



RUTGERS
THE STATE UNIVERSITY
OF NEW JERSEY

Offshore Wind Energy Off New Jersey: Where We Are Today

Joseph F. Brodie, Ph.D.

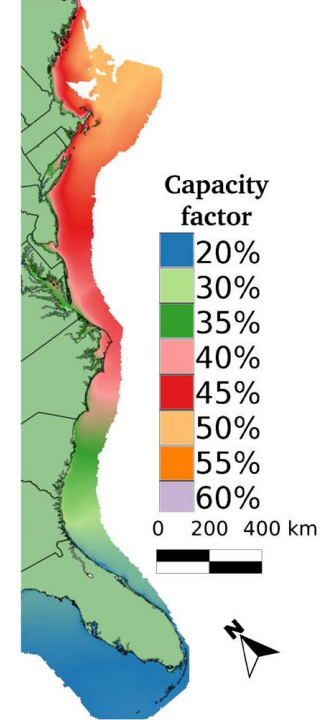
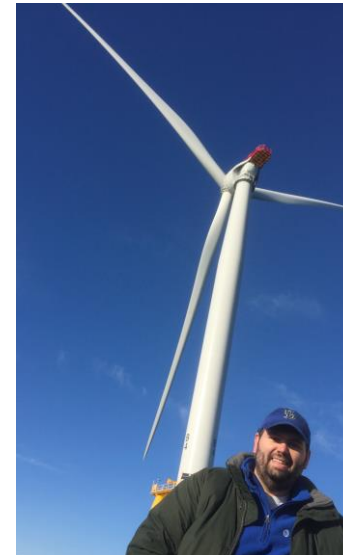
Director of Atmospheric Research

Rutgers Cooperative Extension
Marine Extension Seminar Series
10 December 2018

Center for Ocean Observing Leadership
Department of Marine and Coastal Sciences
School of Environmental and Biological Sciences

What is Offshore Wind?

- Why offshore?
 - Close proximity to load demand
 - Higher, more constant wind speeds
 - Doesn't occupy land resources
 - Much larger turbines than possible onshore
- Only one operating offshore wind farm in the US at Block Island, RI (5 turbines)
- Offshore development is dramatically different than onshore
 - Physical and biological characteristics and concerns
 - Multiple ocean uses



Dvorak et al. 2012

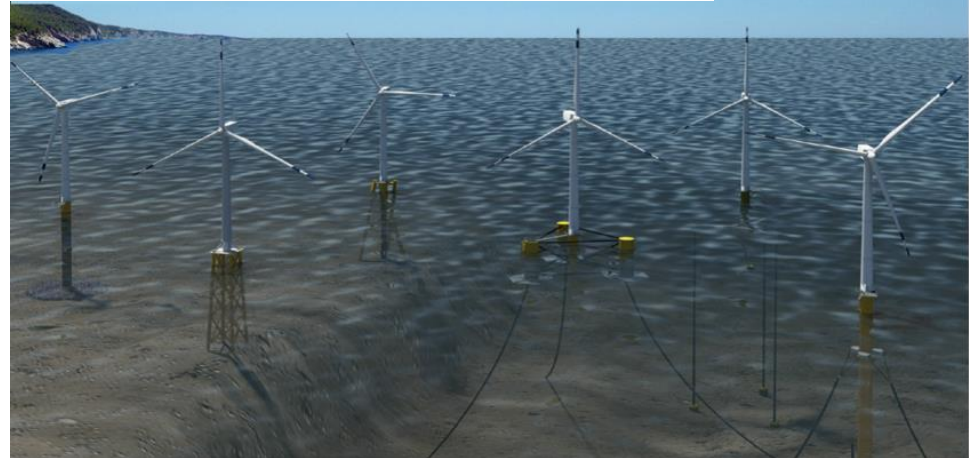
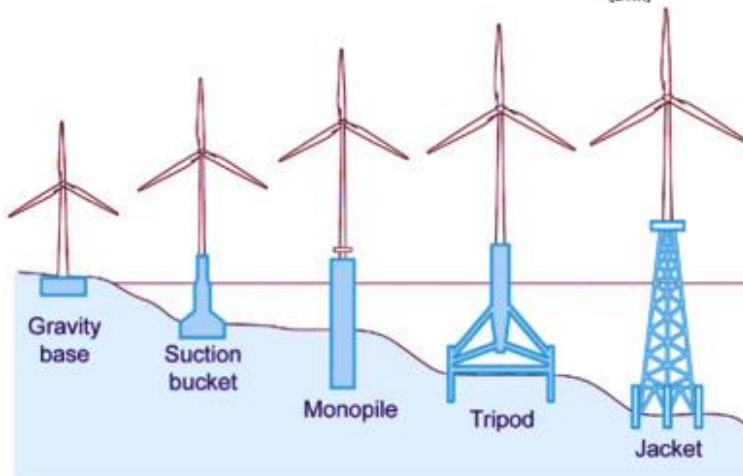
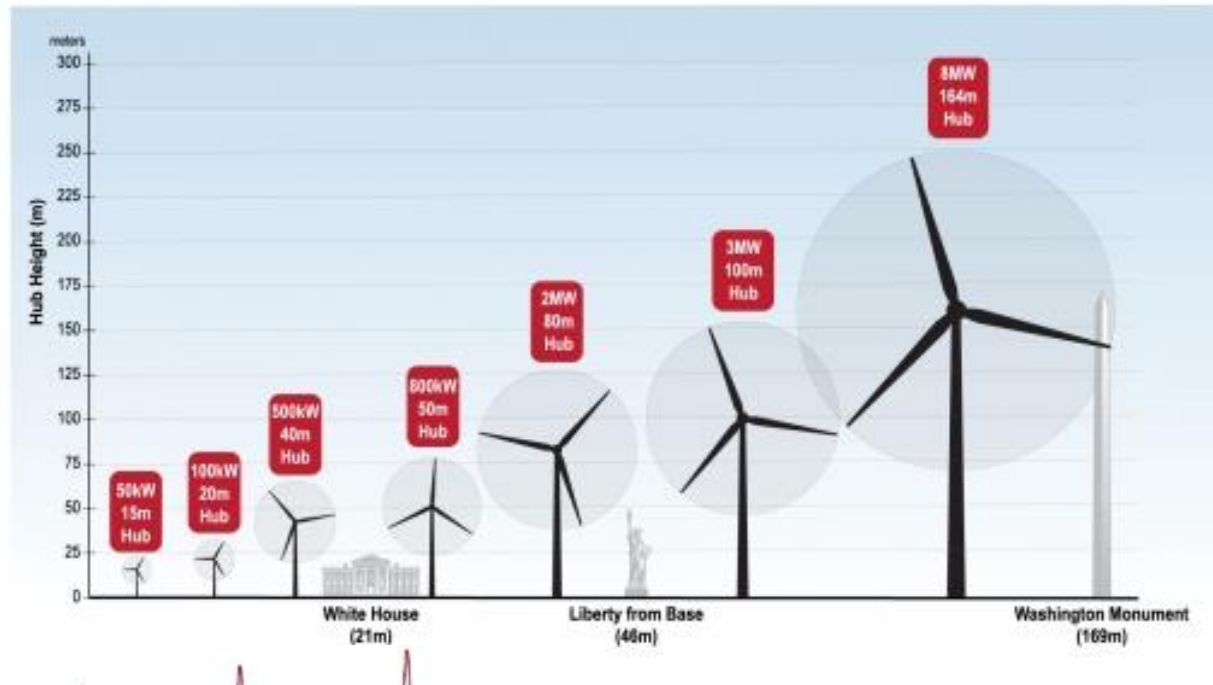


