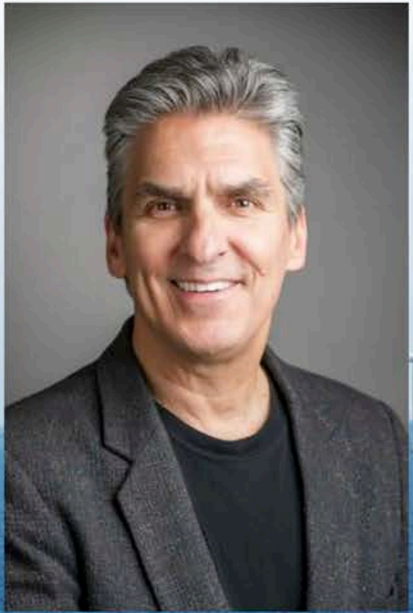
NATIONAL OFFSHORE WIND
RESEARCH & DEVELOPMENT CONSORTIUM

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

BOEM
Bureau of Ocean Energy Management



NOWRDC Webinar:
Offshore Wind Energy Potential in the US Gulf of Mexico

July 14, 2020

National Offshore Wind R&D Consortium

Goal: Facilitate a nationally-focused, not-for-profit organization collaborating with industry on prioritized R&D activities to reduce levelized cost of energy (LCOE) of offshore wind in the U.S. and maximize other economic and social benefits

Desired Impacts:

- Innovations directly responsive to the technical and supply chain barriers faced by offshore wind project developers in the U.S.
- Build strong networks connecting technology innovators, investors, and industry
- Increase U.S. content and job opportunities

Consortium R&D Funding : @$41 M ($20.5 DOE funds, matched by NYSERDA) – plus state (MA, VA, MD) and member contributions

Project Awards to Date

Pillar	Technical Challenge Area	Proposal Title	Lead Proposer
Pillar 1: Offshore Wind (OSW) Plant Technology Advancement	1.1: Array Performance and Control Optimization	Computational Control Co-design Approach for Offshore Wind Farm Optimization	Stony Brook University
		Impact of Low Level Jets on Atlantic Coast Offshore Wind Farm Performance	General Electric
		Reducing LCoE from Offshore Wind by Multiscale Wake Modeling	Cornell University
		Wind Farm Control and Layout Optimization for U.S. Offshore Wind Farms	NREL
	1.2: Cost-Reducing Turbine Support Structures for the U.S. Market	A Low-Cost Modular Concrete Support Structure and Heavy Left Vessel Alternative	RCAM Technologies
	1.3: Floating Structure Mooring Concepts for Shallow and Deep Waters	Demonstration of Shallow-Water Mooring Components for FOWTs (ShallowFloat)	Principle Power, Inc.
		Design and Certification of Taut-synthetic Moorings for Floating Wind Turbines	University of Maine
		Dual-Functional Tuned Inerter Damper for Enhanced Semi-Sub Offshore Wind Turbine	Virginia Tech
		Innovative Anchoring System for Floating Offshore Wind	Triton Systems, Inc.
		Innovative Deepwater Mooring Systems for Floating Wind Farms (DeepFarm)	Principle Power, Inc.
		Shared Mooring Systems for Deep-Water Floating Wind Farms	NREL
		Techno-Economic Mooring Configuration and Design for Floating Offshore Wind	UMass Amherst
	1.4: Power System Design and Innovation Challenge Statement	Development of Advanced Methods for Evaluating Grid Stability Impacts	NREL
Pillar 2: OSW Power Resource and Physical Site Characterization	2.1: Comprehensive Wind Resource Assessment	A Validated National Offshore Wind Resource Dataset with Uncertainty Quantification	NREL
	2.2: Development of a Metocean Reference Site	Development of a Metocean Reference Site near the MA & RI Wind Energy Areas	WHOI
Pillar 3: Installation, O&M and Supply Chain Solutions	3.2: Offshore Wind Digitization Through Advanced Analytics	Enabling Condition Based Maintenance for Offshore Wind	General Electric
		Physics Based Digital Twins for Optimal Asset Management	Tufts University
		Radar Based Wake Optimization of Offshore Wind Farms	General Electric
		Survival Modeling for Offshore Wind Prognostics	Tagup, Inc.
	3.3: Technology Solutions to Accelerate U.S. Supply Chain	20GW by 2035: Supply Chain Roadmap for Offshore Wind in the US	NREL

Offshore Wind in the US Gulf of Mexico

Walt Musial
National Renewable Energy Laboratory
Offshore Wind Lead

July 14, 2020

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NATIONAL OFFSHORE WIND
RESEARCH & DEVELOPMENT CONSORTIUM

Speaker Bio

Mr. Walt Musial
Principal Engineer
Offshore Wind Platform Lead
National Renewable Energy Laboratory
Golden Colorado, USA

Walt Musial is a principal engineer and leads the offshore wind research platform at the National Renewable Energy Laboratory (NREL) where he has worked for 31 years. In 2003 he initiated the offshore wind energy research program at NREL which focuses on a wide range of industry needs and critical technology challenges. Walt also developed and ran NREL's full scale blade and drivetrain testing facilities for 15 years. Earlier, Walt worked as a test engineer for five years in the commercial wind energy industry in California. He studied Mechanical Engineering at the University of Massachusetts - Amherst, where he earned his bachelor's and master's degrees, specializing in energy conversion with a focus on wind energy engineering. He has over 100 publications and two patents.

- NREL Overview
- Gulf of Mexico Renewable Energy Study
- Gulf of Mexico Offshore Wind Advantages and Challenges
- Gulf of Mexico Offshore Wind Cost Study
- Next Steps

National Renewable Energy Laboratory (NREL)
Science Drives Innovation

Renewable Power

Solar

Wind

Water

Geothermal

Sustainable Transportation

Bioenergy

Vehicle Technologies

Hydrogen

Energy Efficiency

Buildings

Advanced Manufacturing

Government Energy Management

Energy Systems Integration

Grid Integration

Hybrid Systems

NREL Quick Facts

- 2,685 Employees, Postdoctoral Researchers, Interns, Visiting Professionals, and Subcontractors
- Patents Issued for NREL Technologies to Date 571
- More than 1,700 Scientific and Technical Materials Published Annually
- 3 National Centers
- 16 Research Programs
- 871 Active Partnerships with Industry, Universities, Foundations, and Governments
- More than 70 Countries Represented by Staff
- 65 R&D 100 Awards

Partnership Strategy: Bringing Innovations to Market

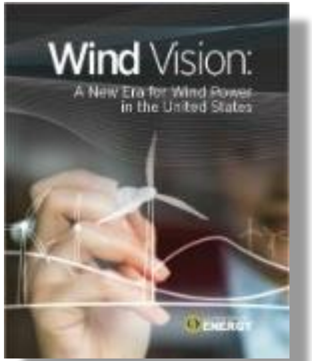
Industry invests in short-term R&D when they are confident about a return on investment.

NREL conducts research that makes it possible for industry to bring important new solutions to the market by:

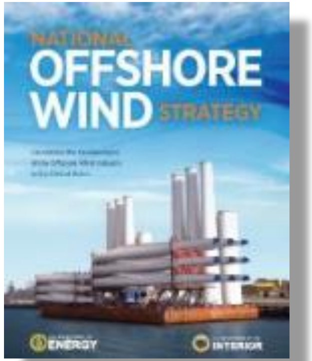
- Assuming a longer, broader view
- Taking on early-stage, high-risk R&D
- Being technology agnostic and objective

NREL's Flatirons Campus *(above) was established in 1977 and supports over 150 staff dedicated to wind energy and marine energy research. NREL staff pioneered the development of today's design tools, standards, and test facilities.*

