Offshore Wind in the Gulf of Mexico:

Natural Resource Revenue Potential

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List of Acronyms and Abbreviations

$/MWh	Dollars per megawatt hour
BOE	Barrels of Oil Equivalent
BOEM	Bureau of Ocean Energy Management
BREEZE Act	Budgeting for Renewable Electrical Energy Zone Earnings Act
CPS	Coastal Political Subdivisions
CUP	Coastal Use Permit
CZMA	Coastal Zone Management Act
DOE	Department of Energy
DOI	Department of Energy
DOI's ONRR	DOI's Office of Natural Resources Revenue
GOMESA	Gulf of Mexico Energy Security Act
GPS	Gulf Producing States
GW	Gigawatts
IRA	Inflation Reduction Act
km^2	Square Kilometer
LACE	Levelized Avoided Cost of Energy
LCMP	Louisiana Coastal Management Program
LCOE	Levelized Cost of Energy
LDEQ	Louisiana's Department of Environmental Quality
LDNR	Louisiana's Department of Natural Resources
LDNR's OMR	LDNR's Office of Mineral Revenues
LDWF	Louisiana's Department of Wildlife and Fisheries
LPSC	Louisiana Public Service Commission
MW	Megawatts
NREL	National Renewable Energy Laboratory
OCS	Outer Continental Shelf
OCSLA	Outer Continental Shelf Lands Act
PSN	Proposed Sale Notice
RISEE Act	Reinvesting in Shoreline Economies & Ecosystems Act
SLCRMA	State and Local Coastal Resources Management Act
SMEB	State Mineral and Energy Board
WEAs	Wind Energy Areas

Executive Summary

The Gulf of Mexico has long played a central role in energy production for the United States. Offshore oil and gas drilling in the federal Outer Continental Shelf (OCS) waters of the Gulf of Mexico currently contributes to 15% of the total U.S. crude oil production and 5% of natural gas production (U.S. Energy Information Administration 2022). However, the outlook for Gulf of Mexico energy production is changing. Dwindling reserves in shallow, lower cost lease areas, plus regulatory uncertainty regarding new oil and gas leases in the area have shifted the outlook for future fossil fuel production in the Gulf of Mexico. At the same time, the federal government has announced plans to deploy 30 gigawatts (GW) of offshore wind energy across the U.S. by 2030 and the Louisiana Climate Action Plan set a statewide goal of generating 5 GW of offshore wind power by 2035 (The White House n.d.; Climate Initiatives Task Force 2022). The development of wind energy in the Gulf of Mexico has the potential to leverage Louisiana's existing workforce and strengths in offshore development, diversify the region's energy mix, reduce greenhouse gas emissions, and provide a new source of public revenue. This report summarizes the existing regulatory framework for offshore wind developments in the Gulf of Mexico and the coast of Louisiana, examines how regulation of offshore wind will resemble and differ from the existing framework for oil and gas development in the Gulf, expands on the potential for Gulf of Mexico wind energy production, and offers projections for the revenue potential of forthcoming federal wind leases in the region.

Three offshore federal wind leases near the Texas and Louisiana coasts are expected to be auctioned by the Bureau of Ocean Energy Management (BOEM) in the later half 2023. **Combined, the three Gulf of Mexico wind leases cover 300,000 acres and are estimated to have a generating capacity of nearly 3.7 GW—sufficient to power 1.3 million homes.** They will be the first federal wind leases in the Gulf of Mexico and as a result there is a large amount of uncertainty as to the level of developer interest and the amount of revenue that could be generated from the lease sale. The following factors are most likely to have a positive or negative influence on developer interest in Gulf of Mexico wind leases:

- **Wind speeds**: Lower average wind speeds than other U.S. areas where previous wind lease sales have been completed. Lower wind speeds will require developers to build larger, more expensive turbines to effectively utilize wind resources.
- **Other environmental conditions**: Shallow waters in the Gulf of Mexico allow for lower cost, fixed turbine platforms compared to deep waters like those on the West Coast of the U.S. that will require the use of expensive floating platforms. However, a soft sea bottom substrate and the threat of hurricanes in the Gulf of Mexico will require more robust jacket structures to protect turbines.
- **Workforce and infrastructure**: Due to the existing oil and gas industry, Louisiana and Texas both have a strong existing workforce and the supply chain and manufacturing capability to effectively deploy wind developments in the Gulf of Mexico. Coupled with a generally lower cost of labor compared to other federal offshore wind regions, these factors will serve to reduce the cost of construction and operation for wind developers.
- **Electricity markets and renewable energy standards**: The Gulf of Mexico region generally sees lower average wholesale electricity prices than other offshore wind leasing regions. In addition, a lack of statewide renewable portfolio standards or mandated offshore wind procurement goals suggests that wind power will in the region will not benefit from the captive market that boosted interest in most prior lease sales.

There is a great deal of uncertainty in the outlook for this fledgling market, but based on the factors listed above and historical data on previous lease sales for offshore wind, we estimate that the BOEM Gulf of Mexico lease auctions will net revenues ranging somewhere between $78.7 million and $2.7 billion. **Within the wide range of potential lease bid outcomes, we offer a medium scenario estimate of $404.6 million,** which is consistent with recent trends of rising interest in offshore wind development in the United States.

Table 1. Gulf of Mexico Federal Wind Lease Revenue Scenarios.

	Low Scenario	Medium Scenario	High Scenario
Bonus Bids (2023)	$78.7 M	$404.6 M	$2,664 M
Annual Rents (2023)	$0.2 M	$0.7 M	$0.9 M
Annual Operating Fees (2030)	$3.1 M	$8.2 M	$34.1M
2023 Leased Capacity (MW)	1,832	2,748	3,663
2030 Operational Capacity (MW)	1,832	3,663	7,327

Table 1 above shows estimated low, medium, and high revenue scenarios for the 2023 BOEM lease sales and the level of offshore wind electricity production by the year 2030. Those familiar with oil and gas leases will be aware of bonus bids, rents, and royalties as the primary sources of revenue from federal offshore leases. In the case of wind, an operating fee equal to 2% of the value of generated electricity replaces the royalty rate seen in oil and gas leases. **Unlike oil and gas leases—where royalties are the largest source of revenue—lease bonus bids are expected to be the largest source of revenue from federal wind leases for the foreseeable future.** This difference implies that the majority of offshore wind revenues will come in the form of irregular, one-time increments as additional leases are made available.

Though we can estimate the level of revenue the federal government stands to receive from offshore wind lease sales, **the sharing of wind revenues with Gulf of Mexico states is not well defined**. Federal revenues from oil and gas leases in the Gulf of Mexico are currently allocated to nearby state and local governments through a structure established by the Gulf of Mexico Energy Security Act (GOMESA). GOMESA revenues provide a critical source of funding for coastal restoration projects in Louisiana, but the Act does not contemplate other sources of revenue like offshore wind. The broader Outer Continental Shelf Lands Act (OCSLA) allows for revenue sharing from wind developments in the OCS, but only in a narrowly defined area known as the 8(g) zone, which does not include the upcoming BOEM lease areas. Pending federal legislation like the RISEE and BREEZE have the potential to enable revenue sharing for states. Both would expand the scope of GOMESA to include offshore wind leases, with differences in the state proportions of allocated revenues.

The three lease areas soon to be auctioned in the Gulf of Mexico represent only a fraction of the potential for offshore wind in the region. The National Renewable Energy Laboratory (NREL) estimates that the technical potential for wind energy production in the Gulf of Mexico is over 1,500 GW, and other federal initiatives like the Department of Energy's Hydrogen Hubs program could spur the development of green hydrogen production in the Gulf of Mexico using offshore wind as an energy input. The installation and operation of these technologies offers an opportunity for Louisiana to leverage its existing strengths in the offshore energy sector. Gulf of Mexico wind leases also represent a new revenue opportunity for Louisiana—if a state allocation structure is established—though it is unlikely that wind revenues will be as high or consistent as current levels of revenue from oil and gas.

1. Introduction

The federal government recently announced plans to deploy 30 GW of offshore wind energy by 2030, a major step forward in the transition to clean and renewable energy (The White House 2021). This opportunity is estimated to create over 77,300 jobs and lead to $12 billion a year in capital investments. The generated power will supply over ten million households a year, an amount which would emit 78 million metric tons of CO_2 if generated by burning fossil fuels instead.

Over the past decade, interest in offshore wind has increased dramatically, as shown by exponentially growing cash bids (i.e., total amounts as well as price per acre) since the first lease sold off the coast of Delaware in late 2012 (BOEM n.d.). Since the first lease sale, leases for eleven more wind energy areas (WEAs) have sold, encompassing a total area of over 2.6 million acres along the Atlantic and Pacific coasts. Last year alone, leases in four WEAs were sold which, when combined, make up almost 40% of the total acreage sold in U.S. waters. The New York Bight lease sold for $4.37 billion, an over 35,000-fold price-per-acre increase compared to the Delaware lease ten years prior.

The Gulf of Mexico offers an as-yet-untapped resource for offshore wind energy with great potential to secure revenue for gulf states and reduce our dependency on oil and gas. In this report, we highlight how Louisiana can take advantage of this opportunity and move toward a clean energy future. Section 2. describes the regulatory framework for resource development on the Louisiana coast. We give a brief overview on the regulation and revenues of mineral resources on state lands and waters, as well as federal waters and revenue sharing with gulf states under the Gulf of Mexico Energy Security Act (GOMESA). The potential for offshore wind development in the Gulf of Mexico and existing regulatory frameworks for offshore wind are outlined in Section 3. This section provides insight into available wind resources, estimated cost and value metrics, as well as economic impacts modeled for 2030 deployment. We discuss pending federal legislation (RISEE Act, BREEZE/ Lower Energy Costs Act) and summarize federal and state regulatory frameworks, as well as frameworks in Europe and Asia. In Section 4. , we provide low, medium, and high scenarios for expected lease bids and operating fee revenue for the Gulf of Mexico based on historical offshore wind lease bidding data in the U.S., as well as wind capacity growth assumptions expected for 2050. Finally, Section 5. includes a summary of our findings and recommendations for management of public revenues associated with offshore wind in the Gulf of Mexico with revenue considerations to support a sustainable coast in the long term.

2. Regulatory Framework for Resource Development on Louisiana's Coast

This section provides an overview of the methods by which natural resources are regulated and developed in Louisiana—with special emphasis on oil and gas drilling activities on the state's coast, the framework for resource development in federal waters outside of Louisiana's coastline, how public revenues are generated in both state and federal jurisdictions, and the primary uses of natural resource revenues in Louisiana.

2.1. Managing Louisiana's Coastal Resources

Louisiana's Department of Natural Resources (LDNR) is the primary regulatory body overseeing the development and production of oil and gas, energy, mineral resources, as well as other natural resources in Louisiana, including sources of renewable energy like wind and solar. Oil and gas regulation is primarily led by LDNR's Office of Conservation, in partnership with the Office of Mineral Resources as well as the Office of Coastal Management when a project is determined to impact natural resources within Louisiana's Coastal Zone. Outside of LDNR, the Department of Environmental Quality (LDEQ) also has oversight and permitting authority when it comes to any drilling or other activities which could have a negative effect on land, water, or human health.

Any natural resource extraction by drilling in the state must be permitted by LDNR's Office of Conservation, whether on public or private land or water bottoms.[1] The natural resource permitting process varies depending on the resource in question and its location, whether inshore, offshore, on state lands or water bottoms, or in the Louisiana Coastal Zone, which has a wider set of regulations to ensure the protection of coastal resources. The Coastal Zone is likely to be an important consideration in future wind energy developments along Louisiana's coast, even those developed in offshore waters, as transmission facilities will need to traverse the coastal boundary in order to bring electricity generated offshore to market.

2.1.1. Louisiana's Coastal Zone

Louisiana's Coastal Zone is an area of approximately 16,000 square miles, stretching across the southern portion of the state and extending three nautical miles off of Louisiana's coastline to the federal waters boundary. The Coastal Zone was originally established by the State and Local Coastal Resources Management Act (SLCRMA) of 1978 as a follow up to the federal Coastal Zone Management Act (CZMA). SLCRMA authorized LDNR to develop and implement the state's Coastal Management Program, a set of guidelines and regulations created to "protect, develop, and, where feasible, restore or enhance the resources of the state's coastal zone."[2] As per CZMA, Louisiana's Coastal Management Plan was developed within the criteria of NOAA's Office of Coastal Management and ultimately approved by NOAA as a state coastal program.

The Louisiana Coastal Management Program (LCMP) set the boundary of the Coastal Zone and criteria for "granting, conditioning, denying, revoking, or modifying of coastal use permits."[3] Under Louisiana's Coastal Use Guidelines, a Coastal Use Permit (CUP) is required for any land uses or activities in the Louisiana Coastal Zone (see Figure 1) which could have a "direct or significant impact on coastal waters."[4]

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[1] La. R.S. 30:28.
[2] La. R.S. 49:214.22.
[3] La. R.S. 49:214.27.
[4] La. R.S. 49:214.23.

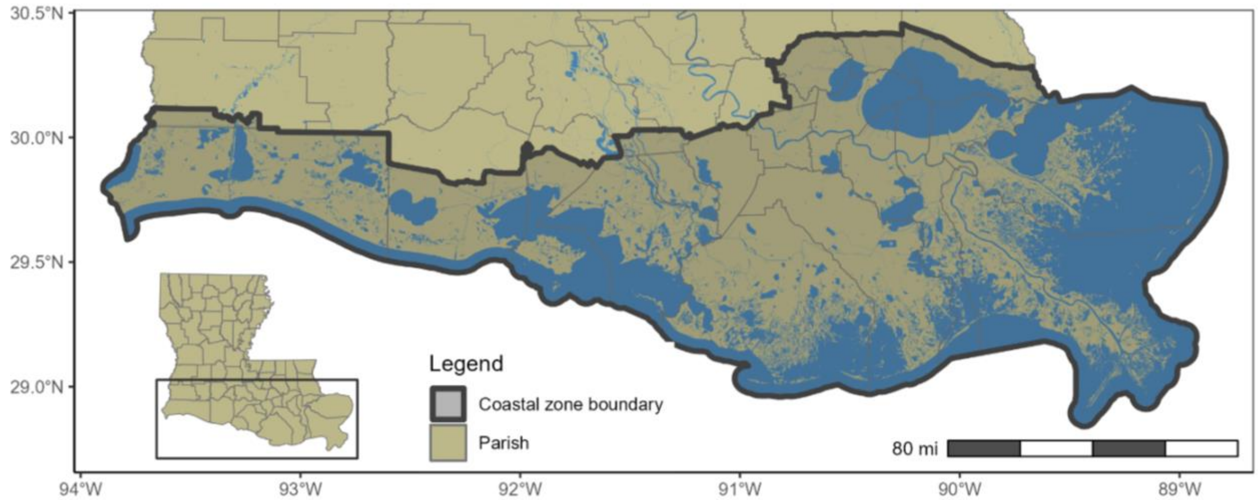

Figure 1. Louisiana's Coastal Zone Boundary
Note: The original boundary was drawn in 1980 and expanded in 2012. The boundary spans multiple parishes and extends three nautical miles from the coastline.