Image: Vattenfall

Block Island Wind Farm



Turbine Sizes and Foundations



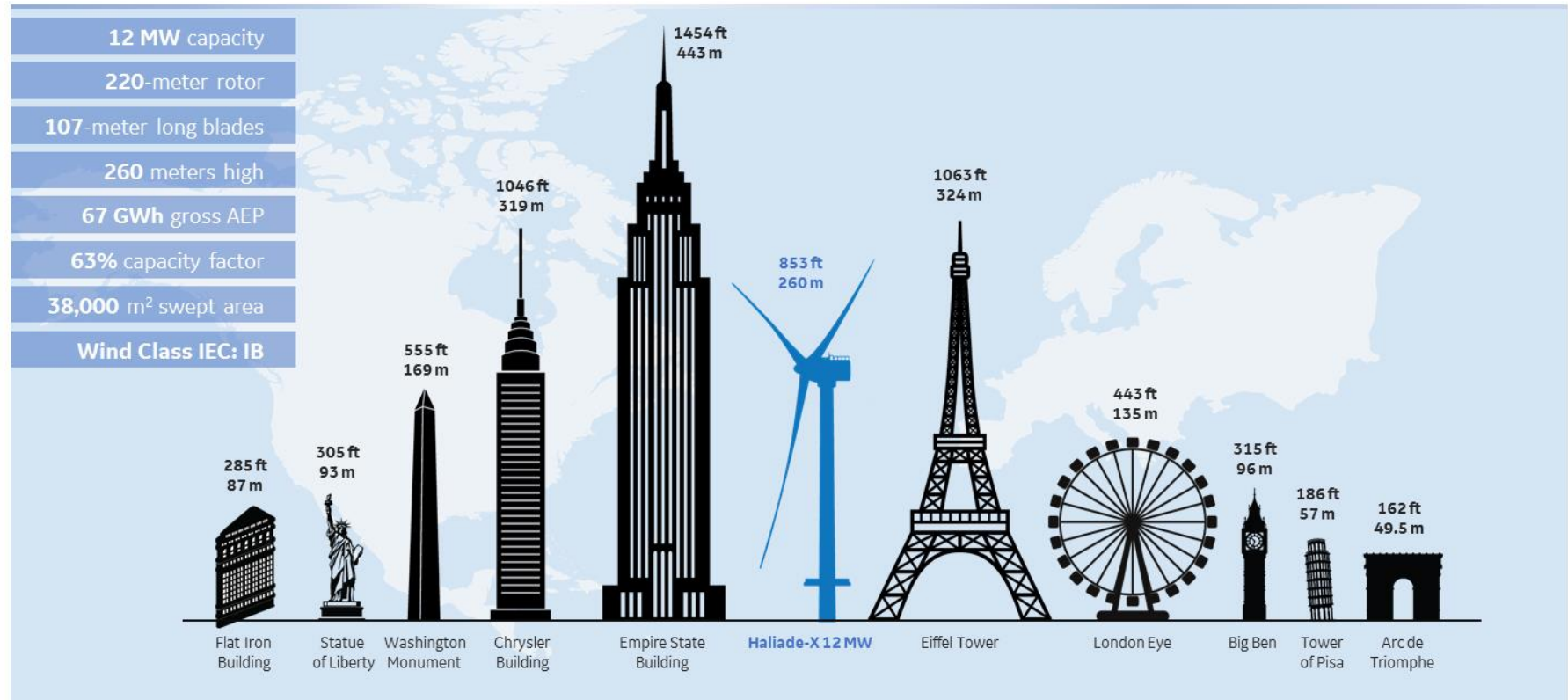
HALIADE-X 12 MW



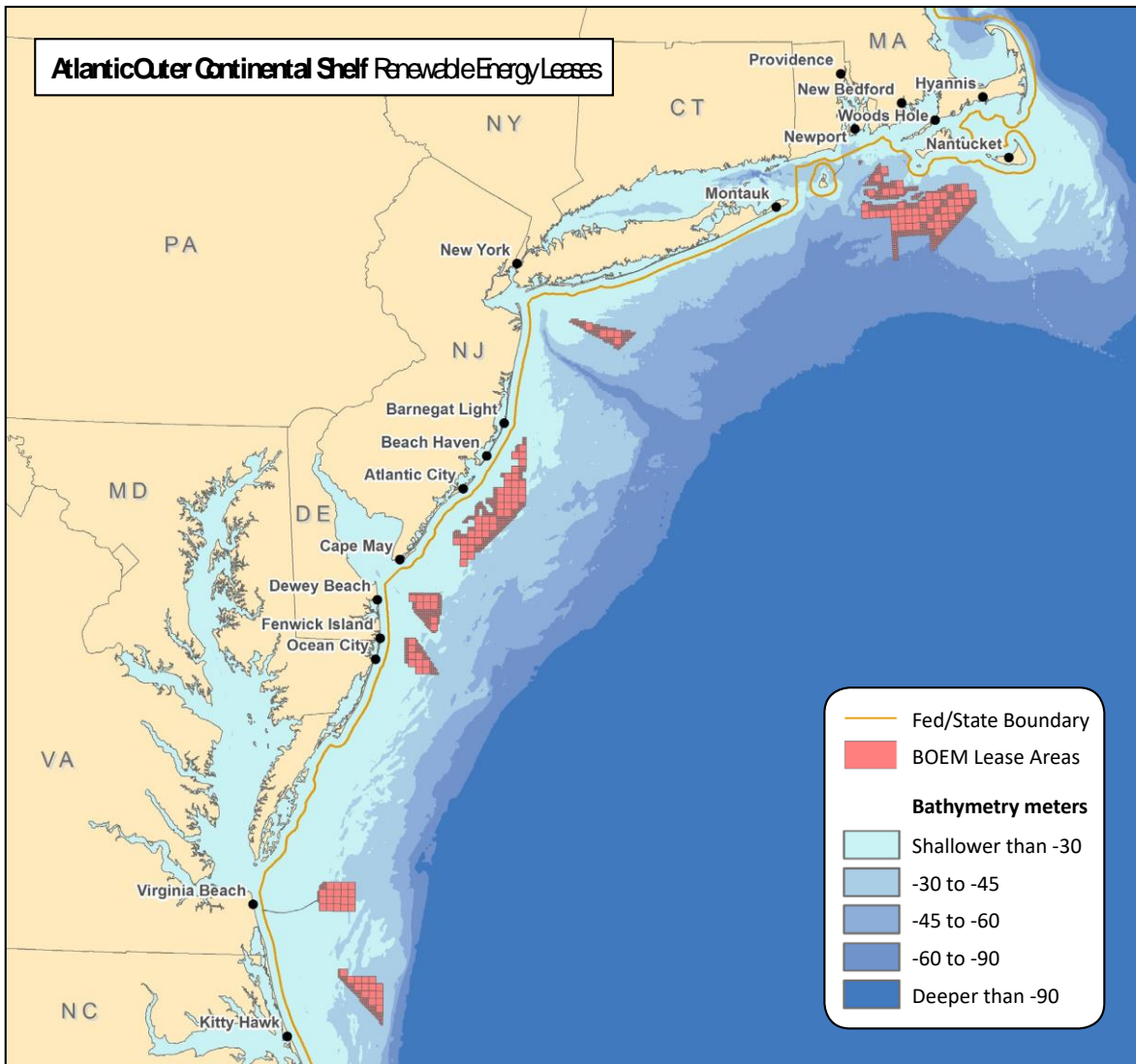
GE Renewable Energy is developing **Haliade-X 12 MW**, the biggest offshore wind turbine in the world, with **220-meter rotor**, **107-meter blade**, leading capacity factor (**63%**), and **digital capabilities**, that will help our customers find success in an increasingly competitive environment.

One **Haliade-X 12 MW** can generate **67 GWh annually**, which is **45% more** annual energy production (AEP) than most powerful machines on the market today, and twice as much as the Haliade 150-6MW.

The **Haliade-X 12 MW** turbine will generate enough clean power for up to **16,000** European households per turbine, and up to **1 million** European households in a 750 MW configuration windfarm.



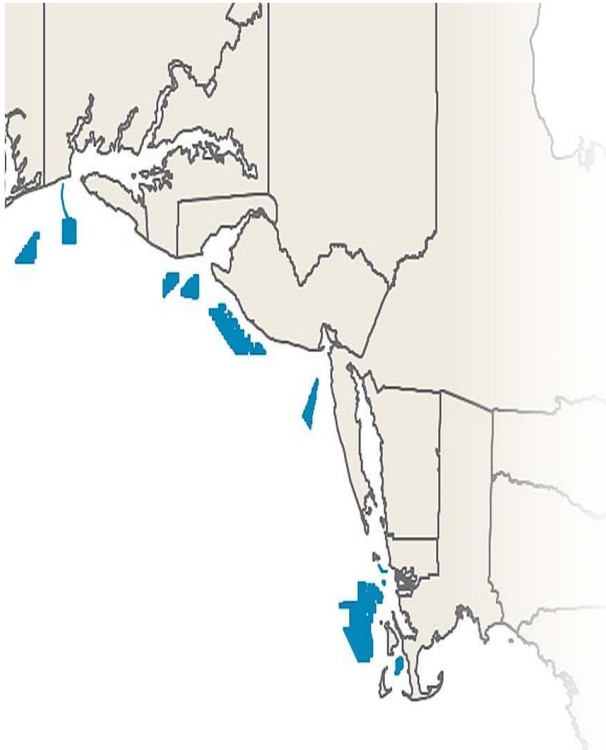
Active Federal Wind Energy Leases



Lease		Year
★ CVOW	Dominion/Ørsted	2020
★ Vineyard Wind	Avangrid	2021
★ South Fork	Deepwater	2022
★ Ocean Wind	Ørsted	2022
★ Bay State Wind	Ørsted	2022
★ US Wind MD		2022
★ Revolution Wind	Deepwater	2023
★ Skipjack/GSOE	Deepwater	2023
★ Dominion		2025
★ US Wind NJ		2026
★ Empire/Boardwalk	Equinor	2027
★ Kitty Hawk	Avangrid	2027

Source: BOEM May 2018

State Commitments



State	OSW Goal (MW)	Renewable Goal
Massachusetts	1,600	25% by 2030
Rhode Island	400	38.5% by 2025
Connecticut	250	20% by 2020
New York	2,400	50% by 2030
New Jersey	3,500	50% by 2030
Maryland	368	25% by 2020
Total	8,518	

Source: BOEM Aug 2018

New Jersey Solicitations	Year
1,100 MW	2018 (now!)
1,200 MW	2020
1,200 MW	2022

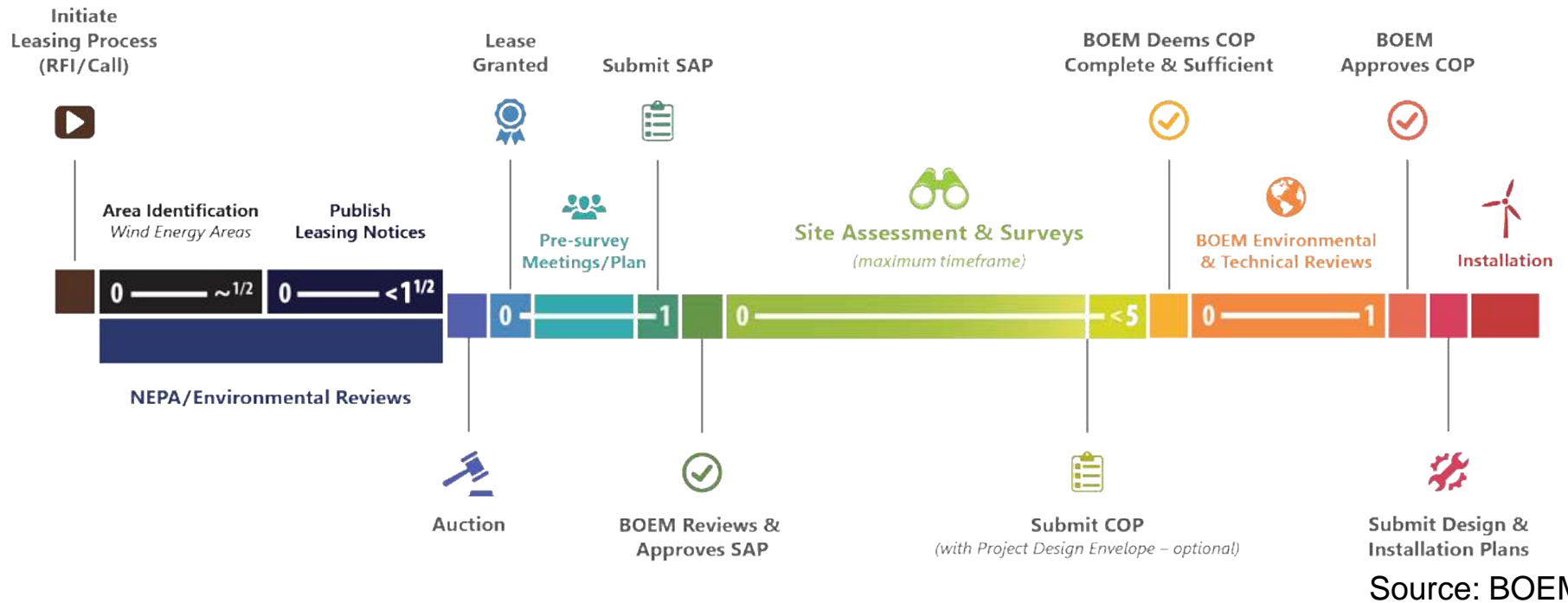
The Federal Offshore Wind Process: Bureau of Ocean Energy Management

[Planning & Analysis]

[Leasing]

[Site Assessment]

[Construction & Operations]