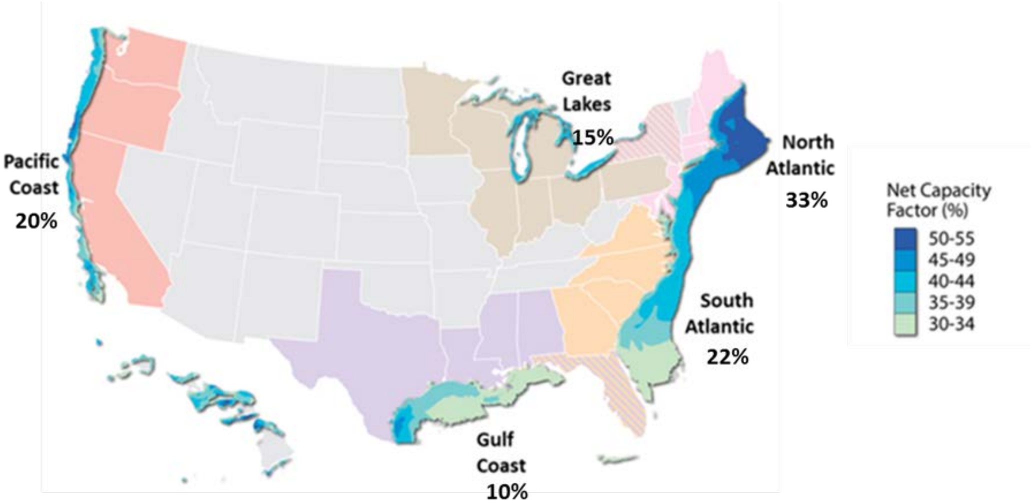
2016 DOE/DOI Offshore Wind Strategy



March 2015



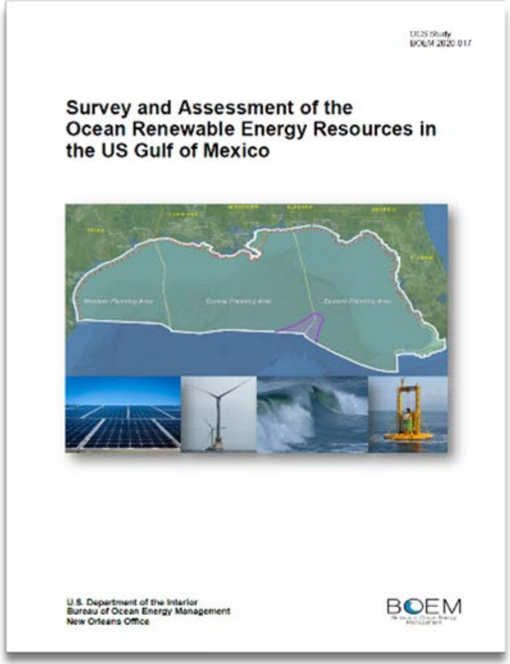
September 2016

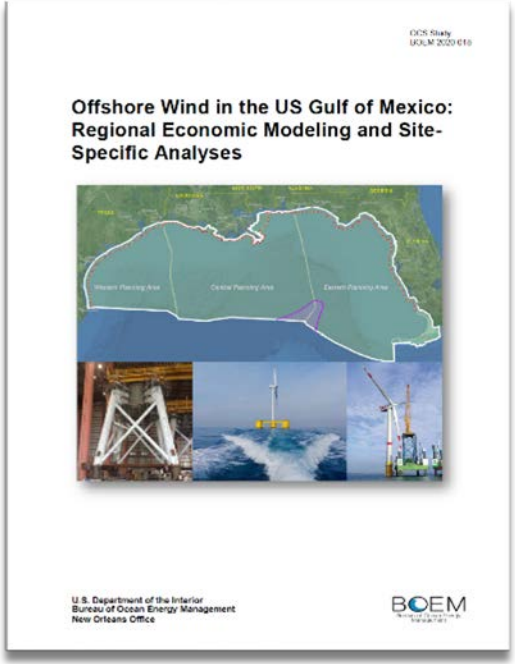


- 2016 Strategy helped formalize DOE and DOI (**Bureau of Ocean Energy Management** [**BOEM**]/Bureau of Safety and Environmental Enforcement [BSEE]) relationship
- 2016 strategy provides framework for offshore wind in USA
- DOE/DOI Wind Vision scenario calls for 86-GW of Offshore Wind in USA by 2050 (7% of electricity) in five regions **including the Gulf of Mexico**

Gilman, P et al. 2016. National Offshore Wind Strategy; Facilitating the Development of the Offshore Wind Industry in the United States. U.S. Department of Energy; U.S. Department of the Interior. https://energy.gov/sites/prod/files/2016/09/f33/National-Offshore-Wind-Strategy-report-09082016.pdf

BOEM Sponsored Two NREL Studies on Gulf of Mexico (GOM) Through Interagency Agreements – Published May 2020





Special Acknowledgements:

- **Mike Celata,** BOEM's GOM Regional Director
- **Rebecca Green** for initiating the project
- **Andrea Heckman** the BOEM project manager

Musial W, Tegen S, Driscoll R, Spitsen P, Roberts O, Kilcher L, Scott G, and Beiter P (National Renewable Energy Laboratory and the Alliance for Sustainable Energy, LLC, Golden, CO). 2019. Survey and assessment of the ocean renewable resources in the US Gulf of Mexico. New Orleans (LA): Bureau of Ocean Energy Management. Contract No.: M17PG00012. Report No.: OCS Study BOEM 2020-017. https://espis.boem.gov/final%20reports/BOEM_2020-017.pdf

Musial W, Beiter P, Stefek J, Scott G, Heimiller D, Stehly T, Tegen S, Roberts O, Greco T, Keyser D (National Renewable Energy Laboratory and the Alliance for Sustainable Energy, LLC, Golden, CO). 2020. Offshore wind in the US Gulf of Mexico: regional economic modeling and site-specific analyses. New Orleans (LA): Bureau of Ocean Energy Management. 94 p. Contract No.: M17PG00012. Report No.: OCS Study BOEM 2020-018. https://espis.boem.gov/final%20reports/BOEM_2020-018.pdf

“Survey and Assessment of the Ocean Renewable Energy Resources in the U.S. Gulf of Mexico”

<u>NREL Authors:</u>

Walt Musial

Suzanne Tegen

Rick Driscoll

Paul Spitsen (DOE)

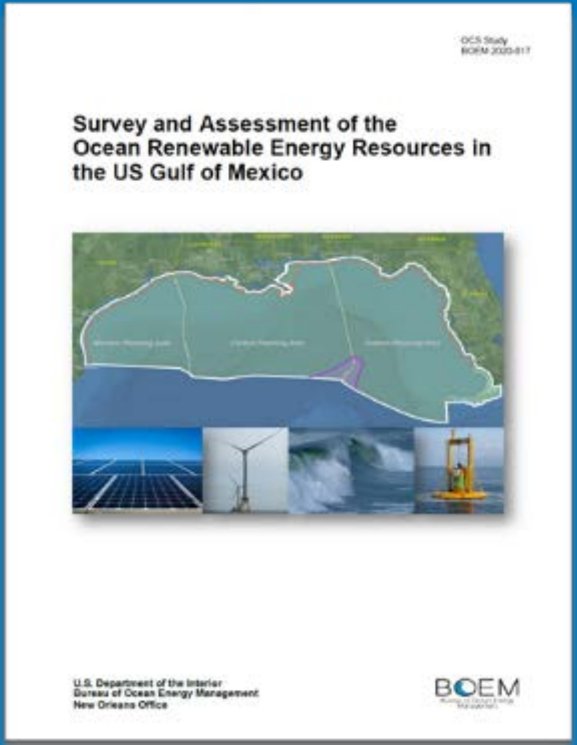
Owen Roberts

Levi Kilcher

George Scott

Philipp Beiter

Research conducted 2017-2018



Gulf of Mexico Ocean Renewable Technologies

- Renewable energy types evaluated:

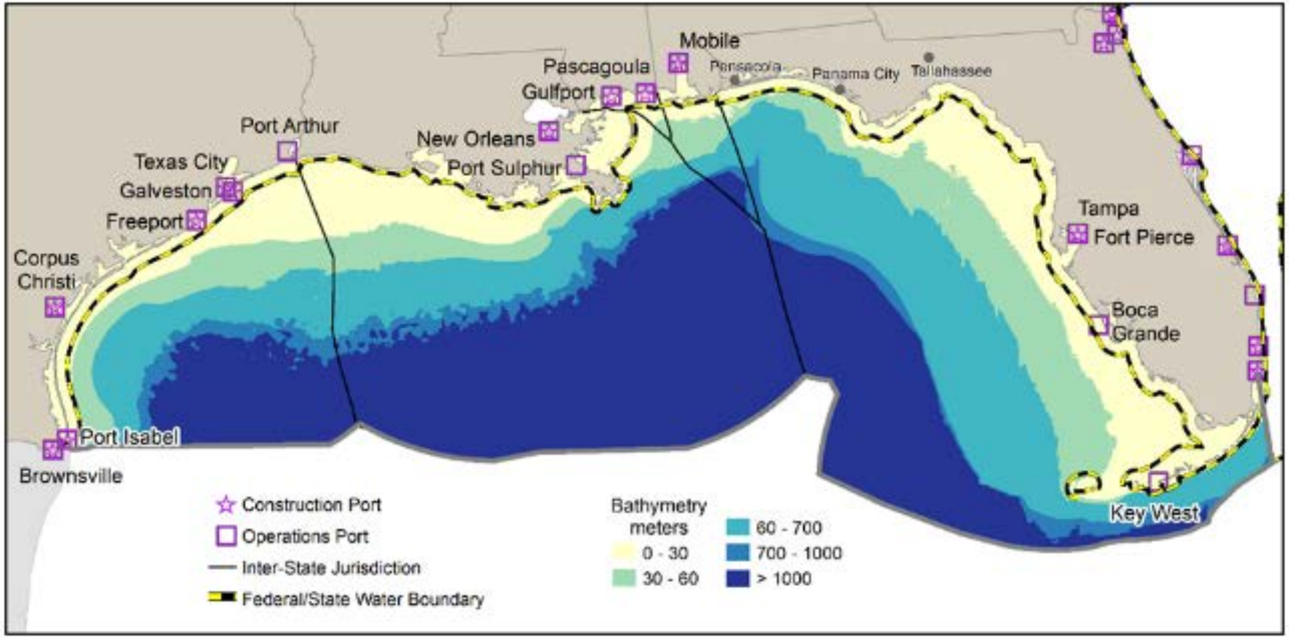
This Presentation

1. **Offshore wind**
2. **Wave energy**
3. **Tidal energy**
4. **Ocean current energy (Loop Current)**
5. **Ocean-based solar photovoltaic energy (PV)**
6. **Ocean thermal energy conversion (OTEC)**
7. Deep water source cooling (covered in report)