Activities requiring a CUP in Louisiana's Coastal Zone are subdivided into two types: uses of state concern and uses of local concern. This distinction is an important regulatory consideration, as applications for CUPs that fall under the definition of a local use and within the jurisdiction of a local authority with an approved local coastal management program can be approved by local entities. However, the state/local distinction matters less for resource development like oil & gas activities, and potentially wind development, as any mineral resource activities fall under uses of state concern as defined in the Louisiana Revised Statutes (see below).[5]

> Uses of state concern: Those uses which directly and significantly affect coastal waters and which are in need of coastal management and which have impacts of greater than local significance or which significantly affect interests of regional, state, or national concern. Uses of state concern shall include, but not be limited to:
> (a) Any dredge or fill activity which intersects with more than one water body.
> (b) Projects involving use of state owned lands or water bottoms.
> (c) State publicly funded projects.
> (d) National interest projects.
> (e) Projects occurring in more than one parish.
> (f) All mineral activities, including exploration for, and production of, oil, gas, and other minerals, all dredge and fill uses associated therewith, and all other associated uses.
> (g) All pipelines for the gathering, transportation or transmission of oil, gas and other minerals.
> (h) Energy facility siting and development.
> (i) Uses of local concern which may significantly affect interests of regional, state or national concern.[6]

[5] More details on Louisiana's coastal programs and how they may apply to offshore wind development in the state can be found in The Environmental Law Institute's "Louisiana Offshore Wind Energy Framework 2022."
[6] La. R.S. 49:214.25(A)(1)

2.1.2. Regulation of Mineral Resources on Louisiana's Coast

Any company who seeks to develop mineral resources on the coast of Louisiana must comply with a large number of regulations and receive permits for their activities from a handful of state offices. For the sake of comparison to possible processes for coastal wind development, this section will give a brief overview of the leasing and permitting processes for oil and natural gas drilling in Louisiana's Coastal Zone.

The following state offices are the primary entities involved in coastal resource management in Louisiana:

LDNR Office of Conservation – issues permits for all oil and gas drilling in LA.

LDNR Office of Mineral Resources – leases for oil and gas drilling and other mineral resource extraction from state-owned land and water bottoms.

LDNR Office of Coastal Management – Administers Coastal Use Permits (CUPs).

Department of Wildlife and Fisheries (LDWF) – Approval of CUPs for activities in state wildlife management areas and refuges.

Department of Environmental Quality (LDEQ) – regulatory oversight of environmental impact to land, air, and water.

As mentioned above, any activity with a direct or significant impact on coastal waters or resources will require application for a Coastal Use Permit through the LDNR Office of Coastal Management. In addition, CUP approval for any activity conducted in a state wildlife management area or refuge will require additional approval from the Louisiana Department of Wildlife and Fisheries (LDWF).

Permitting requirements will vary depending on whether an activity takes place on privately-owned or state-owned land or water bottoms. In all cases of drilling for oil and gas, a permit must be obtained from the LNDR Office of Conservation, which also requires payment of an annual fee.[7] Any drilling on state lands or water bottoms requires a mineral lease from the State Mineral and Energy Board, administered by LDNR's Office of Mineral Revenues (OMR).[8] State mineral leases are auctioned on a monthly basis to bidders who, once the lease is reviewed and awarded by OMR, are responsible for paying the following:

- An annual rental payment of $30 per acre of leased area.
- A lease bonus, equal to the annual rental payment for the first year.
- A fee, equal to 10% of the combined rental payment and royalty amounts.
- Annual royalty payments, based on a proportion of the resources, as outlined in the lease advertisement.[9]

The above processes—applying for a permit to drill from the Office of Conservation, applying for a CUP for coastal zone activities, and bidding for a mineral lease on state land and waters—are the three primary regulatory requirements for developing oil and gas resources on Louisiana's coast, as well as the primary sources of state mineral revenues outside of severance taxes. There are

[7] La. R.S. 30:28. See next section, or La. R.S. 30:21, for a schedule of application fees which vary depending on well type and production tiers.

[8] La. R.S. 30:124, La. R.S. 36:358(D)(1).

[9] Royalties must be a minimum of 18th of the value of the oil, gas, or other minerals (La. R.S. 30:127). In practice, the royalty amount advertised by OMR has been higher than the minimum. Recent lease sales from 2022 advertised royalty amounts between 20% and 25% (Louisiana Department of Natural Resources n.d.).

many more processes involved in oil and gas drilling on the coast, for instance; permits from the Department of Environmental Quality for impacts on water, land, and air quality as a result of mineral exploration. These permits are relevant to wind energy production but are not a major source of revenue for the state and are thus excluded from the scope of this report.

2.1.3. Revenues from State Lands and Water Bottoms

Mineral revenues in Louisiana consist of severance taxes, permit fees, and the royalties, bonuses, and rental payments derived from state mineral leases. The largest source of mineral revenue is the severance tax, which typically yields several hundred million annually for the state but has reach upwards of $1 billion. The bulk of severance tax comes from the production of oil and gas.

Severance Taxes

In addition to any bonus bid, rental payments, and royalties paid on a mineral lease, any extraction of oil, natural gas or other natural resources in Louisiana requires the payment of a severance tax based on the volume and type of resource extracted. Presently, the severance rate for oil is 12.5% of the current market value at the time of removal, though this rate diminishes depending on the type and quality of the extract (Louisiana Department of Revenue n.d.). Natural gas is currently taxed at a volumetric rate of $0.177 per thousand cubic feet (Mcf), again with declining rates depending on well type and quality (Louisiana Department of Revenue, n.d.).

Table 2. Louisiana Severance Tax Collections, FY17-22.

Fiscal Year	Revenue
FY 2022	$515.2 million
FY 2021	$263.2 million
FY 2020	$426.4 million
FY 2019	$511.8 million
FY 2018	$461.0 million
FY 2017	$385.8 million

Source: Louisiana Dept. of Administration, Comprehensive Annual Financial Report for FY 2021-2022.

As can be seen in the Table 2 above, severance revenues in Louisiana can fluctuate greatly from year to year largely because of price changes, but also production changes in response to market price volatility.

Finally, the transportation of natural resources can also incur a tax. For instance, any entity engaged in transporting natural gas via pipeline must pay a franchise tax of 1% of annual gross receipts.[10]

Drilling Permit Fees

The Office of Conservation at DNR conserves and regulates the state's oil, gas, and lignite resources; regulates exploration and production; controls and allocates energy supplies and

[10] La. R.S. 47:1031

distribution; protects public safety and environment from waste occurring from harvesting these resources. The LDNR Office of Conservation charges annual fees for oil and gas, which are divided into production tier fees based on the "Barrels of Oil Equivalent" (BOE) and regulatory fees based on the type of facility.[11]

- Production tier fees for 2022 – 2023
    a. Fees range from $141 (1 to 5,000 BOE) to $1,933 (110,001 to 9,999,999 BOE); zero production is set to $22 (zero production)
- Regulatory fees for 2022 – 2023
    a. Type A commercial facilities: $18,900
    b. Type B commercial facilities: $9,450
    c. Class II wells (non-exempt) & Class III wells: $1,890
    d. Class I wells: $27,777

Royalties, Bonuses, Rental Payments, and Coastal Use Permit Fees

As mentioned in the section above, any entity leasing state land or water bottoms for mineral extraction is responsible for paying a bonus bid on the lease sale as well as an annual rental payment of $30 per acre and a royalty payment based on the value of the resource obtained. If the area where drilling occurs is within the Louisiana Coastal Zone, the producer must apply for a Coastal Use Permit (CUP) which has additional fees associated. Of these funding sources, royalties from state mineral leases form the largest portion, earning the state over $150 million in 2021 while bonuses, rents, and other mineral lease revenues added up to less than $10 million in the same year (Edward L. O'Brien, III 2022).

2.2. Federal Oil and Gas Framework

2.2.1. The Federal Offshore Oil and Gas Lease Process

Any company pursuing the option to secure rights to drill for oil or natural gas in the federal waters of the Gulf of Mexico must acquire a lease from the BOEM through a competitive lease sale process. Leases are awarded qualified bidders based on which bidder offers the highest bonus bid for a lease area. Once a lease is awarded, the operator is required to pay a rental fee until the lease is operational, after which they are required to pay a royalty based on the volume of the resource extracted. Royalties are the dominant source of federal revenue from drilling activities in the OCS, and a significant portion of these revenues are transferred to GOMESA federal revenue sharing program. Figure 2 below outlines the federal OCS oil and gas leasing process.

[11] Per ACT 362 of Regular Session 2015, which amended La. R.S. 30:21(B)(1) and 136.1(D) and to enacted R.S. 30:4(P)

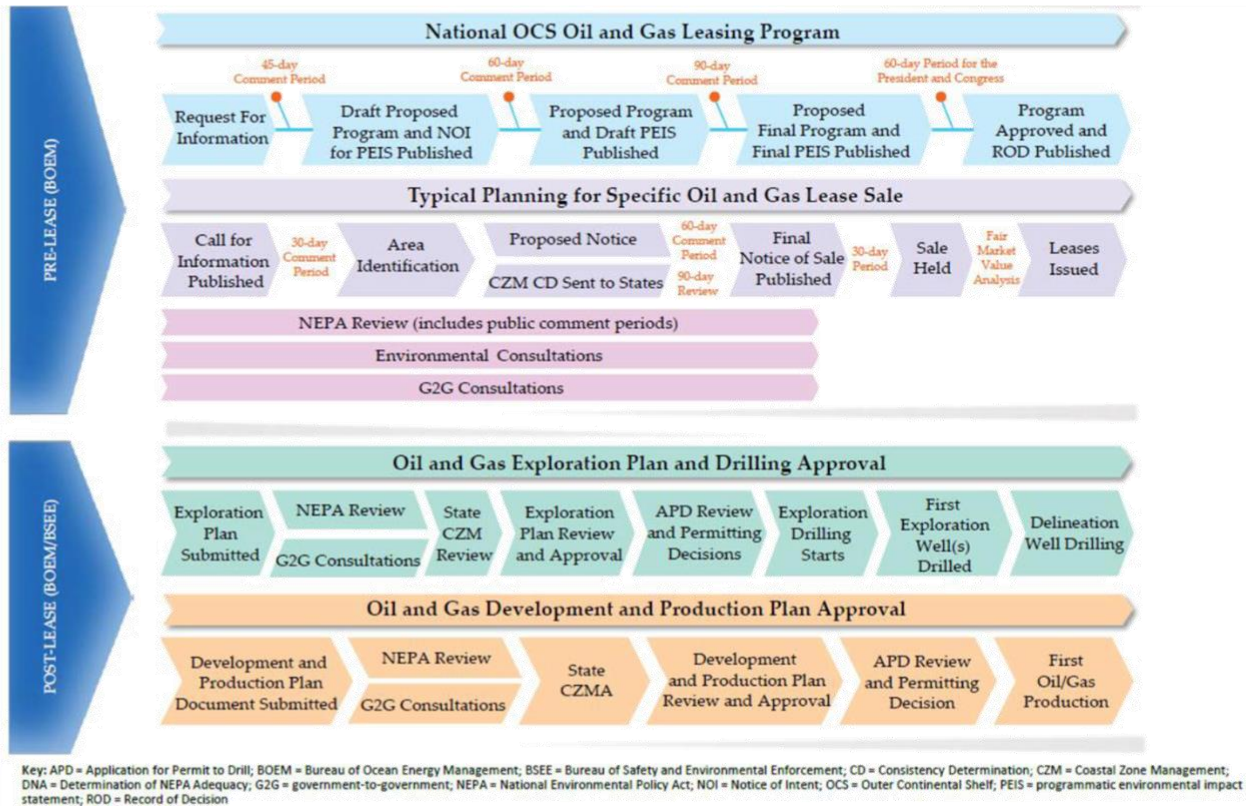

Figure 2. Federal Offshore Oil and Gas Leasing Process.
Source: BOEM, "2023–2028 National Outer Continental Shelf Oil and Gas Leasing Proposed Program."

BOEM's management of the OCS oil and gas lease program operates under five-year cycles which consist of three main processes:

1. The *Program Development Process* consists of planning and development by BOEM to determine leasing areas, conduct a programmatic environmental impact statement (PEIS), and solicit public comment, ultimately ending with approval of the program and PEIS by Congress and the President and the issuing of a record of decision.
2. BOEM will then initiate the *Leasing Process* by issuing a call for nominations. During the early stages of the leasing process, BOEM will conduct a review in line with the National Environmental Policy Act of each lease sale area, consult with state governments and federal environmental agencies, and conduct a consistency determination to evaluate potential lease activities' impacts on state and federal coastal zone areas. Once a final notice of sale is issued, the lease process can take place, which is conducted in a sealed bid format. Bids are evaluated using a fair-market analysis to determine if there are any anti-trust issues before issuing leases to the highest bidder. This process can take up to two years to complete (BOEM 2022).

3. Once leasing rights are issued, the final process is the *Exploration and Development Process*, which involves oversight by BOEM into lease operators and further environmental review for individual well sites.[12]

2.2.2. State and Local Revenues from Federal Waters

Over the past 20 years, federal offshore oil and gas revenues from the Gulf of Mexico totaled over $120 billion. These revenues are a mix of bonus bids, rents, royalties, and other revenues, but royalties make up about 80% of the annual total on average, with royalty revenues ranging between $2.4 billion and $7.3 billion (U.S. Department of the Interior 2023a). Royalty revenues—payments to the federal government based on the amount of resource produced and the market rate—are the majority source of federal offshore oil and gas revenues. Royalties alone in 2022 were $7.1 billion, the highest amount since 2008 (see Figure 3).

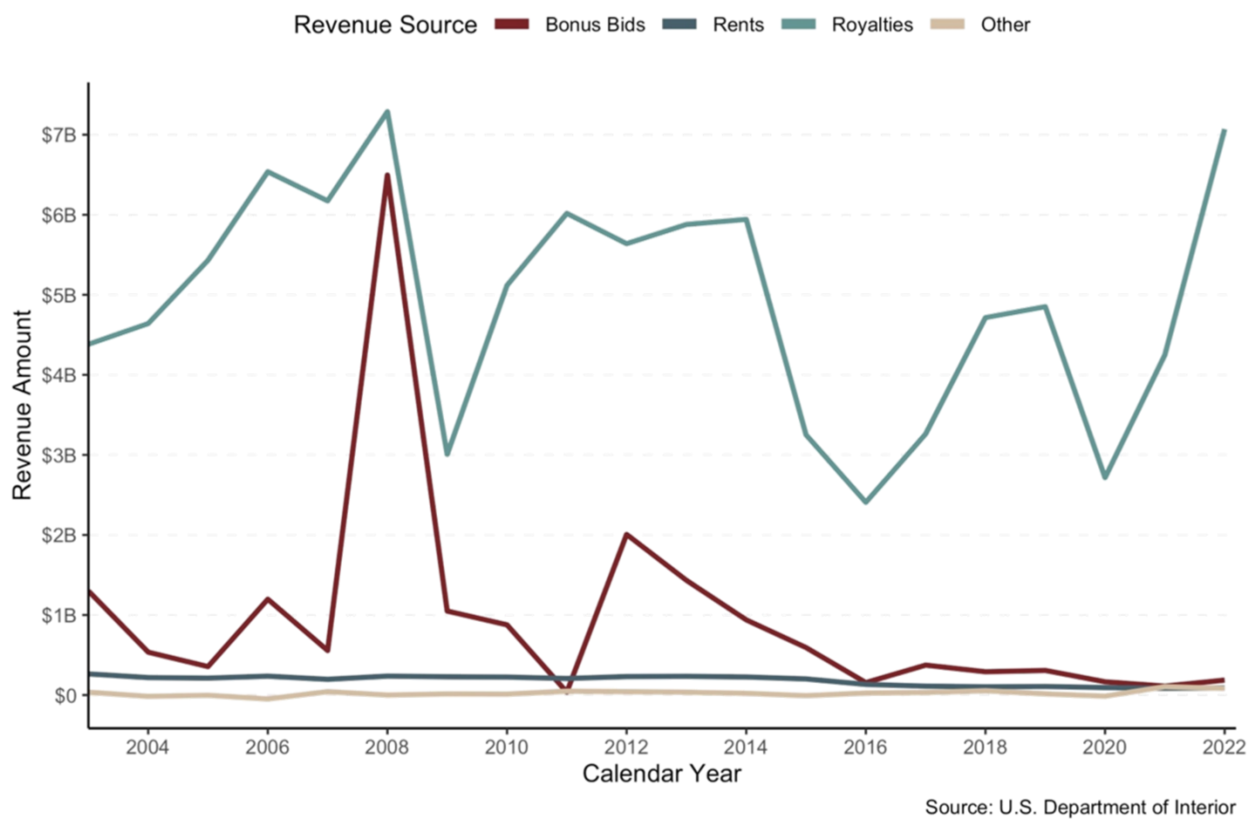

Figure 3. Federal Oil and Gas Lease Revenues from the Gulf of Mexico by Type

[12] Information on leasing process from BOEM's "2023–2028 National Outer Continental Shelf Oil and Gas Leasing Proposed Program."