6 to 10+ year process from initial call to commissioning

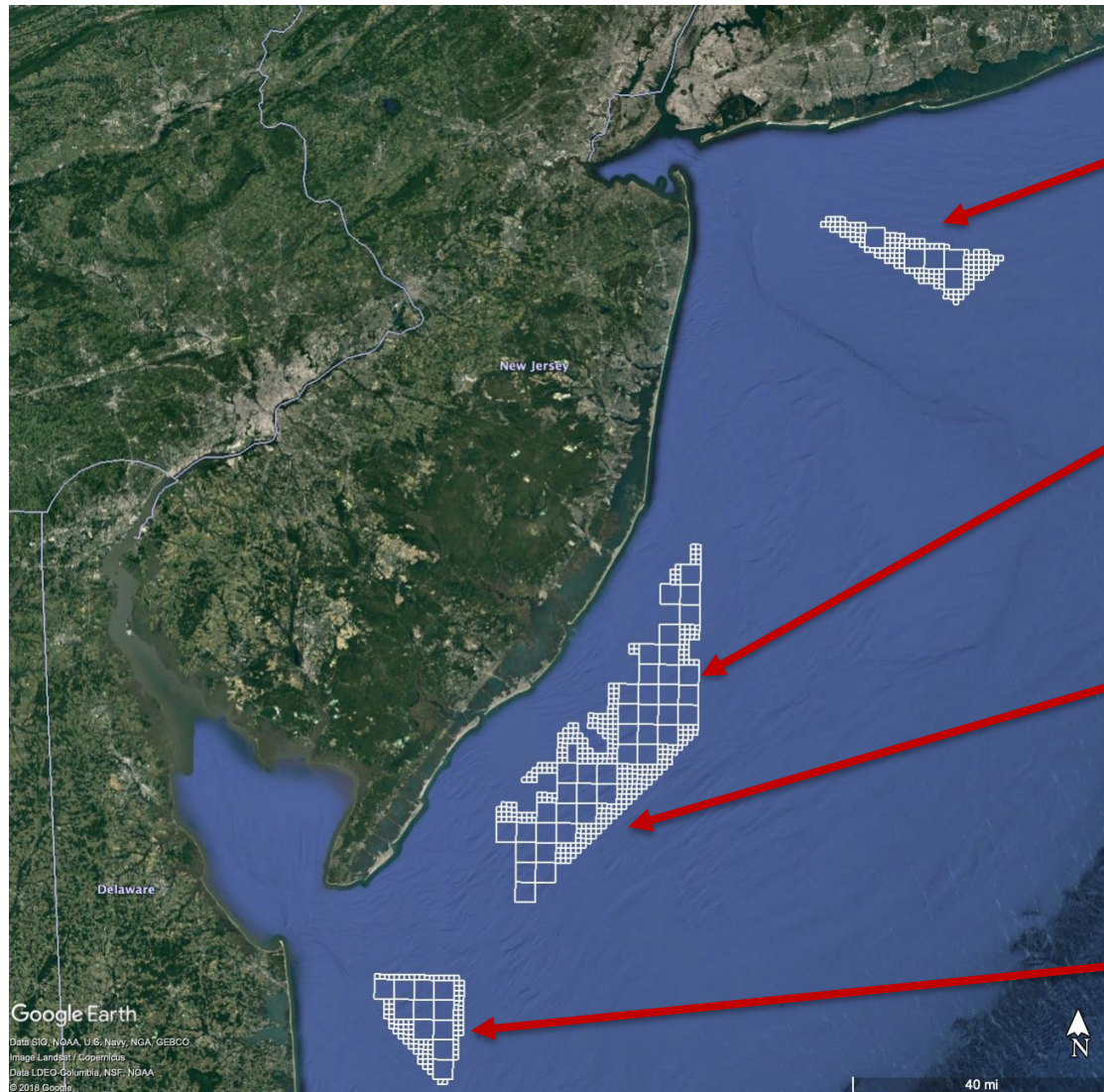
Where Does the State Come In?

- Large offshore wind lease areas are in federal waters (outside 3 nm from coast)
- State and local governments control locations where power is brought ashore
- Wind farms do not have a customer without state approvals to sell power into the state (in NJ, this is an Offshore Renewable Energy Certificate, or OREC)
- Developers need federal government for leasing and federal permits, and state/local governments to actually bring the power ashore and sell it into the grid

State Actions

- OWEDA (Offshore Wind Economic Development Act)
 - Signed in 2010 by Gov. Christie
 - Laid groundwork for OSW in NJ, consistent with NJ Energy Master Plan
 - “Net economic benefit test”
 - Created the NJ OREC process
- Executive Order #8
 - Signed in January 2018 by Gov. Murphy
 - Sets goal of 3.5 GW by 2030
 - Mandates BPU begins rulemaking process to move OREC process forward – first solicitation due December 28
 - Mandates development of NJ OSW Strategic Plan (more on this later)
- Executive Order #28
 - Signed in May 2018 by Gov. Murphy
 - NJ renewable energy goals of 21% by 2020, 35% by 2025, and 50% by 2030

NJ Current Leases



Empire Wind
Boardwalk Wind
Equinor

US Wind NJ
US Wind

Ocean Wind
Ørsted

Skipjack
Garden State Offshore
Deepwater (Ørsted)

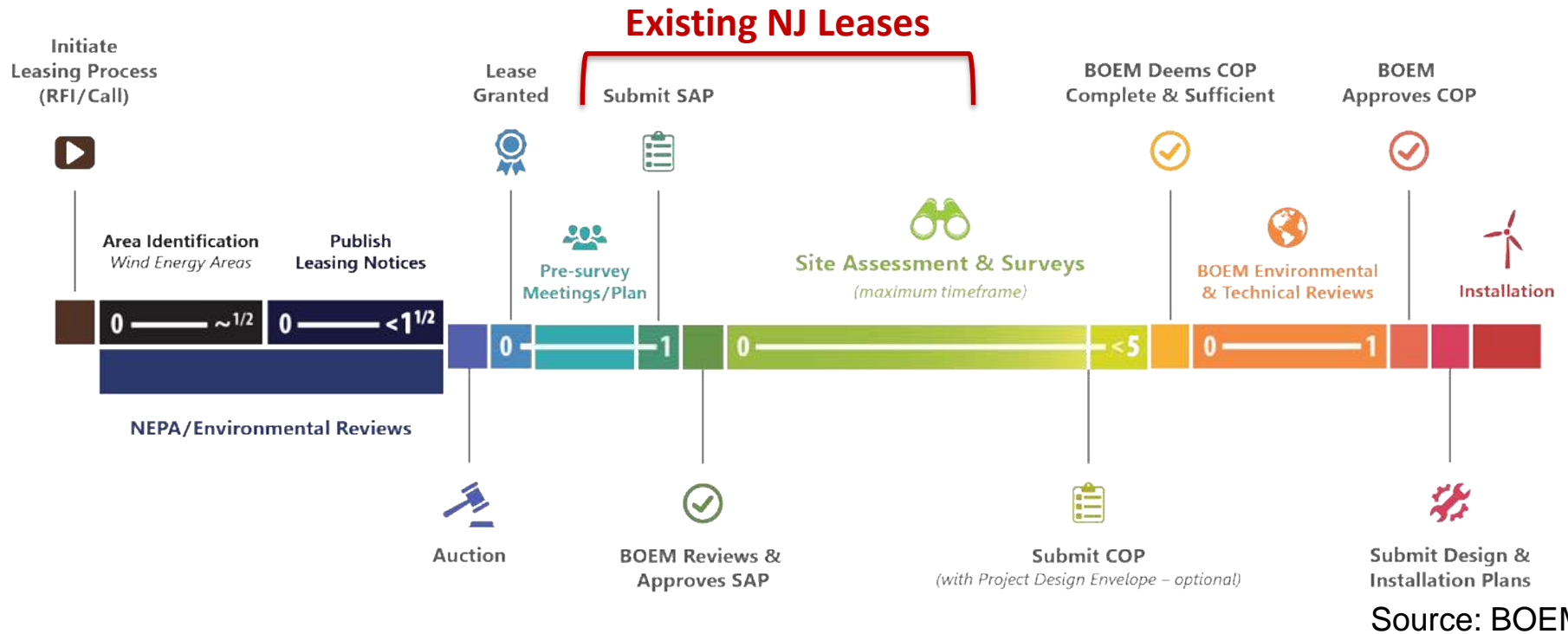
The Federal Offshore Wind Process

[Planning & Analysis]

[Leasing]

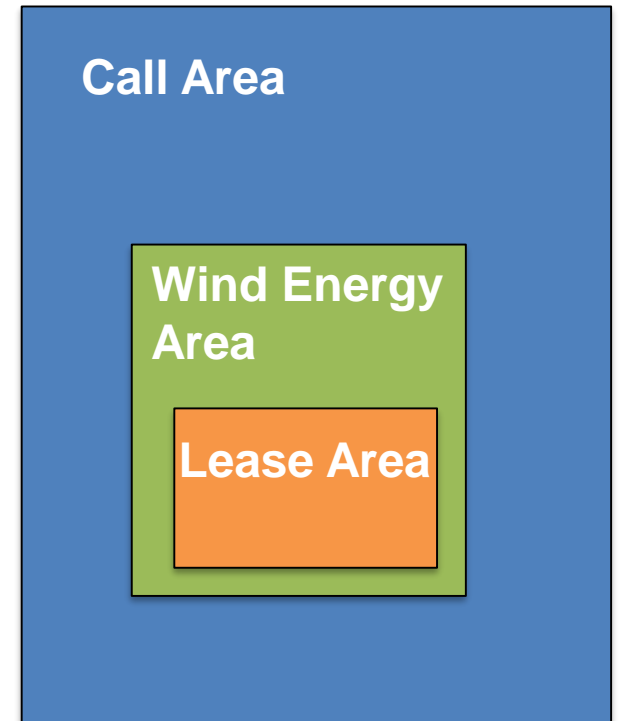
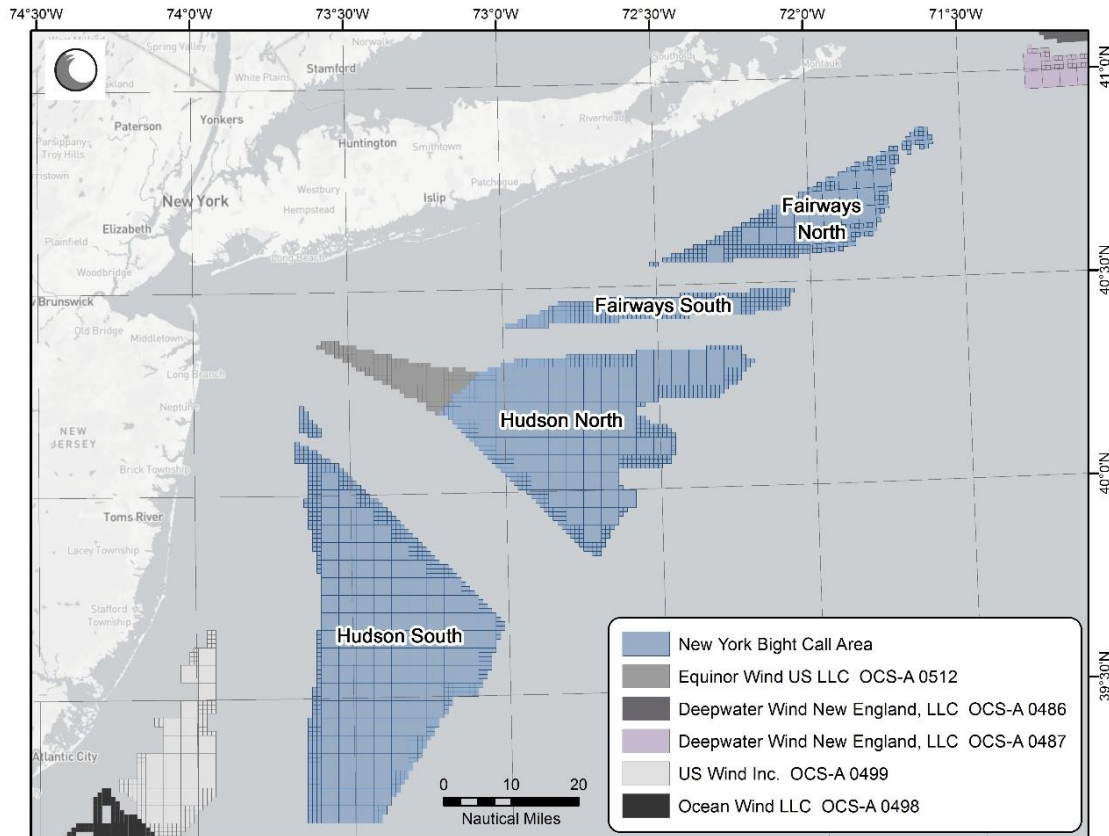
[Site Assessment]