- Considered state and federal waters
- Evaluated each based-on resource, technology readiness and cost potential

Renewable Energy Study Domain

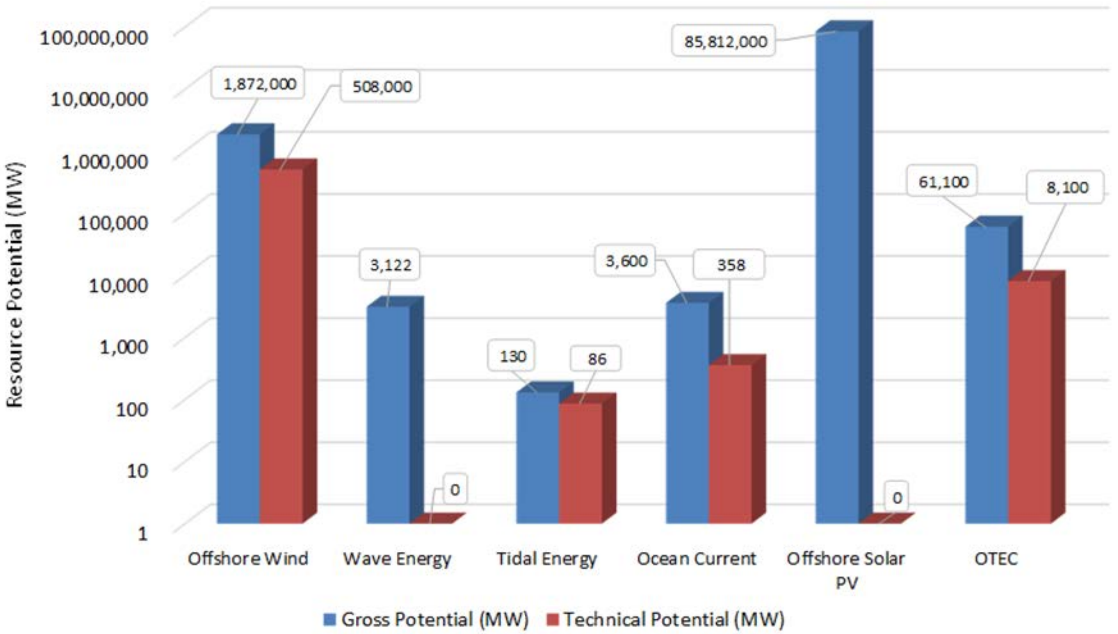
- Shoreline to the 200 nautical mile (nm) exclusive economic zone (EEZ)
- State to state boundaries extended to EEZ
- 1000 m isobath (OTEC excepted)
- 50-m isobath (wave flux energy)



Bathymetry of the GOM out to the International EEZ

Offshore Renewable Resources in the Gulf of Mexico

- 6 technology types: gross and technical energy resources shown on log scale
- Technical resource filters were developed for most nascent renewable technologies
- Offshore wind has the highest technical capacity with 508 GW
- Ocean based solar has the highest gross potential capacity but is limited by extreme wave survival
- Floating solar may be a big opportunity for sheltered bays and lakes.



Gross and Technical Offshore Renewable Energy Potential for the Gulf of Mexico by Technology Type

Technology Resource, Readiness and Cost Potential

Technology Type	Resource Adequacy	Tech Readiness	LCOE Range
Offshore Wind	HIGH	MATURE	$0.095/kWh to $0.19/kWh
Offshore Solar Photovoltaics (PV)	HIGH	EARLY	$0.14/kWh to $0.35/kWh
Ocean Current	MEDIUM	EARLY	$0.15/kWh to $0.38/kWh
Ocean Thermal Energy Conversion (OTEC)	MEDIUM	EARLY* *Small-scale demonstration	$0.14/kWh to $0.98/kWh
Tidal Energy	LOW	MATURE	$0.15/kWh to $0.31/kWh
Wave Energy	LOW	EARLY	$0.14/kWh to $1.00/kWh

- Offshore wind has the highest readiness level; 27 GW installed
- All others have not progressed past prototype stage
- Offshore wind is the only source with credible commercial scale cost information.

Offshore Wind was Down-selected for Further Study

“Offshore Wind in the U.S. Gulf of Mexico: Regional Economic Modeling and Site-specific Analysis”

<u>NREL Authors:</u>

Walt Musial

George Scott

Philipp Beiter

Tessa Greco

Jeremy Stefek

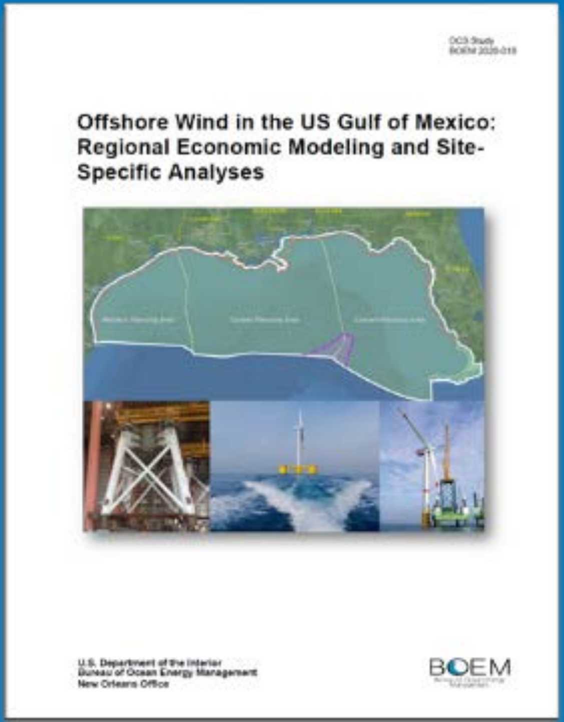
Donna Heimiller

Tyler Stehly

Suzanne Tegen

Owen Roberts

David Keyser



Offshore Wind in the US Gulf of Mexico: Regional Economic Modeling and Site-Specific Analyses

U.S. Department of the Interior
Bureau of Ocean Energy Management
New Orleans Office

BOEM

Research conducted 2018-2019

Advantages and Challenges of Offshore Wind in the Gulf of Mexico

Advantages

Resource Quantity

1/3 of U.S. shallow water resource is in the Gulf of Mexico - shallow water lowers substructure cost

Proximity to Oil and Gas Supply Chain

Offshore wind can leverage existing capabilities

Mild Climate

Warmer waters and lower sea states can decrease operating costs and increase turbine access

