The pesticide management plan is not developed.
Performance Standard 4 - Community Health, Safety and Security		
4.1 Community health and safety	Partially Aligned	Complementing the analysis of the current and future vulnerability of communities
4.2 Services provided by ecosystems	Partially Aligned	Development of ES analyses based on globally recognized

		guidance documents and registration tools.
4.3 Community exposure to disease	Not Aligned	The identification of public health risks is not developed.
4.4 Emergency Preparedness and Response	Aligned	
4.5 Physical security	Not Aligned	The training programme for the surveillance force is not being developed.
Performance Standard 5 - Land Acquisition and Involuntary Resettlement		
5.1 Project design	Partially Aligned	Completion of the alternatives analysis including impacts related to involuntary relocation and economic activities.
5.2 Compensation and benefits to displaced persons	Partially Aligned	Completion of the analysis in relation to the local level effect of land use change, and identification of contracting changes.
5.3 Community participation and grievance mechanism - vulnerability	Partially Aligned	Design of the mechanism for handling complaints and claims, from the beginning of the project.
5.3 Community participation and grievance mechanism - grievance mechanism	Not Aligned	Design of the mechanism for handling complaints and claims, from the beginning of the project.
5.4 Planning and Implementation of Resettlement and Livelihood Restoration - Census of People	Aligned	
5.4 Planning and Implementation of Resettlement and Livelihood Restoration - Resettlement Action Plan, a Livelihood Restoration Plan	Partially Aligned	Complementing income restoration alternatives
5.4 Planning and Implementation of Resettlement and Livelihood Restoration - Expropriation Processes	Not Aligned	No Resettlement Action Plan is developed.
5.5 Private Sector Responsibilities in a Government Managed Resettlement	Not Aligned	
Performance Standard 6 - Biodiversity Conservation and Sustainable Management of Living Natural Resources		
6.1 Biodiversity protection and conservation	Partially Aligned	Complementation of the analysis of critical habitats, biodiversity action plan, invasive alien species; complement to identify impacts (noise, collision, etc.)

6.2 Management of ecosystem services	Partially Aligned	Development of ES analyses based on globally recognized guidance documents and registration tools.
6.3 Sustainable management of living natural resources	Not Applicable	
6.4 Supply Chain	Not Aligned	Verification systems and practices are not developed as part of the environmental management system.
Performance Standard 7 - Indigenous Peoples		
7.1 Prevention of adverse impacts	Partially Aligned	Complementation of the analysis related to the life plan of the communities.
7.2 Participation and consent	Partially Aligned	Complementing the analysis with a focus on vulnerable groups. The consent of the communities is not contemplated.
7.3 Mitigation and development benefits	Partially Aligned	Complementing the analysis of social identities
7.4 Responsibilities of the private sector when the government is responsible for handling indigenous peoples' issues	Partially Aligned	Complementation of alternative ethnic community characterization processes.
Performance Standard 8 - Cultural Heritage		
8.1 Protection of cultural heritage in project design and implementation	Partially Aligned	Complementing analyses related to intangible cultural heritage.
8.2 Use of cultural heritageby the project	Partially Aligned	

Source: ERM Analysis

10.3.3 Grid Connection Requirements

In Colombia, to obtain a grid connection, all developers must fulfill the requirements of the CREG 075-2021 regulation. The goal of this regulation is to make the grid connection process more efficient, transparent, unified and release unused transport capacity.

Obligated Subjects Interested in connecting generators, cogenerators, self-generators and end users Transporters and Marketers.

Capacity allocation procedure (Class 1 projects)

1. Registration of interested parties, through the single window, companies interested in assigning capacity must register the projects separately, submit a connection study and the physical feasibility of the projects; evaluating different alternatives; If among the alternatives is the expansion of assets for use, at least one alternative must be included that includes the connection to an existing substation. If the connection is to a substation of the national interconnected system that does not yet have defined engineering, the physical feasibility study should not be submitted.

Through the single window that UPME will make available, the promoter will be able to download the necessary information to carry out the studies.

2. The requirements of the projects to file the application are: i) COD not older than 15 years, ii) UPME will receive the applications until March 31 of each year, everything that is filed after that date will be analyzed the following year. This filing is done through the single window, including a connection study and physical feasibility.

3. UPME will define a fee to be charged for the review of the studies.

4. The delivery of missing information to the study is only allowed once.

5. The transporter will have 20 working days to review and make comments on the studies, it must deliver its statement on the feasibility of the connection alternatives and present other alternatives if it considers that the ones presented are not viable.

6. The allocation of transportation capacity will be made annually and is governed by the procedure written in resolution UPME 000528 of 2021.

Projects are divided as follows:

- Row 1, projects that require expansion of the national interconnected system.
- Row 2, projects that do not require expansion of the national interconnected system.

The position assigned to each project will be published no later than September 30 of every year. The concept of connection for the projects in row 1 will be issued no later than December 20 of every year and for row 2 on October 31 of every year.

Criteria for capacity allocation

- Compliance with the guidelines provided in numerals 1 and 2 of article 4 of Resolution 40311 of 2020 of the Ministry of Mines and Energy.
- The allocation of transportation capacity will meet the expansion needs and requirements of the National Interconnected System.
- UPME may prioritize the projects that maximize the use of available generation resources assigned with system commitments or those that guarantee less generation cost.
- Greater net benefit per kW of transmission capacity, for example incremental benefits in the reduction of losses, restrictions, improvements in reliability.
- Obtaining environmental licensing and/or completion of the prior consultation.
- To be able to connect to the National Transmission System, the project must comply with the network code (CREG 025-1995).
- If the connection is to the Regional Transmission System, the project must also comply with what is stipulated in CREG Resolution 075-2021.

Characteristics Interconnection Guarantee:

- $10 USD per kW of assigned capacity, in COP
- Updatable every year with DANE's IPP
- Validity: COD + 3 months
- Bank guarantee, bank guarantee, stand-by letter of credit
- Granted by entities with investment grade
- Payment within 2 (15) days of the request for national (international) entities

Execution Of Interconnection Guarantee:

- Project cannot be executed (monitoring reports)
- No update or extension of the warranty
- Third non-compliance in Curve S milestones
- In COD capacity in operation < 90% assignment
- No reconnection after temporary departure/renewal
- Exception: if project progress > 60%, 80% guarantee is executed

Tracking of Projects

Approved by UPME in the following cases:

- Overwhelming force
- Public order reasons
- Delays in obtaining permits and licenses
- Delays in SIN expansion works

Assignment:

- UPME authorizes assignment between projects that:
- have not entered into operation
- Connect to the same connection point
- Capacity assigned to the same interested party
- Use the same primary resource
- Stay up to date with milestones of your S-Curves

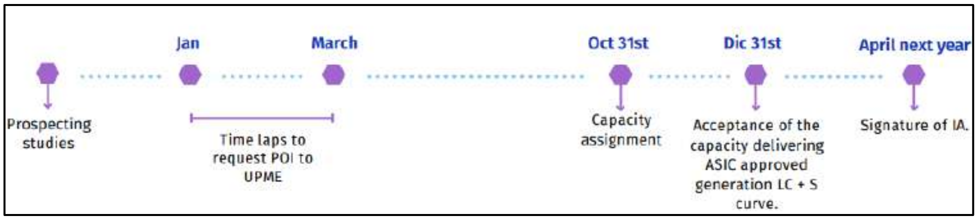
Compliance milestones Curve S:

- Progress reports on the date of each milestone, or 6 months after a milestone was due
- UPME will publish this information

Non-compliance Curve S

- 1st and 2nd time → Guarantee X 2
- 3rd occasion → Guarantee execution and capacity release
- Capacity release
- Project cannot be executed (monitoring reports)
- Interested party did not meet post-assignment requirements
- The warranty was not properly updated
- 3rd non-compliance with S-curve milestones
-

Exhibit 91 Interconnection Capacity Assignment Timeline



10.4 Global Approaches to Offshore Wind Regulatory Frameworks

Offshore wind turbines are now operating in 16 countries[37] across the globe and those projects have been delivered through a wide range of regulatory frameworks. In most markets, these frameworks have evolved, and continue to evolve as more has been learnt about the development of offshore wind projects. This evolution has often been as a result of close cooperation between the government and industry, working together to resolve issues, reduce risks, improve efficiency, and lower costs.

In generalising the experience so far, governments have taken three main approaches to organising their frameworks for offshore wind (see section 3.2 of Key

[37] Countries include; Belgium, China, Denmark, Finland, France, Germany, Ireland, Japan, Netherlands, Portugal, South Korea, Spain, Sweden, United Kingdom, USA, and Vietnam.

Factors report[38]), and each approach has a differing level of government involvement. Exhibit 92 provides a summary of these three approaches.

Exhibit 92 Comparison of the three main approaches to organising frameworks for offshore wind development (adapted from Table 3.1 in Key Factors report)

	Ad-hoc	Two-competition	One-competition
Summary	First come, first served approach. Entirely developer led.	Separate competitions for lease rights and offtake agreement. Sharing of responsibilities between government and developer.	Single competition for lease and offtake agreement. Government takes majority of responsibility for project development.
Description of activities	**Developer**: Initial feasibility work to identify and select a preferred site. Applies to government for site rights. **Government**: Responds to request and assesses application in isolation to other potential future requests. **Both**: Negotiate terms. **After award:** Developer progresses all stages of project development to obtain permits, grid connection agreement, and	**Government**: Decides areas to be leased, preferably using Marine Spatial Planning (MSP) principles (likely to be broad areas, rather than specific project boundaries due to uncertainty at this stage) and manages competition, providing rules and terms of lease. **Developers**: Respond by assessing project areas and bidding in the leasing competition following its rules. **After award**: Select winners, usually based on bidder and project merits. Winners negotiate	**Government**: Carries out early-stage work (data collection, initial design, initial permitting, and grid planning) to sufficiently de-risk a defined project site and enable developers to place informed, tariff-based bids. Prepare the grid connection and offtake agreement to be offered in the competition. Manages competition, providing rules and terms of agreements. **Developers**: Respond by assessing sites, the data package, and bidding following competition rules.

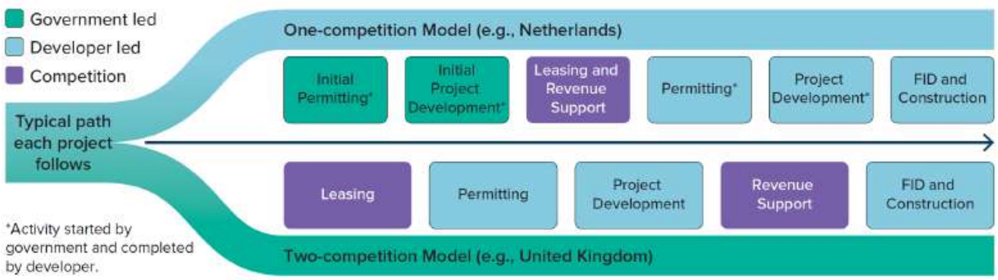
[38] World Bank.Key Factors for Successful Development of Offshore Wind in Emerging Markets (English). Washington, D.C.:http://documents.worldbank.org/curated/en/343861632842395836/Key-Factors-for-Successful-Development-of-Offshore-Wind-in-Emerging-Markets

	secure an offtake agreement.	limited details of lease with the terms provided, then progress all stages of project development to obtain permits, grid connection agreement, and secure an offtake agreement (which is the second competition in this approach).	**After award**: Select winners, usually based on tariff of bid. Winners negotiate details of lease with the terms provided, then progress remaining stages of project development including final design and final permitting.
Pros (from government perspective)	- Very little effort required as developer takes entire responsibility and risk - No lease competition to design or manage	- Some control over location and timing of projects - Possible to strategically plan grid for projects - Manageable milestones with time to coordinate	- Precise control over location and timing of projects - Only a single competitive process to manage - High certainty that projects will be delivered successfully
Cons (from government perspective)	- Difficult to manage competing applications and the timing of development - No control over location and timing of projects, so not possible to plan strategically - Unlikely to result in the most optimal, low-cost projects	- Need to carefully design the lease competition and its rules - Requires some planning and coordination of leasing and offtake competitions	- High risk and responsibility for government - Requires large government commitment, coordination, resourcing, and financing for pre-development activities - Can be difficult to get all elements of the competition right
Examples	Korea, Philippines	Taiwan, UK, USA	Denmark, Germany, Netherlands

Source: RCG analysis

The exhibit below provides a generalised overview of the main development milestones under the one- and two-competition approaches to organising offshore wind frameworks (for a more thorough overview of approaches taken in different markets, see Figure 3.4 in the Key Factors report). Under a one-competition model, the government undertakes the planning and pre-development activities for a specific project at a defined site, before running a competition to select a developer to complete the development and construct the project. In the two-competition approach, the government runs a leasing competition (usually within pre-defined, broad areas that have been identified through strategic and spatial planning), then the developer is responsible for grid connection and permitting activities, prior to the competition to secure a revenue or offtake agreement.

Exhibit 93 Overview of frameworks and sequence of milestones in one- and two-competition approaches. (Taken from Figure 3.3 in Key Factors report)



Source: World Bank Key Factors Report

The choice of which broad approach to take has tended to depend both on a government's typical approach to managing private sector infrastructure development and the market's level of maturity. Often countries have begun with an ad-hoc type approach, with little government planning or support, but have then quickly moved to a more organised approach, with either a strong government intervention (one-competition type approach) or taking a more balanced approach to responsibilities and leadership (two-competition type approach).