GOMESA

The Gulf of Mexico Energy Security Act (GOMESA) is a federal revenue sharing program designed to share federal OCS revenues with four Gulf states: Texas, Louisiana, Mississippi, and Alabama, known as the Gulf Producing States (GPS). Under GOMESA, each GPS receives a portion of revenue from oil and gas leases in federal waters, which is then split up among each state government and their Coastal Political Subdivisions (CPS), based on a state's proximity to each lease area. Louisiana currently receives the largest portion of GOMESA state and local disbursements at around 44% of total revenues. The state's disbursement is further divided between the state government and the 19 Louisiana parishes designated as CPS jurisdictions under GOMESA (see Figure 4). More detailed information on the revenue sharing formula among Gulf Producing States under GOMESA can be found in a 2021 Blanco Center report, "Louisiana's Changing Outlook for Coastal Financing: 2020 and Beyond."

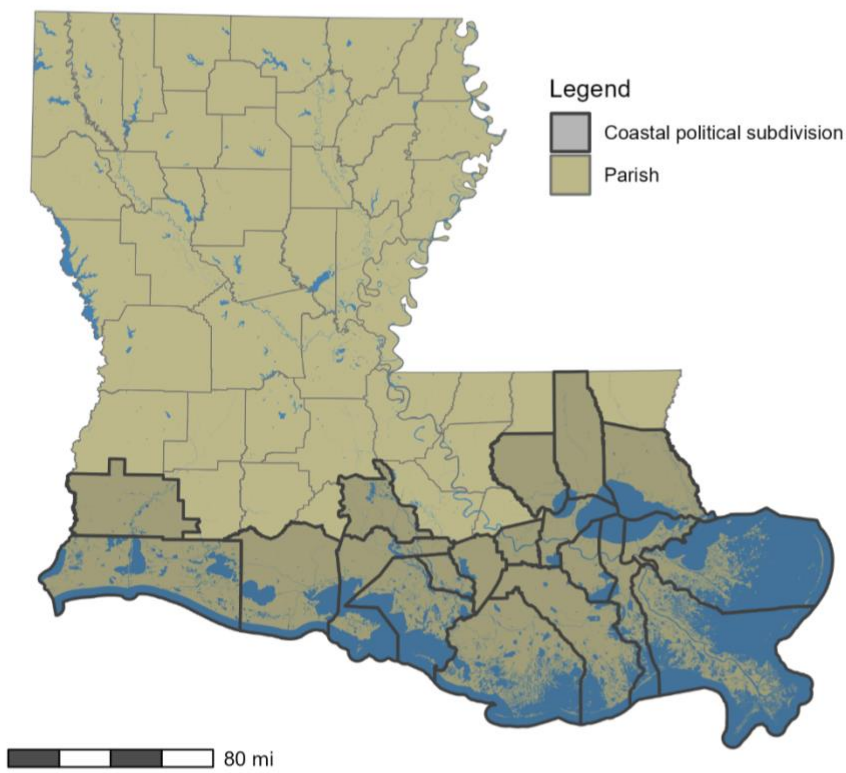

Figure 4. Louisiana's Coastal Political Subdivisions under GOMESA.

Qualifying revenue sources under GOMESA include bonus bids, lease rents, and production royalties from oil and gas producers operating in the OCS. Any company seeking to explore for or produce oil and/or natural gas must secure a lease by paying a bonus bid. Once a lease is secured, the lessee must pay rent to the Department of Interior, as well as royalties which are based on a percent of revenues or value once the well is producing.

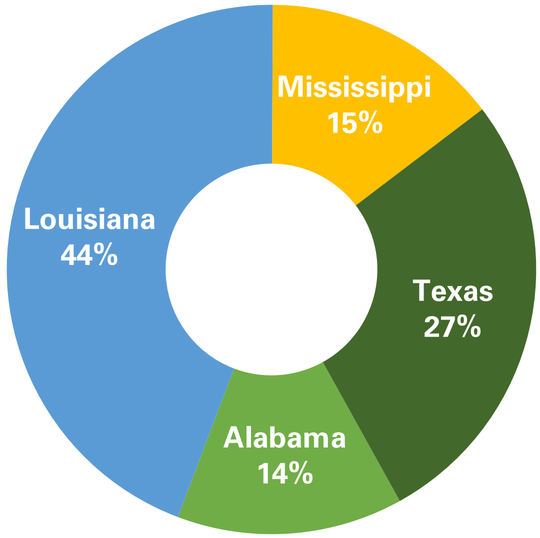

Figure 5. Current Allocation of GOMESA Disbursements to State and Local Governments

FY 2022 GOMESA Funding Allocation

The Department of Interior collected $924.9 million in qualified GOMESA revenues in 2022. Out of this amount, over $353 million was distributed to state and local governments of the four Gulf of Mexico. Louisiana currently received the largest portion of these revenues at 44% of the state and local disbursement for FY 2022 (Figure 5). Louisiana's portion of FY 2022 GOMESA revenues was over $156 million, with $124.9 million allocated to the state government's 80% portion and the remaining $31 million distributed to the 19 CPS parishes' 20% allocation (U.S. Department of the Interior 2023b). The allocation of GOMESA revenues to Gulf states is currently capped at $500 million per year, but the cap is scheduled to be removed in fiscal year 2056.

3. A New Opportunity: Offshore Wind

Compared to the global market, the offshore wind industry in the U.S. is still in its infancy. Without the constraints of economic feasibility, cumulative national offshore wind resources have the net technical potential to generate over 7,000 TWh/year, or almost twice the entire country's annual electricity demand (Comay and Clark 2021). The Offshore Wind Market Report produced by NREL for the U.S. Department of Energy (DOE) Office of Energy Efficiency and Renewable Energy Wind Energy Technologies Office estimates that the domestic potential generating capacity of offshore wind energy development just surpassed 40,000 MW in 2022, compared to the globally installed capacity of over 50 GW, and 368 GW generating capacity potential (Musial et al. 2022).

Since the first wind energy area lease sale in late 2012 (Delaware), there has been growing interest in offshore wind energy, as demonstrated by ever-increasing figures for total cash bids and price-per-acre paid in auction. A total of twelve leases in eight states were sold between 2012 and 2022.

In 2022 alone, leases in the New York Bight, Carolina Long Bay, and two areas in California were successfully auctioned off, totaling about 972,000 acres. Combined, these areas would generate enough power to supply over four million homes with renewable energy ("Biden-Harris Administration Announces Winners of Carolina Long Bay Offshore Wind Energy Auction" 2022; "Biden-Harris Administration Announces Winners of California Offshore Wind Energy Auction" 2022). While most WEA's are in the northern and mid-Atlantic, the most recent auction of the two California leases opened the Pacific to offshore wind development. The BOEM is planning on holding additional offshore lease sales in the central Atlantic, northern Pacific, Gulf of Maine, and Gulf of Mexico, ("Secretary Haaland Outlines Ambitious Offshore Wind Leasing Strategy" 2021). Developing these new sites for wind energy production would bring the nation closer to meeting the federal government's goal of deploying 30 GW of offshore wind energy by 2030.

3.1. Potential for Offshore Wind Development in the Gulf of Mexico

3.1.1. The Gulf of Mexico

The offshore wind leasing schedule proposed by BOEM suggests a leasing sale as early as late 2022 to early 2023 for the Gulf of Mexico, however, no leases or projects are active yet ("State Activities | Bureau of Ocean Energy Management" n.d.). In late 2022, BOEM finalized two WEAs totaling just under 2,800 km^2 (682,540 acres) in the Gulf of Mexico (see Figure 6), a 2,057 km^2 (508,265 acres) area roughly 40 nautical miles off the ports of Freeport and Galveston (Texas), and a 705 km^2 (174,275 acres) area just over 50 nautical miles off the ports of Port Arthur, Texas and Lake Charles, Louisiana (Celata 2022). A Proposed Sale Notice (PSN) for three areas of over 1,200 km^2 (300,000 acres) in total and the potential to power nearly 1.3 million homes was announced in a recent Department of the Interior (DOI) press release ("Interior Department Proposes First-Ever Offshore Wind Sale in Gulf of Mexico" 2023).

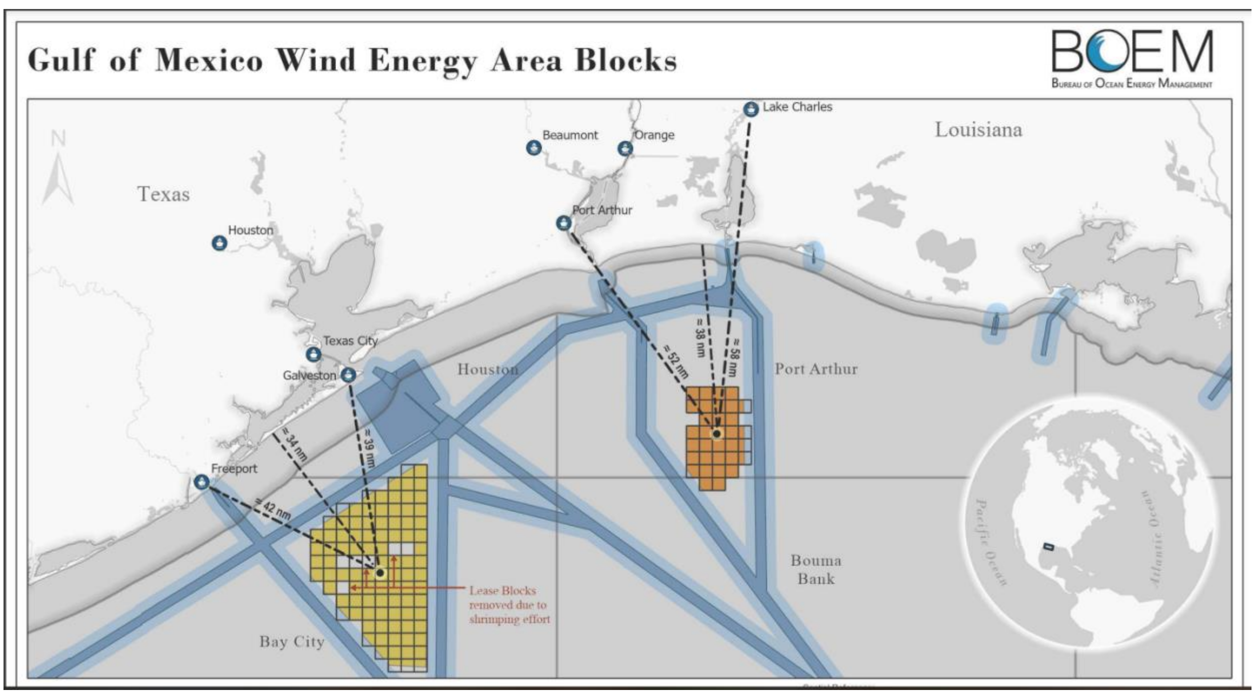

Figure 6. Finalized WEAs in the Gulf of Mexico announced by BOEM
Source: Celata 2022.

A joint report put forth by the DOE and DOI estimated the technical resource capacity potential (577 GW) and technical resource net energy (1,806 GWh/year) in the Gulf of Mexico, which rank second and third, respectively, among U.S. offshore wind resource regions (Gilman et al. 2016). While wind resource capacities are similar to those in other U.S. regions, development in the Gulf of Mexico poses unique challenges, such as lower annual average wind speeds, softer sea bottom substrate, as well as extreme weather events such as tropical storms and hurricanes, which all need to be accommodated by turbine design and engineering. In contrast, the Gulf of Mexico's shallow water depths, milder weather and calmer sea states, as well as reduced labor cost and already well-established oil and gas supply chains compare favorably to other regions (Musial et al. 2020).

3.1.2. Wind Resources and Turbine Technology

Annual average wind speeds in the North Sea and Atlantic range between 8.5 and 10 meters per second. In the Gulf of Mexico, wind resources are comparatively less strong, with annual averages between 7 and 9 meters per second. Onshore wind turbines compensate for lower wind speeds with higher hub heights and increased rotor diameters to achieve a similar energy output to turbines in areas with stronger winds. Generally, using turbines with maximum power generation is desirable as fewer units per plant are needed, which in turn can reduce capital costs as well as operations and maintenance cost. Using a similar approach, offshore wind turbine technology needs to be optimized for lower wind speeds to reach turbine ratings comparable to those in the North Sea, when deployed in the Gulf of Mexico.

In a recent report on regional economic modeling in Gulf of Mexico offshore wind, NREL authors suggested four turbine concepts of different rotor diameter and hub height applicable to varying wind speed ranges in the Gulf (Musial et al. 2020). All four turbine designs reach the same rating of 10 MW as the reference model designed by the Danish Technical University (DTU) (Bak et al. 2013), with specific power ratings ranging from 234 W/m^2 to 303 W/m^2, with the highest specific power rating drawing equal to that of the reference model. The authors suggest applicable regions for each of the four designs based on available wind resources. However, current industry trends show rapid development of increased power generating capacity, with the most ambitious development aiming for serial production of 16-MW nameplate turbines by 2024 (MingYang Smart Energy 2021). Currently, the largest offshore wind turbines are operating in Denmark and the Netherlands with a capacity of 14 MW (Musial et al. 2022). Larger, and thus, more efficient, turbines drive down the cost of power generation across the plant. These promising developments in turbine technology support the Gulf of Mexico as potential wind energy resource despite comparatively lower wind speeds.