Challenges

Hurricane Exposure

The risk of a major hurricanes could increase turbine and substructure cost

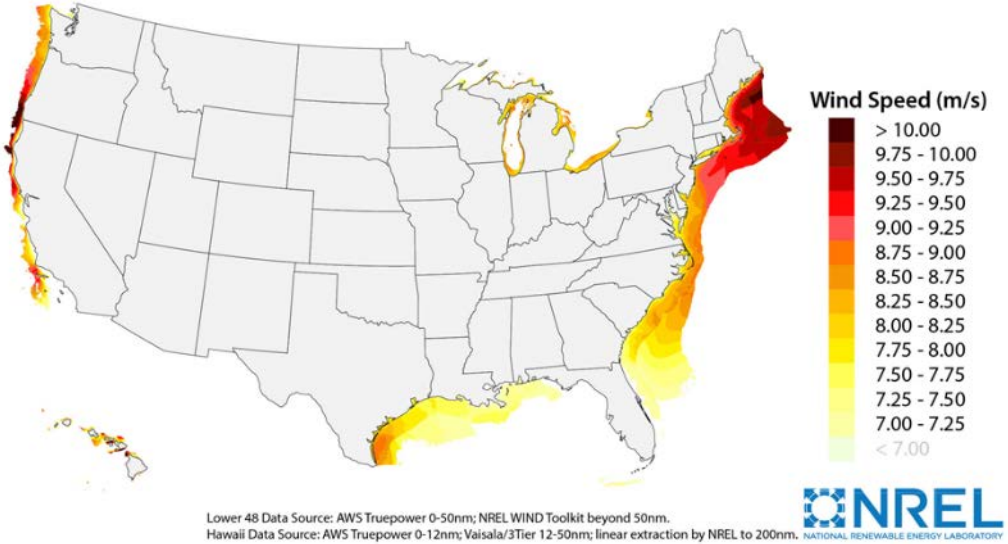
Low Average Wind Speeds

Lower wind speeds decrease capacity factors and increase LCOE

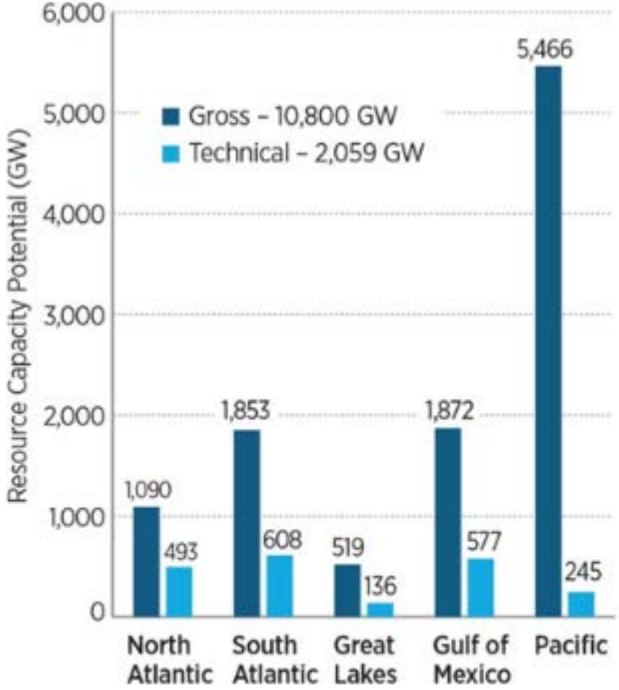
Softer Soils

Soft soils limit the type of substructure and increase substructure cost

U.S. Resource Potential



Wind speed map for the U.S. offshore wind energy technical resource

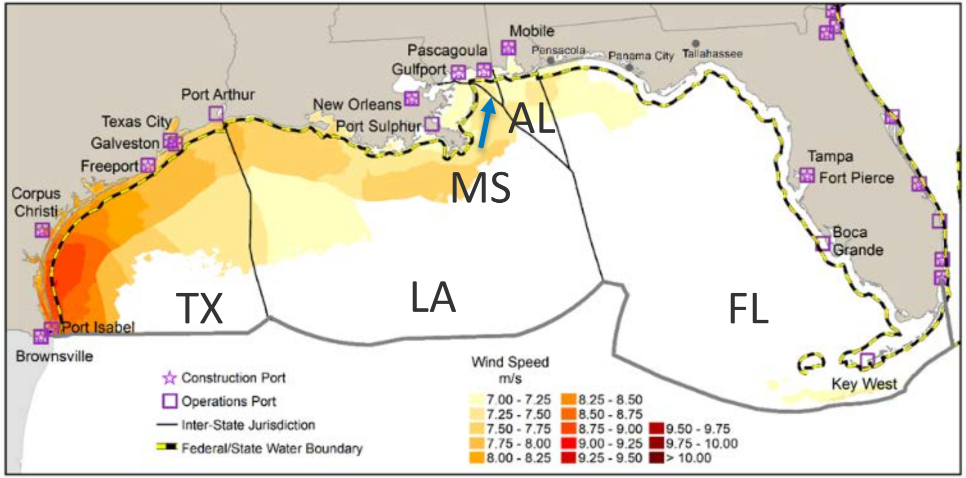


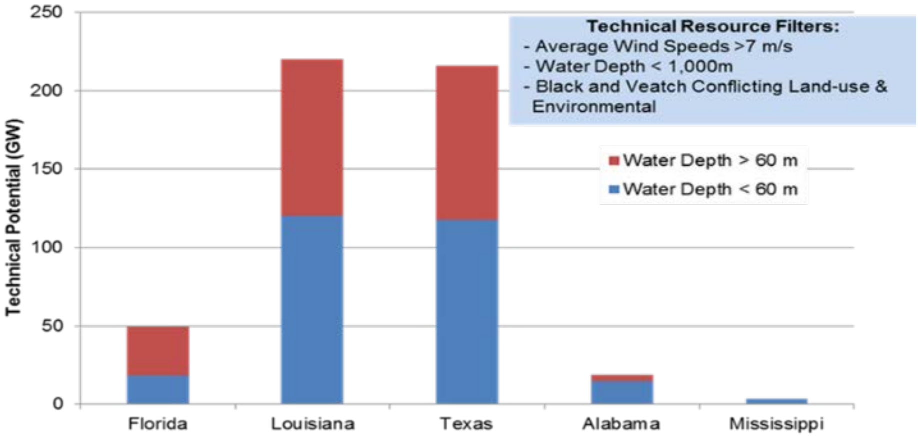
Offshore Gross Resource (dark blue) and Net Technical (light blue) Resource Potential Estimates for Five U.S. Offshore Wind Regions (Figure source Gilman et al. 2016)

Gilman, P et al. 2016. National Offshore Wind Strategy; Facilitating the Development of the Offshore Wind Industry in the United States. U.S. Department of Energy; U.S. Department of the Interior. https://energy.gov/sites/prod/files/2016/09/f33/National-Offshore-Wind-Strategy-report-09082016.pdf

Gulf of Mexico Technical Offshore Wind Resources

- NREL's 2016 resource assessment identified 508 GW of technical potential[1]
  - Resource capacity based on 3 MW/km^2 array density
  - Technology filters include:
    - > 7 m/s wind speed
    - < 1000 m water depth
- This capacity has an energy-generating potential of 1,556 terawatt-hours (TWh)/year (yr) which is double the 779 TWh electric usage of the five GOM states recorded by Energy Information Agency in 2018
- Most viable wind resources in Texas and Louisiana
- Abundant shallow water resource area
- On average, lower sea states and year-round mild climate allow better service access and lower downtime





1. Musial W, Beiter P, Heimiller D, Scott G. 2016. 2016 Offshore Wind Energy Resource Assessment for the United States (Technical Report). NREL/TP-5000-66599. National Renewable Energy Laboratory (NREL), Golden, CO (US). http://www.nrel.gov/docs/fy16osti/66599.pdf .

Compatibility With Offshore Wind Infrastructure Needs

- The Gulf of Mexico (GOM) is better outfitted for offshore wind structures and marine operations than other parts of U.S.
- Fabrication capabilities exist for steel support structures; investments to increase production volume needed
- Labor force in the GOM is rich with the skills required for offshore wind due to similarity with oil and gas; additional for special skills (e.g. HV electrical, turbine technology)
- Jones Act requires a U.S. fleet; potential to adapt and modify ships, repurpose heavy lift vessels
- Ports facilities are generally well equipped but may need modifications to accommodate turbine height clearances, etc.

Gulf of Mexico – Offshore Wind Challenges

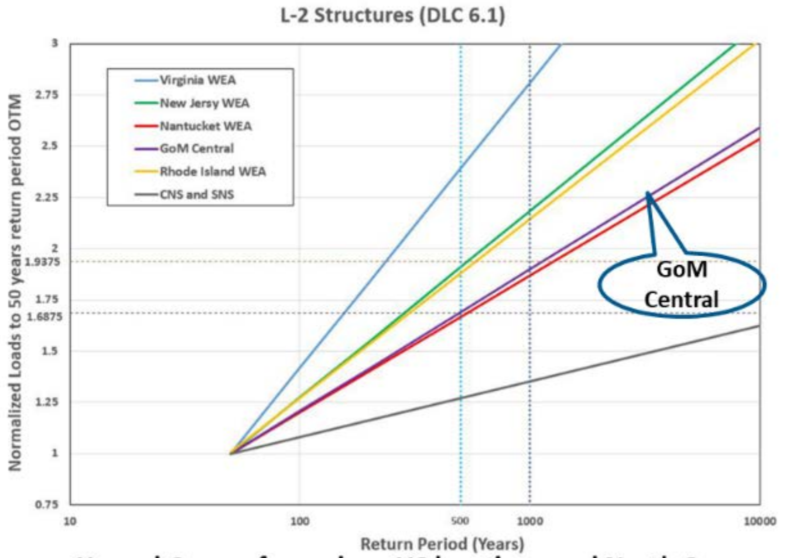
- Hurricanes
  - Site specific design requirements
  - Learn from Asian deployments (e.g. Taiwan)
  - Hurricane adapted systems
- Low windspeeds
  - Larger rotor diameter to increase energy capture (low specific power)
  - Added strength to resist extreme wind
- Soft sediments
  - Jackets with wider base/footprint
  - Best practices for Oil and Gas

Hurricane Katrina 2005, Central Gulf of Mexico 400 Year Return Conditions (courtesy of Keystone Engineering)

Turbines Need to be Optimized to Maximize Energy Production at Extreme Hurricane Sites

Design for Hurricane Resilience

- Support structures can be designed to API RP 2A standards from oil and gas industry for site specific conditions (see hazard curve in figure)
- API RP-2A – robustness check – adopted by IEC 61400-03-1 edition 2 (2019)
- Turbines are designed and type certified to IEC 61400-01 and 61400-03-1 standards
- Some site conditions may exceed IEC Class 1 design criteria (70 m/s 3 sec gust)
- IEC 61400-01 recently added Typhoon Class with 80 m/s gust condition.



