WINDExchange
U.S. DEPARTMENT OF ENERGY

Northeast Wind Resource Center

Northeast Wind Resource Center Webinar

Opportunities and Barriers Shaping the Offshore Wind Market in the Northeastern U.S.

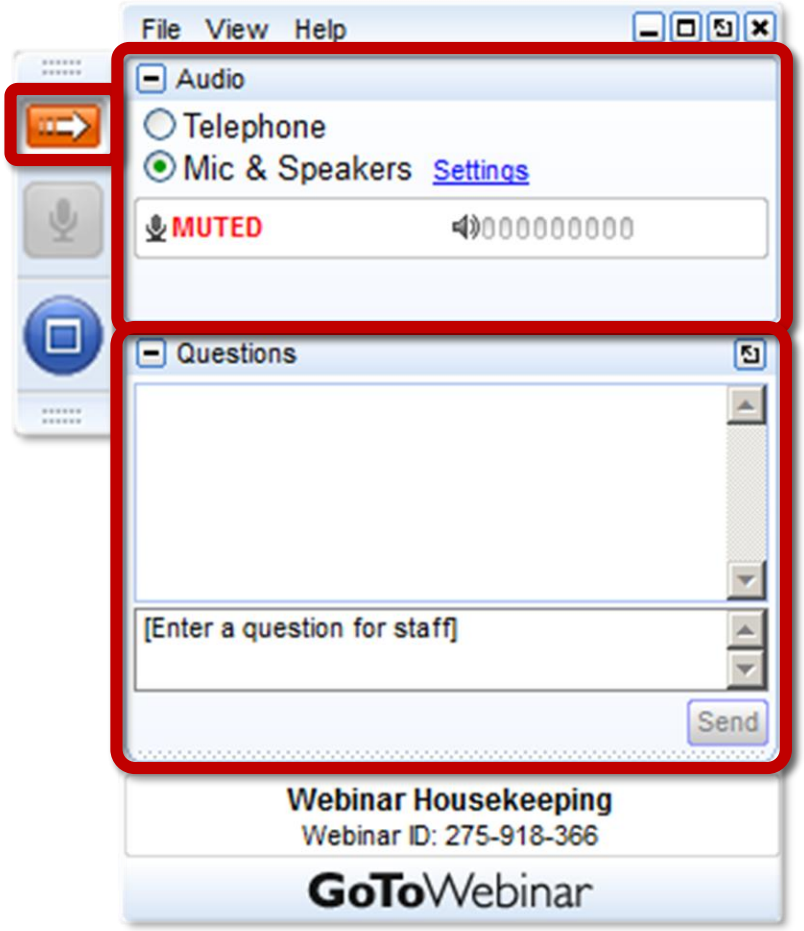
Hosted by
Val Stori, Clean Energy Group
November 20, 2017

CleanEnergyGroup
Innovation in Finance, Technology & Policy

Sustainable Energy Advantage, LLC

MAINE OCEAN & WIND INDUSTRY INITIATIVE

Housekeeping



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The Northeast Wind Resource Center

The Northeast Wind Resource Center (NWRC) is the regional epicenter for salient, unbiased information on land-based and offshore wind energy in the Northeastern United States. Published research, studies, and analyses associated with the issues impacting public acceptance of wind deployment are available in the NWRC Resource Library.