Some of the main lessons that governments have learnt through running and improving these frameworks include;

- Any approach to organizing frameworks can work, as long as it is well executed and provides the clarity and certainty required by developers.
- It is highly beneficial to provide strategic guidance on where to place offshore wind projects. Spatial planning of offshore wind projects reduces the risk of adverse environmental and social impacts, and allows strategic planning and investment in the transmission grid. This ultimately reduces development risk and costs.
- Cooperation and collaboration between government and industry is essential to ensure the frameworks are both fit-for-purpose and acceptable to investors. An ongoing, open dialogue helps to resolve issues and identify areas for improvement.
- Qualifying criteria is useful to screen companies to ensure these have the technical and / or financial capabilities. A pre-qualification process also encourages partnership between local and international players to create the necessary capacities.

- Frameworks need to be robust, transparent, and fair to encourage developer participation and investment, and also to prevent disputes or challenges by unsuccessful developers.

10.5 Options for Offshore Wind Frameworks in Colombia

Colombia's current regulatory frameworks provide a good basis to deliver offshore wind projects and create a successful offshore wind sector (see section 10.3 for a summary of these frameworks). There are some issues with the existing frameworks, that will need to be resolved to be better suited to manage the challenges and risks of offshore wind, and these include;

- The concession/leasing framework [39] does not manage competing applications for seabed rights, and is first-come, first-served. This does not allow for the selection of the most suitable developer to deliver a project, nor does it provide the government with any strategic control over the placement and timing of projects.
- Permitting requirements are currently not clear and it is likely that developers will be responsible for securing an uncertain number of permits and approvals from many different agencies and stakeholders.
- There is no marine spatial plan to inform site selection or environmental and social impact assessment (ESIA), meaning that developers can make applications for sites anywhere in Colombia's waters, even if these sites are not appropriate or pose high development risks.
- The requirements of an offshore wind ESIA are not yet known (although ANLA is working on specific Terms of Reference). It will be important for these ESIA requirements to align with those of commercial lenders (who typically require projects to meet IFC's Performance Standards) and Good International Industry Practices (GIIP).
- There is currently no strategic plan for transmission grid expansion to connect large-scale offshore wind generation. This will be essential if projects are going to be developed in Colombia's most energetic offshore wind resources off La Guajira, as these are projects will be the lowest-cost options.
- A direct competition for offtake agreements with solar and onshore wind will not be suitable for offshore wind. While offshore wind projects may be price competitive, the tariffs required (particularly for the first projects) are unlikely to be cheaper than solar and onshore wind, so projects would not win an auction. If developers cannot see a commercially viable route to market, they will be unwilling to invest the US$50 – 100 million in DevEx required before a project is ready to enter a tariff auction.

1. The most straightforward option to address these issues would be to adapt the current frameworks to best suit offshore wind development. This would imply following a typical two-competition approach, similar to the model used in the UK, for example (see section 10.4). Specific

[39] Lit 21 art 5° y art 166 dec 2324/1984 y art 169 dec 2324/1984 y art 65 dec 2106/2019

recommendations on the steps to follow are covered in Exhibit 5 and Chapter 3.2..

The alternative option is to depart from the current regulatory framework and design a new approach as single competition, similar to the model used in Denmark, for example (see section 10.4).

This one-competition approach would be considerably more demanding on the government. Commissioning survey and assessment work at the first project sites, for example, would likely cost in excess of US$20 million and take 3 years to complete. This approach would, however, provide the government with far more precise control over the scale, location, and timing of projects, giving more certainty that capacity targets would be met.

11 FINANCIAL AND ECONOMIC ANALYSES

11.1 Levelized cost of energy (LCoE) estimation for offshore wind in Colombia

This section outlines the results of an LCoE assessment of the “Low” and “High” scenarios outlined in Section 2.

11.1.1 Overall Approach & Modelled Cases

The “Low” and “High” scenarios were modelled based on an individual, bottom-up LCoE assessment of each of the interest areas discussed in Section 4. For each of the periods 2030, 2040, and 2050, a selection of 8-12 project sites and sizes were evaluated across a set of 12 different sensitivity cases.

From a total of over 300 individually modelled project permutations, results were grouped according to their foundation design (fixed versus floating) and COD (Commercial Operations Date) year. To develop the low and high buildout cases, projects were sorted to ensure the largest reasonable project sizes were included in each buildout scenario to provide a robust distribution of results.

11.1.2 Modelling Methodology

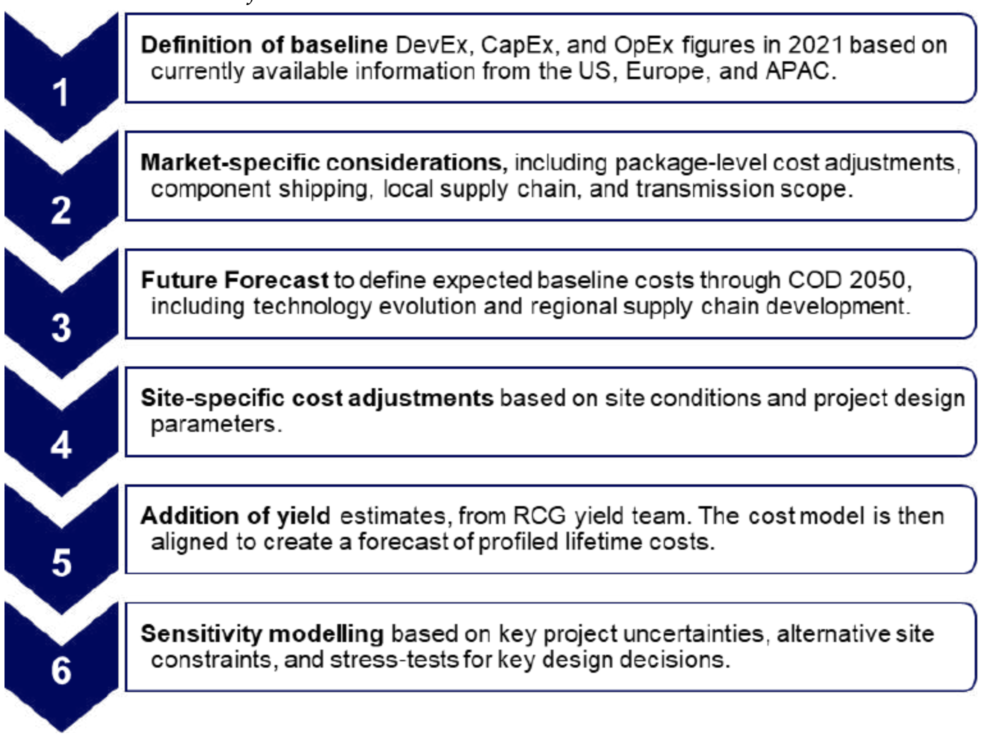
RCG’s modelling methodology focuses on creating a robust technical estimate of LCoE. This approach means that LCoEs represent the present value of lifetime technical costs and energy production, excluding the incentives and commercial drivers (e.g. revenue indexation, competitive landscape, etc.) that underpin energy prices at auction. RCG’s cost forecasting model utilizesd a series of cost baselines constructed using high-confidence data from offshore wind farms from the Americas, Europe, and Asia. This costing approach has been tailored to the known technical and supply chain conditions in Colombia, drawing from industry-standard approaches from more mature offshore wind markets.

Present-day costs are projected forward to accommodate the market and technology trends key to the cost landscape at the COD. This incorporates expected technology advancements and supply chain maturity regionally.

Following cost baseline adjustments, a basic desktop wind energy yield assessment was conducted for the areas of interest discussed in Section 4. This yield assessment relied upon publicly available modelled wind speed data from the Global Wind Atlas (GWA) and estimates of wakes and losses.

Turbine selection is a critical part of both cost and yield estimation, with specific power curves used wherever available to provide the most accurate estimates of yield and net capacity factor. Increasing turbine capacities were utilized ranging from 15 to 25MW over the 2030-2050 analysis period. All results in the analysis are presented in real 2021 values.

Exhibit 94 LCoE Workflow



Source: RCG

11.1.2.1 Input Assumptions

All modelled cases assume the following baseline inputs:

- 8% WACC for fixed-foundation offshore wind, 10% WACC for floating through 2030 before reducing to 8%
- 30-year project life
- 500 MW maximum AC circuit size

Transmission CapEx is considered for the offshore export cables and substations. Notable exclusions from this assessment include:

- All onshore transmission upgrade costs,
- Grid tariffs as applicable,
- Geotechnical and geophysical conditions, due to a lack of high-quality data,
- Cost premiums due to local content investments or commitments,
- Port upgrade fees or unique facility set-up costs,
- Taxes, fiscal incentives, import tariffs, or other market fees.

Due to the lack of actual deployment of offshore wind in the Colombian market, all new-market premiums applied reflect RCG's experience from other new markets such as the US and Taiwan.

CapEx and OpEx figures assume primarily foreign-supplied components and shipping distances for component supply to Colombia are calculated from major European ports.

Exhibit 95 Key Assumptions

Parameter	Application	Description
Project capacity	Project-specific	For the high buildout case, a range of project sizes were calculated up to the total target capacity for that decade. For the low buildout case, large projects were excluded so as to only assess the range of costs across projects sizes that fit within the buildout target. For example, the high buildout 2030 case includes project sizes of up to 1000 MW, while the low buildout case is capped at 200 MW. Modelling a range of sizes was considered prudent given the sensitivity of offshore wind LCoE to scale effects. RCG accounts for scale-effects with package-level economies of scale factors based on the number of units installed.
Water depth	Project-specific	Mean water depths have been measured based on bathymetry GIS data.
Foundation concept	Project-specific	The fixed-bottom (FX) sites have been assessed assuming monopile foundations. Costs account for turbine size, average site depth, and future innovation and cost efficiencies expected in the market. Floating sites (FL) have been assessed assuming currently deployed floating platform technology. Costs account for turbine size, average site depth, and future innovation and cost efficiencies expected in the market.
Construction port	Project-specific	Preliminary analysis of the most suitable construction ports is included, and likely vessel route distances measured for input to the model. In some cases, upgrades may be required to these construction ports before they are viable, however these risks have been considered in the risk assessment and have not been factored into the LCoE analysis at this time.
Installation vessel	General	It is assumed that European turbine and foundation installation vessels will be utilized for all sites. Shipping distances account for the trans-Atlantic mobilization required and these costs are differentiated according to the known distances.
Export cable length	Project-specific	Representative cable routes have been measured for onshore and offshore distances to the nearest suitable substation. Costs account for high-level GIS routing, but no adjustments have been made to account for ground conditions due to the lack of high-quality spatial data.
Turbine size	General	15 MW has been assumed for all sites with COD 2030, 20 MW turbines for 2040, and 25 MW turbines for 2050.

COD Year	General	COD years are pegged to the buildout scenarios (e.g. 2030, 2040, 2050). These COD inputs direct a set of global cost reduction scenarios that underpin RCG's LCOE model, assessed individually on a package-cost level.
Project life	General	30 years has been assumed for all sites.
Other transmission	General	AC circuits are assumed for most projects, capped at a 500 MW circuit cut-off size (based on estimated technology progression and to remove potential bias for any borderline projects like SE1). TUST grid tariffs are based on POI.
WACC	General	We have assumed a WACC of 10% for floating wind at the 2030 period and 8% for fixed, reducing both to 8% for the 2040 and 2050 periods, to reflect a nominal increase in technology risk premium between the two technologies.

Source: RCG-ERM, 2021

Exhibit 96 provides an overview of the general drivers that affect LCoE.

Exhibit 96 List of key LCoE drivers

LCoE Driver	Description
Economies of scale	Greater economies of scale (i.e. larger project capacities e.g. 1GW+) help reduce costs by making processes more efficient across fabrication, construction, and operations and maintenance.
Supply chain	Access to an adequate and capable supply chain is an important factor in reducing LCoE, in particular, the ability to create a market of suppliers to reduce costs by maximizing the ability of supply chain partners to deliver.
Optimization of site conditions	High wind speeds, lower water depths, and favorable ground conditions all contribute to reducing LCoE significantly; in addition a developer's experience with certain site conditions will also impact their particular ability to optimize project LCoE.
Market competitiveness	Competition between developers encourages innovation and adaptation to reduce LCoE and ultimately win the ability to deliver their projects through competitive processes.
Technology improvements	Technology improvements such as larger wind turbines and improvements in foundation design can significantly reduce LCoE; developers have a good sense of the future changes in technology.
Increased capacity factor	One of the single biggest influences on LCoE; the higher the capacity factor, the more electricity generated and thus the lower the LCoE, even after considering potential increased O&M costs.
Cost of transmission assets	Distance from shore is a key driver in LCoE due to the impact of cost of installing export cables for each project. Where costs could be shared between projects due to strategic offshore transmission/grid design, LCoE would be reduced.
Cost of delay to transmission asset build	In the event of any delays to the construction of the transmission assets, costs would be incurred particularly due to degrading assets as well as compensation payments that would need to be made for lost revenue.

Source: RCG analysis

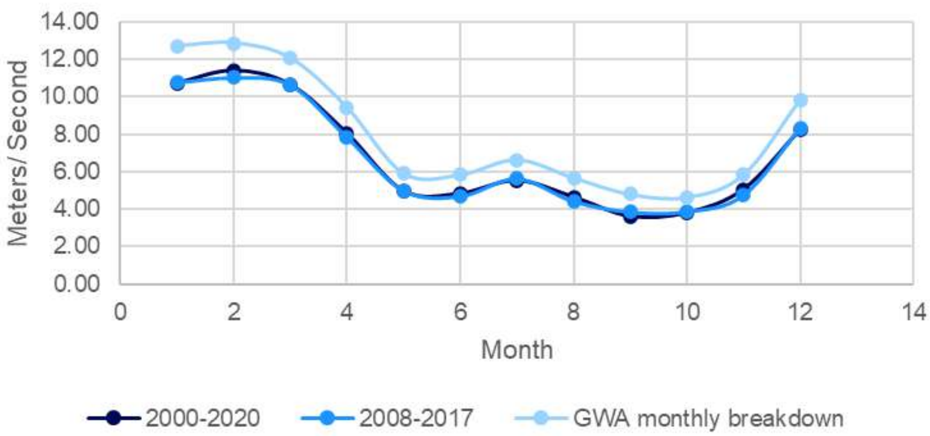
11.1.2.2 Representative Energy Yield Profiles

Colombia has a world class offshore wind resource, with P50 net capacity factor (NCF) values, particularly in the Eastern Zone around Guajira, substantially above what is typically observed in leading offshore wind markets including the UK and US. Such high NCF values contribute to reducing the cost of delivered energy and delivering high volumes across the year. This section provides a view of representative monthly wind speeds across the studied regions and for both fixed and floating foundation areas.