In March 2023, New Orleans-based wind turbine manufacturer Gulf Wind Technologies announced a $10 million collaboration with Shell New Energies US LLC to advance the offshore wind industry in the Gulf of Mexico ("Gulf Wind Technology and Shell to Collaborate on Offshore Wind Technology and Workforce Development for the Gulf of Mexico" n.d.; Duchmann 2023). The Shell Gulf Wind Technology Accelerator program aims to develop turbines specifically designed for local conditions, including variability in wind resources, generally lower wind speeds compared to the U.S. coasts, and tropical storms. Demonstrator turbines could be ready for deployment and testing as early as 2024.

3.1.3. LCOE, LACE, and Net Value

Levelized Cost of Energy

Levelized cost of energy (LCOE) is a function of total project expenditures such as capital cost, maintenance cost, and operating cost over its lifespan divided by the sum of its energy production over its lifespan. This measure allows for comparing the competitiveness of different power generating technologies of various cost points, risks, lifespans, or generating powers ("Levelized Costs of New Generation Resources in the Annual Energy Outlook 2022" 2022). Several factors unique to the Gulf of Mexico can increase both capital and running costs of offshore wind farms, such as more expensive substructures to accommodate the soft bottom, extra material for larger rotor blades and increased hub height to make up for slower wind speeds, as well as higher insurance premiums due to hurricane threats (Beiter et al. 2016; Musial et al. 2020). The monopile structure which is the most commonly used substructure design in the global offshore wind market, is not well-suited for the soft soils and physical forces under tropical storm conditions in the Gulf of Mexico. Oil and gas structures in the region typically use jacket substructures to cope with soft soils and extreme weather and this design may be well-adaptable for offshore wind turbines (Musial et al. 2020). However, the shallower water depths, proximity to shore, established oil and gas supply chains, as well as low labor costs make this region financially attractive (Musial et al. 2020).

NREL's LCOE estimates range from below $70/MWh (Texas) to $170/MWh (Florida Keys) (Table 3). Western Louisiana (south of Lake Charles) is estimated to range from $80/MWh to $95/MWh (Beiter et al. 2016; 2017; Musial et al. 2020). The Texas and western Louisiana estimates are close to or even below the current average U.S. offshore wind LCOE estimate of $84/MWh (Musial et al. 2022), and those previously modeled for WEAs recently sold in the Atlantic ($80–150/MWh) and Pacific ($100–200/MWh) Oceans by 2027 (Beiter et al. 2017). However, trends in the European offshore wind industry show successful cost reduction in LCOE ("SET-Plan – Declaration on Strategic Targets in the Context of an Initiative for Global Leadership in Offshore Wind" 2016), and spatial-economic models indicate similar potential in the U.S. WEAs owing to technological advancements, which decrease both running costs as well as capital cost (i.e., turbines, substructures, or electrical infrastructure). The U.S. LCOE is projected to decline to $60/MWh by 2030 (Musial et al. 2022), corroborated by more recent estimates for the New York Bight WEA which put LCOE in the much lower range of $57–63/MWh (Green et al. 2022).

Levelized Avoided Cost of Energy

Levelized avoided cost of energy (LACE) is an essential factor to estimate the economic potential of any asset. LACE describes the market value of the generated electricity—in other words, what it would cost the grid to generate the same electricity otherwise. Similar to LCOE, LACE is a measure to compare dissimilar energy generating technologies. LACE is the sum of the economic value generated over its lifespan divided by the sum its electrical generation over its lifespan (i.e., the measure compares the economic potential to that of other energy sources, as seen in "Levelized Costs of New Generation Resources in the Annual Energy Outlook 2022" 2022). LACE estimates usually carry a greater uncertainty than LCOE estimates as they take into account local wholesale electricity prices which are subject to change, as well as what-if scenarios of how the grid would operate without the new asset in question (Beiter et al. 2016). Furthermore, LACE does not consider regional policies or subsidies that can greatly alter influence the economic potential. LACE estimates for the Gulf of Mexico WEA range from under $40/MWh (Florida panhandle) to over $70/MWh (east Texas) (Table 3). Unlike LCOE, modeled LACE values did not show a pronounced trend over time in the Gulf of Mexico (Beiter et al. 2017). The highest Gulf of Mexico LACE estimates compare favorably to those previously modeled for 2027 for the north Atlantic ($15–60/MWh) and Pacific ($45–65/MWh) WEAs (Beiter et al. 2017).

Net Value

Contrasting LCOE and LACE (i.e., subtracting LCOE from LACE) gives an estimate of the net value at a given wind energy area and serves as a better estimator of economic value than either measure on its own (Beiter et al. 2017). A positive net value suggests economic viability without subsidies. None of the current net value estimates in the Gulf of Mexico are above $0/MWh (Table 3, Figure 7), however, several areas are close and within the error margin of the analysis (Musial et al. 2020). Sites close to shore off Texas and western Louisiana have the highest net value, and pockets of relatively high net value can also be found off the coasts of Pensacola and Panama City

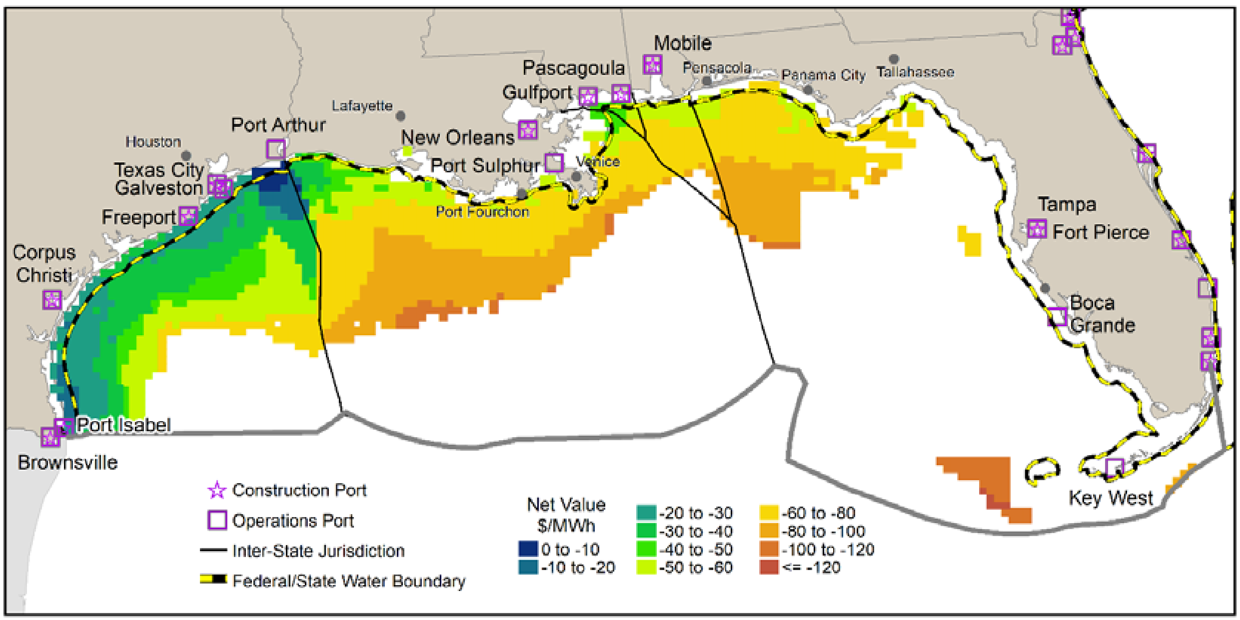

Figure 7. Estimated Net Value of Wind Energy Areas in the Gulf of Mexico

(Florida), respectively. It should be noted that the models to calculate both LCOE and LACE values assume conservative scenarios for estimates, and true net values for this region may in fact be much higher and close to or above $0/MWh (Beiter et al. 2016; 2017; Musial et al. 2020). Similarly, in the Atlantic and Pacific Oceans where offshore wind area leases were recently sold, conservative estimates for net value modeled for 2027 range from -$100/MWh to -50/MWh in the Pacific, from -$50 to $0/MWh between New England and Virginia, and -$140/MWh to -$50/MWh between North Carolina and the Atlantic coast of Florida. However, both the Pacific and Atlantic have regions with much higher net value estimates further north, with Oregon reaching values -$50/MWh to -$40/MWh, and Massachusetts and Rhode Island exceeding $15/MWh by 2027 (Beiter et al. 2017).

Table 3. Offshore Wind Feasibility Metrics for Gulf of Mexico Locations.

Metric	Value	Unit	Location
Wind Speed	8.25 to 9	m/s	Western Texas
	7.75 to 8.25	m/s	Texas
	7.5 to 7.7.5	m/s	East Texas
	7.75 to 8	m/s	Western Louisiana
	7.25 to 7.75	m/s	Louisiana
	7 to 7.25	m/s	Mississippi to Florida panhandle
LCOE	90 to <70	$/MWh	Texas
	80 to 95	$/MWh	Western Louisiana
	120 to 90	$/MWh	Louisiana
	120 to 90	$/MWh	Mississippi to Florida panhandle
	170	$/MWh	Florida Keys
LACE	50 to 55	$/MWh	Texas
	>70	$/MWh	East Texas
	45 to 50	$/MWh	Western Louisiana
	50 to 55	$/MWh	Louisiana
	<40 to 45	$/MWh	Mississippi to Florida panhandle
	40 to 45	$/MWh	Florida Keys
Net Value	-30 to -20	$/MWh	Texas
	-10 to 0	$/MWh	East Texas
	-40 to -30	$/MWh	Western Louisiana
	-80 to -40	$/MWh	Louisiana
	-80 to -40	$/MWh	Mississippi to Florida panhandle
	-100 to -120 and under	$/MWh	Florida Keys

Source: Musial et al. 2020.

3.1.4. Tax Credits and Subsidies

Tax credits and local subsidies can make investments in domestic offshore wind energy more attractive. While a detailed analysis of available incentives is beyond the scope of this report, this section will provide a brief overview on federal tax credits from which wind energy projects may be eligible to benefit. Production tax credits have been increased and extended through 2024 by the Inflation Reduction Act (IRA), signed into law on August 16, 2022.[13] Additional credits may be granted to facilities meeting prevailing wage and registered apprenticeship requirements. The production credit may be collected for the first ten years of plant operation. Alternatively, developers may receive a one-time 30% investment tax credit, which is based on the investment

[13] H.R.5376, 117th Congress 2021-2022

capital and is collected once the equipment is online. Further incentives include stackable bonuses for facilities that meet domestic content thresholds and/or are located in communities otherwise dependent on fossil fuels. Additional tax credit provisions in the IRA that may be of interest to Louisiana and other Gulf of Mexico states include advanced manufacturing production tax credits, as well as funding allocated for facilitating interregional electric transmission: Advanced manufacturing credits incentivize domestic production of wind turbine components, critical minerals, as well as offshore wind vessels. Funding to the DOE will support construction and/or modification of electric transmission facilities, as well as for convening stakeholders and conducting analysis facilitating interregional transmission of offshore wind electricity. Further information on U.S. wind industry federal incentives is available at the Office of Energy Efficiency and Renewable Energy (U.S. Department of Energy 2023).

3.1.5. Modeled Economic Impacts for 2030 Deployment

In October 2022, BOEM announced the designation of two WEAs in the Gulf of Mexico ("BOEM Designates Two Wind Energy Areas in Gulf of Mexico | Bureau of Ocean Energy Management" 2022). The finalized WEAs span a combined area of 2,800 km^2 (682,540 acres) off Galveston, Texas and Lake Charles, Louisiana, respectively (Celata 2022). BOEM estimate that in total, the two sites would generate almost 8,300 MW (at 3 MW/km^2), or 29,034,000 MWH/year, sufficient to power nearly 3 million homes (Celata 2022). In a recent press release BOEM invites feedback from the public which of the WEAs offshore Galveston should be included in the Final Sale Notice ("Interior Department Proposes First-Ever Offshore Wind Sale in Gulf of Mexico" 2023). In comparison, recent lease sales in the New York Bight and Carolina Long Bay span areas of 1,865 km^2 and 445 km^2, respectively, and are projected to generate 5,600 MW and 1,337 MW (Musial et al. 2022).

The Gulf of Mexico includes several other sites of high potential for offshore wind farm development. NREL identified three example sites for economic evaluation: Port Isabel and Port Arthur in Texas, and Pensacola in Florida (Musial et al. 2020). All of these sites (A) are in shallow water below 40 meters (131 ft), (B) have relatively high net value estimates as well as port proximity, yet are beyond the state-federal boundary, (C) are at least 350 km^2 (86,478 acres) with enough space for a wind farm to generate at least 1 GW, and (D) do not conflict with previously established uses such as shipping routes, oil and gas structures, or protected ecosystems or bird flight paths. An additional set of three sites (Galveston, Texas; New Orleans, Louisiana; and Panama City, Florida) would also satisfy the aforementioned criteria but could not be included in the analysis of NREL's 2020 assessment. The authors selected the three candidate sites for one of the following attributes: (A) lowest LCOE (Port Isabel), (B) highest LACE and net value, as well as potential crossover possibilities into Louisiana (Port Arthur), and (C) high net value despite high LCOE and relatively low wind speeds, as well as representing the eastern Gulf of Mexico (Pensacola).

The NREL study used the estimates from the NREL Jobs and Economic Development Impact (JEDI) model (Lantz, Goldberg, and Keyser 2013; Tegen 2017) to assess the selected sites. JEDI estimates for one 600 MW offshore wind development in 2030 value the total construction cost at approximately $2.1billion and the total operation cost at $70/kW or $42M/year. Model outputs suggest one site would create almost 4,800 full-time equivalents (FTEs; equivalent to 40 hours a week throughout one year), generating $445 million in GDP, $330 million in earnings, and $754 million in output during construction period. During operating years, 150 FTEs would be created, grossing $14 million in GDP, $11 million in earnings, and $19 million in output, annually. All dollar amounts are at 2015 value.

3.2. Existing Regulatory Frameworks for Offshore Wind

Promising development environments for offshore wind installation in the U.S. include North Atlantic (Maine, Massachusetts, Rhode Island, New York, New Jersey, Ohio), South Atlantic (Delaware, Maryland, Virginia, North Carolina, South Carolina), Gulf of Mexico (Texas, Louisiana, Mississippi, Alabama), and Pacific (Oregon, California, Hawaii) (Spitsen et al., 2022). Offshore wind resources are co-managed by federal and state public agencies which collect, disburse, and utilize public revenues from these offshore wind leasing and production. Guided by the Outer Continental Shelf Lands Act, rules for revenue collection from offshore wind resources are highly consistent across U.S. states.

3.2.1. Existing Federal Framework

The Department of the Interior (DOI)'s Bureau of Ocean Energy Management (BOEM) is in charge of overseeing the leasing and permitting of federal offshore wind projects on the U.S. Outer Continental Shelf, and DOI's Office of Natural Resources Revenue (ONRR) is authorized to collect four categories of revenues during different stages (Figure 8), including (1) while securing a lease (lease sales), (2) before energy production (annual rent), and (3) during energy production (operating fees) (U.S. Department of the Interior n.d.). First, developers can secure leases from BOEM during competitive or non-competitive lease sales. ONRR collects the bonus from the highest bidder in exchange for granting the lease. In a non-competitive bid, BOEM and the single interested party will negotiate the lease price, and an acquisition fee of $0.25 per acre is due. Second, before energy production begins, the developer pays an annual rent to ONRR. Rent is based on the area granted in the lease ($3 per acre). Third, once the wind facility is operational, ONRR collects operating fees from the developer, similar to royalties in oil and gas production. The operating fee is set to 2% of the anticipated revenue of wind energy produced in the facility. Additionally, ONRR also collects other revenues such as settlement agreements and interest payments.