[Construction & Operations]

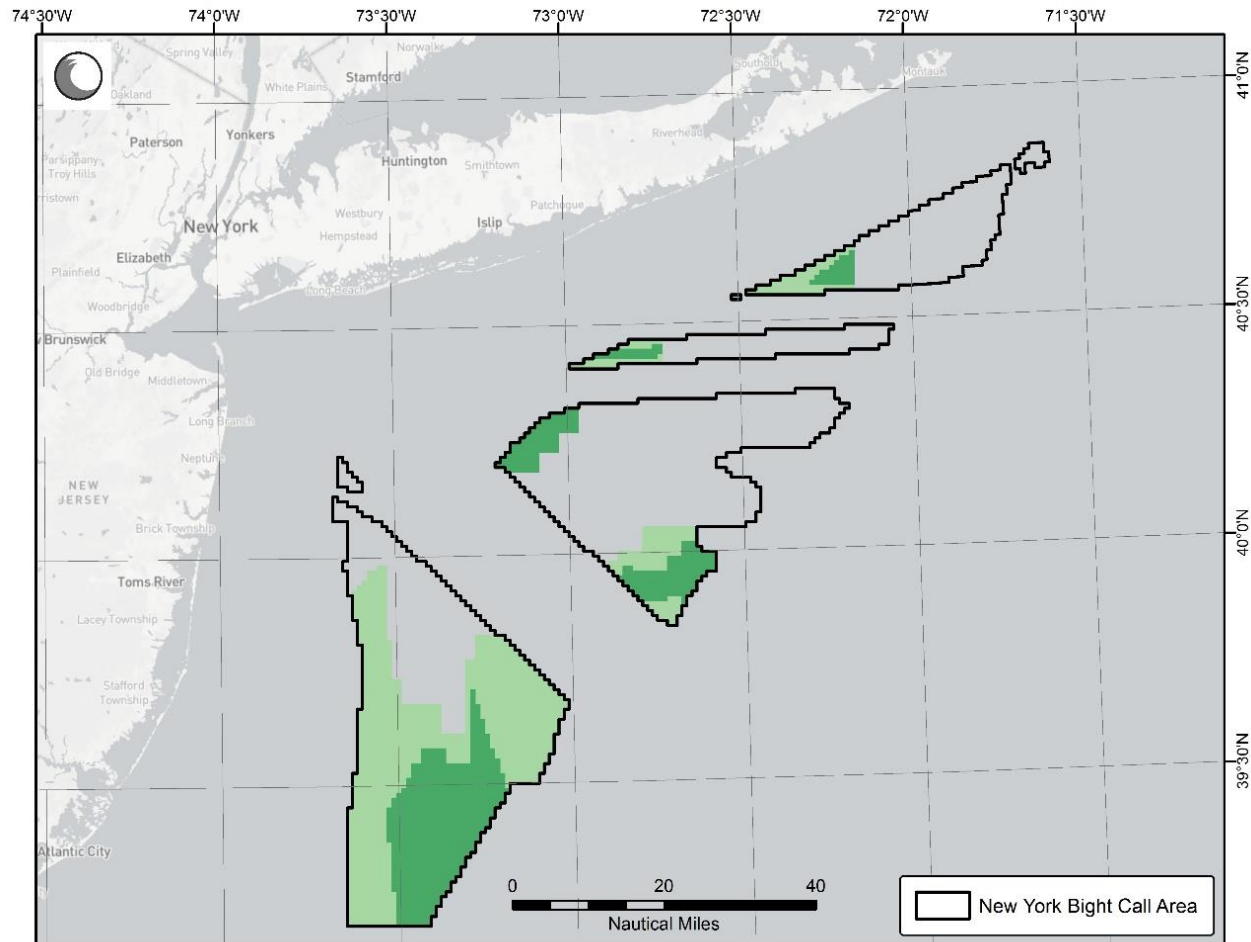


6 to 10+ year process from initial call to commissioning

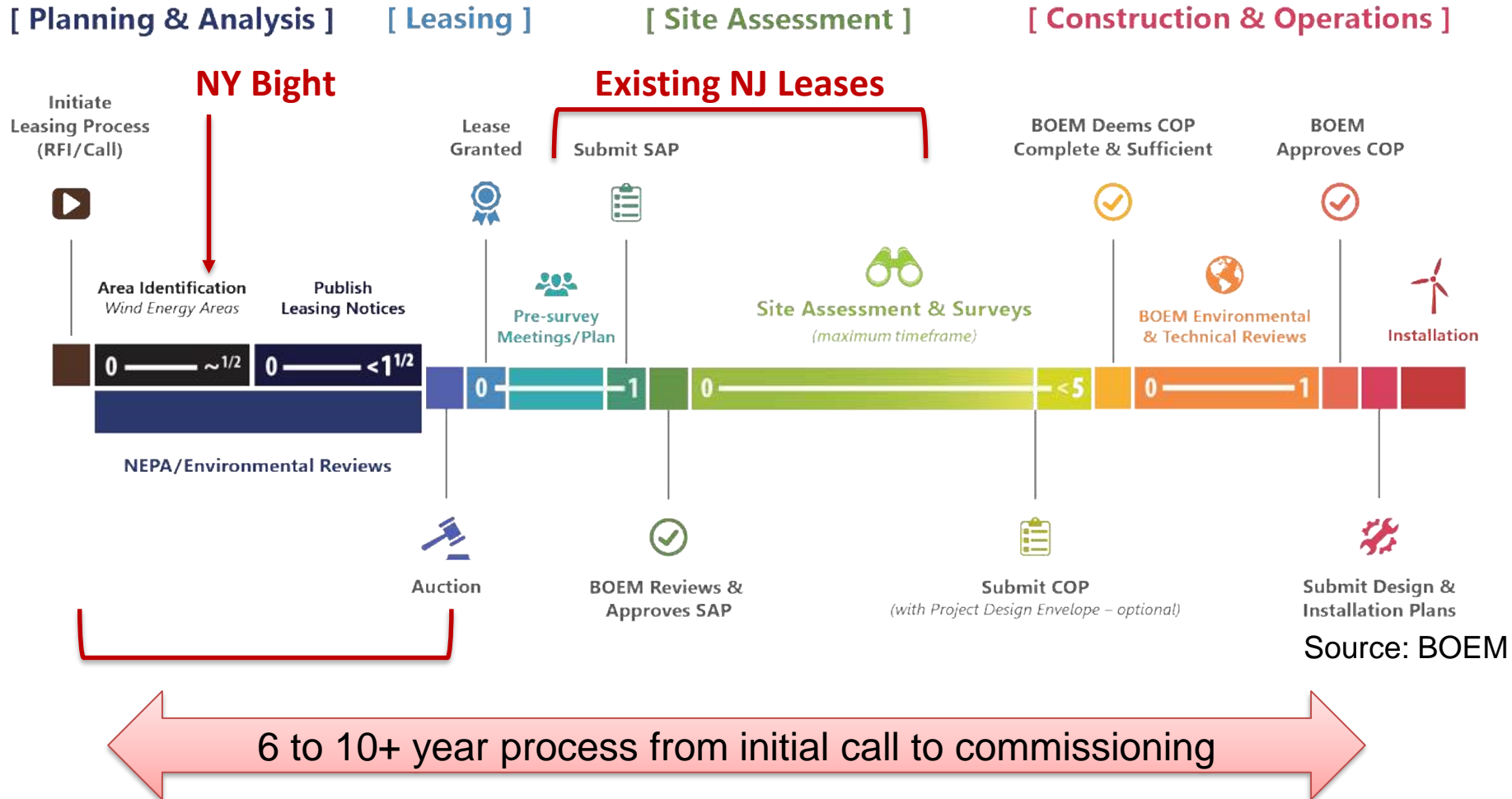
The New York Bight



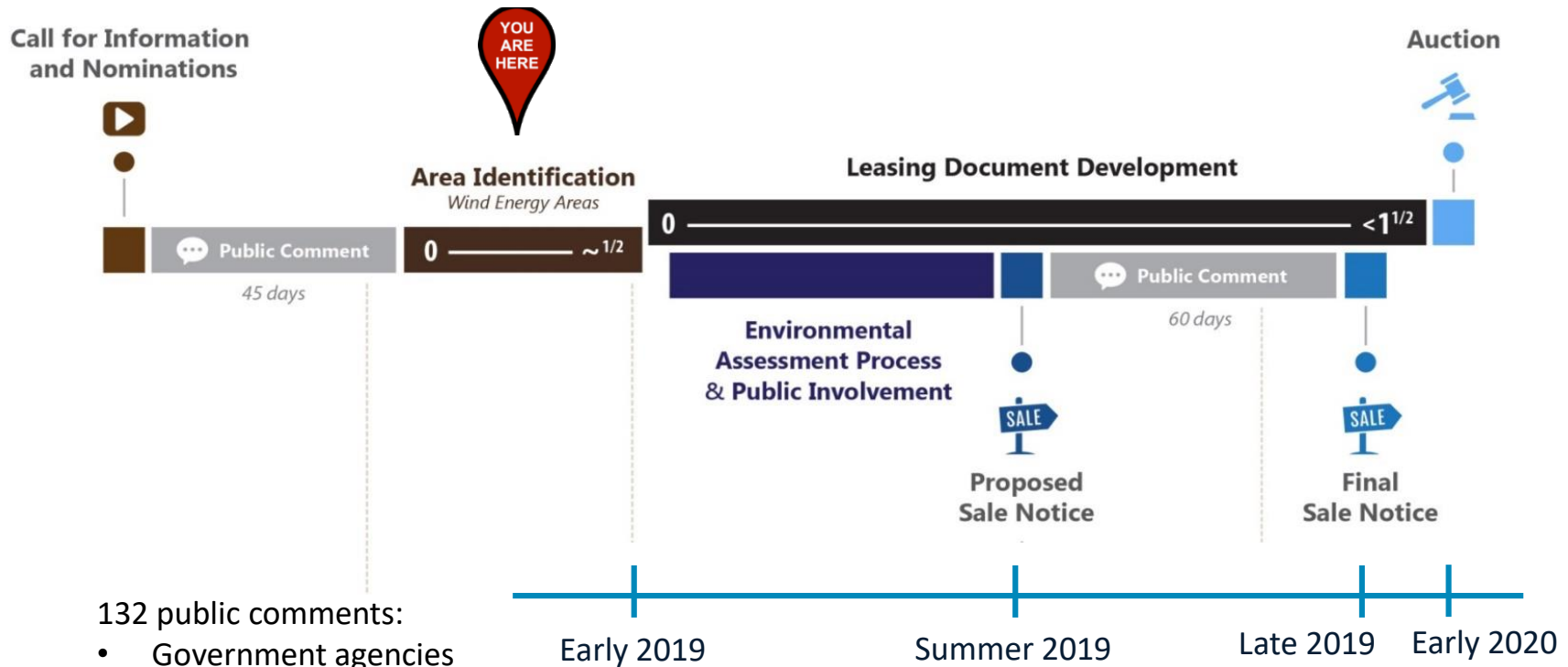
Initial Draft WEAs



The Federal Offshore Wind Process



Current Stage of NY Bight



132 public comments:

- Government agencies
- Fishing industry
- Maritime transport
- OSW developers
- Other industry
- NGOs
- Academia
- General public

Source: BOEM Nov 2018

Public Comment Periods:

BOEM required to acknowledge and address all comments received, which are all part of the public record

NJ Strategic Plan

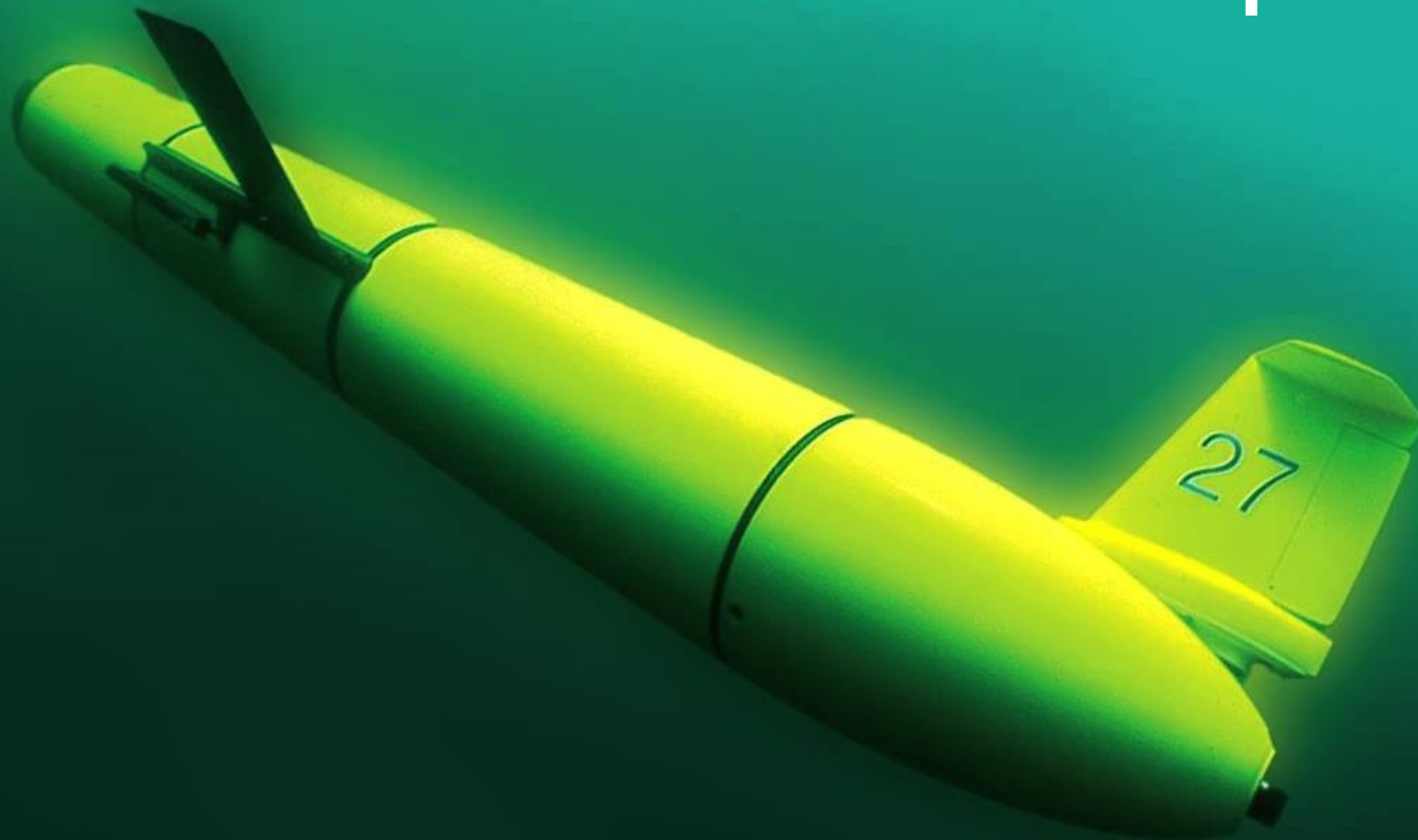
- Mandated by EO8
- Focus on 3 areas
 - Supply Chain and Workforce Development
 - Energy Pricing and Markets
 - Environmental Protection
- Stakeholder engagement is key throughout the process
- Led by 5 NJ government offices, with 6 member contracting team



Add to the Conversation

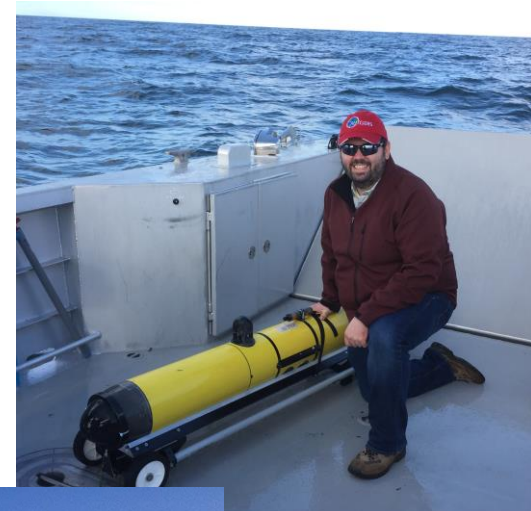
- Next NJ Public Meeting: Thursday, December 13, 6 PM, Atlantic County Government Building
- Stakeholder specific meetings starting in January
- Stay tuned to the process:
www.njcleanenergy.com/nj-offshore-wind

RUCOOL: Improved Observing for Better Offshore Wind Development



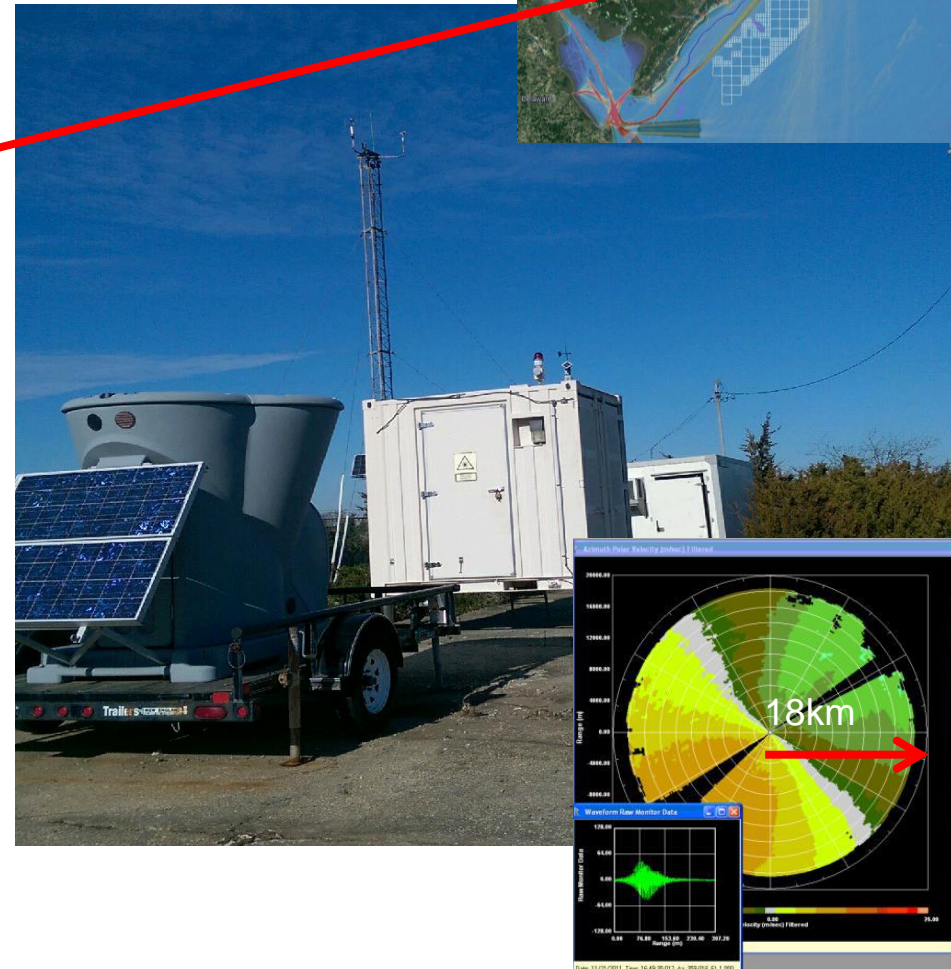
RUCOOL Overview

- Founded as the Coastal Ocean Observation Lab in 1992 by Scott Glenn & Oscar Schofield
- 5 tenure-track faculty (including the founders)
- 1 extension faculty
- 3 PhD-level research scientists
- 7 graduate students
- 18 FT research and operations staff
- Numerous undergraduate students (10+ presently)



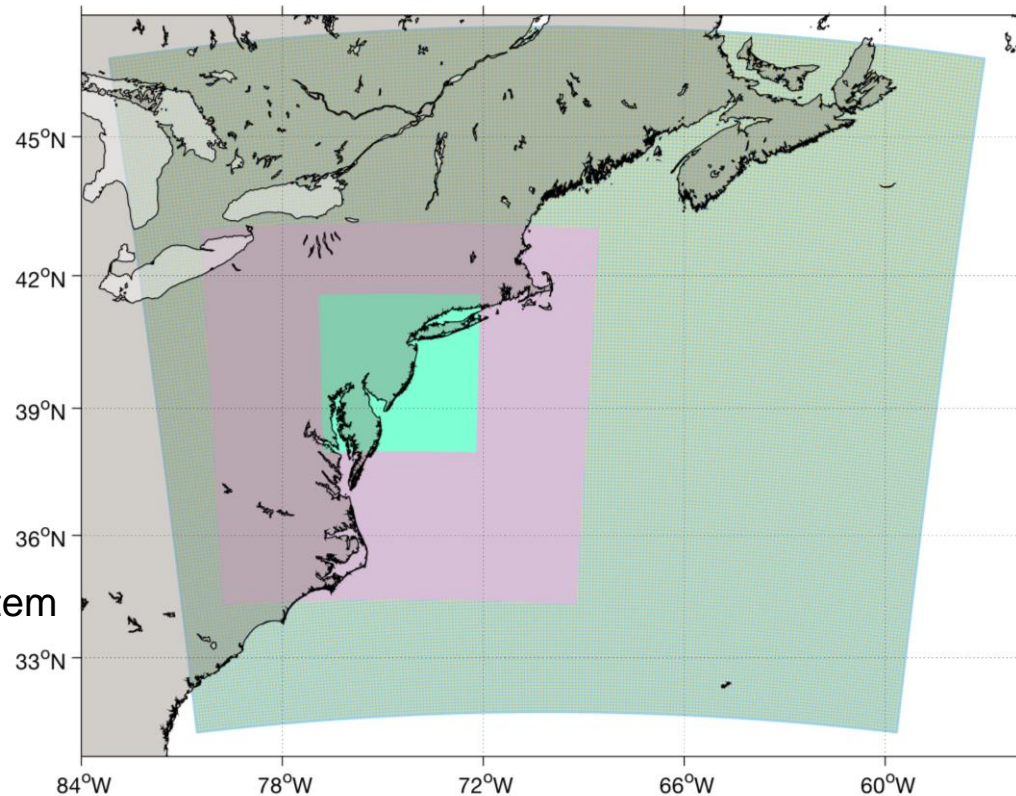
Coastal Met-Ocean Monitoring Station

- Located at the RU Marine Field Station in Tuckerton, NJ
- 12 m meteorological tower
- Triton SODAR
- Lockheed WindTracer scanning lidar