Representative NCFs by Zone (including fixed and floating):

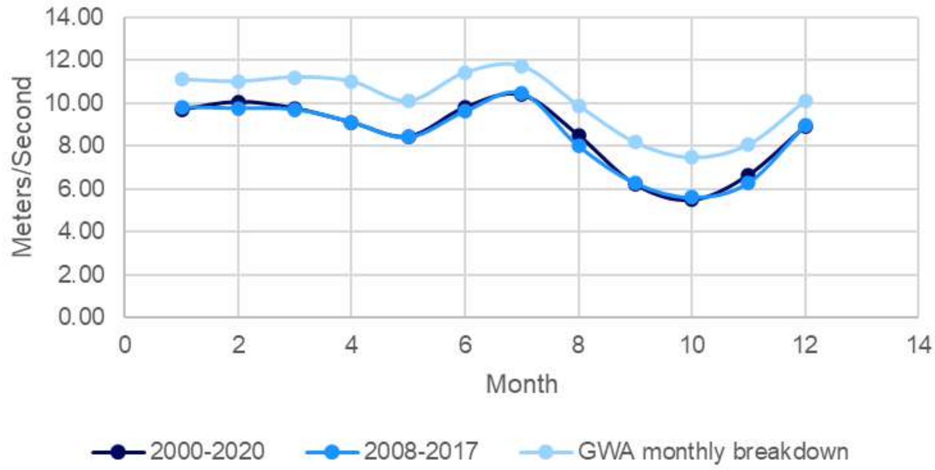
- Western Zone: 37.5% to 48% (Note: in the western zone, fixed-foundation NCFs are expected at very bottom of this range depending on siting and for exploration zones modelled; high end represents floating. This difference is not as substantial in the other zones.)
- Central Zone: 52% to 65.5%
- Eastern Zone: 67.5% to 69.5%

Exhibit 97 Representative Monthly Average Wind Speed – Western Zone Fixed Foundation



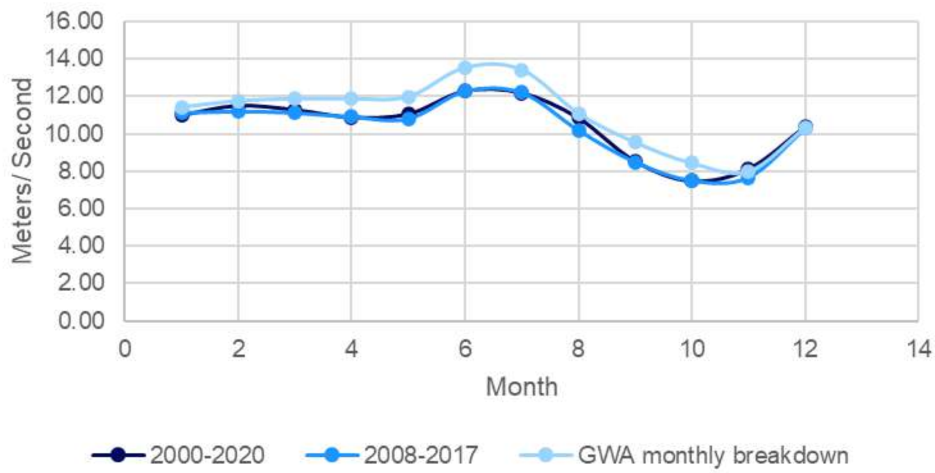
Source: RCG Analysis, Global Wind Atlas

Exhibit 98 Representative Monthly Average Wind Speed – Central Zone Fixed Foundation



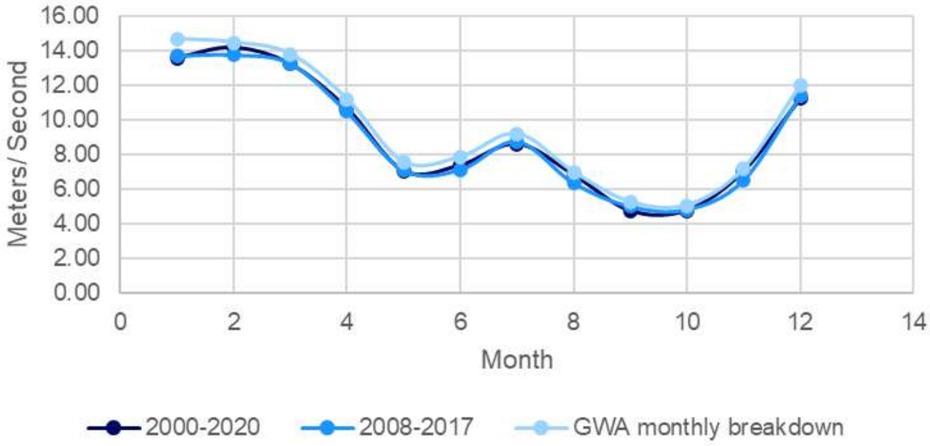
Source: RCG Analysis, Global Wind Atlas

Exhibit 99 Representative Monthly Average Wind Speed – Eastern Zone Fixed Foundation



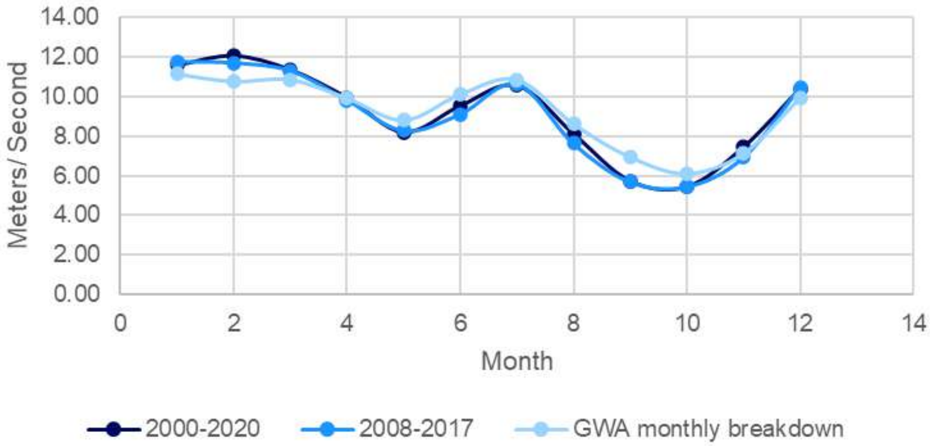
Source: RCG Analysis, Global Wind Atlas

Exhibit 100 Representative Monthly Average Wind Speed – Western Zone Floating Foundation



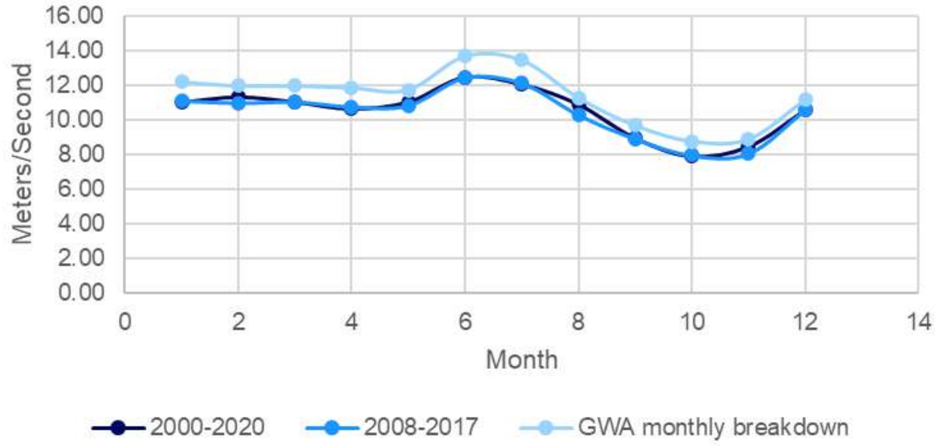
Source: RCG Analysis, Global Wind Atlas

Exhibit 101 Representative Monthly Average Wind Speed – Central Zone Floating Foundation



Source: RCG Analysis, Global Wind Atlas

Exhibit 102 Representative Monthly Average Wind Speed – Eastern Zone Floating Foundation



Source: RCG Analysis, Global Wind Atlas

11.1.2.3 Representative CapEx/OpEx Costs

Below table shows indicative CapEx/OpEx cost ranges for modelled exploration zones. CapEx and OpEx costs were calculated at the exploration zone level, and as described above, for each of the periods 2030, 2040, and 2050, a selection of 8-12 project sites and sizes were evaluated across a set of 12 different sensitivity cases.

From a total of over 300 individually modelled project permutations, results were grouped according to their foundation design (fixed versus floating) and COD year to provide a robust distribution of results.

As such, values below represent indicative ranges for the exploration zones. Individual project zones will vary and require independent characterization. As outlined in Exhibit 96, project conditions such as smaller-scale projects, longer offshore transmission distances and deeper waters leads to higher CapEx values. Particularly when comparing individual projects of below 1 GW, project size is the single biggest predictor of where projects fall in the CapEx ranges indicated below.

Exhibit 103 Fixed Foundation Offshore Wind, 200-1000MW Project Size, USD $2021 Estimates

Cost Category	Unit	2030 COD, 15MW WTG	2040 COD, 20 MW WTG	2050 COD, 25 MW WTG)
Capex	k/MW	3,000 - 4,500	2,800 - 4,300	2,500 - 3,000

Generation OpEx Y1-Y5	k/MW annually	33 - 37	28 - 30	23 - 24
Generation OpEx Y6-Y15	k/MW annually	37 - 41	31 - 34	25 - 28
Generation OpEx Y16+	k/MW annually	29 - 32	24 - 26	20 – 21
Offshore Transmission OpEx Y1-Y5	k/MW annually	2 - 5	2 - 4	1 - 2
Offshore Transmission OpEx Y6-Y15	k/MW annually	2 - 6	2 - 5	2 - 2
Offshore Transmission OpEx Y16+	k/MW annually	2 - 6	2 - 5	2 - 2
Nontechnical OpEx	k/MW annual avg	3 - 4	3 - 3	2 - 3

Source: RCG Analysis

Exhibit 104 Floating Foundation Offshore Wind, 200-1000MW Project Size, USD $2021 Estimates

Cost Category	Unit	2030 COD, 15MW WTG	2040 COD, 20 MW WTG	2050 COD, 25 MW WTG
Capex	k/MW	4,000 - 5,500	3,700 - 4,500	3,000 - 3,500
Generation OpEx Y1-Y5	k/MW annually	36 - 40	29 - 33	23 - 26
Generation OpEx Y6-Y15	k/MW annually	41 - 46	33 - 37	27 - 30
Generation OpEx Y16+	k/MW annually	32 - 36	26 - 29	21 - 24
Offshore Transmission OpEx Y1-Y5	k/MW annually	2 - 5	2 - 4	2 - 2
Offshore Transmission OpEx Y6-Y15	k/MW annually	2 - 6	2 - 4	2 - 2
Offshore Transmission OpEx Y16+	k/MW annually	2 - 6	2 - 4	2 - 2
Nontechnical OpEx	k/MW annual avg	4 - 4	3 - 3	2 - 3

Source: RCG Analysis

11.1.3 Results (*All Figures Estimated $2021*)

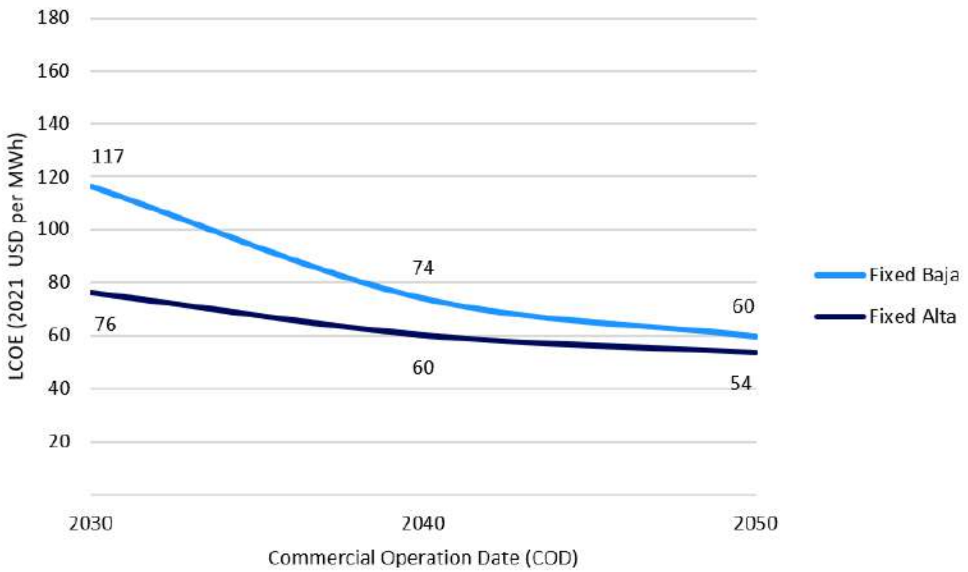
Please note that the following results are specifically modelled representations of the cases outlined in Section 2.