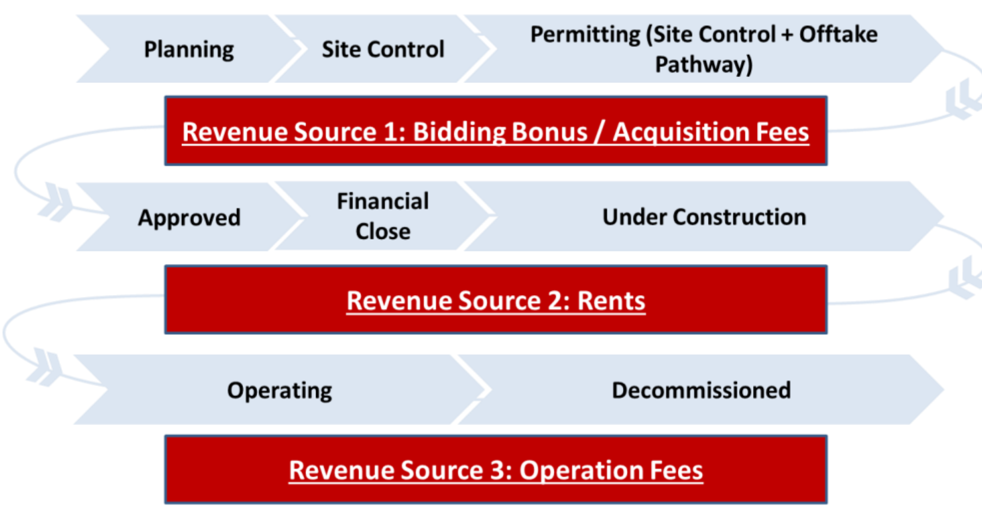

Figure 8. Overview of the Federal Revenue Process

Depending on whether offshore wind leasing and production are in federal or state waters, the associated revenues are disbursed in different manners. According to the Outer Continental Shelf Lands Act (OCSLA), for offshore wind leasing and production that lies within 3 nautical miles of the state-federal waters boundary, leases are managed by states. Within the OCS 8(g) zone, which is another 3 nautical miles seaward from the state-federal waters boundary, revenues are shared with adjacent state at a 27% rate (Figure 9). (U.S. Department of the Interior 2020). Most other offshore wind leasing and production, however, are located in federal waters in the U.S., including the other only project that has started commercial operation by January 2023: Coastal Virginia Offshore Wind (CVOW)-Pilot. In this case, all the revenues collected are deposited in the U.S. Treasury.

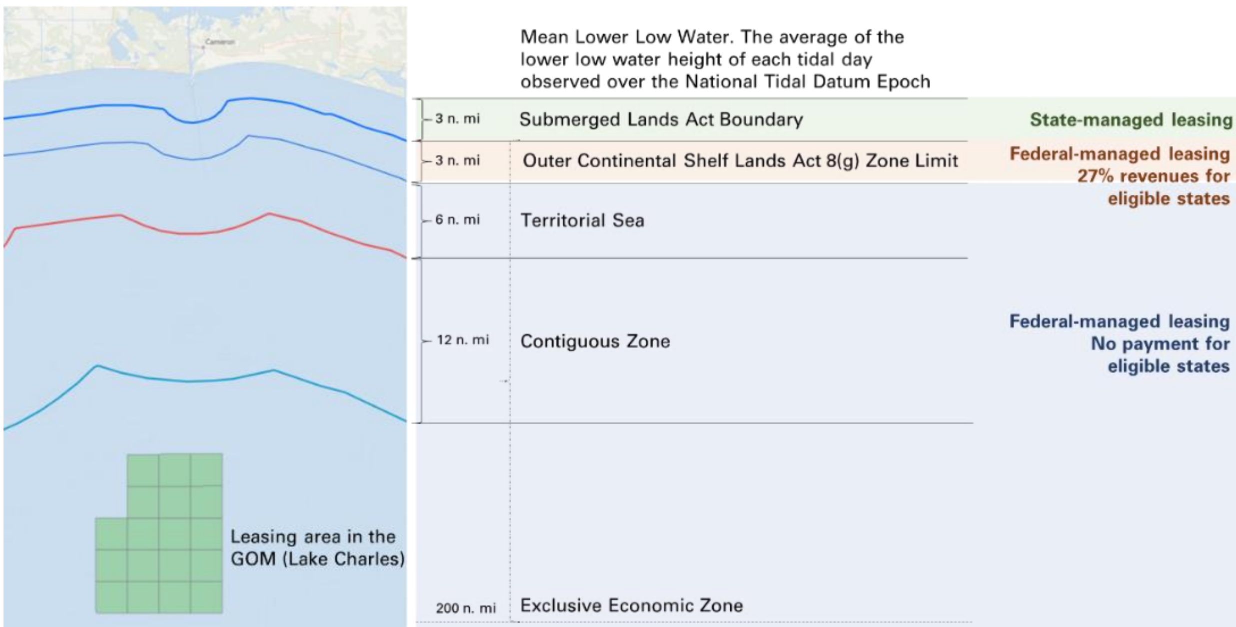

Figure 9. Distance-to-Shore in the Gulf of Mexico.

3.2.2. Pending Federal Legislation

In addition to the existing federal framework, the Reinvesting in Shoreline Economies and Ecosystems (RISEE) Act and the Budgeting for Renewable Electrical Energy Zone Earnings (BREEZE) Act represent two proposed changes that would increase the public financing mechanisms and revenue sharing for offshore wind power pursuant to the OCSLA and the Gulf of Mexico Energy Security Act (GOMESA). The BREEZE Act was included in the Lower Energy Costs Act introduced to the House in March 2023.[14] Both RISEE and BREEZE Acts propose to allow coastal states that are located within 75 miles of the geographical center of a wind project to receive revenues.

[14] H.R.1, 118th Congress, 2023 - 2024

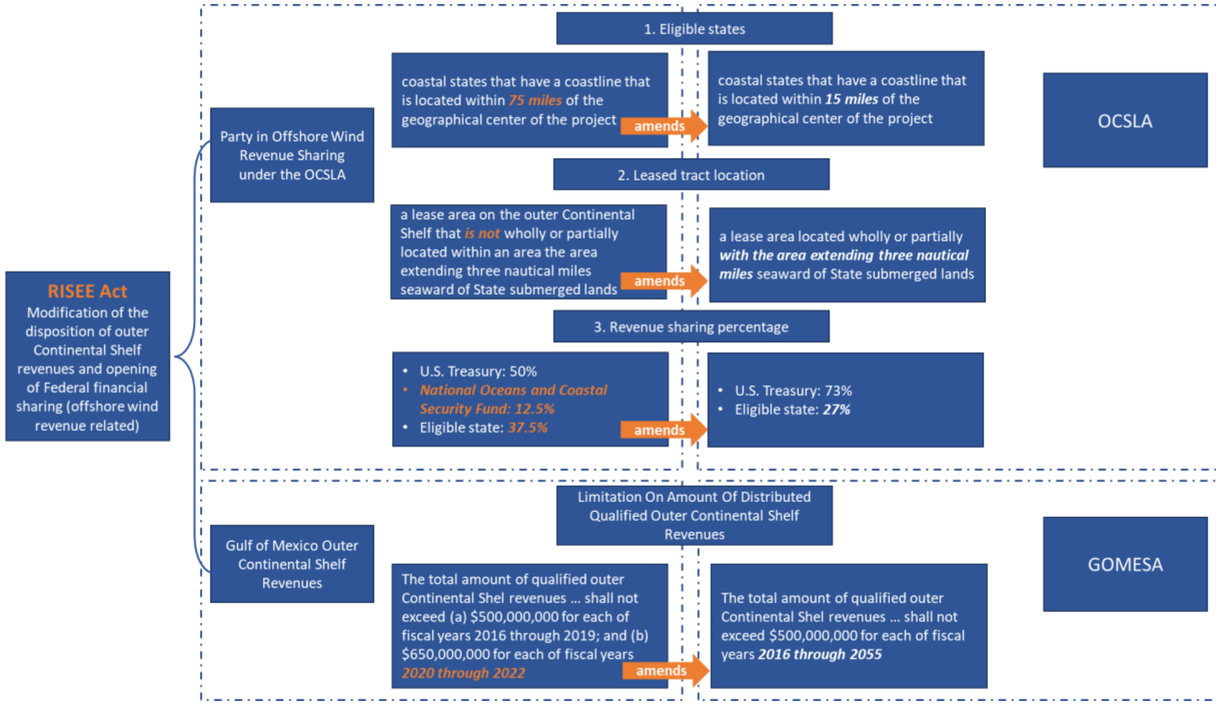

Figure 10. Proposed Amendments to OCSLA and GOMESA in the RISEE Act

The RISEE Act was read twice in the Senate and referred to the Committee on Energy and Natural Resources on June 17, 2021. As displayed in Figure 10, this bill is intended to modify the disposition of certain OCS revenues, particularly offshore wind, and to open federal financial sharing to enhance opportunities for renewable energy in coastal states (Whitehouse, 2021). In addition to allowing states to receive revenues from projects in more broadly defined areas, the RISEE Act proposes to adjust the revenue sharing among different parties. The RISEE Act would develop a benefit sharing model that would send 37.5% of offshore wind leasing and production revenues to adjacent states, 50% to the U.S. Treasury and 12.5% to be deposited into the National Oceans and Coastal Security Fund, which supports activities that protect, conserve, and restore ocean, coastal, and lake ecosystems (National Oceanic and Atmospheric Administration; Senate Energy and Natural Resources Committee 2022). Although the Senate lowered the amount shared with states relative to the original bill, this revenue sharing scheme would still represent a breakthrough as the first opportunity to disburse offshore wind revenues generated in federal jurisdictions to states. Additionally, the RISEE Act would potentially increase Gulf of Mexico OCS revenues for adjacent states by removing a $500 million cap on the total qualified Outer Continental Shelf revenues (effectively including a $375 million cap on the amount of revenue directly disturbed to coastal states and a cap of $125 million on revenues shared with the Land and Water Conservation Fund, Senate Energy and Natural Resources Committee, 2022).

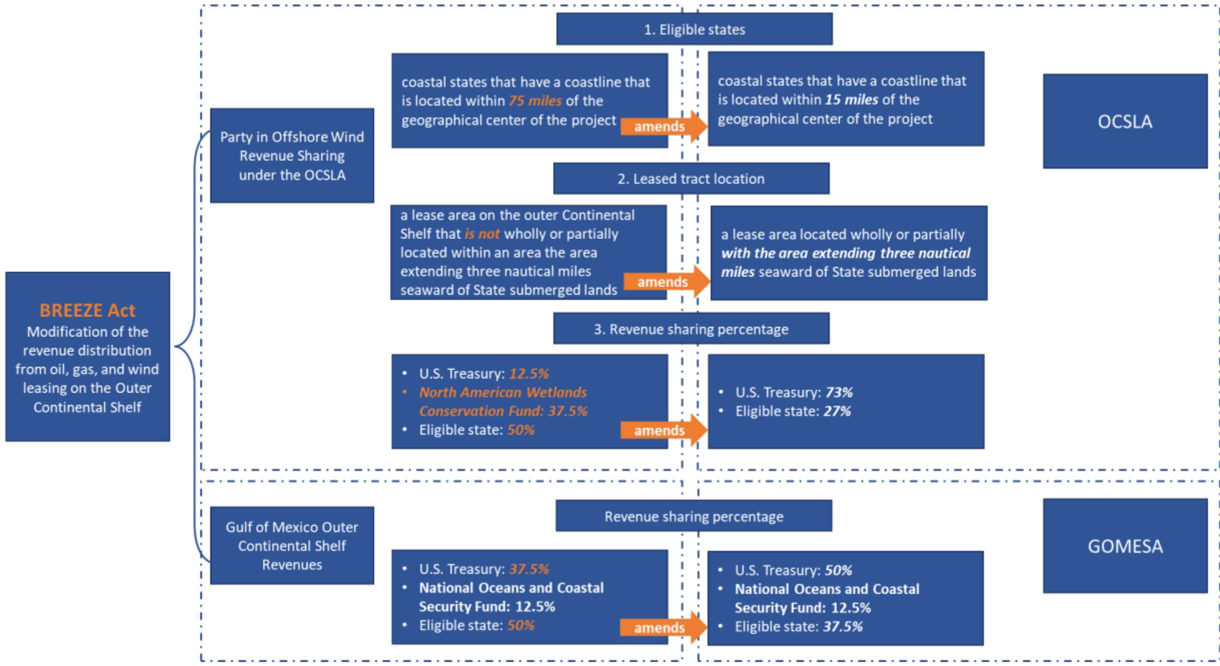

Figure 11. Proposed Amendments to OCSLA and GOMESA in the BREEZE Act

The BREEZE Act was introduced in the House and referred to the Committee on Natural Resources and to the Committee on the Budget (Figure 11). Adding the North American Wetlands Conservation Fund as a recipient of revenue from offshore continental shelf revenues, the BREEZE Act amends the revenue sharing model under the OCSLA. Putting forward amendments to the GOMESA of 2006, the BREEZE Act proposes to increase the percentage of revenues shared from 37.5% of OCS revenues to 50%.[15]

3.2.3. Existing Louisiana Framework

As with other natural resources like oil and gas, the Department of Natural Resources (LDNR) sets criteria for the state's Coastal Use Guidelines, acts as the permitting authority for the Coastal Use Permit (CUP) process, and will manage any leases of state lands or water bottoms for wind energy in conjunction with the State Mineral and Energy Board (SMEB).

Coastal Use Permits will likely be required for any offshore wind energy activities on Louisiana's coastline (even in federal waters) as transmission lines will likely be sited through the coastal zone and state-owned lands and water bottoms. The territorial sea (within 30 nautical miles of coastline), the seashore, all running waters, and any navigable water bottoms in Louisiana are owned by the state, and as such, a wind energy facility on Louisiana's coast will likely be required to lease state land in order to operate.

LDNR also cooperates with Department of Wildlife and Fisheries (LDWF) who has jurisdiction over state wildlife management areas and refuges. LDWF must authorize any CUPs or wind leases of

[15] H.R.8437, 117th Congress 2021-2022

lands under their jurisdiction. LDWF also issues "dredge and fill" permits which will likely be relevant to offshore wind development.

The Louisiana Public Service Commission (LPSC) has plenary authority to regulate the generation, distribution, and transmission of electrical power in the state of Louisiana. As a result, LPSC will have some jurisdiction over siting decisions for offshore wind transmission lines.

LDNR's Office of Mineral Resources (OMR) regulates the leasing of state lands and water bottoms for wind energy with rulemaking and oversight from the State Mineral and Energy Board (SMEB). SMEB consists of the Governor (via a designate), the LDNR Secretary, and nine Governor appointed members ("Office of Mineral Resource, State Mineral and Energy Board" n.d.).

As a result of 2022's Act 443 (H.B. 165), royalty amounts are now set by SMEB, which has the sole "authority to accept the bid it finds is most advantageous to the state."[16] Previously, royalty amounts required, "a minimum dollar amount set and a minimum percentage of revenue to be produced by each wind turbine" set by the House and Senate Committees on Natural Resources. Under the current law, SMEB has the authority to set royalty amounts based on the lessee's gross revenues. LDNR is required to advertise royalty costs as part of the bid process for wind leases. Further information on the mineral lease process in Louisiana state waters can be found in the Blanco Center's Coastal Financing report (Barnes and Osland 2021).