Hazard Curves for various US locations and North Sea (Courtesy of Keystone Engineering)

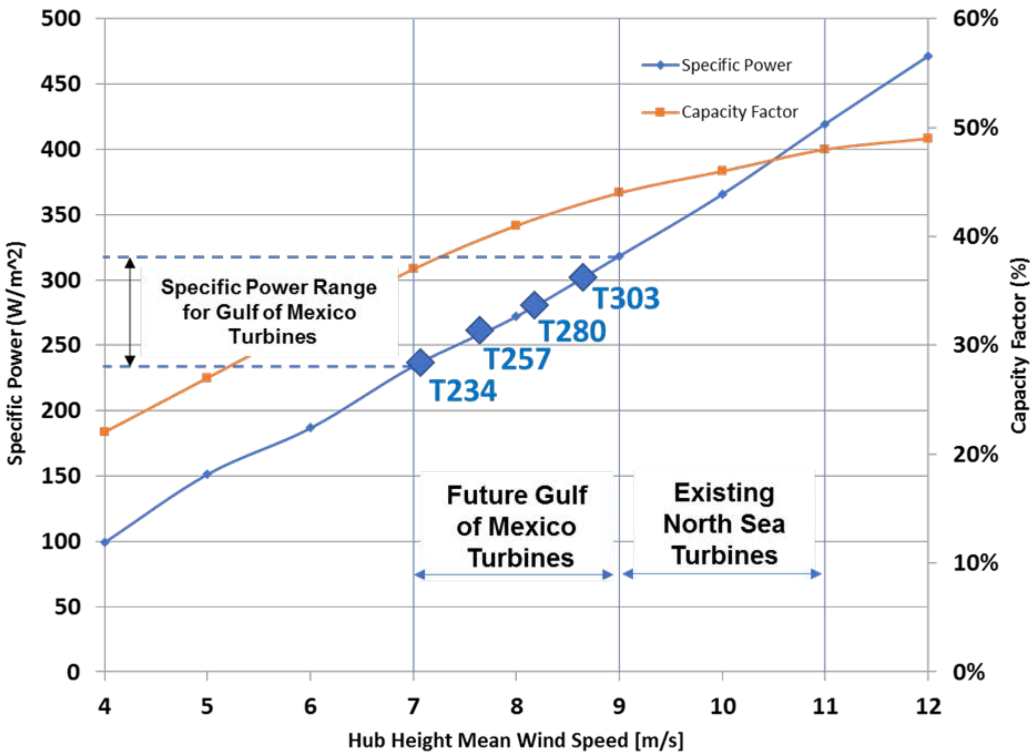
Hall. 2015. Hurricane Design in the Standards - IEC Hurricane Classes and API Hazard Curves, Keystone Engineering. Accessed March 2020. http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=3&ved=2ahUKEwj4_P-Oi6foAhUygnIEHWkxAtMQFjACegQIBxAB&url=http%3A%2F%2Fusmodcore.com%2Fcontent%2Ffile%2FHall-Rudy_IECHurricaneClassesAndAPIHazardCurves.pdf&usg=AOvVaw0gB8y5QeLeOCjO3l4fBeVL

A Better Understanding of Hurricanes is Needed for a Mature Offshore Wind Industry to Flourish in the Southern United States

Hurricane Research Needs

- Geo-spatial hurricane risk assessment of all sites (primarily, south of Cape Hatteras NC) to determine which IEC criteria are sufficient (or not)
- Harmonization of National Hurricane Center terminology and IEC design criteria (e.g. Saffir-Simpson scale)
- High fidelity models to assess detailed anatomy of limit state hurricanes to understand ultimate and fatigue load cases resulting from anomalous factors such as wind shear, gust factors, veer, eye-wall vorticity and directional wind dynamics.
- Turbine innovations to reduce structural profile of blade and tower components, and operational mitigation strategies to reduce loads

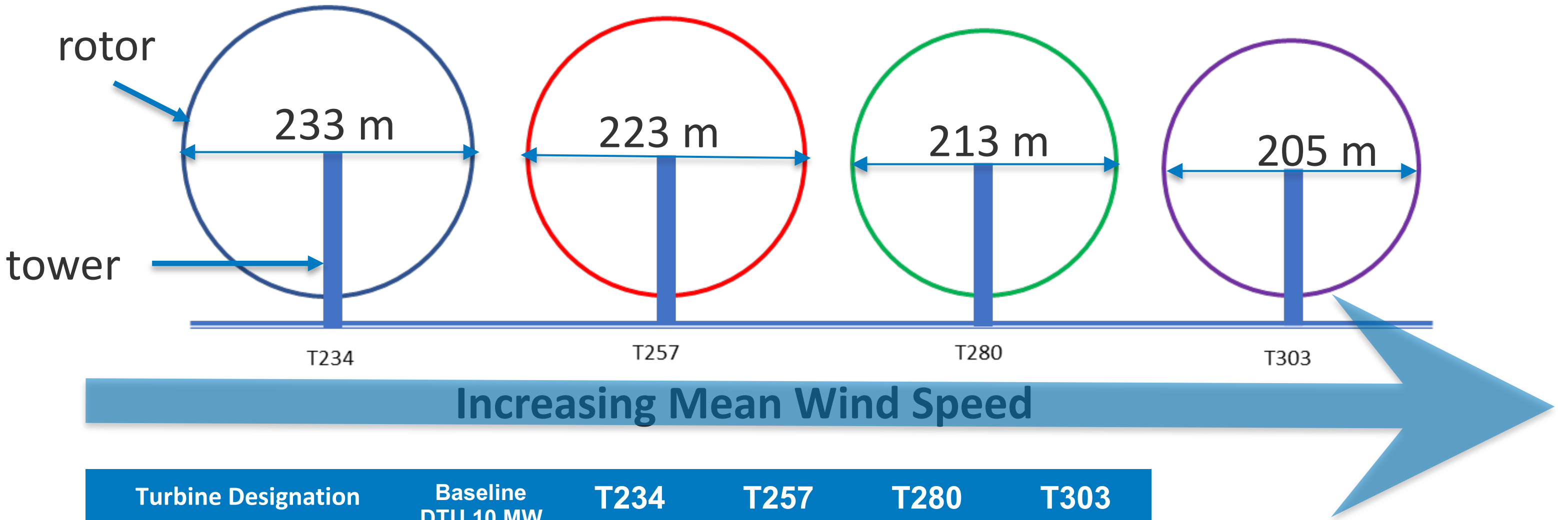
Gulf of Mexico Low Wind Speed Turbines



- Lower mean wind speed sites require turbines with larger diameter rotors for optimum energy production (e.g. lower specific power [Watts/m^2])
- Specific power range for GOM is 230 W/m^2 to 320 W/m^2 (lower than North Sea turbines)
- Larger rotors are heavier, have greater loads, need taller towers, and must be designed to handle extreme hurricane conditions
- Hypothetical GOM turbine designs were developed for mean wind speeds from 7.0 m/s to 9.0 m/s to use in cost analysis

Specific Power = Turbine Nameplate Capacity (watts)/Swept Area (m^2)

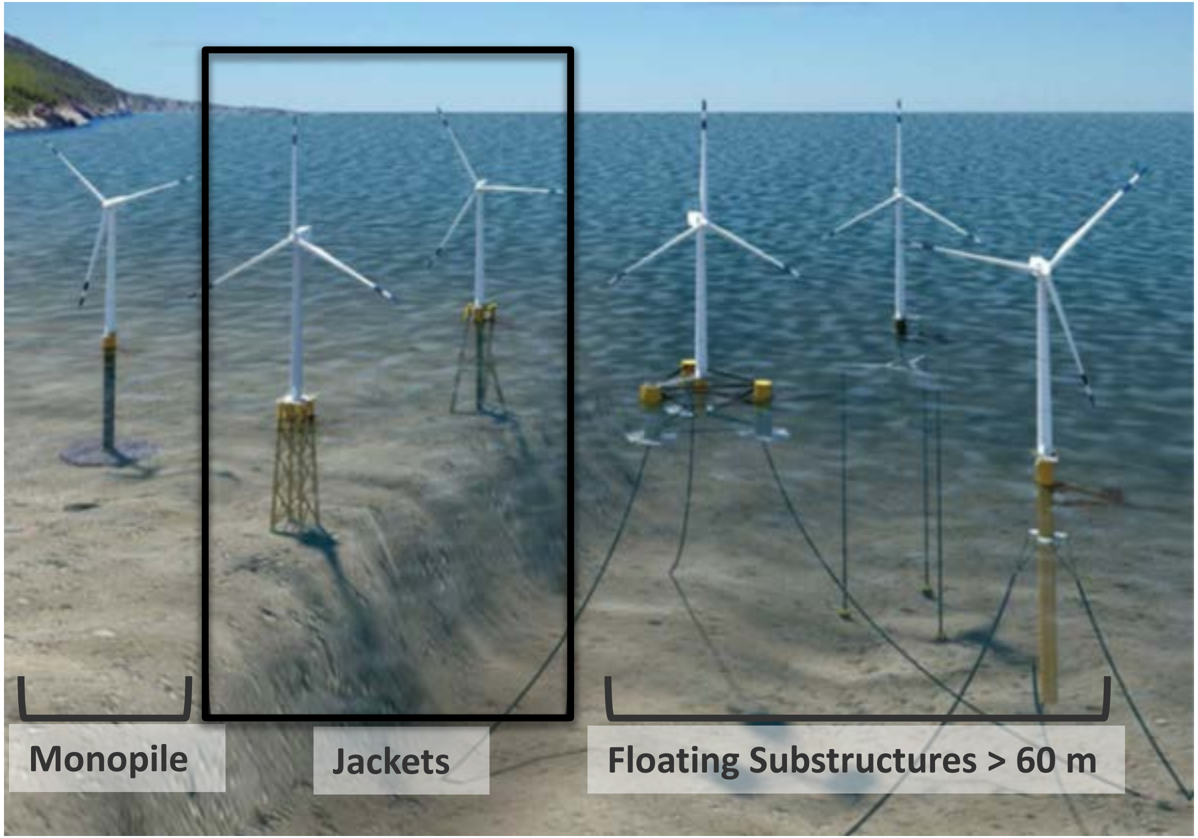
Gulf of Mexico Low Wind Speed Turbines



Turbine Designation	Baseline DTU 10 MW	T234	T257	T280	T303
Applicable Wind Speeds (m/s)	9.0	<7.25	7.25 to 7.75	7.75 to 8.25	> 8.25
Rotor Diameter (m/ft)	205/673	233/764	223/732	213/699	205/673
Specific Power (W/m^2)	303	234	257	280	303
Hub Height (m/ft)	125/410	141.5/464	136.5/448	131.5/431	126.5/415
Turbine Rating (MW)	10	10	10	10	10