In the Low and High cases respectively, as shown in Exhibit 105 Fixed Foundation Offshore Wind LCoE - Low and High Buildout Cases, the central LCoE ranges from $117 USD - $76 USD in 2030 for fixed-bottom wind. Over time the LCoEs in both the Low and High case respectively drops significantly, to $74 USD - $60 USD in 2040 and to $60 and $54 in 2050, reflecting reduction in new market premiums, global cost reductions, and the further concentration of buildout in the Central and Eastern Zones (with improved wind resource by comparison to the Western Zone) to achieve the cumulative buildout targets.

The High deployment case reflects larger constituent project sizes (capacity volumes), which achieves economies of scale benefits that cannot be achieved in the smaller project sizes under the Low scenario. Many costs associated with installation have substantial fixed or nearly fixed components (such as cost of vessel transit time) that are more economically afforded by larger projects. Local project development services are another example – investments in this category can be similar whether a project is 200MW or 500MW, for example.

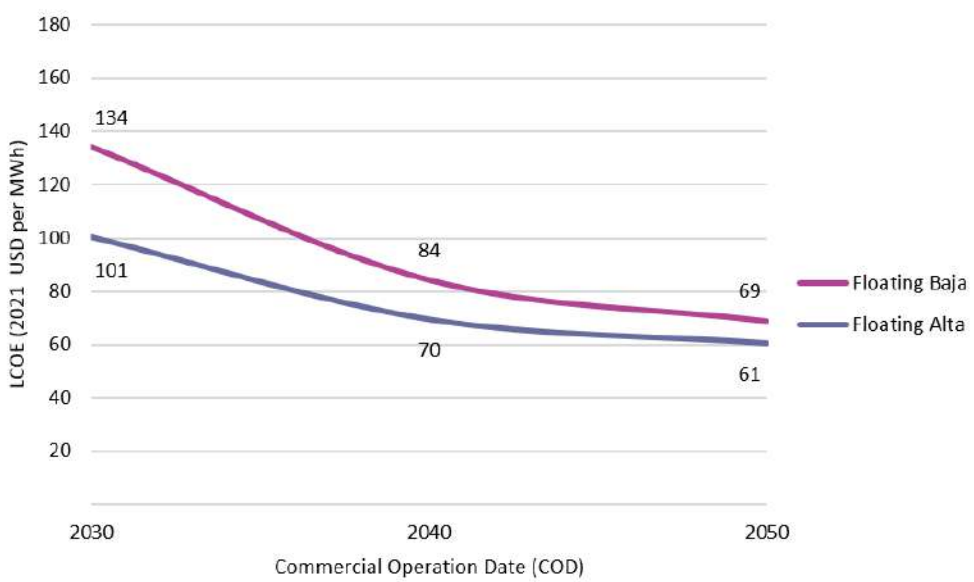
Exhibit 106 presents the forecast for floating offshore wind LCoE, with Low and High cases ranging from $134 USD to $131 USD respectively in 2030 to $69 USD to $61 USD in 2050. Like fixed-foundation wind, significant cost reductions are expected over the 2030-2050 period as new market premiums, global costs, and project economics improve. The premium for floating wind compared to fixed offshore wind is in the +10-30% range over the period of 2030-2050, with greater divergence in the 2030 figures; given the earlier-stage nature of floating wind technology, steeper LCoE reductions are expected over time as compared to the more mature fixed foundation technology.

Exhibit 105 Fixed Foundation Offshore Wind LCoE - Low and High Buildout Cases



Source: RCG Analysis

Exhibit 106 Floating Foundation Offshore Wind LCoE – Low and High Buildout Cases

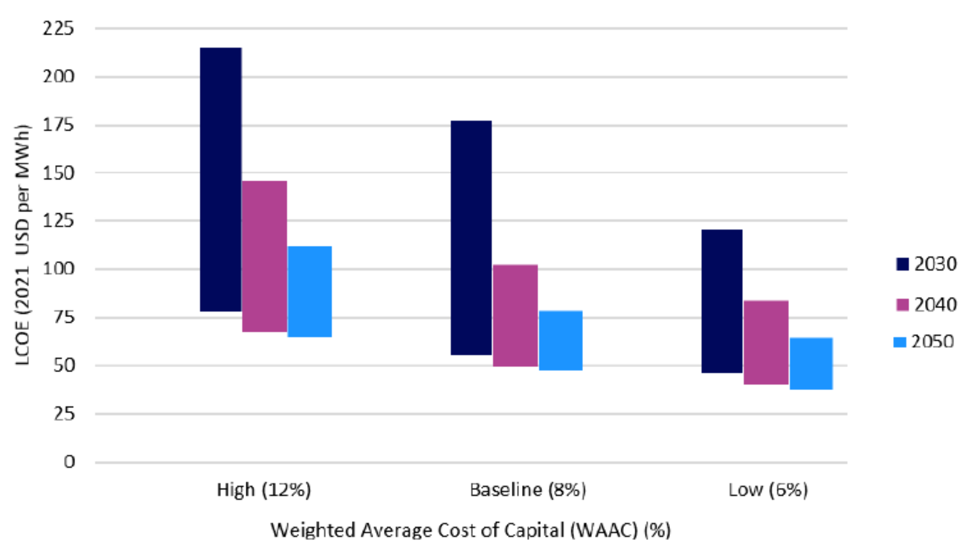


Source: RCG Analysis

Project sponsor weighted average cost of capital has a significant influence on LCoE and is an important area to manage through a variety of tools to minimize risk for the debt and equity investors. Exhibit 107 presents the distribution of LCoE outcomes across the 2030-2050 periods depending on the underlying WACC assumption. We selected 8% as a baseline WACC, which is representative for typical, early projects in Colombia, making use of both local (higher cost) and international debt. We have presented 6% as a low WACC case, which could possibly be achieved through risk reduction measures including guarantees, market maturity, and blended concessional finance to reduce debt costs. We have also demonstrated the impact a high WACC of up to 12% can have on project LCoE. In all cases, we assume that projects are funded using non-recourse project finance. In some cases, it is possible that the WACC could be further reduced if a sponsor funds a project on its balance sheet.

Within each COD year, the ranges represent the high and low LCoE values across all 300+ individual project cases assessed, driven by differences in CapEx (primarily a function of economies of scale) and capacity factor (primarily a function of site location).

Exhibit 107 WACC Sensitivity



Source: RCG Analysis

11.1.3.1 Local Content and LCoE

The LCoE forecast does not consider any adjustments due to potential supply of major local components (such as under the high growth, high local content scenario) and assumes the major components are imported. While select large components, such as foundations, can under certain circumstances present LCoE advantages with local supply, developing this capacity requires up-front capacity building investments that may negate any LCoE benefit. Based on analysis in other markets, it is expected that increasing shares of local content as envisioned in the high growth, high local content scenario generally is not expected to alter LCoE beyond the uncertainty range presented, though it will increase local capture of gross economic output.

11.1.3.2 Sensitivity: Western vs. Eastern Projects at 1 GW Size

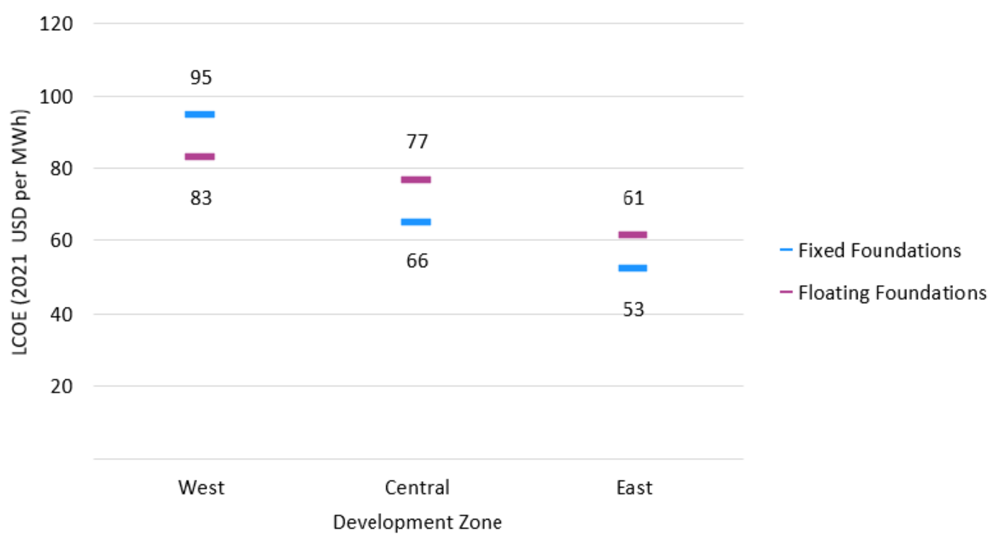
The wide range of net capacity factors estimated across the three wind energy zones means that different site locations exhibit substantial variations in estimated LCoE. In this sensitivity, we control both the COD year and capacity size to create a direct comparison of approximate LCoE between each of the three zones, effectively removing consideration of onshore transmission capacity as a key constraint.

The fundamental assumptions for this sensitivity are as follows:

- 2040 COD
- 1 GW project size, 20 MW WTG
- 8% WACC (equivalent to past cases)

CapEx/OpEx is characterized bottom-up at the project level using estimated points of interconnection for cable distances, calculated vessel transits, and all site-specific factors known such as depth etc., within previously stated ranges. Matching assumptions in past cases, no onshore transmission or grid upgrades costs are included within these LCoE figures.Notably, 2040 LCoEs in the Western Zone are expected to be lower for floating than for fixed-bottom projects due to the superior relative yield performance of floating vs. fixed sites in this zone.

Exhibit 108 Site Location Sensitivity on the Estimated LCoE for a 1GW project in 2040



Source: RCG Analysis

11.2 Economic benefits and jobs initial estimation

11.2.1 Purpose

This section provides an overview of potential ranges of jobs and direct gross economic output for representative offshore wind projects that make up the presented capacity deployment scenarios. As discussed in this section, estimates at this stage are highly uncertain, guidance oriented, and do not replace a project-specific, bottom-up appraisal.

11.2.2 Methodology

11.2.2.1 Local Content Estimation

To assess the share of local content, the project team referred to the Supply Chain analysis Readiness Assessment and made projections about local content across the various supply chain segments under the high and low market growth scenarios. The results are shown in Exhibit 109.

Exhibit 109 Projected share of local content

	Low Growth Scenario	High Growth Scenario

	2030	2040	2050	2030	2040	2050
Capacity Installed (Cumulative MW)	200	500	1,500	1,000	3,000	9,000
Project Development Services	30%	50%	50%	30%	70%	70%
Turbine - Nacelle	0%	0%	0%	0%	0%	0%
Turbine - Blades	0%	0%	0%	0%	25%	25%
Turbine - Towers	0%	0%	0%	0%	25%	25%
Foundations*	0%	0%	0%	0%	25%	25%
Subsea Cables	0%	0%	0%	0%	0%	0%
Installation	5%	5%	5%	5%	10%	20%
Operations and Maintenance	70%	70%	70%	70%	70%	90%

* Foundations include primary and secondary steel, as well as transition pieces

Source: Author's analysis

Colombia is a relatively isolated geographic market for offshore wind presently. Limited export opportunities to neighboring markets may thus reduce the economic case to invest in the local supply chain for major components. Accordingly, local content will be highly dependent on the outlook for domestic market growth.

- Under a **low growth, low local content scenario**, local content would most likely be derived almost exclusively from local project development services, offshore installation support (such as tugboats and barges), and operations and maintenance. Even in a long-term scenario, the market volume is unlikely to justify investments in component manufacturing.

- In the **high growth, high local content scenario**, where the local market reaches several gigawatts in size, with sufficient government incentives, it is possible that major components, including turbines and foundation components could be manufactured in Colombia. We have modeled the high deployment case to resemble a 'high local content' case, but note that it may be possible for the high deployment case to be delivered with low relative amounts of local content and all imported components with minimal impact on overall LCoE.

Local Content Categories

Below is a brief summary of local content assessment by category:

- Project development services: Capacity building in the short and medium-term will help to localize project development services, and we anticipate a relatively large share in local content for project development services in the long-term, both in a low growth and a high growth scenario.

- Turbine components: in a low-growth scenario, investment in specialized facilities for nacelles, blades, and towers are unlikely. However, if the market volume progresses towards several gigawatts of planned offshore wind capacity, we anticipate the potential of some specialized facilities.

- Foundations: the share of local content in manufacturing foundations considers the primary structure as well as secondary steel and transition pieces. In a low growth scenario, all foundation and foundation components will likely be imported from facilities abroad that have serial manufacturing capabilities customized toward offshore wind foundations (e.g. large monopile rolling facilities). In the long-term however, under a high growth scenario, it can be anticipated that secondary steel and fittings, as well as potentially transitions pieces and one-off foundations for offshore substation topsides, may be procured and manufactured locally.

- Subsea Cables: Subsea transmission cables are highly specialized and require dedicated facilities. Although there exists capabilities in parallel sectors in Colombia, the ease of importing this component and the relatively low benefit on project economics to source locally rather than import suggests that subsea cables will continue to be imported.

- Installation: Local content in installation considers the deployment of local vessels and crews to support offshore construction. This would likely include the use of local vessel fleets including tugs and flat bottom barges. It is assumed that Special Purpose Installation Vessels will continue to come from abroad.

- Operations and Maintenance: Routine O&M activities will be undertaken by local staff, with capacity building taking place in an early stage in the market. Under a high growth scenario, where the market reaches maturity, we anticipate nearly all O&M operations to use primarily local content.