3.2.4. Other Existing Frameworks

From Other U.S. States

In addition to federally managed offshore wind leasing, wind farms are planned, constructed, and operated in different types of "state" waters, including water within the Outer Continental Shelf Lands Act 8(g) Zone (six nautical seaward from lands), Submerged Lands Act boundary (three nautical seaward from lands), and state-owned inland lakes. Up to now, offshore wind projects in "state" waters are not as common as those in federal waters, largely due to the lower wind speed in areas closer to shore, as well as public's concerns about coastal recreational and fishing activities (Margaronis 2021). However, small-scale projects in state waters tend to serve as pilots of future upscales in farther, federal waters. There are three permitted offshore wind projects in "state" waters.[17]

These offshore wind projects in "state" waters are subject to permitting and leasing processes that vary by state and, at the same time, are not independent from the federal framework. Within the federal-state boundary, state departments are primarily responsible for approving construction of wind turbine and transmission lines, contracting land leases, and overseeing environmental compliance (Table 4). In comparison, though located within the Outer Continental Shelf Lands Act 8(g) boundary, Block Island Wind Farm crosses the federal-state boundary, and thus its leasing and environmental review processes are administered by both state agencies (i.e., Rhode Island Coastal Resources Management Council and Rhode Island Department of Environmental Management) and their federal counterparts (i.e., BOEM). Additionally, federal agencies, including Department of Energy (DOE) and National Science Foundation, constantly assist in developing

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[16] HB 165 amended LA R.S. §41:1732.

[17] The Vandenberg Offshore Wind Energy Projects are located in California's state water and have been under environmental impact review administered by California State Lands Commission by April 2023.

state offshore projects through upfront investment. For instance, among the $147 million construction cost of the New England Aqua Ventus I, DOE provided $47 million financial support through the Advanced Technology Demonstration Program for Offshore Wind.

Table 4. Pipeline of Permitted Offshore Wind Farms in State Water.

Project Name	Block Island Wind Farm	New England Aqua Ventus I	Icebreaker
(Estimated) Commercial Operation Date	2016	2023	2042
Project Status	In commercial operation	Under construction	Pre-Construction
Geographic Location	Rhode Island	Maine	Ohio
Nameplate Capacity (MW)	30	12	21
Distance to Shore	3.3 nautical miles southeast of Block Island	2 nautical miles southwest of Monhegan Island	5.7 nautical miles Northwest of Cleveland
Type of Lease	Federal-managed leasing with 27% revenues for eligible states	State-managed Submerged Lands Lease with the State of Maine	State-managed Submerged Lands Lease with the State of Ohio
Construction Permitting Authority	New England District, Department of the Army	Maine Public Utilities Commission	Ohio Power Siting Board
Leasing Authority	Rhode Island Coastal Resources Management Council; BOEM	Maine Department of Agriculture, Conservation & Forestry	Ohio Department of Natural Resources
Environmental Review Authority	Rhode Island Department of Environmental Management; BOEM	Maine Department of Environmental Protection	Ohio Department of Natural Resources
Developer	Ørsted and Eversource	University of Maine/ Diamond Offshore/ RWE	Lake Erie Energy Development Corporation
External Investors	Société Générale of Paris, France; KeyBank National Association of Cleveland, Ohio; GE Renewable Energy; Citibank	U.S. Department of Energy (Advanced Technology Demonstration Program for Offshore Wind); U.S. National Science Foundation	U.S. Department of Energy

Sources: (BOEM n.d.); (Court News Ohio 2022); (Deepwater Wind 2014); (Livesay n.d.); (Maine Public Utilities Commission n.d.); (Spitsen et al. 2022); (U.S. Army Corps of Engineers 2014).

In short, offshore wind projects in near-shore state waters are subject to state policies and regulations regarding power generation permits, environmental impact review, and leasing processes, all of which vary state by state. Future research could focus on how state departments co-manage wind resources and associated public revenues when technology allows increasing number of offshore wind production in near-shore areas.

From Other Countries

Beyond the U.S., offshore wind leasing systems in different countries appear to be similar albeit some regional variations. The Europe is a global leader in the development of offshore wind power and has explored regulatory approaches for over three decades. Main European offshore wind power producers include the United Kingdom (UK), Germany, the Netherlands, and Denmark, which had top offshore wind installation in 2021 (Spitsen et al., 2022). The Asia Pacific region appears to be a promising player in harnessing offshore wind, particularly with the rapid growth of offshore wind power industry in China and strategic planning in India (Vasconcelos et al. 2022). Although considered as substantial potential in Africa and South America, offshore wind is still in its infancy in these regions.

Speaking of public revenues generation from offshore wind production, the combination of bidding bonus, leasing rents, and operational fees appears to be the most frequent choice for offshore wind farms. For instance, in the UK, federal revenue generation operates similarly to oil and gas royalties in the U.S. Offshore wind leases are owned and managed by the Crown Estate(Garside and Ambrose 2019) Despite similar options of this model, auction designs, leasing term options, and formulas of operational fees vary by country and thereby impact revenue generation. Different auction designs, such as simultaneous ascending auctions with package bidding and simultaneous multiple round auctions, make a difference in terms of bidding bonus. Additionally, a short lease term, such as three or five years, allowing resource assessment and technology testing for a short period before offshore wind power production may bring revenues before large-scale commercial production plans. This is applicable in countries where location technical due diligence is a responsibility of developer (e.g., in Vietnam and Australia) rather than a national or provincial government (e.g., in China). Finally, compositions of operational fees are distinct in different countries and jurisdictions. While the value of produced offshore wind power is partially influenced by wholesale electricity prices reflective of market fluctuations in the U.S., it is fixed in Germany where power providers would be reimbursed should their revenues fall below the fixed, negotiated rates.

Deviating from this model, in places where lands and seabed are not leased but held by offshore wind power companies, governments usually collect an asset tax or duty. Land acquisition in Australia is an example where the rate of duty is up to approximately 5.95% of the land purchase price or value (KPMG Law 2020). Property tax is levied on the lands of power production facilities in South Korea at a preferential rate of 0.2%, and a similar type of tax is imposed on the immovable property utilized by wind power projects in Vietnam. In Japan, fixed asset (1.4% of the value of the underlying land which is usually assessed by the government) and city planning taxes are levied (applicable in certain municipalities) (KPMG Law 2020). India applies its carbon credit system to offshore wind farms by collecting 10% of the gross amount of income from transfer of carbon credits.

Regarding economic incentives, unlike the U.S. government that opted for fair market returns as a major economic incentive to encourage the development of its offshore wind industry, many other countries, especially in the nascent stages of their offshore wind industry, chose the forbearance of a lease fee or royalty charge as an incentive, sometimes in addition to subsidies including guaranteed feed-in tariffs (Portman et al. 2009). For instance, nearly non-existent lease fees were once common in Europe until the 2010s and are still not rare in the Asia-Pacific region where countries recently started developing their offshore wind power industries (Snyder and Kaiser, 2009). In comparison, the U.S. states tends to choose creating a market demand for renewable energy by implementing standards for renewable portfolios that oblige suppliers to offer a certain proportion of green energy including offshore wind power as an economic stimulate (National Conference of State Legislatures 2021).

In short, the model of bidding bonus, rents, and operational fees is a common choice of public finance mechanism of offshore wind revenues around the world. In the early of industrial development, though, it is common that government provides financial support such as avoidance of rents in certain periods for testing activities and renewable energy certificates that promote prices of electricity produced by offshore wind power.

3.2.5. Discussion of Tax Policies in Relation to Fledgling Industries

Feed-in-Tariff, subsidies, loan programs (low interest loans, guarantee loans), and preferential tax policies are commonly adopted in various Asian-Pacific countries to nurture the emerging offshore wind power industries.

In the U.S., a number of states have leveraged renewable portfolio standards, offshore wind renewable tax credits, and power purchase agreements to incentivize offshore wind development and bolster the growth of manufacturing and other wind-related services (Beiter et al. 2020). By showing a state's commitment to procuring wind generated electricity, these programs can create greater interest from lease bidders—making them more likely to drive up bid amounts and revenues—but they also serve as a form of economic development that can catalyze investment in the regional workforce and supply chain.

Taxes on wind and solar energy facilities are not common in the United States, where much of the regulatory focus on the renewable energy industry has engaged in encouraging development through subsidies and incentives. When states do opt to tax renewable energy facilities, it is typically via property taxes, which fund government activities in the communities where facilities are located. Those property taxes can include nameplate capacity taxes or production taxes which are levied on the electricity generated by a facility, and ad valorem taxes which are levied on the value of land and assets belonging to the facility.[18]

Nameplate capacity taxes are levied as a set rate, using a formula based on the generation capacity of the equipment when operating at full power. Production taxes are based on the actual amount of energy produced. They are usually most likely to be on a set rate per kWh but could theoretically be set as a percentage of the market price for electricity.[19] The ad valorem tax is the most common form of tax levied on wind and solar facilities, though states differ in whether or how ad valorem taxes are applied and if components like turbines are considered real or personal property. Sales and use taxes may also apply to the sale of materials and equipment for wind energy production and even to the sale of electricity generated, though many states have implemented tax exemptions for sales of equipment and materials used for wind and solar production.

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[18] Nameplate and production taxes are sometimes implemented as payments in lieu of taxes (PILOTs). Production taxes are sometimes also called "generation" taxes.
[19] This approach is used for severance taxes levied on oil and natural gas extraction in Louisiana.

4. Assessment of Offshore Wind Revenue Potential

Several factors impact the expected revenue from wind development in the Gulf of Mexico. Bonus bids, rents, and operating fees all provide opportunities for revenue. While rents are the most stable option with a standard amount per acre, both bonus bids and operating fees have multiple factors that impact the amount of revenue. This section provides an overview of the potential impacts on revenues as well as a discussion of a range of low, medium, and high scenarios and the expected values that would result under each.

4.1. Influences on Bonus Bid Outcomes

Prior to a lease sale BOEM determines if there will be a non-competitive or competitive process. In a non-competitive process, only one party is interested in developing wind energy for a specified area. In this case the agency negotiates the lease directly and the developer pays an acquisition fee (currently $0.25 per acre) in lieu of a bonus bid. For competitive processes, BOEM notifies the public of the intent to lease, holds a sale, and leases the area to the highest bidder (U.S. Department of the Interior n.d.). Both acquisition fees and bonus bids provide a one-time revenue source from wind leases. For competitive lease sales, bonus bids are impacted by several factors including developer interest in the location, the level of competition among bidders, the expected cost of development, and the potential return from electricity generated.

4.1.1. Developer Interest and Level of Competition

Since the first wind energy area lease sale in late 2012 (Delaware), offshore wind leasing has had a fluctuating but generally increase trend as demonstrated by ever-increasing figures for total cash bids and price-per-acre paid in auction (see Figure 12, Figure 13) (Bureau of Ocean Energy Management n.d.). The Delaware offshore wind lease was executed with a non-competitive acquisition fee as only one group illustrated interest in bidding. The sale brought in the default amount for non-competitive processes at $0.25 per acre for a total of just over $24,000.

In contrast to the 2012 Delaware wind lease, recent sales have had competitive bids and often multiple rounds of biddings. These two factors have propelled bids to reach record numbers for the total bid and bid per acre. In 2022, the first lease areas in the Pacific were sold in California for $1,400 per acre ($332 million, Morro Bay) and $2,000 per acre ($255M, Humboldt/Eureka), respectively. In the Atlantic, the Carolina Long Bay lease sold for a cash bid similar to those off the California coast ($262.5 million) yet surpassed the Pacific sites in price-per-acre ($2,400). The sale of the New York Bight lease made headlines with a record-breaking sale of $8,831 per acre, and a total cash bid of $4.37 billion. Bidder competition played a role in the record bid amount paid for the NY Bight lease. In this auction 18 developers bid in 64 rounds, paying much more than the non-competitive acquisition rate seen in 2012. The growing level of interest from developers in recent sales suggest future wind lease sales will likely show interest from multiple parties with potential for multiple rounds of bidding, increasing the price per acre.

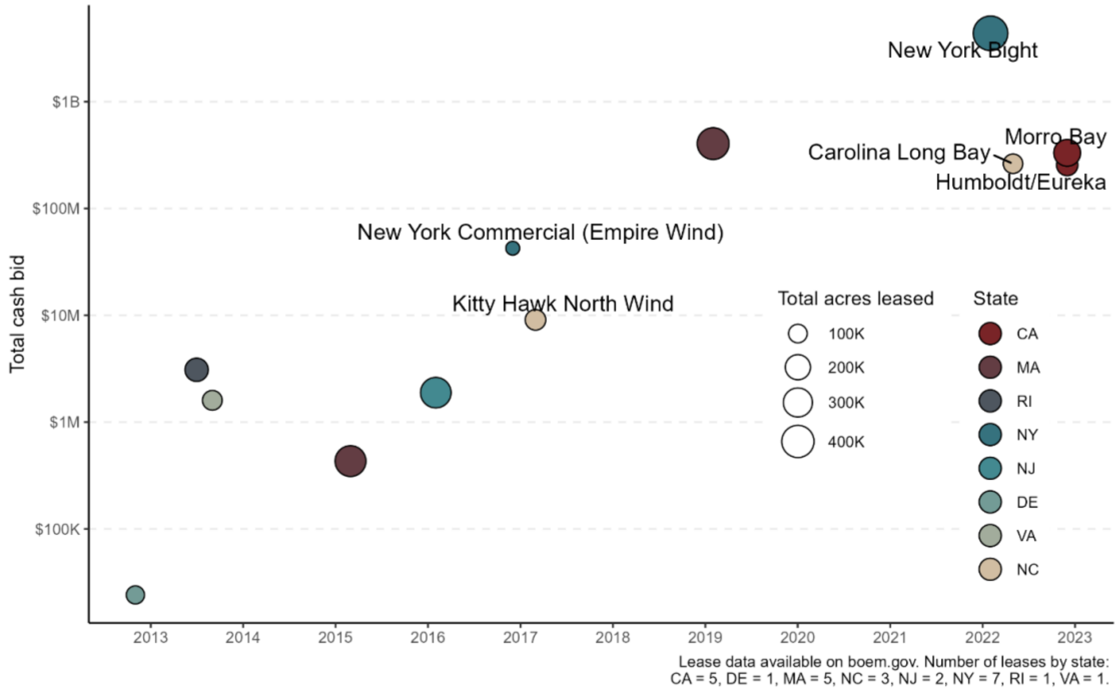

Figure 12. Total Cash Bid Price for Offshore Wind Area Lease Bids in the United States
Note the logarithmic scale.