Real-Time Weather Modeling RU-WRF

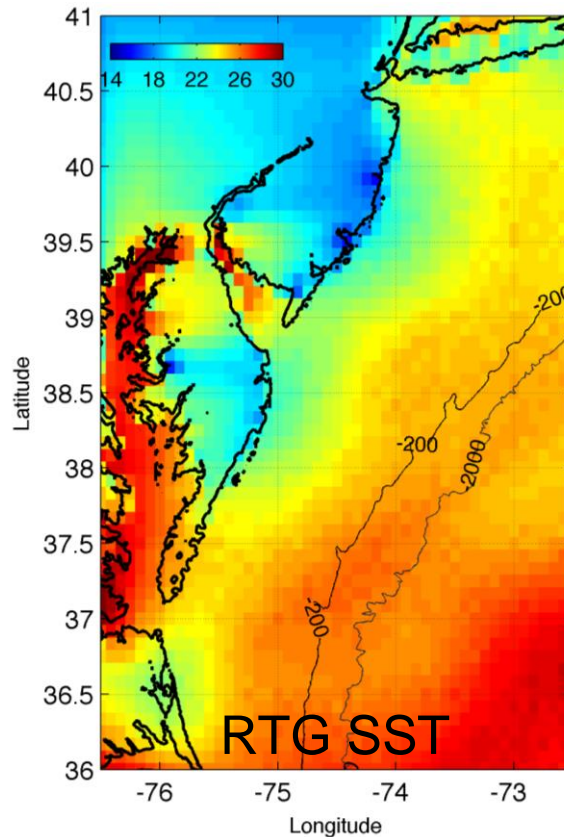
- Run Continuously 2011 – Present
- Triple nested: 9km-3km-1km
 - 9km: 0, 6, 12, 18Z cycles
 - 3km: 0, 12Z cycles
 - 1km: 0Z cycle (Research Mode)
- Hourly forecast:
 - 9km: out 5 days
 - 3km: out 2 days
 - 1km: out 1 days
- Lateral Boundary Conditions:
 - 9km: 0.25 degree Global Forecast System
 - 3km: RU-WRF 9km
 - 1km: RU-WRF 3km
- Vertical Levels:
 - 40 levels more tightly packed near the surface.
- Surface Boundary Condition:
 - RUCOOL Coldest Dark Pixel Composite



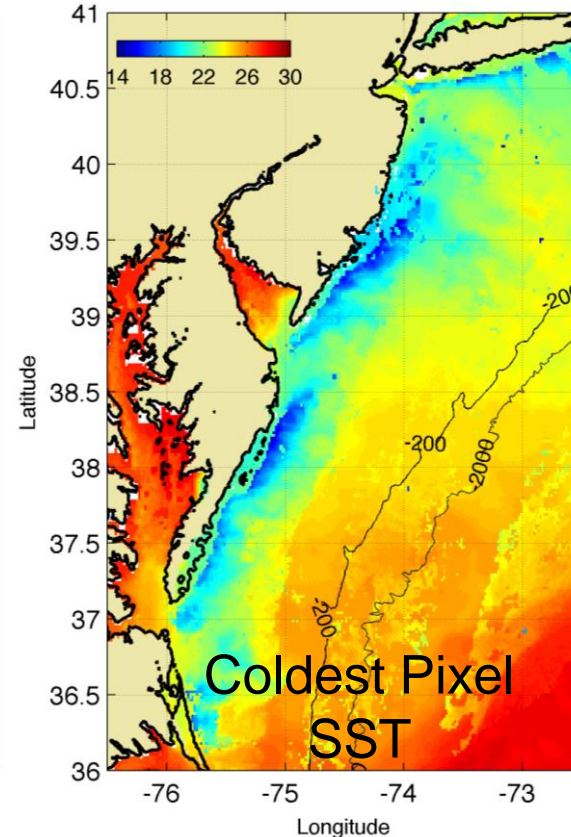
Regional Coldest Dark Pixel Composite SST Captures Coastal Upwelling

Example:
8 July 2013 Upwelling

Standard
National
Satellite
Sea Surface
Temperature
(SST) Product

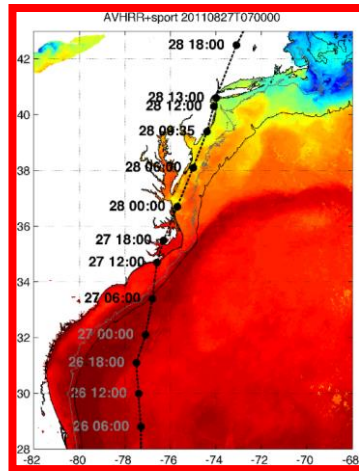


Rutgers
Regional
Satellite
Sea Surface
Temperature
(SST) Product



Cold Water Influences Coastal Storms

Hurricane Irene – Aug 2011

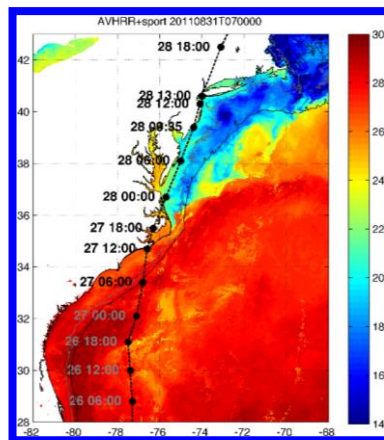
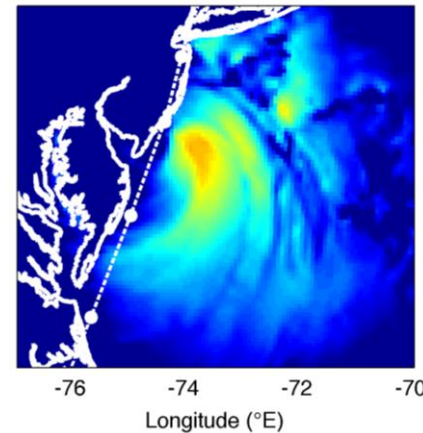


Warm
Ocean



Cat I
Hurricane

WRF Warm SST W Spd (kts)

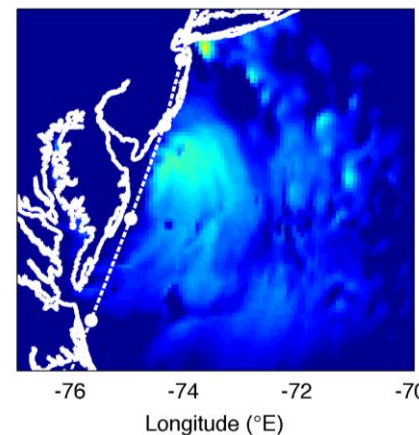


Cold
Ocean



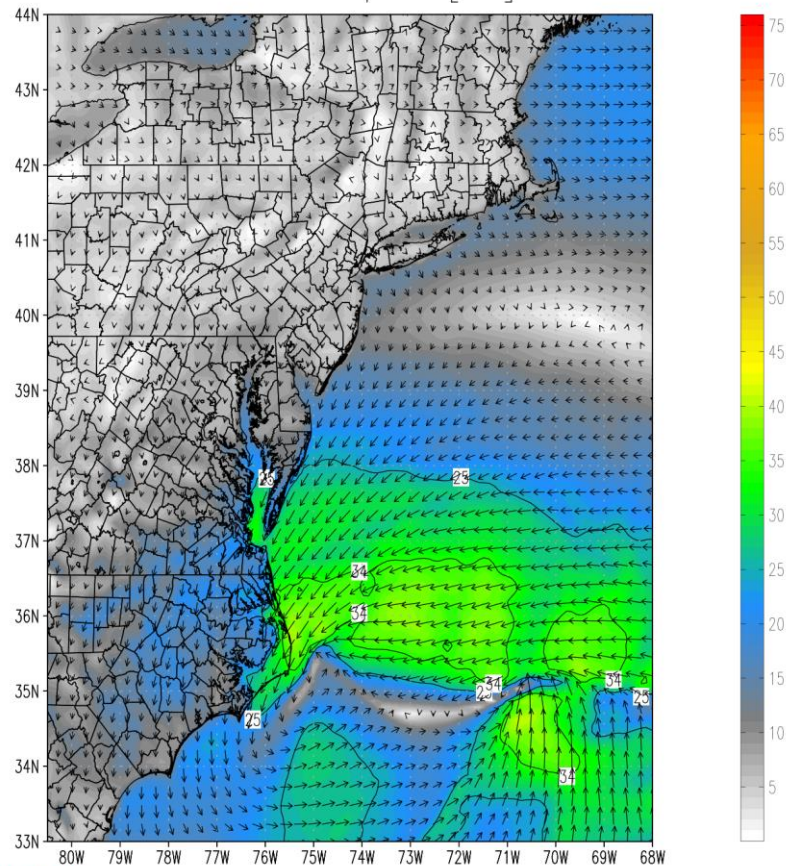
Trop
Storm

WRF Cold SST W Spd (kts)



RU-WRF Daily Model Output

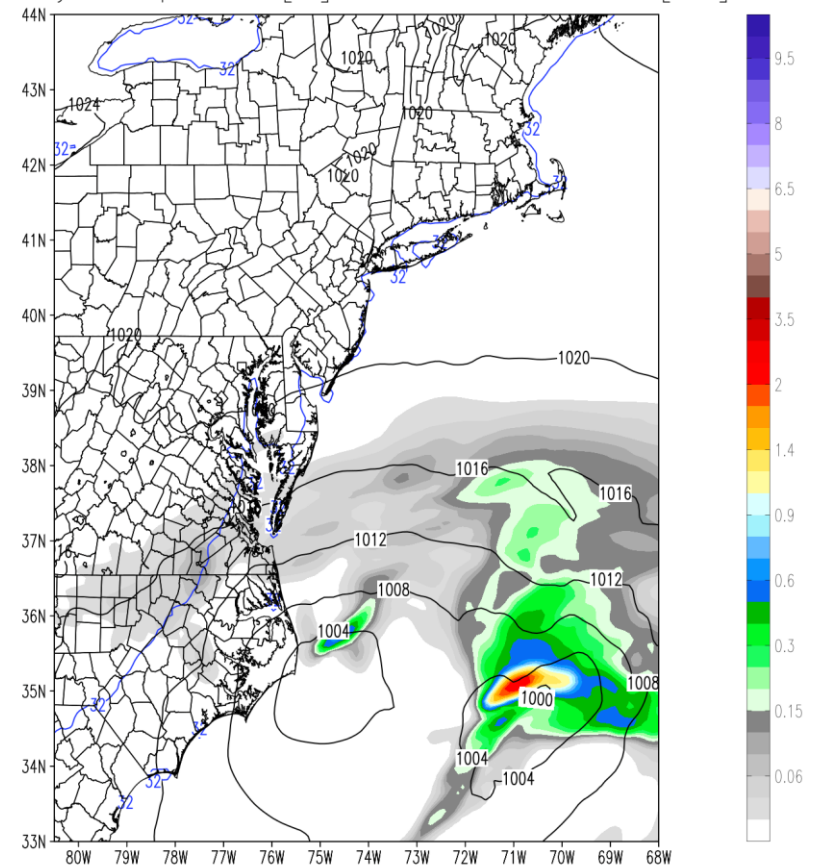
10m Wind Speed [kts]