11.2.2.2 Direct & Indirect Job Creation Estimation

Uncertainty

Forecasting the quantity of jobs created by an offshore wind project is highly uncertain and influenced by a wide range of factors including the specific location and development plan for individual projects, the technology and contractors utilized, and any program design or procurement requirements established by the government or purchasing entity. As a result, *values presented in this section are merely reference grade, based on secondary research from past projects in other markets, and do not substitute for an estimate prepared at the project-level by a project developer/sponsor, based on a specific project design.* This roadmap report, by virtue of assessing a wide variety of offshore wind areas and considering different technologies, time periods, and local content approaches, necessarily carries very high uncertainty with respect to estimates of gross direct and indirect job creation in Colombia.

Approach

The project team conducted a desktop literature review to identify peer-reviewed articles and industry accepted analyses of the job-years generated per MW of offshore wind capacity installed. Figures vary based on differences in methodological approaches as well as in-country factors such as labor intensity metrics assumed; however, recent studies have been able to offer accepted general figures for job-years created per installed capacity. The result is typically displayed as Full Time Employee Years (FTE) / MW. **One FTE year is equal to one full-time job for one year.**

The results of jobs creation per MW installed for wind energy have been summarized in a 2019 peer-reviewed scientific publication, *Wind Power and Job Creation*.[40] Among the relevant regional results the project team drew from in the literature review, Simas and Pacca[41] found that the (onshore wind) job potential in Brazil corresponds to 13.5 persons-year equivalent for each MW installed between manufacture and first year of operation of a wind power plant. Offshore wind has been found to have the potential to contribute more jobs per MW installed than onshore wind, due to the fact that offshore wind farms have a higher average investment cost than onshore wind farms - and overall jobs creation is typically tied to investment level. [42]

The International Renewable Energy Agency (IRENA) has found that a 500 MW offshore wind installation would generation 10,000 FTE years, or approximately 20 FTE years per installed megawatt. It should be noted that these figures include both Direct and Indirect jobs creation, as defined below:

- **Direct jobs** include manufacturing of key components, power plant construction, and operation and maintenance (O&M)
- **Indirect jobs** are related to the supply and support of the wind-power industry at a secondary level.
- **Induced jobs** are jobs created from economic impact of a particular industry or sector; for example, those created by expenditures of employees in that sector. (Induced jobs are excluded from this analysis)

Based on the literature review, we estimated FTE-years / MW for offshore wind in general, and furthermore distribute that figure across the various segments of offshore wind development, including project development, construction, installation and operations and maintenance, including scalar efficiencies.

[40] Aldieri, Luigi, Grafstom, Sundström, Kristoffer, and Paolo Vinci, Concetto. Wind Power and Job Creation. Sustainability 2020, 12, 45; doi:10.3390/su12010045

[41] Simas, M.; Pacca, S. Assessing employment in renewable energy technologies: A case study for wind power in Brazil. Renew. Sustain. Energy Rev. 2014, 31, 83–90 (Cross Referenced)

[42] Bilgili, M.; Yasar, A.; Simsek, E. Offshore wind power development in Europe and its comparison with onshore counterpart. Renew. Sustain. Energy Rev. 2011, 15, 905–915

11.2.2.3 Direct Economic Impacts – Gross Economic Output in Colombia from Capital and Operating Expenditures

Uncertainty

Similar to estimating job creation, forecasting economic impacts from offshore wind spending, even at the direct level, is highly uncertain and unique to individual project locations, methods, contracting strategies, local content, experience, and wide variety of other factors. This roadmap report, by virtue of assessing a wide variety of offshore wind areas and considering different technologies, time periods, and local content approaches, necessarily carries high uncertainty with respect to estimates of gross economic output in Colombia.

Approach

In this section we have focused on the direct, gross economic output of the low growth, low local content and high growth, high local content scenarios outlined above. Estimates of development, capital, and operating expenditures for representative projects were derived from RCG's proprietary LCoE model and sized according to the same capacity scenarios outlined in Section 2.

Following estimation of development, capital, and operating expenditures for the forecast capacity scenarios, total project spending was discounted according to the local content multipliers outlined in Section 11.2.2.1 to estimate the direct, gross economic output that could be realized locally in Colombia under the respective capacity growth pathways and local content scenarios. Results are shown in the next section.

11.2.3 Results

11.2.3.1 Estimated FTE-Years & Gross Economic Output in Colombia

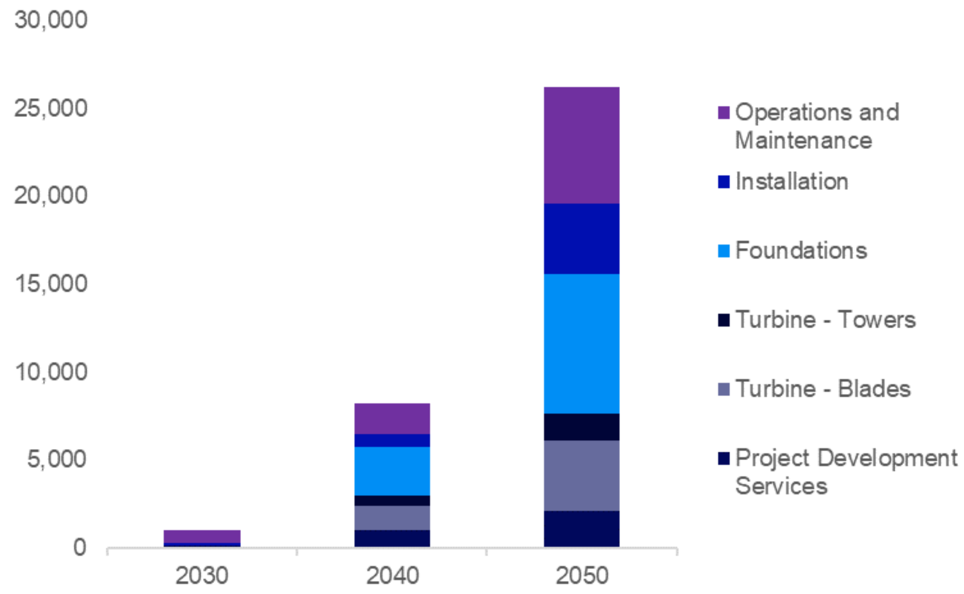
Note: all estimates in this section represent cumulative totals in the year listed.

High Growth, High Local Content Scenario

Exhibit 110 shows the Colombian annual FTE years of employment and gross economic output estimated to be created by offshore wind under the cumulative market volumes in the high growth scenario. The analysis estimates an impact of ~1,000 FTE years by 2030, ~8,000 FTE years by 2040, and increasing to ~26,000 in 2050 as significant additional capacity is developed in the final decade. For gross economic output in Colombia, the analysis estimates ~$100 Million USD $2021 by 2030, ~$1 Billion USD $2021 by 2040, and ~$3 Billion USD $2021 by 2050.

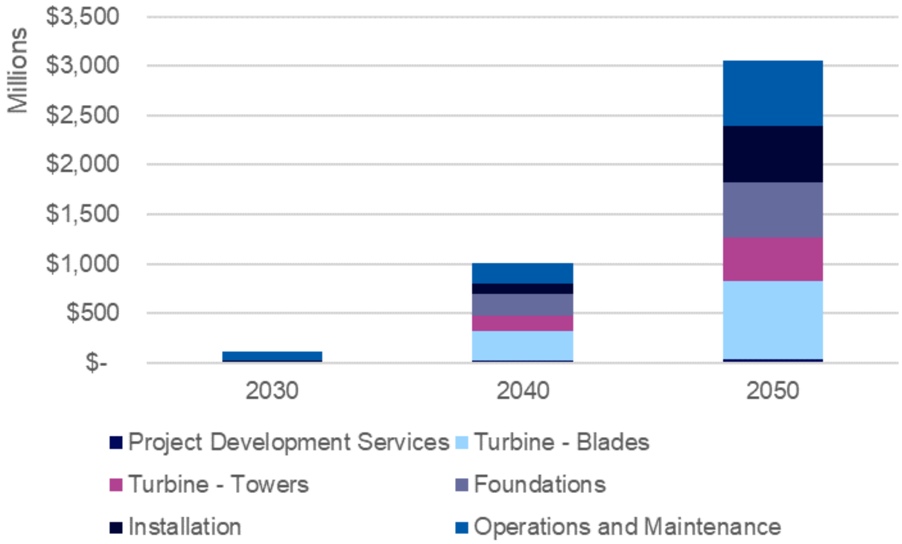
In the high-growth scenario, *select proportions of* project development services, installation services, partial local supply of components including foundations (primarily secondary steel structures), blades, towers, and operations and maintenance all contribute to local content and FTE-years. As discussed above, the high capacity growth scenario does not in itself necessitate significantly greater shares of local supply for major components – achieving such an outcome may require encouragement through prescriptive procurement policies and/or other developments outside of Colombia's control, such as development of offshore wind markets in nearby countries in Central and South America.

Exhibit 110 FTE-years in High Growth, High Local Content Scenario



Source: RCG analysis

Exhibit 111 Direct Local Spending – High Growth, High Local Content Scenario



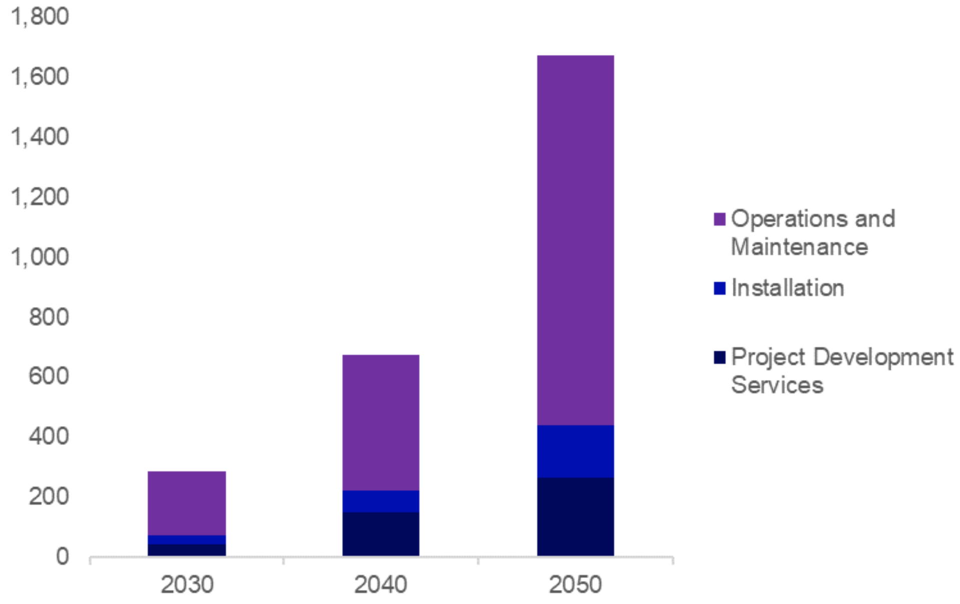
Source: RCG analysis

Low Growth, Low Local Content Scenario

Exhibit 112 shows the Colombian annual FTE years of employment and gross economic output estimated to be created by offshore wind under the cumulative market volumes in the low growth scenario. The analysis estimates an impact of ~300 FTE years by 2030, ~700 FTE years by 2040, and increasing to ~1,500 in 2050 as additional capacity is developed in the final decade. For gross economic output in Colombia the analysis estimates ~$25 Million USD $2021 by 2030, ~$60 Million USD $2021 by 2040, and ~$130 Million USD $2021 by 2050.

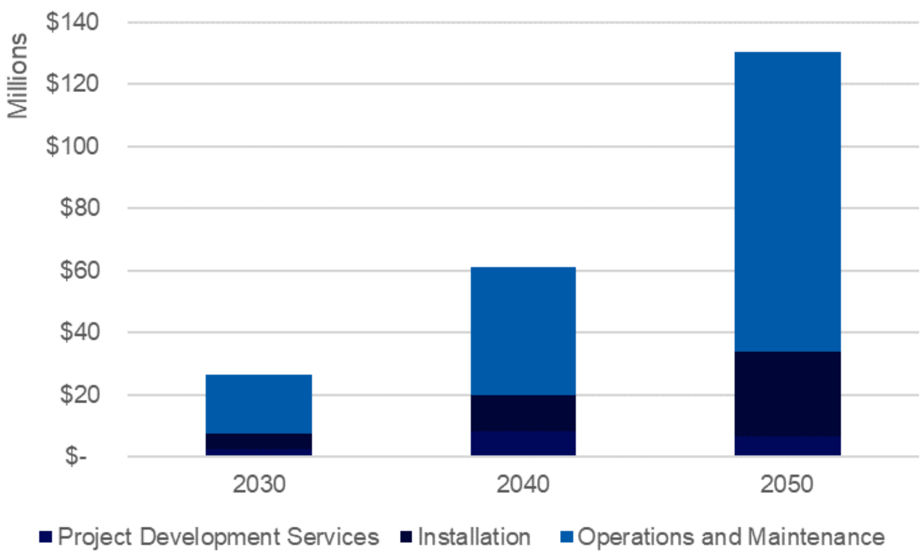
In the low-growth scenario, *select proportions of* project development services, installation services, and operations and maintenance all contribute to local content and FTE-years. The results of the low growth scenario consider aspects of project development, construction, and operations that generally are localized regardless of specific preferential policy or prescriptive requirements.

Exhibit 112 FTE-years in Low Growth, Low Local Content Scenario



Source: RCG Analysis

Exhibit 113 Direct Local Spending – Low Growth, Low Local Content Scenario



Source: RCG analysis

11.3 Bankability of Offshore Wind Projects

11.3.1 Purpose

The purpose of this section is to discuss elements that impact the bankability of offshore wind projects, including the cost of capital, debt financing, and investor appetite.