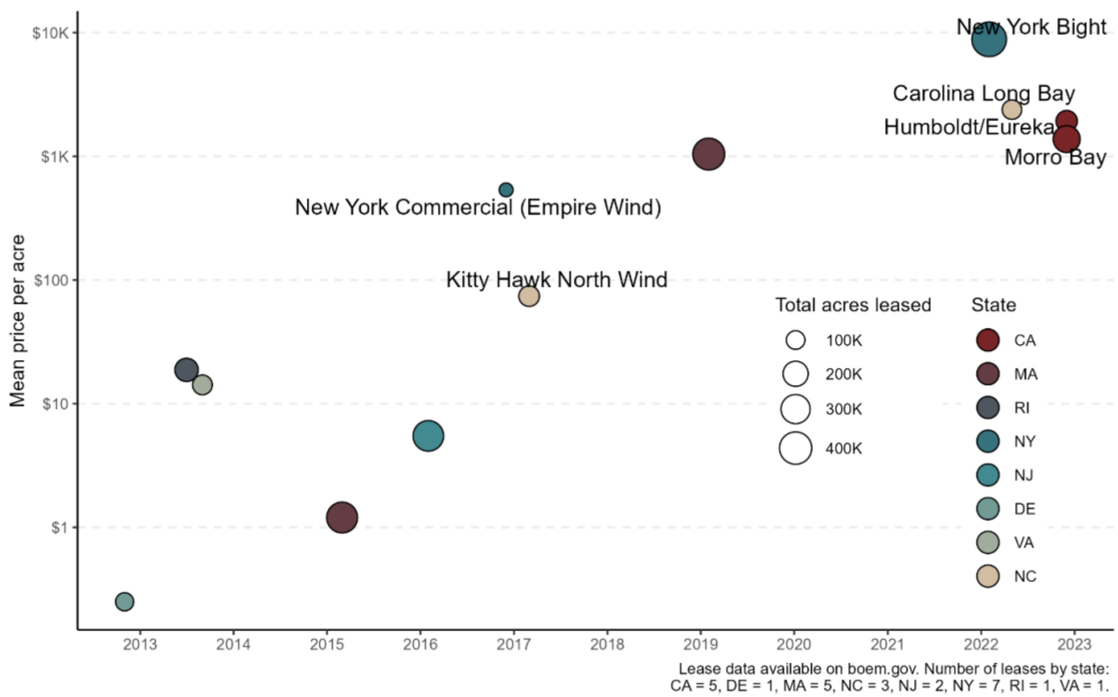

Figure 13. Mean Price per Acre for Offshore Wind Area Lease Bids in the United
Note the logarithmic scale.

4.1.2. Cost of Development

Differences in the natural environment, labor, and equipment impact development costs for offshore wind projects. While the shallow waters and generally calm seas can be an advantage for wind projects in the Gulf of Mexico, the slower wind speeds as compared to other offshore wind areas and the slower wind speeds can increase costs. Section 3.2 discusses the differing requirements for wind turbines in the Gulf of Mexico that result from the slower wind speeds and soft sea floor. A discussion of a recently announced turbine development project in New Orleans will take advantage of existing Gulf of Mexico manufacturing and offshore partnerships ("Gulf Wind Technology and Shell to Collaborate on Offshore Wind Technology and Workforce Development for the Gulf of Mexico" n.d.; Duchmann 2023).

Existing projects can provide an overview of expected cost trends for developing wind projects, even without considering the unique environmental and workforce landscapes of differing projects. Capital expenses (CapEx) are the major driver of overall lifetime costs, as pre-operational expenses dwarf those incurred by operation and maintenance for wind projects. Cost trends for offshore wind energy derived from existing projects worldwide are projected to continue declining over the next decade.

In the U.S., the Dominion Offshore Wind Energy Project off the Virginia coast is one of the few offshore wind projects close to commercial operation (CSD 2026). The lease was secured in 2013 for $1.6 million and comprises 112,799 acres,[20] with a capacity of 2,587 MW, roughly $14 per acre and $618 per MW. Dominion Energy reports CapEx at $3,788 per kW ($3.79 million per MW) (Dominion Energy 2021). The cash bid for the lease procurement makes up less than 0.02% of the total CapEx. In contrast, more recent bids such as the New York Bight (2022, 488,201 acres)[21] were sold for a total of $4.37 billion, around $1.46 million per acre. On average, a single lease in this WEA cost $763 per kW ($763,000 per MW), amounting to roughly 22% of average U.S. offshore wind projects CapEx reports ($3,400 per kW).

The most recent Offshore Wind Market Report by NREL summarizes reported CapEx for global projects that are either operational or scheduled to commence operation in the near future (Musial et al. 2022). The report shows a decreasing trend for CapEx since 2017, with an average of $4,000 per kW in Europe and the U.S. in 2021. The lower, global average of $3,700 per kW is due to lower average numbers in Asia; however, trend lines are converging and are projected to reach $3,100 per kW before 2030.

Certain environmental factors in the Gulf of Mexico will increase CapEx compared to other regions: lower annual average wind speeds in the Gulf of Mexico require larger turbines, and thus, incur higher construction costs, and hurricanes will likely increase insurance rates as well as extra material to ensure sturdiness. However, numerous other factors have the potential to decrease CapEx: shallower water and lower wave heights require less material for substructure reinforcements; and an existing oil and gas infrastructure including ports, structures, and personnel are already available.

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[20] BOEM lease OCS-A 0483, available from boem.gov.

[21] BOEM leases OCS-A 0537, OCS-A 0538, OCS-A 0539, OCS-A 0541, OCS-A 0542, OCS-A 0544; available from boem.gov.

4.1.3. Expected Return on Electricity

Understanding the assumptions behind the potential return for developers from the electricity generated by an offshore wind project provides insight into potential bids. As detailed in Section 3.1.3, lower wholesale energy costs in the Gulf of Mexico region reduce the expected returns from energy produced by offshore wind projects.

States can impact demand for renewable and clean energy through electric utility regulation and financial incentive policies. Portfolio standards for renewable or clean energy are a common way state legislators encourage purchase of energy such as wind. Renewable energy portfolio standards can impact expected returns from wind energy by creating a market for wind energy. Thirty states have renewable or clean energy targets or requirements (National Conference of State Legislatures 2021). Requirements can vary from partial or full renewable energy requirements. Only 10 states have a 100% renewable or clean energy portfolio requirement. In the Gulf of Mexico, Texas is the only state with renewable energy portfolio requirements. Their target, a renewable generation requirement of 5,880 MW by 2015 and 10,000 MW by 2025 was established in 1999 and has been met (National Conference of State Legislatures 2021). States bordering the Gulf of Mexico region do not have renewable energy requirements (Arkansas, Tennessee) or those goals have expired (Oklahoma).

States also have options for incentivizing investment in renewable energy which may impact the expected return on investment and, as a result, potentially impact bid amounts. Some states have created a public benefit fund or used electricity planning and procurement policies to push for investment in renewable energy sources (U.S. Environmental Protection Agency 2022). These incentives can reward utility performance with adherence to specific targets. However, these targets usually follow a goal or renewable energy target which most Gulf of Mexico states do not have. While energy prices are lower and there are few state-level standards or incentives for investing in wind energy, the Gulf of Mexico states are large energy consumers. Louisiana is the highest industrial user and highest overall energy user on a per capita basis (U.S. Energy Information Administration 2020). While Louisiana ranks much lower on residential energy use per capita (29th), it ranks high for transportation (4th). Texas, Alabama, Mississippi, and Arkansas all rank within the top 20 for total energy consumption per capita. As large-scale energy users across the Gulf of Mexico gradually consider and invest in different options for powering their equipment, transportation, and industrial work, offshore wind may provide a cleaner source.

4.2. Operating and Rental Fees

Once a lease bid has been approved by BOEM, the selected operator will be required to pay an annual rental rate of $3 per acre of the lease area. Unlike offshore oil and gas leases, rental fees for offshore wind developments are only charged prior to the operation of a lease. For leases that have started operating but are not fully developed, a rental fee will be charged based on the uninstalled capacity of the lease. An operating fee, based on the generated capacity of the development, will replace the rental fee once a lease is completely under operation. Figure 14 illustrates the relative magnitude of leases since 2012 based on their per acre lease payment. Recently, the New York Bight had the largest total number of acres. The graph does not illustrate a tendency toward larger magnitude leases; recent and older leases have had both small and large acreages. The Carolina Long Bay lease is similar in acreage to the first leases in 2012.

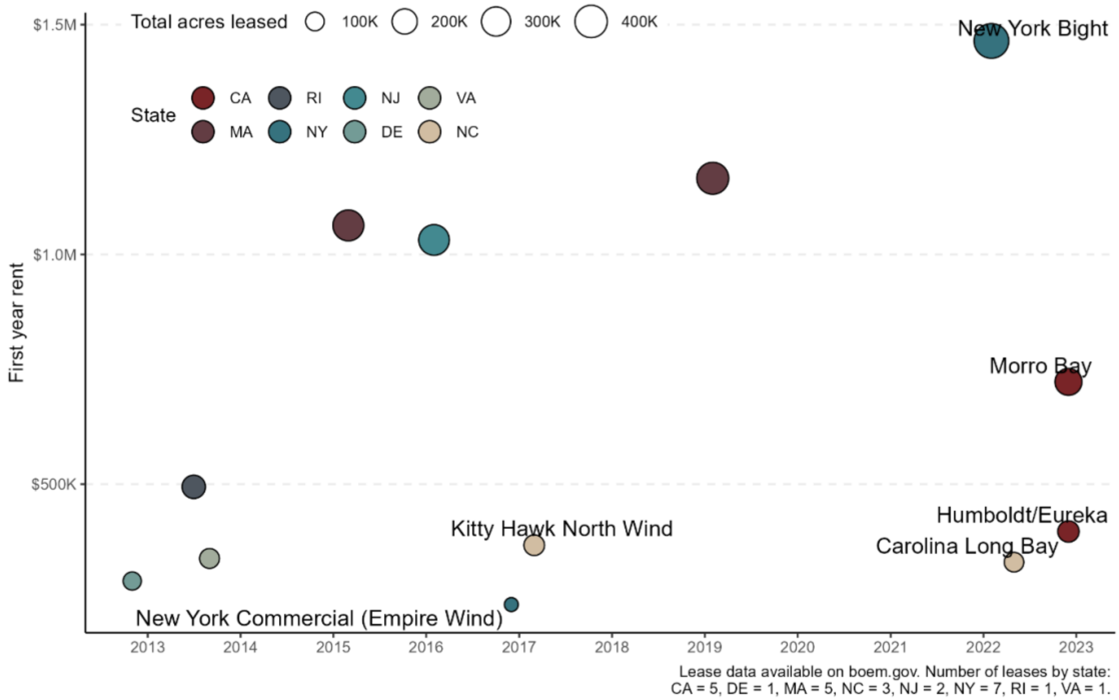

Figure 14. First Year Rent Amounts for Offshore Wind Area Lease Bids in the United States
Rent is calculated as $3.00 per acre.

4.2.1. Operating Fee Formula

The annual operating fee for offshore wind developments is similar in some regards to royalty and severance tax rates for oil and gas leases in the Gulf of Mexico. The fee is a fixed rate of two percent, imposed on the amount and the wholesale value of the electricity produced at a given lease site. The wind operating fee rate is considerably lower than the royalty rate for offshore oil and gas, which is currently set at 18.75%. The formula BOEM uses to calculate annual operating fees for offshore wind leases is based on the following inputs, which are outlined in the Proposed Sale Notice (PSN).[22]

- The nameplate capacity of the turbines in operation, in megawatts (MW).
- The number of hours in a year (8,760).
- An initial capacity factor of 40 percent.[23]
- The current wholesale electricity price in dollars per megawatt hour ($/MWh).
- An operating fee of two percent.

The 40% capacity factor, hours per year, and 2% operating fee are each set value, while the wholesale electricity price and nameplate capacity of a lease are variable inputs, depending on market conditions for electricity, the size of turbines installed, and whether the full capacity of a lease has yet to be installed. The following equation applies the BOEM operating fee formula to a

[22] The PSN for the Gulf of Mexico wind leases can be found at www.boem.gov/renewable-energy/state-activities/gulf-mexico-activities.
[23] BOEM will initially set the capacity factor at 40% for the first six years of commercial operation of a lease, before adjusting to reflect the actual generating capacity of the lease over the previous five years.

hypothetical lease assuming a lease area of 100 acres with an installed capacity of 3MW/acre and an average wholesale electricity price of $40/MWh. In this hypothetical scenario, the lease developer would be responsible for paying an annual operating fee of $840,960.

$$\text{Annual Operating Fee} = 300\text{ MW} \times\ 8{,}760\left(\frac{\text{hours}}{\text{year}}\right) \times 0.40\,\frac{\$40}{\text{MW/h}}\,\text{Power Price} \times\ 0.02 = \$840{,}960$$

4.2.2. Operating Fee Assumptions

Based on the fact that some of the inputs within the operating fee formula are not constant or will be based on future market conditions, the scenario estimates seen in Section 4.3. rely on assumptions about lease capacity, the wholesale price of energy during operation, and the timeline from lease sale to operation.

Installed Capacity

Gulf of Mexico wind leases will have an "array power density," or a final installed capacity of 3 MW per km^2 (Musial et al. 2020; Celata 2022). This figure is used in capacity calculations in multiple BOEM and NREL and refers to the amount of electricity able to be produced by area in a wind lease, which depends on the size, efficiency, and spacing of the installed turbines, in addition to wind speeds. The Gulf of Mexico has lower wind speeds than other offshore wind lease areas in the U.S., however, innovations in turbine design may lead to greater efficiencies that allow Gulf of Mexico wind developments to meet or surpass the assumed 3 MW per km^2 power density.

Wholesale electricity prices

Predicting the future price of wholesale electricity is outside of the scope of this report, so we rely on historic averages from the ERCOT and MISO transmission systems to estimate prices for each scenario. This is in line with the process described in the Gulf of Mexico Proposed Sale Notice.[24] Prices of wholesale electricity were considerably high in 2022 as a result of extreme weather events and the effect of the war in Ukraine on demand for domestic natural gas (Aniti 2023). ERCOT prices in particular were much higher than normal. Winter Storm Uri caused average wholesale prices on the ERCOT grid to skyrocket to over $1,800/MWh in February of 2021. A July heatwave also contributed to a high annual price at over $160/MWh.

Time from lease sale to operation

The time from lease sale to operation is another hard to predict factor affecting operating fee estimates, especially as there are few precedents to rely on. Block Island, the first offshore wind farm in operation in the United States, only took about a year to construct, but site approval, permitting, and public hearings added and additional 3 years. Other projects have taken even longer. Dominion Energy finalized a lease agreement with BOEM for their Coastal Virginia Offshore Wind (CVOW) project in 2013. A two-turbine pilot of the CVOW project was constructed in

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[24] "The wholesale power price, expressed in dollars per MWh, is determined at the time each annual operating fee payment is due. For the leases offered in this sale, BOEM proposes to use the ERCOT (Texas Coast Region) and Louisiana MISO (Louisiana Coast Region) average price per MW from the Enerfax power prices dataset within Hitachi's ABB Velocity Suite." (Bureau of Ocean Energy Management 2023)

2020, while the full commercial-scale portion of the project is slated to begin construction in 2024 ("CVOW Timeline" n.d.).

4.3. Low, Median, and High Scenarios for Federal Revenues

As elaborated above, lease bid, rents, and operating fees are impacted by multiple factors of both natural environment and socio-economic conditions in offshore wind production areas. To showcase the fluid situations and possible variations in potential revenues from offshore wind in the Gulf of Mexico, we develop a three-scenario framework factoring in all these influencers with a temporal lens.