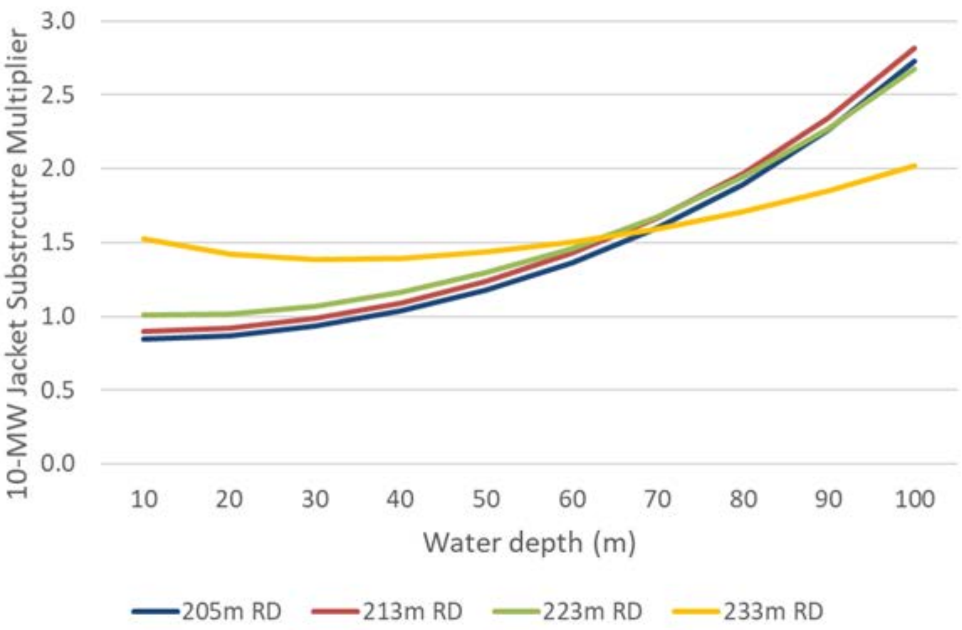
Key Reference: Bak, C., Zahle, F., Bitsche, R., Kim, T., Yde, A., Henriksen, L. C., Natarajan, A. 2013. The DTU 10 MW Reference Wind Turbine. Danish Technical University. http://orbit.dtu.dk/files/55645274/The_DTU_10MW_Reference_Turbine_Christian_Bak.pdf

Common Offshore Wind Turbine Substructures



- Jackets will likely work best in the soft soils of the Gulf of Mexico
- Jackets have been proven by the oil and gas industry
- Monopiles may be not be feasible due to soft soils
- Cost analysis assumes jacket will be deployed in the GOM

Jacket Cost Analysis



Jacket cost increases with water depth and rotor size

Offshore Wind Economic and Cost Analysis for the Gulf of Mexico Region

NREL's Cost Model Description

- NREL's cost model is the **O**ffshore **R**egional **C**ost **A**nalyzer (**ORCA)**
- Developed in 2015; maintained by NREL (funded by DOE)
- Enables geo-spatial cost estimation of offshore wind projects in U.S. and future costs over time
- Fixed-bottom and floating capability
- "bottom-up" tool; sums individual component costs and spatial cost variables
- Updated when new data become available
- Three categories of cost elements:
  - **Fixed costs** are site independent
  - **Variable costs** have distinct relationships with spatial parameters (water depth, wind climate, distances, etc.)
  - **Cost multipliers** vary in general with total project cost

Beiter, P., W. Musial, A. Smith, L. Kilcher, R. Damiani, M. Maness, S. Sirnivas, T. Stehly, V. Gevorgian, M. Mooney, and G. Scott. 2016. *A Spatial-Economic Cost Reduction Pathway Analysis for U.S. Offshore Wind Energy Development from 2015–2030* (Technical Report). NREL/TP-6A20-66579. National Renewable Energy Laboratory (NREL), Golden, CO (US). www.nrel.gov/docs/fy16/66579.pdf.

Key Modeling Assumptions for Gulf of Mexico

Objective:

- Provide an indication of future economic viability along the Gulf of Mexico coastline through estimates of geographically varying estimates of offshore wind ***LCOE* and *Net Value***

GOM modified assumptions for this LCOE analysis in 2027 (COD) include:

- Baseline assumptions documented in Beiter et al. (2016; 2017)
- Assumes installation and O&M vessel availability in GOM by 2027 (COD)
- Gulf of Mexico low specific power 10-MW turbines on jackets substructures
- Model includes financial assumptions (fixed charge rate = 9.1%; tax rate = 26%)
- Adjustments for 25% increase in insurance rate,
- Reduced costs for export cables relative to 2016 study

Economic Terminology

$$\text{Net Value } (\$/\text{MWh})_i = \text{LACE}_i - \text{LCOE}_i$$

Where:

Economic Potential = Net Value > 0

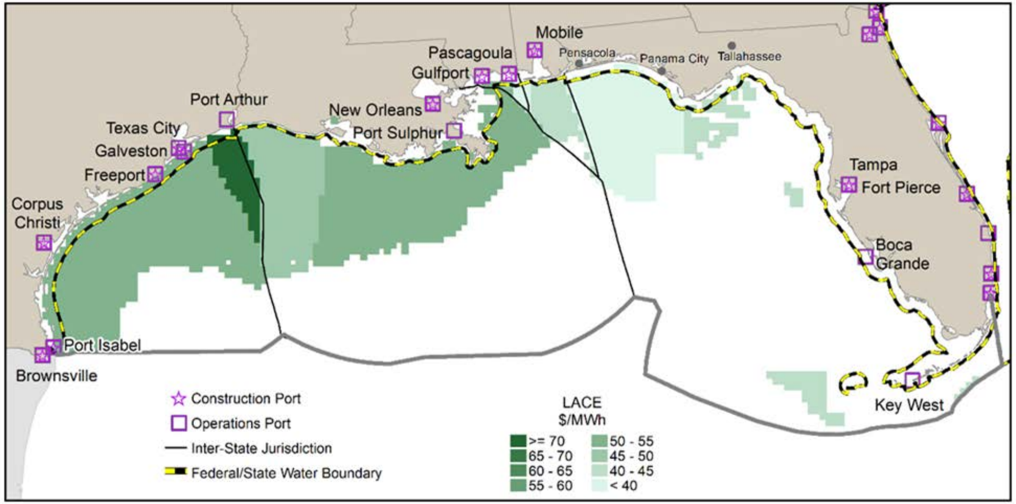
LACE = Levelized Avoided Cost of Energy

LCOE = Levelized Cost of Energy

$$\text{LCOE} = \frac{(\text{FCR x CapEx}) + \text{OpEx}}{\text{AEP}_{net}}$$

Where:

FCR	=	fixed charge rate (%)
CapEx	=	capital expenditures ($/kW)
OpEx	=	average annual operational expenditures ($/kW/year)
AEP_{net}	=	net average annual energy production (kWh/year).