11.3.2 Method

This section was directly adapted from previous World Bank Offshore Wind Roadmap studies that are relevant to all global markets, as well as local sources and stakeholder feedback.

11.3.3 Results

11.3.3.1 Bankability and international financing

Offshore projects represent significant capital investments. For many emerging offshore markets, the first offshore projects will seek a mix of local and international lending. For debt financing, local banks can provide local knowledge and manage cash flows in the local currency. International banks, on the other hand, provide knowledge of offshore wind projects, provide risk mitigation and lending at favorable rates. The bankability of offshore wind projects – i.e., the willingness of banks to provide the necessary lending - depends on many factors. Banks have to assess the track record of the developer, the political and regulatory stability over the lifetime of the project, risk allocation and risk management, the business case of the project and ensure that projects are fully aligned with international standards and best practices and comply with national regulations. Some of the main considerations for bankability are described below.

11.3.3.2 Developer track record

The complexity and scale of offshore wind projects is greater than onshore wind. As such, banks will favor experienced international developers for developments, including demonstration and pilot projects. However, over time, collaboration between international and national developers can also help transfer the necessary knowledge and experience to the local developers, particularly to those who gain experience with onshore wind projects in Colombia.

11.3.3.3 Political and regulatory stability

As previously discussed, among the risks considered when new national markets are opening up for offshore wind is the possibility that government support will be inconstant across political divisions, raising the prospect that investments towards construction could be later invalidated by a regulatory proceeding under a new government. The risk of major reversals of policy must be considered for projects spanning decades. It is reasonable for investors and lenders to do an in-depth assessment of the stability and commitment of the Government for offshore wind, and the more the durable and supportive government policy is the better across all aspects including PPAs and all required permits and licenses.

11.3.3.4 Force majeure

Government acts which affect the performance of the PPA, the non-issuance of licenses or approvals to the developer, nationalization of the developer's property, and other events of a political nature must be included as a force majeure event in the power offtake agreement or PPA. These risks could be mitigated through the explicit inclusions of political acts and regulatory changes in the force majeure clause.

11.3.3.5 Risk allocation

The guiding principle has been that risk should be placed where it can be best managed. There are some risks, such as higher operating costs, which investors should bear as they are well placed to manage them. If risks are placed with investors that are outside of their control, such as regulatory risks, they will require an increased rate of return for bearing them or eventually they will decide not to invest and to allocate their capital to other international investment opportunities.

11.3.3.6 Business case

The main driver for bankability on a specific project will always be the business case. A well-documented feasibility study that demonstrates sufficient cash flow to service debt and provide dividends to equity is a must. Among the many unknowns in a 25–30-year business case, a few stand out, including the cost of capital and exchange rate risk. The cost of capital for projects in emerging markets can be very high, particularly with local financing. An alternative is to finance in USD or EUR through international financial institutions. This could provide a significantly lower cost of capital, but at the same time increase the project's exposure to exchange rate risk.

11.3.3.7 Currency Risk

Receiving payment for electricity in Colombian Pesos presents increased cost and risk to international developers that must hedge foreign exchange risk against liabilities denominated in USD or EUR etc. This is a more acute challenge for a program in the multi GW scale.

11.3.3.8 Financing Availability

Colombia has financed a variety of major, multi-billion USD public infrastructure projects, such as have been a part of 4G and 5G plans, that are comparable to offshore wind plants in cost depending on project size. Colombia has been successful in attracting foreign capital from major institutions in the US, UK, and China to support financing of such projects,[43] and it is expected that the same is possible for offshore wind plants in the future. Capital structures will vary by developer/developer consortium and according to contract types and incentives offered. Minimizing counterparty risk and creating long-tenor, durable and binding offtake agreements will reduce the cost of capital by comparison to riskier structures and reduce the cost of delivered energy for consumers.

[43] See, e.g. regarding 4G and 5G public infrastructure plans. *Colombia pushes ahead with ambitious infrastructure plan.* Financial Times, 2020. https://www.ft.com/content/0c4dda64-4ee8-4738-87dd-740fad9c3008

12 SELECT STAKEHOLDERS

12.1 Purpose

This section provides a list and brief description of the key public stakeholders in Colombia and their role / responsibility in the market. The purpose of the section is to provide a high-level list of stakeholders and organizations in Colombia tasked and briefly describing their function in the market.

12.2 Methodology

In consultation with the World Bank and the Ministerio Minas y Energía (Minenergía or MME), the project team identified several potential stakeholders in the market. This included the key government agency stakeholders with respect to site concessions (leasing and permitting), power grid planning, and granting environmental and social permits. This section identifies the main government agencies in the country; however, does not include local stakeholders who may also require pre-consultation or concession.

Inception Mission

As part of this Roadmap Study research, and in consultation with the World Bank and Minenergía, the project team identified and engaged with a priority group of approximately ten (10) stakeholders in Colombia as part of an Inception Mission. The Inception Mission included virtual meetings with relevant agencies and local stakeholder groups to carry out fact-finding, validate collected information, and structure the proposed workplan for the Roadmap Study based on the information, views and feedback gathered. Information from the stakeholder meetings was integrated into the analysis and results of the roadmap study.

Exhibit 114 Inception Meeting Stakeholders Consulted

Entity	Sector
Ministerio Minas y Energía (MME or Minenergía)	Government
Autoridad Nacional de Licencias Ambientales (ANLA)	Government
Unidad de Planeación Minero Energética (UPME)	Government

Agencia Nacional de Hidrocarburos (ANH)	Government
Dirección General Marítima (DIMAR)	Government
Autoridad Nacional de Acuicultura y Pesca (AUNAP)	Government
Association de Energias Renovables de Colombia (SER Colombia)	Industry trade body
Vientos Alisios	Private
Mainstream Renewables	Private
AES	Private
ENEL Green Power	Private

Source: RCG-ERM, 2021

12.3 Results

12.3.1 List of key stakeholders

A table with a list of the key stakeholders begins on the following page. The below table is not exhaustive and additional stakeholders may be missing.

Stakeholder name	Function
Ministerio Minas y Energía (Minenergía or MME) Ministry of Mines and Energy	State office in charge of directing the national policy regarding mining, hydrocarbons and energy infrastructure
Agencia Nacional de Hidrocarburos (ANH) National Hydrocarbons Agency	National agency responsible for overseeing offshore development areas.
Unidad de Planeación Minero Energética (UPME) Mining and Energy Planning Agency	Entity responsible for the indicative planning and development requirements of major energy projects including transmission[44] and generation[45] expansion plans and investments needed.
Ministerio de Hacienda y Crédito Público (Minhacienda) Ministry of Treasury and Public Credit	Responsible for overseeing government finance and budget and implementing the financial policies of the government
Ministerio de Ambiente y Desarrollo Sostenible (Minambiente) Ministry of Environment and Sustainable Development	Formulates and implements national policies related to environmental and sustainable development.
Autoridad Nacional de Acuicultura y Pesca (AUNAP) National Authority for Agriculture and Fisheries	Responsible for administering the agricultural and aquatic / aquaculture policies of the government.
Comisión de Regulación de Energía y Gas (CREG) Electricity and Gas Market Regulator	Market regulator overseeing market structure, competition and operators in electricity, gas, and liquid fuels markets.
Instituto de Investigaciones Marinas y Costeras (INVEMAR)	Provides scientific and technical advice to the National Environmental System.
Autoridad Nacional de Licencias Ambientales (ANLA) *National Authority for Environmental Licenses*	National agency ensuring that projects subject to licensing and permits comply with environmental regulations.
Dirección General Marítima (DIMAR) *General Maritime Authority*	Executes government's maritime policies and regulates all maritime, coastal, and port activities in country, including concessions.
Corporación Autónoma Regional de La Guajira (Corpoguajira) *Regional Autonomous Corporation of La Guajira*	Predominant environmental authority in the Department of La Guajira, overseeing resources and environment.
Corporación Autónoma Regional de Magdalena (CORPAMAG)	Predominant environment authority in the Department of Magdalena, overseeing resources and environment.
Corporación Autónoma del Atlántico (CRA) *Atlantic Regional Autonomous Corporation*	Promoting the responsible use of renewable natural resources and preparing environmental management plans
Directorate of the National Authority for Preliminary Consultation (ANC)	Prior consultation authority
Directorate of the National Authority for Prior Consultation (DANCP)	Prior consultation authority
Association de Energias Renovables de Colombia (SER)	Renewable energy trade body
Ministry of National Defense	Ministry of National Defense
Colombia Aeronautica Civil (Colombia Aerocivil) Colombia Civil Aviation Authority	Aviation authority
Ministry of Commerce, Industry and Tourism	National executive ministry of the Government of Colombia concerned with promoting economic growth though trade, tourism and industrial growth
Organización Nacional Indígena de Colombia National Indigenous Organization of Colombia	Authority of government, justice, legislation and representation of the indigenous peoples of Colombia

Source: RCG – ERM, 2021

[44] Regarding transmission (220 and 500 thousand volt transmission networks), the Plan identifies the expansion needs and definition of projects with respect to technical characteristics (capacities and general location), without specifying routes and exact location of infrastructure. The projects are developed by investors selected through public calls, who are responsible for their financing, designs, environmental licensing, layouts, construction, operation and maintenance. Their remuneration comes from the start-up and tariff of the service.

[45] Regarding generation, the Plan identifies the country's requirements in different scenarios, but does not develop the projects to be executed, since it is the developers who are in charge of financing, permits, execution and operation.

APPENDICES

A APPENDIX A: COLOMBIAN ENERGY SECTOR CONTEXT

12.4 Introduction

Colombia has historically relied heavily on hydropower and thermal power to meet its electricity demand. Non-hydropower renewables such as solar PV and onshore wind have not been utilized in large quantities. However, drivers such as droughts, climate targets and a desire to diversify energy supply mean a large increase in the capacity of renewable energy is anticipated. The following section details the historic and current energy and electricity generation mix in Colombia, the projected increase in electricity demand, and the future energy scenarios that indicate potential energy pathways to 2050.

12.5 Electricity Fundamentals Overview

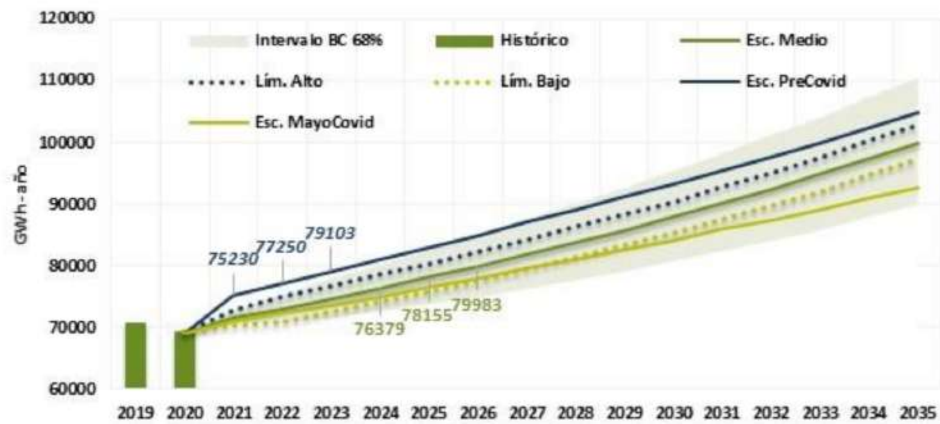
12.5.1 Demand

Electricity demand in Colombia is considered low on a per capita basis when compared to other countries. In 2014, electricity demand was 1312 kWh per capita, which ranks 129th amongst other countries[46]. According to the UPME, national electricity demand in 2021 is expected to be between 70,000 GWh and 75,000 GWh per year. This is expected to rise to between 90,000 GWh and 110,000 GWh per year by 2035, with a projected 2% - 3% annual growth rate[47]. This anticipated increase in electricity demand is due to forecasted electrification of the Colombian energy sector, increased uptake of electric vehicles and an increase in population.

[46] The World Bank, 2014, Electric power consumption 9kWh per capita, retrieved from: https://data.worldbank.org/indicator/EG.USE.ELEC.KH.PC?name_desc=false

[47] UPME, 2021, Proyecciones de demanda, retrieved from: https://www1.upme.gov.co/DemandayEficiencia/Paginas/Proyecciones-de-demanda.aspx

Exhibit 115 Projection of annual electricity demand (GWh-year)



Source: UPME, Annual projection of demand for electric energy and natural gas for the period 2021-2035 (UPME, 2021)

Electricity demand in Colombia is highest along the north coast in the Costa – Caribe region, and in the Centro region, where consumption in 2020 was 17,601 GWh and 16,492 GWh respectively. Electricity consumption elsewhere in the country is lower, with the next highest region Noroeste, which had a 2020 consumption of 9,598 GWh. The regional electricity demand levels closely follow population distribution.