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rucool.marine.rutgers.edu

RU-WRF 9 km Model: Initialized 00Z10DEC2018
Valid 04Z10DEC2018 (Mon) | Forecast Hour 4

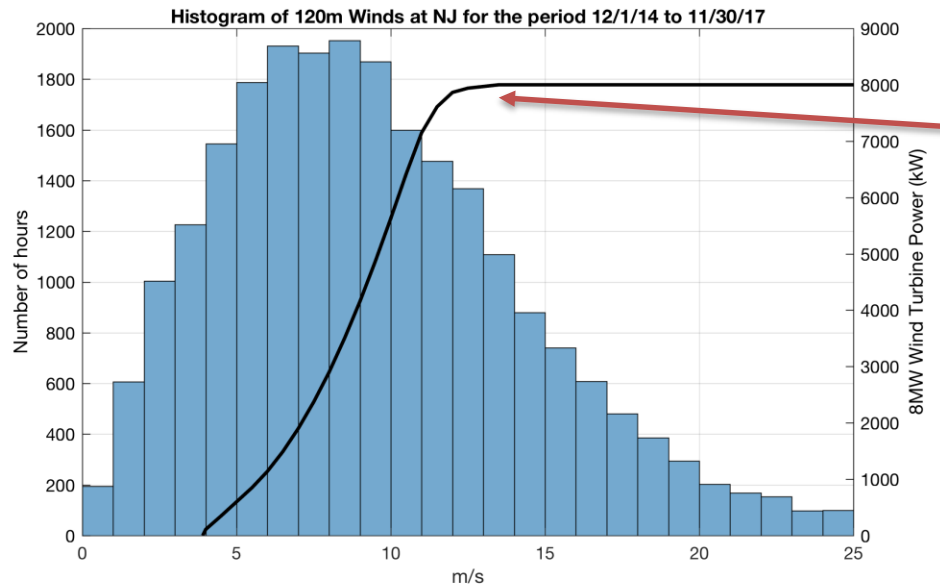
Hourly Precipitation [in]; Sea-Level Pressure [mb]



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RU-WRF 9 km Model: Initialized 00Z10DEC2018
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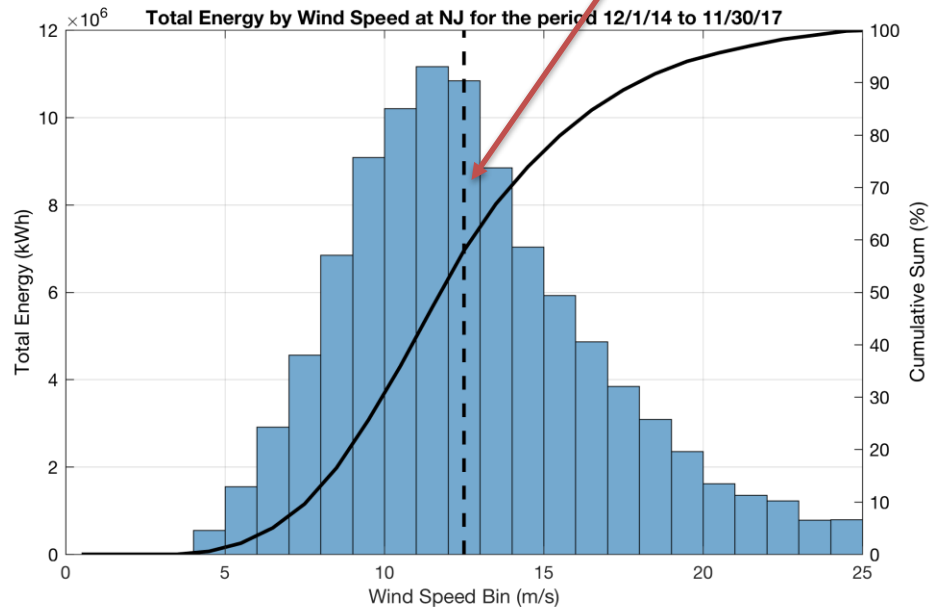
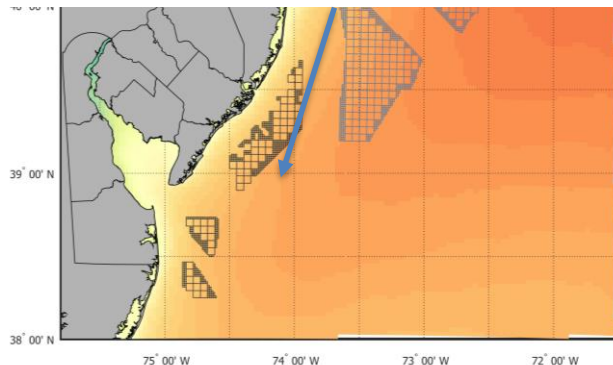
RU-WRF Wind Resource



8 MW wind turbine
12.5 m/s rated speed

60% of energy extracted
below turbine rated speed

Virtual Met Tower



Rutgers University - Center for Ocean Observing Leadership

MARACOOS – A forum to bring forward the best science & technology



Satellite
Receivers



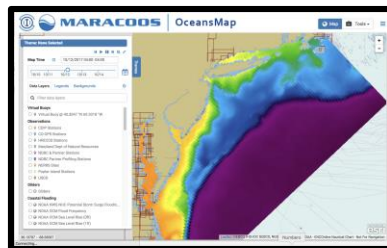
46 Site CODAR
Network



Glider Lab

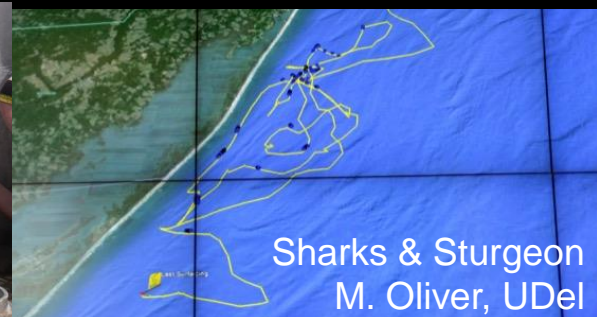
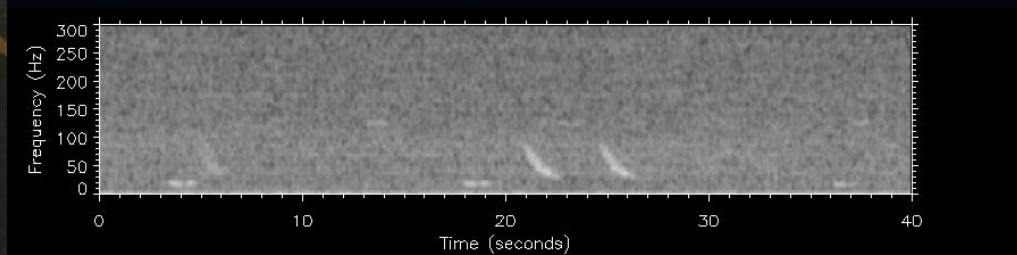
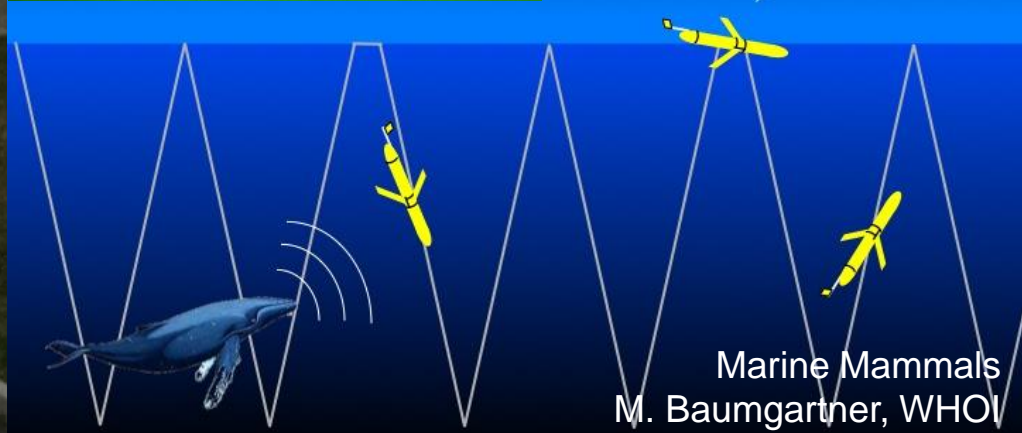
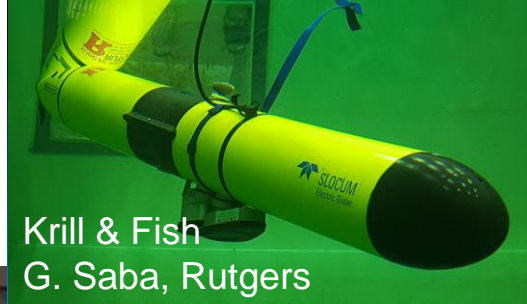