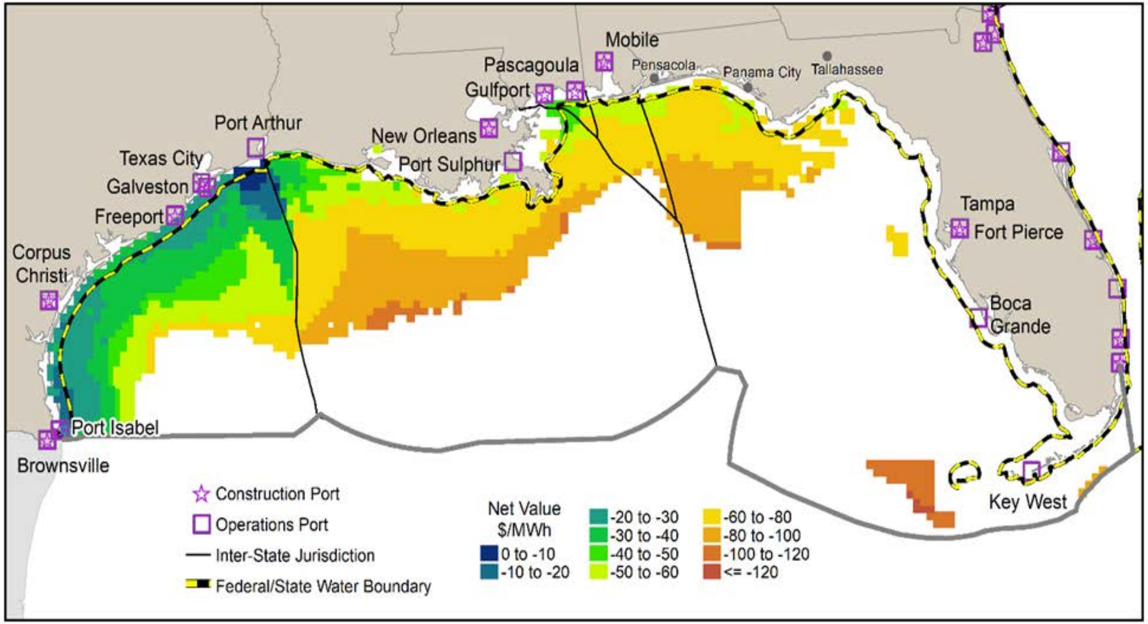


Gulf of Mexico Levelized Avoided Cost of Energy (LACE) (2030 COD)

LACE values for 2030 (COD) were extrapolated from modeled values in 2015, 2022, and 2027 (COD) from Beiter et al. (2017)

Regional Net Value of Offshore Wind Modeled in 2030

- Western GOM sites had highest net value – some sites near -$10/MWh
- No sites showed “economic potential” (positive net value) but a likely uncertainty range is +/-$10/MWh
- Model limitations:
  - Limited to 2027 model year (extrapolated to 2030) – 2032 now available
  - Limited to 10-MW turbines: 12 MW and 15 MW may be more realistic now
  - FCR limited to 9.1 % - higher than some market studies – common assumptions now indicate 7% to 8% FCR.



Estimated Net Value of Offshore Wind for Gulf of Mexico (2030 COD)

2030 Data were extrapolated from modeled data for 2015, 2022, and 2027 in Beiter et al. (2017).

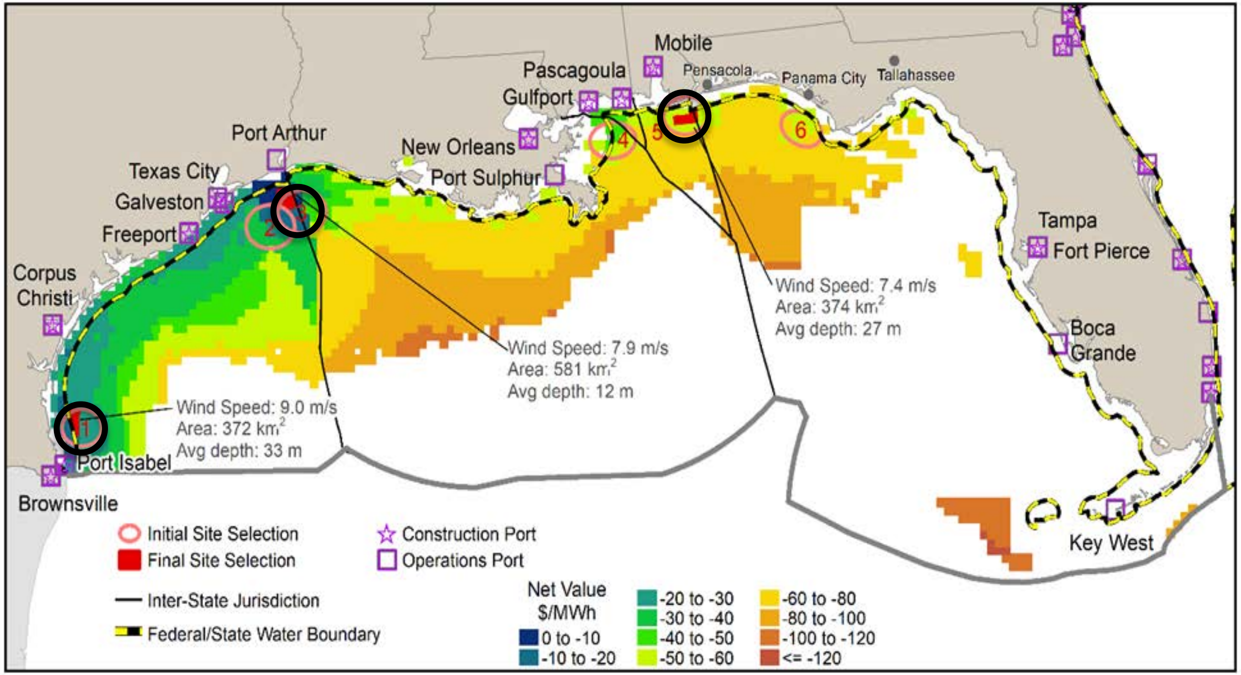
Six Sites Were Selected for Further Analysis

Primary Site Selection Criteria

- Relatively High Net Value
- Large enough (i.e., at least 350 km^2) to support a 1000-MW wind plant
- Relatively low LCOE
- Site in federal waters (BOEM jurisdiction)
- Respect setbacks needed for viewshed
- Take advantage of shallow waters (less than 40 m)

Six sites identified (see map)

Sites 1, 3, and 5 selected for further analysis



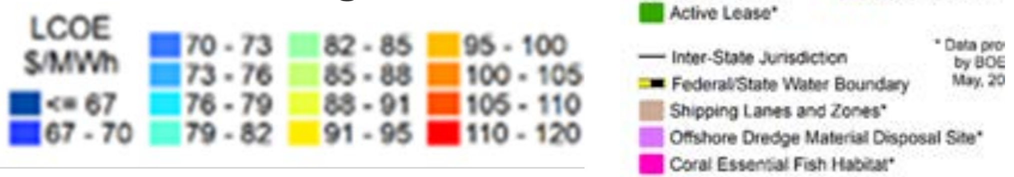
Net Value of Offshore Wind in Gulf of Mexico (2030 COD) with 6 Selected Sites

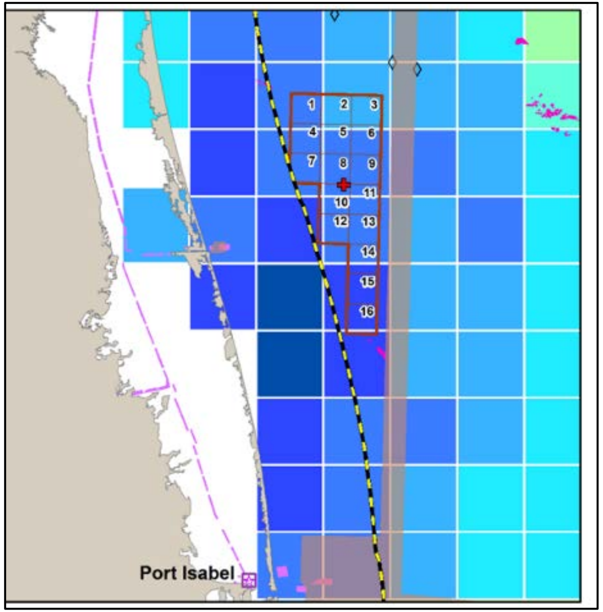
2030 Data were extrapolated from modeled data for 2015, 2022, and 2027 in Beiter et al. (2017).