Exhibit 116 Annual Electricity Demand by Region (2019-2020)

Región	Consumo total (GWh-año)		Crecimiento del consumo año (%)	
	2019	2020	2019	2020
Costa - Caribe	17.523	17.601	6,77%	0,44%
Centro	17.101	16.492	2,80%	-3,56%
Noroeste	9.805	9.598	3,21%	-2,11%
Oriente	7.420	7.210	9,24%	-2,82%
Valle	7.158	6.913	2,36%	-3,43%
Tolima grande	2.901	2.823	3,18%	-2,69%
CQR	2.721	2.668	1,79%	-1,96%
Sur	1.982	1.982	3,58%	0,03%

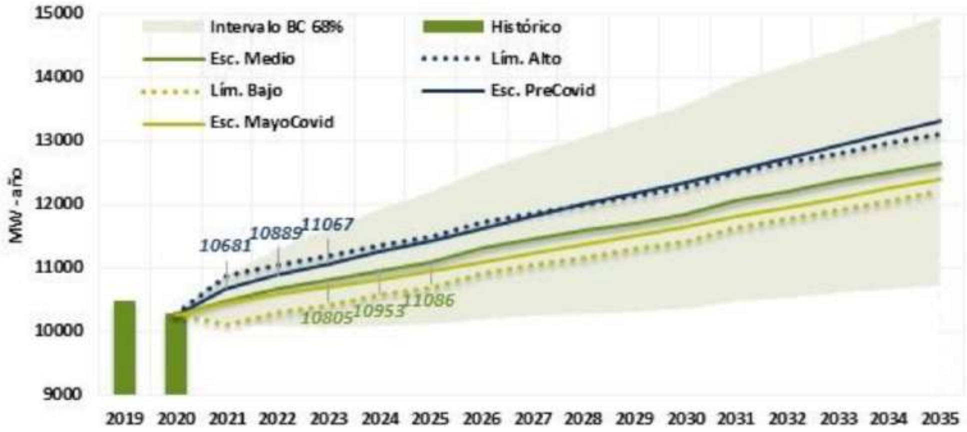
Source: UPME, Electric and Natural Gas Demand Projections, 2021-2035 (June 2021).[48]

[48] UPME, 2021

12.5.2 Capacity

The Colombian electricity generation capacity in 2019 was 18 GW,[49] which exceeds maximum demand to allow for resource variability, seasonality and demand peaks. This generation capacity is expected to increase in line with the anticipated increase in power demand. According to UPME, maximum power demand is expected to be between 10 GW – 11 GW in 2021. This is expected to increase to between 11 GW – 15 GW by 2035. An increase to 15 GW would represent a 2-4% annual growth rate.[50]

Exhibit 117 Projection of maximum power demand



Source: UPME, Annual projection of demand for electric energy and natural gas for the period 2021-2035 (UPME, 2021)

12.5.3 Current Energy Mix

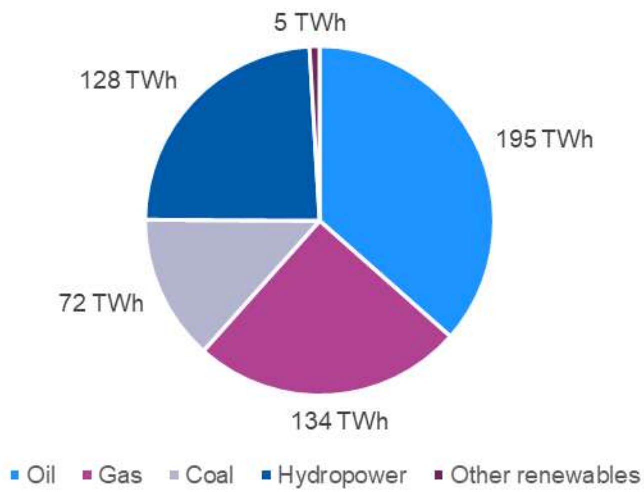
The overall primary energy consumption mix in Colombia is dominated by thermal sources. In 2019, energy produced by oil had the highest utilization at 195 TWh, followed by gas at 134 TWh. Coal contributed 72 TWh. There is currently no nuclear generation in Colombia. Hydropower contributed 128 TWh, making it the highest non-thermal generator in the consumption mix. Solar, wind and biofuels all had negligible impacts on the consumption mix, contributing less than 1 TWh. Other renewables contributed the remaining 5 TWh[51].

[49] UPME, 2020

[50] UPME, 2021

[51] BP, 2021, Statistical Review of World Energy, retrieved from https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy.html

Exhibit 118 2019 Energy Consumption

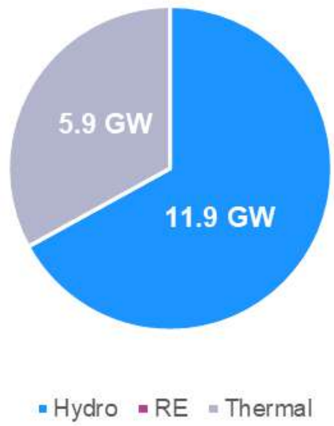


Source: BP Statistical Review of World Energy 2021 (BP, 2021)

The overall energy mix is primarily made up of thermal sources, which are dominant in the transportation and heating sectors, however the electricity generation mix is led by hydropower. The electrical generating capacity of hydropower in 2019 was 11.9 GW, followed by thermal generation at 5.9 GW. The majority of this thermal generation consists of natural gas generating capacity. In 2019 alternative electricity generation such as wind and solar made up less than 1 GW of generation[52], though this is expected to reach 1GW by the end of 2019.

[52] UPME, 2020, Plan Energético Nacional 2020 – 2050, retrieved from: http://www1.upme.gov.co/DemandayEficiencia/Documents/PEN_2020_2050/Plan_Energetico_Nacional_2020_2050.pdf

Exhibit 119 2019 Electricity Generation Capacity



Source: UPME, National Energy Plan 2020 – 2050. Renewable energy share not visible as it was negligible in 2019.

12.5.4 Projected Energy Mix

The National Energy Plan 2020 – 2050 (NEP)[53] defines a long-term vision for the energy sector in Colombia. The document is not a forecast of the future energy sector, but rather an exploration of possible scenarios. Four scenarios are presented, Actualización, Modernización, Inflexión and Disrupción. The four scenarios represent futures with different levels of decarbonization, risks and technological changes, and are defined in the NEP generally as follows:

- Actualización: Scenario in tune with current trends
- Modernización: Gasification as a step towards decarbonization
- Inflexión: Beginning of the electrification of the economy
- Disrupción: Innovation to steer the sector towards carbon neutrality

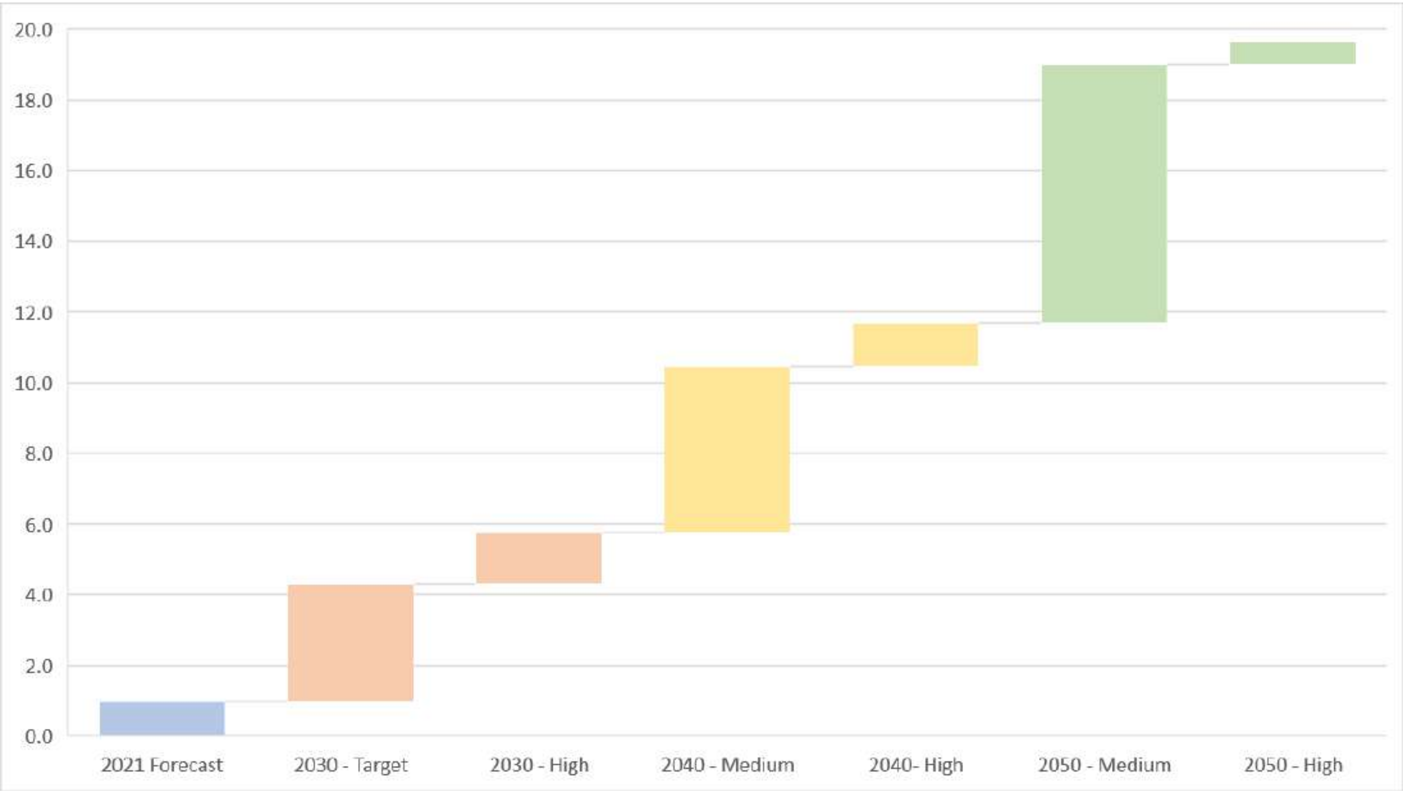
12.5.5 Non- Hydro Onshore Renewables in Colombia

With hydropower and thermal power dominating the electricity mix, non-hydropower renewables are currently limited to small scale installations including technologies such as combined heat and power, solar PV and wind. In order to decrease emissions and reduce a reliance on both hydropower and thermal power, a large increase in the deployment of non-hydropower renewables is anticipated. Colombia's NEP outlines ambitions goals for the growth of non-hydro renewables over the period

[53] UPME, 2020

of 2020 – 2050 including a minimum of nearly 19 GW of installed non-hydro renewable energy by 2050 in all four NEP cases as shown in Exhibit 120.

Exhibit 120 Forecasted Growth of Non-Hydro Renewables in Colombia (GW Operating, 2021 – 2050)

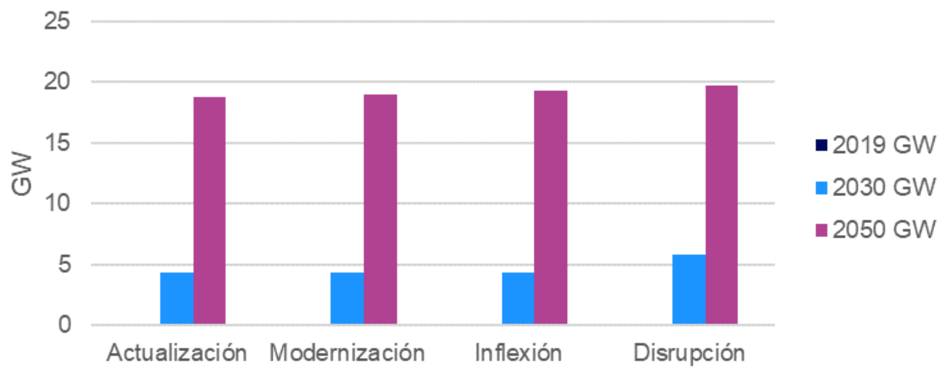


Source: Author's analysis based on the Plan Energético Nacional 2020 – 2050, P. 93. 2021 Forecast is based on a statement by Ivan Duque and is subject to change.[54] Medium = Escenarios de Actualización y Modernización, High = Disrupción.

As of 2019, there was a negligible (~0 GW) capacity of non-hydro renewable energy in Colombia. All four NEP scenarios anticipate this to increase substantially by 2030 to 4 GW - 6 GW. A further increase is expected by 2050, with capacities reaching 19 GW - 20 GW. As the scenarios are currently structured, a large percentage of this capacity would consist of onshore wind and solar PV.

[54] See: https://renewablesnow.com/news/colombia-expects-to-have-over-1-gw-of-renewables-by-end -2021-dice-el-presidente-732017

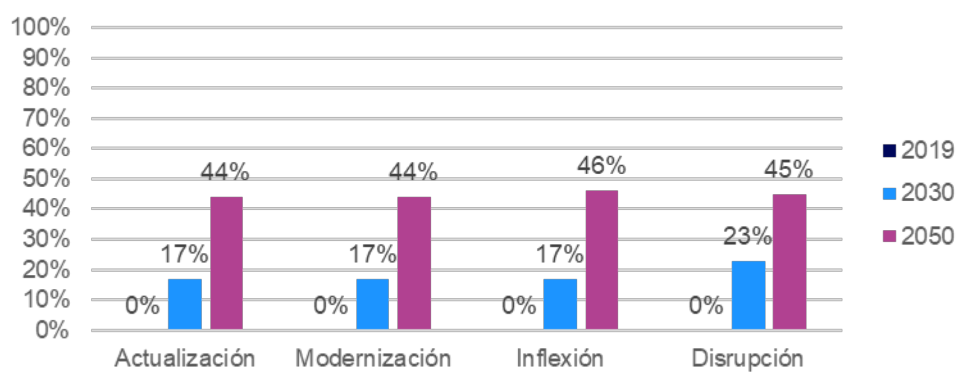
Exhibit 121 Non-hydro RE Electricity Generation Capacity Projection



Source: Minenergía y UPME, National Energy Plan 2020 – 2050

The anticipated increase in capacity correlates to an increase in the percentage share of non-hydro renewables in the electricity generation mix. Across the four scenarios, the proportion of non-hydro renewables is anticipated to increase from ~0% in 2019 to 44% - 46% in 2050.