468 Glider
Deployments

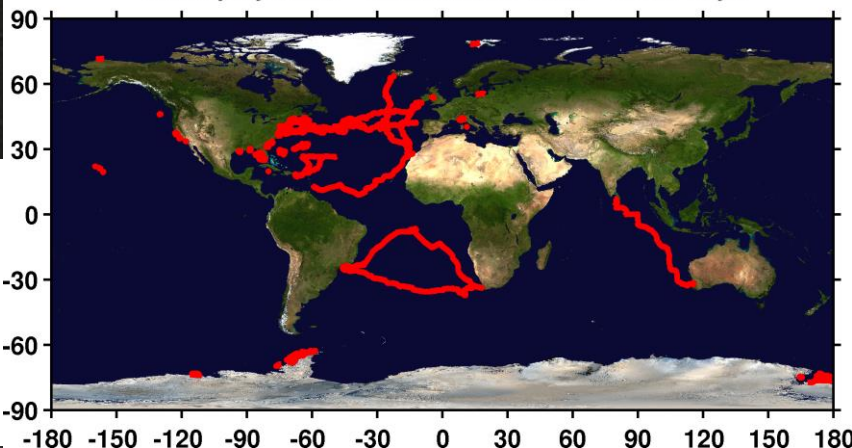


Ocean
Modeling

Tools for Offshore Wind: Glider Testbeds for Marine Organism Detection

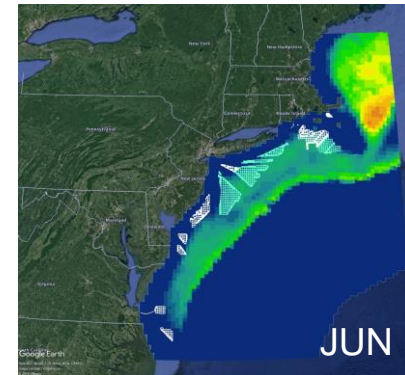
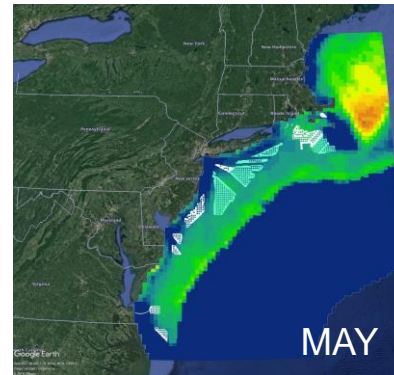
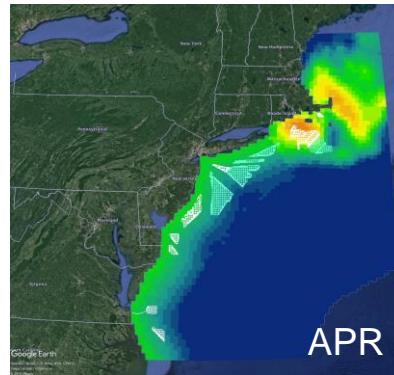
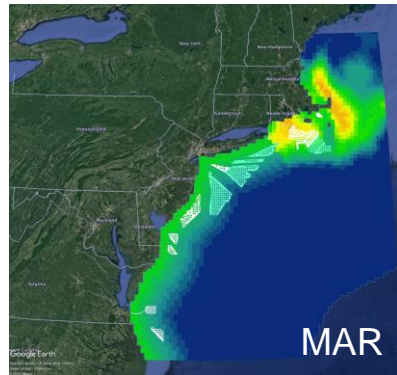


468 deployments - 225478.13km flown - 11626 days

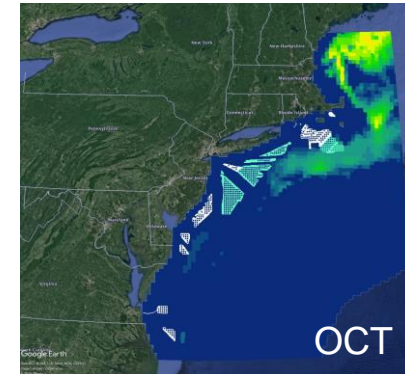
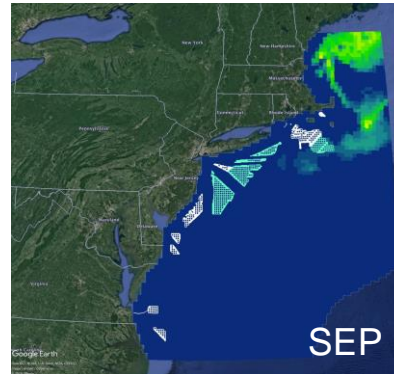
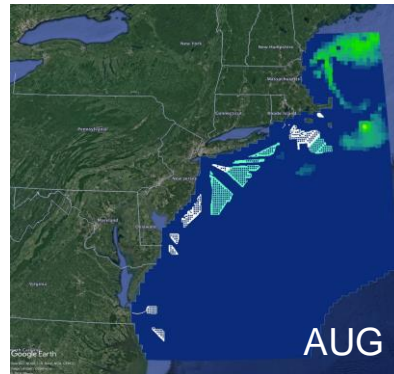
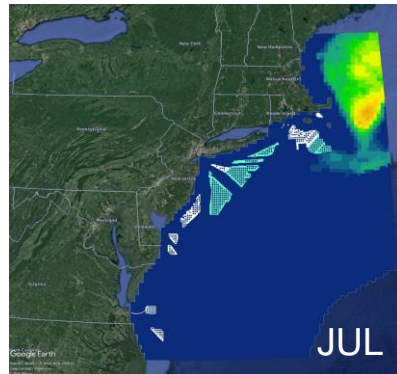


North Atlantic Right Whale: Monthly Distribution

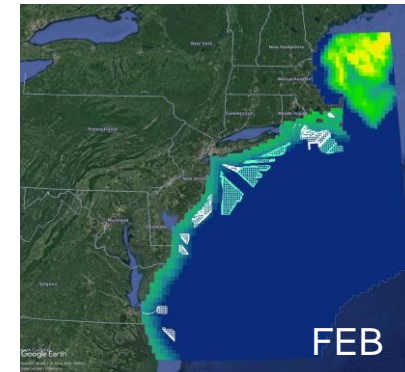
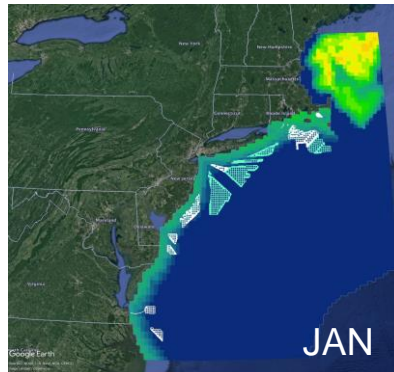
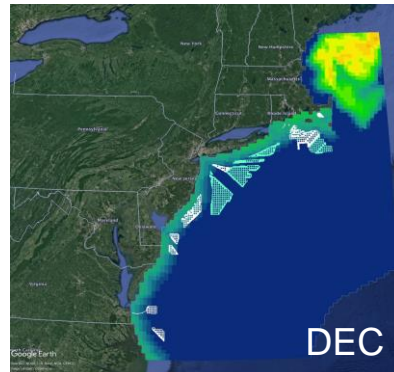
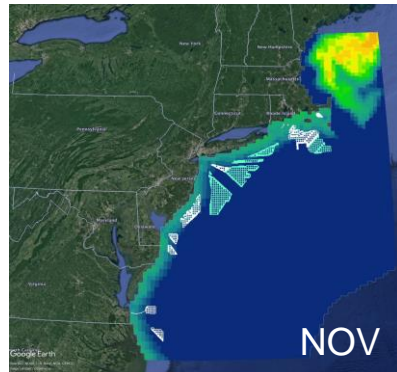
Mid-Atlantic
Peak
Season



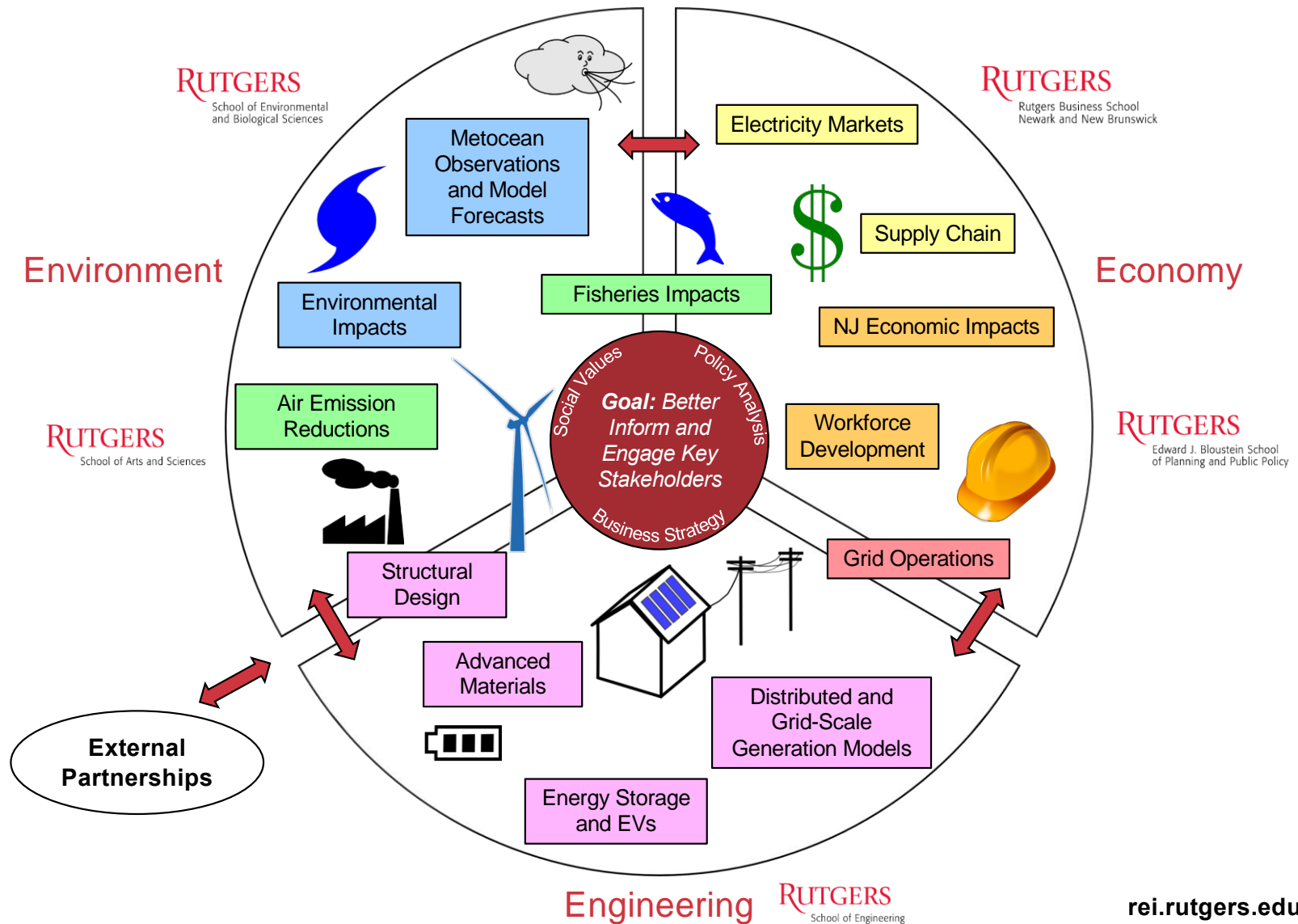
Mid-Atlantic
Low
Season



Mid-Atlantic
Coastal
Season



Rutgers Energy Institute – Wind Working Group: “Triple-E” Multidisciplinary Expertise



In Summary

- Offshore wind is coming to the US, and to NJ
- However, much remains in the process to ensure development is done properly
- The ocean is a complex place, and all stakeholders can have a say in the process
- Researchers at RUCOOL and Rutgers as a whole are helping to better inform this process, making sure the best science is used to make the best decisions

Useful Resources

- RUCOOL: rucool.marine.rutgers.edu
- US BOEM NJ Activities:
www.boem.gov/New-Jersey
- NJ Offshore Wind Strategic Plan:
www.njcleanenergy.com/nj-offshore-wind
- US DOE Wind Energy Technologies Office: www.energy.gov/eere/wind

DISCUSSION AND QUESTIONS

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Image: Vattenfall