Site Specific Cost of Energy Analysis

Gulf of Mexico Site Maps with LCOE Estimated for 2030

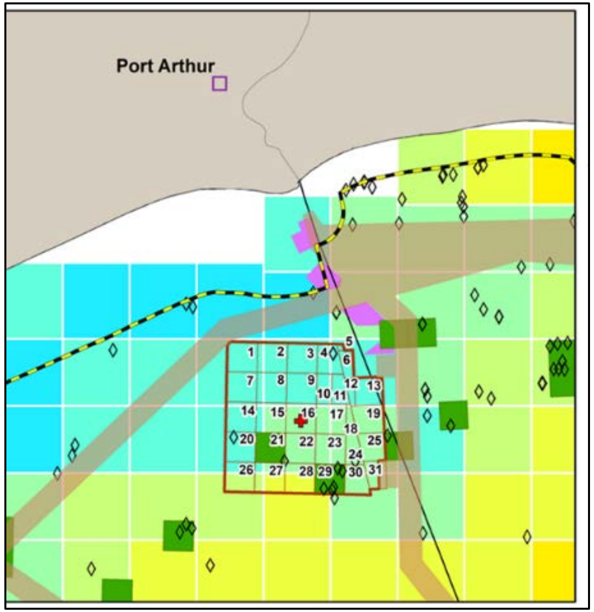
Legends





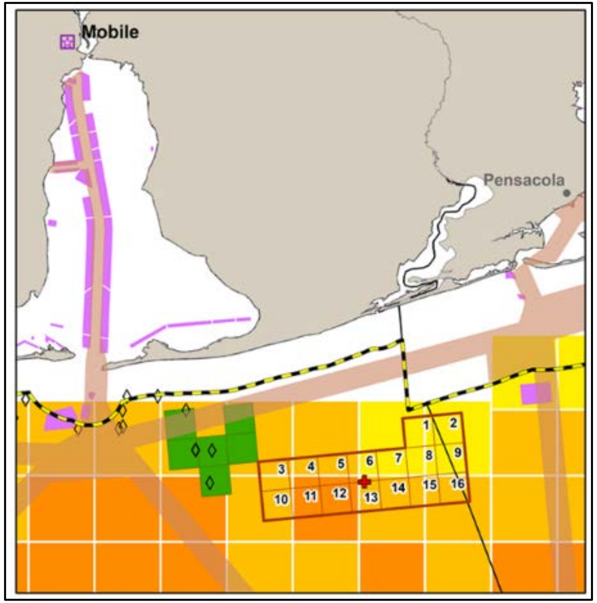
Site 1: Port Isabel

- Wind speeds: 8.8 – 9.1 m/s
- Depth: 26 m to 39 m
- Centroid: -97.06, 26.66



Site 3 – Port Arthur

- Wind speeds: 7.8 – 8.2 m/s
- Depth: 26 m to 39 m
- Centroid: -93.84, 29.34

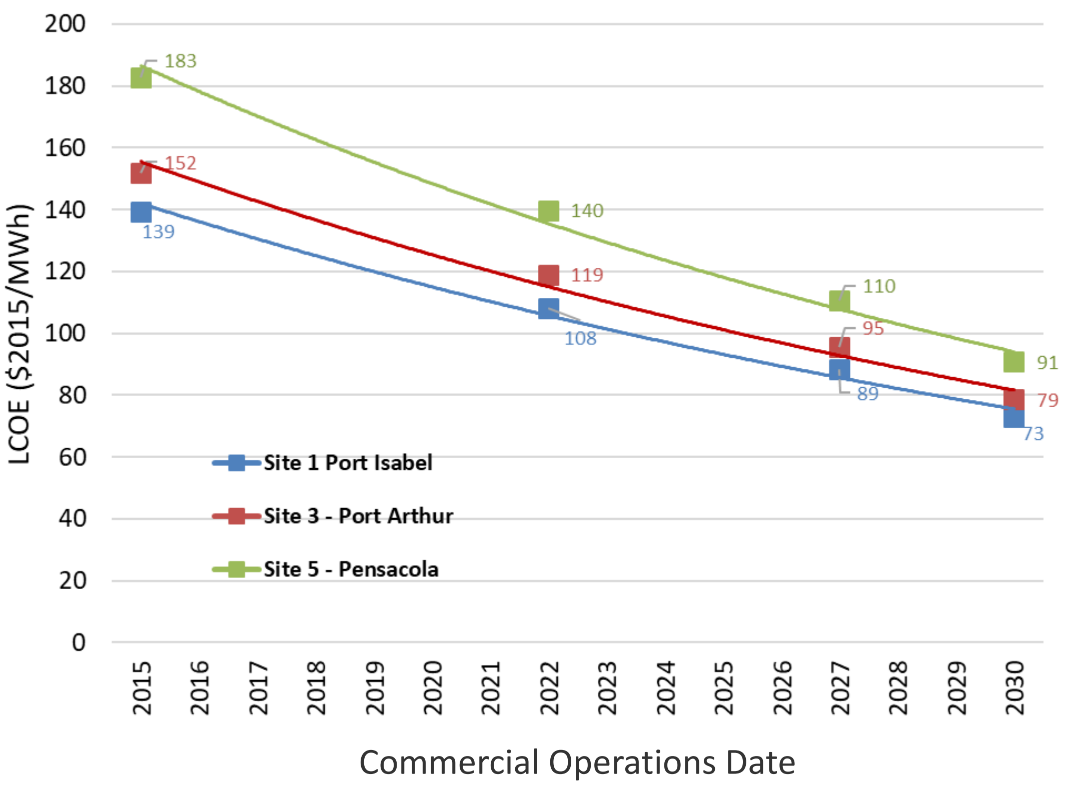


Site 5 – Pensacola

- Wind speeds: 7.37 – 7.39 m/s
- Depth: 19 m to 35 m
- Centroid: -87.60, 30.03

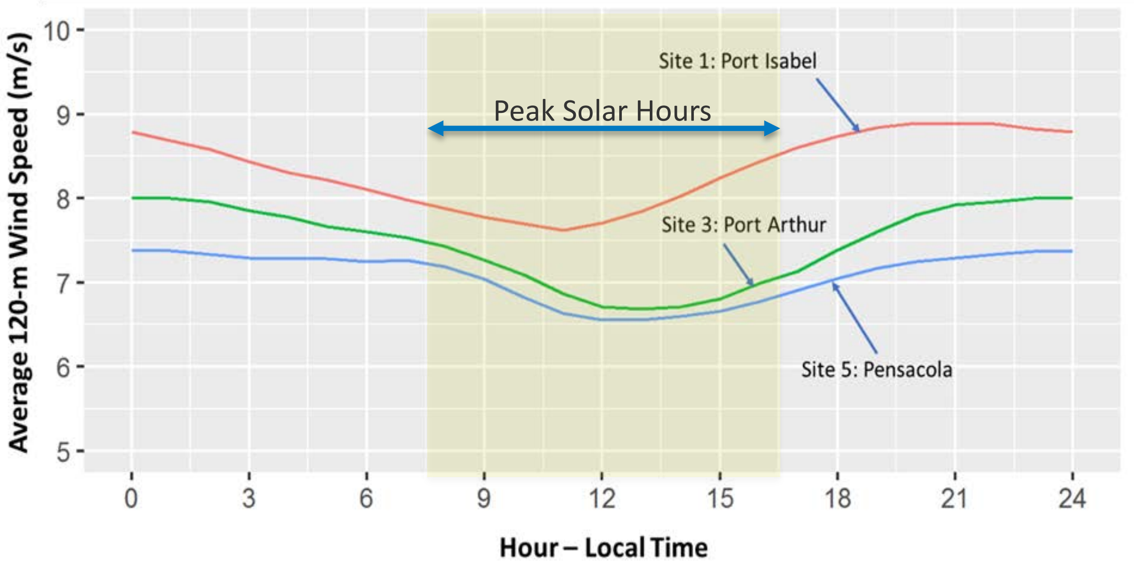
Cost Trajectories for Gulf of Mexico Study Sites

- Cost model estimates show a range of LCOE for 2030 between $73/MWh (Port Isabel) and $91/MWh (Pensacola)
- 2030 costs are extrapolated from 2015, 2022, and 2027 model years
- Costs may be conservative (high) because turbine growth is limited to 10-MW and Fixed Charge Rate (finance) to 9.1%.
- Gulf of Mexico could potentially have cost competitive utility scale offshore wind by early 2030s



Diurnal Wind Characteristics in the Gulf of Mexico

- Diurnal wind cycles exhibit similar day/night characteristics at all sites.
- All three sites have peak winds in the late evening.
- Port Isabel shows an earlier peak at about 21:00 while the other sites are around midnight.
- The low point of the cycle corresponds with mid-day for all sites.
- Lower wind at noon could be advantageous in avoiding over-production during peak solar hours.



Average Diurnal Wind Characteristics in Gulf of Mexico sites modeled at 120-m

JEDI Jobs Gulf of Mexico Site Analysis

- A single representative site (Port Arthur) for the GOM was modeled using the Jobs and Economic Development Impact (JEDI) model
- Close to good wind site potential and GOM infrastructure
- Used same CapEx, OpEx costs, and technology assumptions as cost analysis
- Single project 600-MW results are state independent and scalable to regional deployment
- Local content analysis assumes GOM labor and facilities
- Support for projects outside of region are not considered

Summary of JEDI Findings for Gulf of Mexico

- Total jobs and gross revenue will benefit Gulf of Mexico states, but analysis is not state specific
- Gross economic impacts do not consider changes in other industries
- Manufacturing of jacket substructures was the largest economic driver
- Job impacts due to supply chain support for other regions is additive (e.g. Block Island Wind Farm)
- **Scaling to DOE/DOI Wind Vision scenario** which modeled 8,600 MW of offshore wind in the GOM region: About Fourteen - 600-MW plants would be built.

4470	150	$445	$14
total jobs during construction	annual jobs during operating years	million GDP during construction	million GDP during operating years

Economic activity supported from the construction and operation of a 600-MW GOM offshore wind project at Port Arthur site.

Major Findings and Next steps

Major Findings

- By 2030, the model estimates LCOE between $70/MWh and $80/MWh off the Houston coastal area and south of Corpus Christi
- Clusters of relatively low LCOE sites are estimated in Western Louisiana, and off Pensacola and Biloxi
- Highest **Net Value** sites were estimated to be off Houston, South of Corpus Christi, and in western Louisiana
- No sites had positive net value by 2030: **Gulf of Mexico could potentially have cost competitive utility scale offshore wind by early 2030s**
- Significant gross job creation based on 600-MW plant

Next Steps

- Journal publication of findings – December 2020
- ORCA Model improvements to address larger turbines and lower finance rates
- New resource data is coming
- Hurricane research is needed

Thank you for your attention!

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Photo Credit : Dennis Schroeder-NREL

Questions, Comments?

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