Exhibit 122 RE Electricity Generation Mix Projection



Source: Minenergía y UPME, National Energy Plan 2020 – 2050 (UPME, 2020)

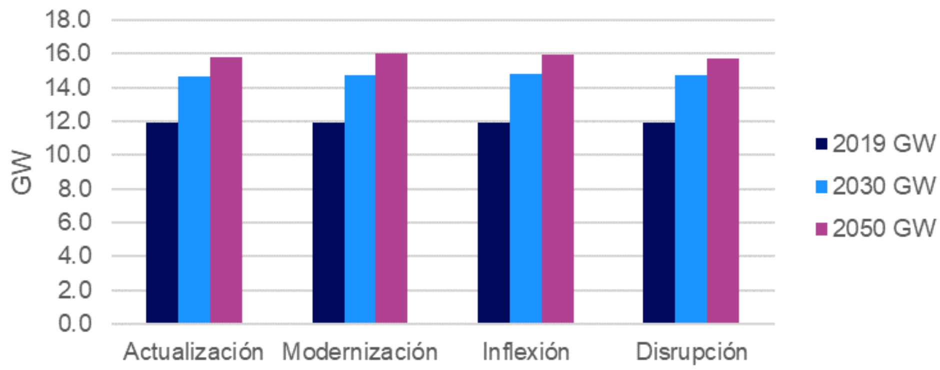
12.5.6 Hydropower in Colombia

Hydropower is currently the dominant contributor to the electricity generation mix, with approximately 12 GW installed giving Colombia the third largest hydro capacity in South America[55]. As a result, in 2019 hydropower contributed towards 24% of the country's total energy consumption[51], and 67% of the total electricity generation. The

[55] NS Energy, 2019, Top five hydroelectric generators in South America, retrieved from: https://www.nsenergybusiness.com/features/hydroelectric-generators-south-america/

NEP scenarios predict an increase in hydropower capacity across all four scenarios. The scenarios predict an increase of 0.9 GW – 1.3 GW between 2019 and 2050.

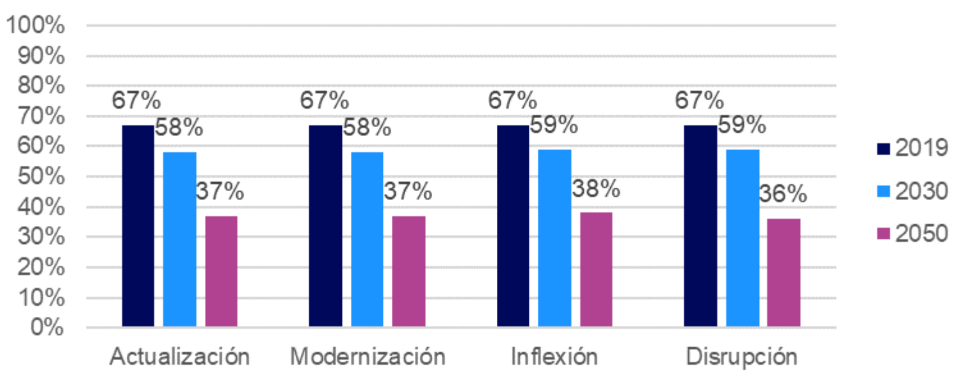
Exhibit 123 Hydropower Electricity Generation Capacity Projection



Source: Minenergía y UPME, National Energy Plan 2020 – 2050

Despite the minor increase in capacity, as a result of increased electricity demand all scenarios anticipate a large decrease in the overall percentage that hydropower contributes to the electricity mix. The percentage of hydropower in the electricity generation mix is projected to drop by 29% - 31% by 2050.

Exhibit 124 Hydropower Electricity Generation Mix Projection



Source: Minenergía y UPME, National Energy Plan 2020 – 2050

Diversification from Hydropower

As presented in the four future scenarios, there is a desire and expectation in Colombia to reduce its reliance on hydropower and diversify the electricity generation mix. One of the drivers for this is the El Niño weather phenomenon and the implications it has on hydropower generation. El Niño is a naturally occurring climate pattern caused by the warming of Pacific Ocean surface temperatures. El Niño is the "warm phase" of a larger phenomenon known as the El Niño-Southern Oscillation[56]. Whilst El Niño is not a regular cycle, it typically occurs irregularly at two to seven year intervals. It can cause a wide range of weather changes and environmental challenges, but in Colombia it has historically led to a decrease in rainfall[57].

Droughts and Hydropower

The El Niño effect contributed towards reductions in rainfall by 40% in 2015 and 2016 which led to the second worst draught in Colombian history[58]. Due to the country's reliance on hydropower for electricity supply the drought had major implications for the energy sector. Hydropower dam levels were reduced by 60% - 70% when compared to previous years meaning an increased amount of thermal backup generation had to be utilized. High levels of demand combined with low levels of hydropower put substantial sustained stress on the generation system and energy market, which led to increases in electricity prices for end users.

Another drought was experienced between 2020 – 2021 which again led to low reservoir levels and an increased reliance on backup thermal generation[59]. An increase in alternative generation such as wind and solar PV is expected to supplement the current energy mix and mitigate the impacts of El Niño going forward by adding new sources of generation.

The Colombian energy and capacity markets are dominated by hydropower, and the policy challenges that have arisen in Colombia since 1993 have mostly pertained to the specific supply problems arising from the interface between a hydro-dominated power grid, the economics of non-hydro generation, and unpredictable climatic events.

12.5.7 Thermal & Other Resources

Thermal power in Colombia currently accounts for 33% of the electricity generation mix, which equates to approximately 6 GW of generation capacity. Whilst thermal power is a key aspect of the generation mix, it also acts to supplement and serve as a backup to the hydropower generation during periods of low hydropower resource availability. Natural Gas is the primary fuel source, followed by coal and oil. Both the

[56] National Geographic, El Nino, retrieved from: https://www.nationalgeographic.org/encyclopedia/el-nino/

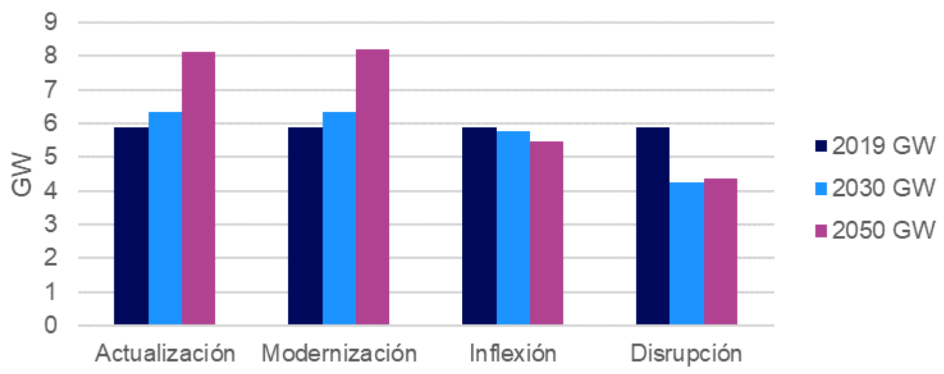
[57] Reuters, 2018, El Nino may cut Colombia's rainfall by 80 percent in quarter-one 2019: minister, retrieved from: https://www.reuters.com/article/us-colombia-weather-idUSKBN1O31X2

[58] World Energy, 2019, El Nino Colombia 2015/16, retrieved from: https://www.worldenergy.org/assets/downloads/El_ni%C3%B1o_Colombia_-Extreme_weather_conditions_SEP2019.pdf

[59] Renewables Now, 2020, Colombia faces lower hydro generation with little renewables to help, retrieved from: https://www.renewablesnow.com/news/colombia-faces-lower-hydro-generation-with-little-renewables-to-help-699508/

Actualización and Modernización scenarios anticipate an increase in thermal energy capacity to 8 GW by 2050. The Inflexión and Disrupción scenarios anticipate decreases in thermal capacity by 2050 to 5 GW and 4 GW respectively. Across the scenarios there is a difference in 2050 of 3.9 GW between the high and low thermal capacity pathways. Whist the difference between the scenarios for hydropower and renewables is relatively minor, this difference is a lot more substantial and is indicative that the future role of thermal power is less clear than that of hydropower and renewable energy.

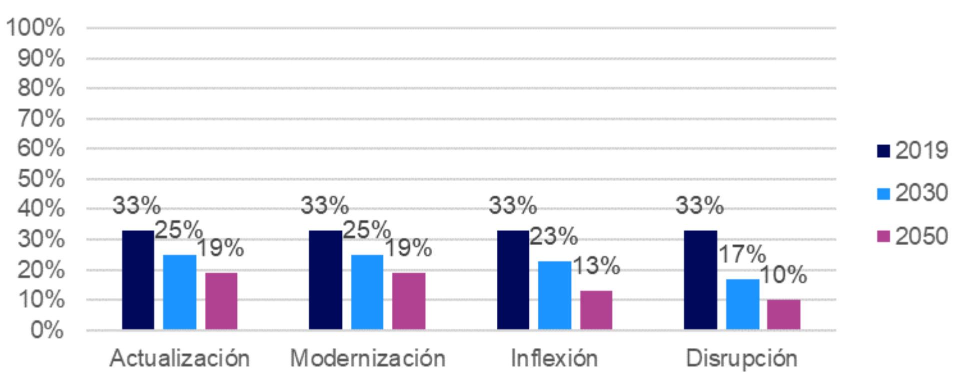
Exhibit 125 Thermal Power Electricity Generation Capacity Projection



Source: Minenergía y UPME, National Energy Plan 2020 – 2050

Despite the varying levels of thermal capacity anticipated, across all four scenarios by 2050 there is an anticipated decrease in the overall percentage of thermal power in the electricity mix. This is driven by an increase in electricity demand which will primarily be accounted for by renewable energy and hydropower.

Exhibit 126 Thermal Electricity Generation Mix Projection



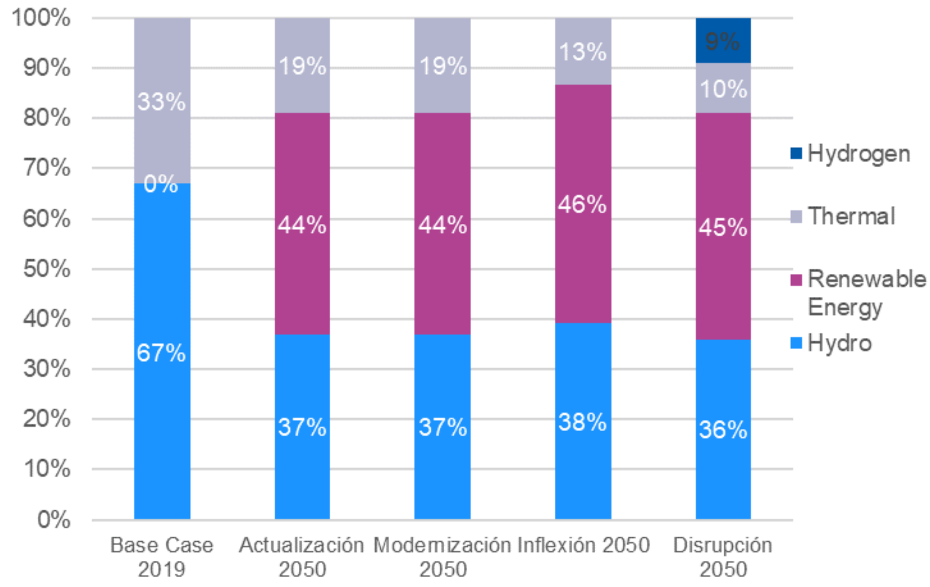
Source: Minenergía y UPME, National Energy Plan 2020 – 2050

There is a long-term goal to reduce the proportion of thermal generation in the electricity generation mix, with goals to reduce 2030 greenhouse gas emissions by 51% when compared to 2014[60]. However as a result of a need to diversify away from hydropower, additional gas and coal generation has recently been brought online[58].

12.5.8 Resource Comparison

Whilst there are key differences between the four NEP 2050 scenarios, namely the quantity of thermal power by 2050, they all predict an overall decrease in the percentage of hydropower and thermal power by 2050. To balance this, all four scenarios anticipate a large increase in the electricity generation capacity of renewable sources.

Exhibit 127 2050 NEP Scenario Outcomes



Source: Minenergía y UPME, National Energy Plan 2020 – 2050

12.5.9 Cost of Energy

The average cost to household consumers is 0.147 USD per kWh, making Colombia the 63rd most expensive country globally by this metric[61]. This household electricity

[60] Climate & Clean Air Coalition, 2021, Colombia's NDC increases its 2030 climate change ambition and integrates new targets that simultaneously improve air quality and health, retrieved from: https://www.ccacoalition.org/en/news/colombia%E2%80%99s-ndc-increases-its-2030-climate-change-ambition-and-integrates-new-targets

[61] Global Petrol Prices, 2021, Colombia electricity prices, retrieved from: https://www.globalpetrolprices.com/Colombia/electricity_prices/

price is very similar to the USA, 17% higher than Brazil, and 55% higher than Mexico. There was a spike in electricity prices during the 2015/16 drought which meant the wholesale spot price of electricity rose from177 US $30 - $50 to over US $400 per MWh[62].

UPME projects that the price of electricity in Colombia is expected to increase over the coming years with potentially increasing marginal fuel costs; Natural Gas prices are expected to increase from US $8.4 per MBTU in January 2021 to US $20.6 per MBTU in January 2050. [63]

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62 World Energy, 2019, El Nino Colombia 2015/16, retrieved from: https://www.worldenergy.org/assets/downloads/El_ni%C3%B1o_Colombia_-Extreme_weather_conditions_SEP2019.pdf

63 Global Petrol Prices, 2021, Colombia electricity prices, retrieved from: https://www.globalpetrolprices.com/Colombia/electricity_prices/

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