4.3.1. Scenarios for Bonus Bid

Of the primary wind lease revenue sources, the bonus bid is the earliest stream of revenue in the short run of an offshore wind project. It tends to be most difficult to estimate because developer bids are dependent on historical trends, cost of development, and expected return on electricity generated from offshore wind, all of which are unique to the Gulf of Mexico and make it difficult to assign the value of other lease areas as a comparison. These factors interactively influence the total bonus bid by impacting acre leased and average bidding bonus in auctions.

Table 5. Inputs to Low, Medium, and High Scenarios of Public Revenues from Bonus Bids

	Low Scenario	Median Scenario	High Scenario
Acreage leased	25% of GOM lease blocks sold in 2023	75% of GOM lease blocks sold in 2023	100% of GOM lease blocks sold in 2023
Average bidding bonus	Massachusetts price: $1,043/acre	75% NC price: $1,795/acre	NY Bight price: $8,831/acre

Historic data provide guidance in assumptions about 1) the percentage of acre leased over the total areas proposed for leasing and 2) mean bonus bid for lease auction in low, median, and high scenarios (Table 5). Among all competitive auctions, the percentage of acres leased ranges from slightly below 50% to fully 100%, with occasional retainment of 10% - 20% of the total lease areas as took place in two cases in Massachusetts. Considering the lower and upper bounds of successfully leased out areas, we assume 25%, 75%, and 100% of the proposed lease area in the Gulf of Mexico would be leased out in auctions in the first round. As for mean bidding bonus bid per acre, we refer to Massachusetts Lease Area (auction on February 1st, 2019) and New York Bight Lease Area (auctioned on February 1st, 2022), the lowest and highest unit bidding price within five years, as the reference for the low and the high scenarios. Among all the leases occurred within five years in Massachusetts, California, North Carolina, and New York, the Carolina Long Bay Lease Area (auctioned on May 1st, 2022) serves as the most comparative case for the upcoming auction in the Gulf of Mexico due to its similar socioeconomic conditions (e.g., lack of robust renewable portfolio standards) and natural environments (e.g., relatively lower wind speed than that in North Atlantic and Pacific). Considering the extreme weather events such as tropical storms and hurricanes in Gulf of Mexico, as well as relatively higher electricity price in North Carolina and consequentially higher expected revenues from offshore wind power, we make a precautious assumption of 75% of Carolina Long Bay Lease Area's average bonus bid for the median scenario.

4.3.2. Scenarios for Rental Fee

Rental fee is the second stream of public revenue from an offshore wind farm. After the auctions, the bidding winner companies would pay rents for the portion of a lease area not under operation while paying operating fees for areas under production as a development is gradually built out. Generally, durations of construction periods of offshore wind projects vary by project, ranging from two-three years (Rodgers 2021) to seven to eleven years (Iberdrola 2023). In this report, we take 2030 as an example to showcase the revenue composition of an offshore wind project in the median-to-long-run.

The unit rental fee is set at $3 per acre and thus, as displayed in Table 6, all uncertainty associated with the total rents comes from the area of lease area sold and under operation. At the beginning of a leasing, companies would pay rents for 100% of areas leased in 2023 and no operating fees until they start operation. In the low scenario, though we take the lower boundary (i.e., 25%) of the range for percentages of leased areas over total areas proposed for leasing, it is plausible to assume that additional areas would be sold, either in competitive or non-competitive bidding by 2030. Similarly, the percentage of areas leased in the median scenario could increase to 100% with potentially growing interests in wind resources in the Gulf of Mexico and additional auctions.

Table 6. Inputs to Low, Medium, and High Scenarios of Public Revenues from Rents

	Low Scenario	Median Scenario	High Scenario
Blocks Sold and in Operation	50% of lease blocks sold and in operation by 2030	100% of lease blocks sold and in operation by 2030	Creation of new lease blocks for sale by 2030 (double the medium scenario)
Unit Rent Price	$3 per acre		

Emerging trends of high demands for green hydrogen production from renewable energy in the Gulf of Mexico may lead to surging interests in offshore wind in the region in particular, contributing to a high scenario where the proposed lease areas double and fully sold out by 2030. Hydrogen produced by offshore wind power could lead to a substantial decrease in greenhouse gas emissions in Louisiana, 70% of which comes from oil and gas production and other industrial sectors in the state (Calado and Castro 2021). In this sense, green hydrogen appears to be a viable solution for decarbonize and thus may drive high demands for offshore wind power in the Gulf of Mexico. At the same time, the unique advantage of Louisiana-its existing pipelines that can be employed to transmit hydrogen produced offshore to the shore-allows affordable costs of developing green hydrogen production from offshore wind (Thorson et al. 2022). In fact, investment in such hydrogen production development has been made, for instance, the Greater New Orleans Development Foundation received $50 million from the federal government, which is supplemented by another $24.5 million state funds to develop a green hydrogen hub (Wolfe 2022), and the implementation of this $74.5 million plan largely relies on the hydrogen production from offshore wind farms in the GOM (Jones et al. 2022).

4.3.3. Scenarios for Operating Fee

Operating fee is a function of local market power price (in $/MWh), installed capacity (in MW), capacity factor for installed turbines (initially set at 40% upon installation by BOEM), operating fee rate (currently set at 2%), hours per year (fixed at 8,760hrs/year). Among these influencers, the variances in operating fees lie in the first two (Table 7). We keep consistent with the scenarios on rents with respect to blocks sold and in operation and translate the acre areas to stalled capacity. Based on electricity generating capacity of the wind turbines estimated by NREL, 3 megawatts (MW) per square kilometer, the three GOM areas proposed for sale in 2023, two areas of 160.15 square miles and one area of 151.23 square miles, would generate 1244.2 MW, 1244.2 MW, and 1175.0 MW installed capacity if fully operational (Gilman et al. 2016).

Table 7. Inputs to Low, Medium, and High Scenarios of Public Revenues from Operating Fees

	Low Scenario	Medium Scenario	High Scenario
Electricity price	75% of 2021 MISO average for LA and TX Hubs ($23.91/MWh)	100% of 2021 MISO average for LA and TX Hubs ($31.89/MWh)	2022 ERCOT average for Houston and South Hubs ($66.42 MWh)
Installed Capacity in MW	707 in 2030	3,663 in 2030	7,327 in 2030
Capacity Factor for Installed Turbines	40% upon installation		
Operating Fee Rate	2%		
Hours Per Year (Fixed at 8,760 hour/year	hours per year (fixed at 8,760hrs/year		

The second factor, power price, is determined at the time each payment is due based on the latest calendar year average of the regional wholesale spot price ($/MWh) (Heinze 2023). In the case of Gulf of Mexico, the proposed power price is the ERCOT Houston and South Hubs price for the Galveston leases and MISO Texas and Louisiana Hubs price for the Lake Charles lease. Among recent MISO and ERCOT wholesale price data in 2021 and 2022 directly from the grid operator websites, the value of 75% of the average for MISO's Louisiana and Texas hubs in 2021 ($23.91MWh) serves for the low scenario, the 2021 average price ($31.89/MWh) for the MISO LA and TX hubs for the medium scenario, and the 2022 average price ($66.42 MWh) for the ERCOT Houston and South hubs serves the high scenario.

Table 8. Low, Medium, and High Scenario Revenue Estimates

	Low Scenario	Medium Scenario	High Scenario
Bonus Bids (2023)	$78.7 M	$404.6 M	$2,664 M
Annual Rents (2023)	$0.2 M	$0.7 M	$0.9 M
Annual Operating Fees (2030)	$3.1 M	$8.2 M	$34.1 M
2023 Leased Capacity (MW)	707	2,748	3,663
2030 Operational (MW)	707	3,663	7,327

As such, this framework illustrates a degree of uncertainty about public revenues from offshore wind power in Gulf of Mexico, which is impacted by developers' interests in offshore wind in this area, technology outlook on wind turbines and power transmission, as well as renewable policy landscape in the region. Resting on these assumptive scenarios,

The second factor, power price, is determined at the time each payment is due based on the latest calendar year average of the regional wholesale spot price ($/MWh) (Heinze 2023). In the case of Gulf of Mexico, the proposed power price is the ERCOT Houston and South Hubs price for the Galveston leases and MISO Texas and Louisiana Hubs price for the Lake Charles lease. Among recent MISO and ERCOT wholesale price data in 2021 and 2022 directly from the grid operator websites, the value of 75% of the average for MISO's Louisiana and Texas hubs in 2021 ($23.91MWh) serves for the low scenario, the 2021 average price ($31.89/MWh) for the MISO LA and TX hubs for the medium scenario, and the 2022 average price ($66.42 MWh) for the ERCOT Houston and South hubs serves the high scenario.

Table 8 presents bonus bids, annual rents in 2023, and annual operating fees in 2030 from offshore wind production in the Gulf of Mexico.

4.3.4. Wind Capacity Growth Assumptions

Research remains sparse on forecasting total offshore wind capacity in the Gulf of Mexico, though there appears to be a common vision of increasing offshore wind power generation from the GOM. To uncover some clues for operating fees revenues in the long-term, this section examines assumptions of wind capacity growth in the GOM.

New areas in the Wind Energy Areas in the GOM may be listed in future Proposed Sale Notices and bided for by. Such expansion of offshore wind power development is highly likely as part of the pursuit of Goal 1 of the 2022 Louisiana's Climate Plan: Shift towards a clean, renewable, and resilient power grid. Under this first goal, action 1.3 is to "strategically plan for the development of offshore wind power", which is targeted towards 5 GW of offshore wind generation by 2035 (Climate Initiatives Task Force 2022). Notably, this is a Louisiana goal rather a goal agreed upon by all Gulf of Mexico States. Given the governance level (state vs region), it is not unreasonable to envision that the entire Gulf of Mexico would possess a higher-than-5 GW offshore wind capacity by 2035. On the other hand, the Louisiana Climate Plan is not a mandate but a strategically actionable approach to the target of net zero by 2050, so the target of 5 GW is more of an inspiration than a commitment. Considering the Gulf of Mexico as one of the five regions of offshore wind production, Musial and Greco (2020) estimated that the Gulf of Mexico may produce 8.6 GW by 2050, representing 10% of the national capacity by 2050. To assess offshore wind resources regardless of economic and policy constraints, Lopez et al. (2022)Considering GOM as one of the five regions of offshore wind production, Musial and Greco (2020) estimated that the GOM may produce 8.6 GW by 2050, representing 10% of the national capacity by then. To assess offshore wind resources regardless of economic and policy constraints, Lopez et al. (2022) evaluate the technical capacity relying on assumptions about turbine technologies according to its Annual Technology Baseline for year 2030 and found the maximum total technical capacity of the Gulf of Mexico is 1,563 GW.

5. Summary and Recommendations

While oil and gas have been the most impactful natural resources in Gulf of Mexico for decades, the outlook for energy production in the region is undergoing changes. The federal government set a goal of deploying 30 GW of offshore wind energy across the U.S. by 2030 (The White House 2021). After designating the first two wind energy areas in the Gulf of Mexico in October 2022, DOI proposed the first-ever offshore wind sale in the region in early 2023, including three lease areas totaling over 300,000 acre and sufficient to power 1.3 million homes when fully operational. In addition to diversifying the region's energy mix and reducing greenhouse gas emissions, offshore wind projects could generate a new of source of public revenue. To examine how such renewable energy development brings financial opportunities for Louisiana, this report explains similarities and differences in financial mechanisms for long-lasting oil and gas activities and emerging offshore wind production, investigates the offshore wind resources in the region and how they are regulated by existing yet changing frameworks, as well as delineates factors influential in determining revenue potential from offshore wind projects in the region.

The well-established financial mechanism for oil and gas leases provides a paradigm for understanding and managing federal revenues from offshore wind projects in the Gulf of Mexico. Federal revenues from oil and gas include three major components: bonus bids, rents, and royalties. Similarly, the federal government collects bonus bids, rents, and operating fees from offshore wind projects. There is a slight difference between these two: oil and gas companies pay rents for the entire lease area until production begins anywhere within the leased block, yet wind companies would pay rents for the portion of a lease area not under operation while paying operating fees for areas under production as a development is gradually built out. As for revenue sharing for producing states in the Gulf of Mexico, federal revenues from oil and gas leases in the region are allocated to nearby state and local governments through a structure established by GOMESA and these revenues provide a critical source of funding for coastal restoration projects in Louisiana. A similar structure to allocate revenues from wind energy projects in the Gulf of Mexico has yet to be established, though pending legislation may expand the limits of GOMESA to include wind revenues.

The Gulf of Mexico has direct access to abundant offshore wind resources. BOEM is currently offering lease areas with potential to generate 3.663 GW of electricity. This represents a small but important first step for wind development in light of the National Renewable Energy Laboratory's 2022 assessment that the Gulf of Mexico has a total offshore wind energy technical capacity potential in of 696 GW from fixed-bottom turbines and 867 GW from floating-bottom, for a total of 1,563 GW (Lopez et al. 2022). These figures provide a technical ceiling for wind generation in the Gulf of Mexico. Immense offshore wind potential does not necessarily indicate enormous revenues for producing states. For instance, the current Gulf of Mexico designated wind energy areas are outside of state waters and under federal jurisdiction. While states have options for some non-oil and gas revenue sharing in the Outer Continental Shelf Lands Act 8(g) zone, these rules would not apply to the proposed Gulf of Mexico lease areas offered by BOEM because they are further offshore and outside of the 8(g) zone (NOAA Office for Coastal Management n.d.).

The unique differences and challenges that wind energy development faces in the Gulf of Mexico region create a great deal of uncertainty about potential revenues from offshore wind from the region. While previous offshore wind leases offer a useful reference for estimating potential revenues from projects in the Gulf of Mexico, they should be framed within local environmental and socio-economic conditions in the region, which impact the production of offshore wind power. While bid amounts and levels of competition for offshore wind leases have trended upward in recent years, the low wind speeds, soft sea floor, and occasionally challenging weather conditions in the Gulf Mexico may reduce the value in this region. Lack of binding renewable energy portfolio standards and low average electricity prices across the Gulf of Mexico also present challenges. Nevertheless, shallow waters, the robust offshore workforce, high level of electricity consumption, and established marine industry (especially offshore transportation, construction, and manufacturing industries) provide valuable support for development of Gulf of Mexico wind projects. Reflective of the variations in total revenues associated with these factors, this report develops a three-scenario framework to illustrate low, medium, and high estimates of bonus bids, rents, and rental fees. In the medium scenario, we estimate that federal revenues from offshore wind projects include: 1) bonus bids of $404.6 M, 2) first-year rents of $0.7 M, and 3) operating fees of $8.2 M at full capacity (circa 2030). As such, bonus bids provide the largest near-term opportunity for revenue from wind; annual rents and operating fees will provide a smaller long-term revenue stream.

The changing mechanisms for revenue sharing as it pertains to wind in the Gulf of Mexico remains a concern for state and local governments. With a changing energy landscape in the region, offshore wind resources could be increasingly important for reducing carbon emissions in energy production and generating revenues for coastal restoration, a major issue in coastal Louisiana. An equitable framework allowing producing states to be involved in public revenue allocation and management is critical in utilizing renewable resources sustainably. GOMESA for oil and gas provides an example of dedicating a proportion of revenues from natural resources to local land and water conservation. Expanding the limits of such paradigms to include renewable energy sources, such as offshore wind, plays an indispensable role in the processes of both energy diversification and environmental improvement.

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