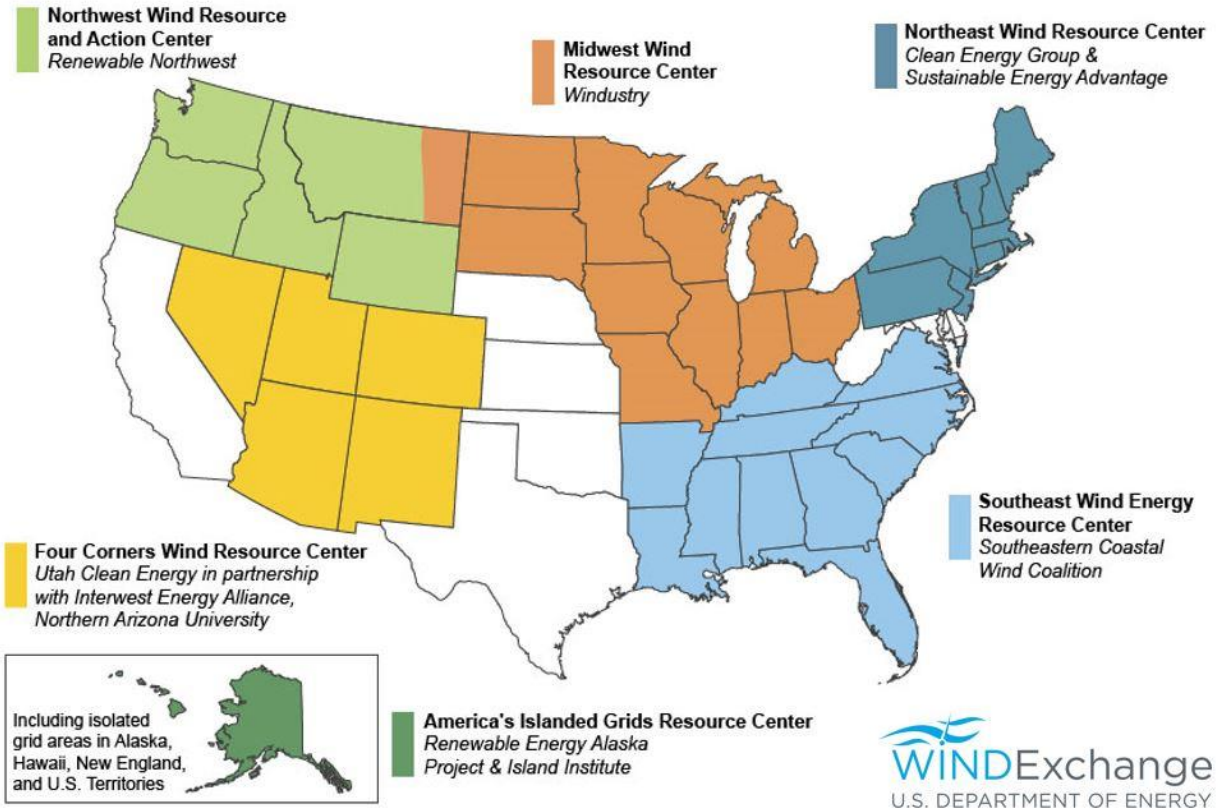
The NWRC is supported in part by a grant from the U.S. Department of Energy's WINDExchange program, and is managed by Clean Energy Group, with participation from Sustainable Energy Advantage and the Maine Ocean & Wind Industry Initiative.

www.northeastwindcenter.org

About WINDExchange

WINDExchange is the U.S. Department of Energy (DOE) Wind Program's platform for disseminating credible information about wind energy. The purpose of WINDExchange is to help communities weigh the benefits and costs of wind energy, understand the deployment process, and make wind development decisions supported by the best available information.

On March 11, 2014, the U.S. Department of Energy (DOE) announced six Wind Energy Regional Resource Centers that were selected through a competitive process administered by the National Renewable Energy Laboratory (NREL).



Panelists

- **Doreen Harris**, New York State Energy Research and Development Authority
- **Bob Grace**, Sustainable Energy Advantage
- **Jordan Shoesmith**, Sustainable Energy Advantage
- **Val Stori**, Clean Energy States Alliance/ Clean Energy Group (moderator)

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Roadmap Project for Multi-State Cooperation on Offshore Wind

Doreen Harris
Director, Large Scale Renewables, NYSERDA

November 20, 2017

Roadmap Project for Multi-State Cooperation on Offshore Wind

This material is based upon work supported by the U.S. Department of Energy award number DE-EE0007220

Participating agencies:

- New York State Energy Research and Development Authority
- Massachusetts Clean Energy Center
- Massachusetts Department of Energy Resources
- Rhode Island Office of Energy Resources

Project coordination:

- Clean Energy States Alliance

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Northeast Offshore Wind Regional Market Characterization

A Report for the Roadmap Project for Multi-State Cooperation on Offshore Wind

U.S. Job Creation in Offshore Wind

A Report for the Roadmap Project for Multi-State Cooperation on Offshore Wind

NEW YORK STATE OF OPPORTUNITY. NYSERDA

U.S. Jones Act Compliant Offshore Wind Turbine Installation Vessel Study

A Report for the Roadmap Project for Multi-State Cooperation on Offshore Wind

New York

New York Offshore Wind Master Plan

A comprehensive State roadmap for advancing development of offshore wind in a cost-effective and responsible manner

Key Elements:

- Stakeholder engagement
- Recommended development sites
- Guidelines for developers
- Analysis and support for cost-effective electricity purchase

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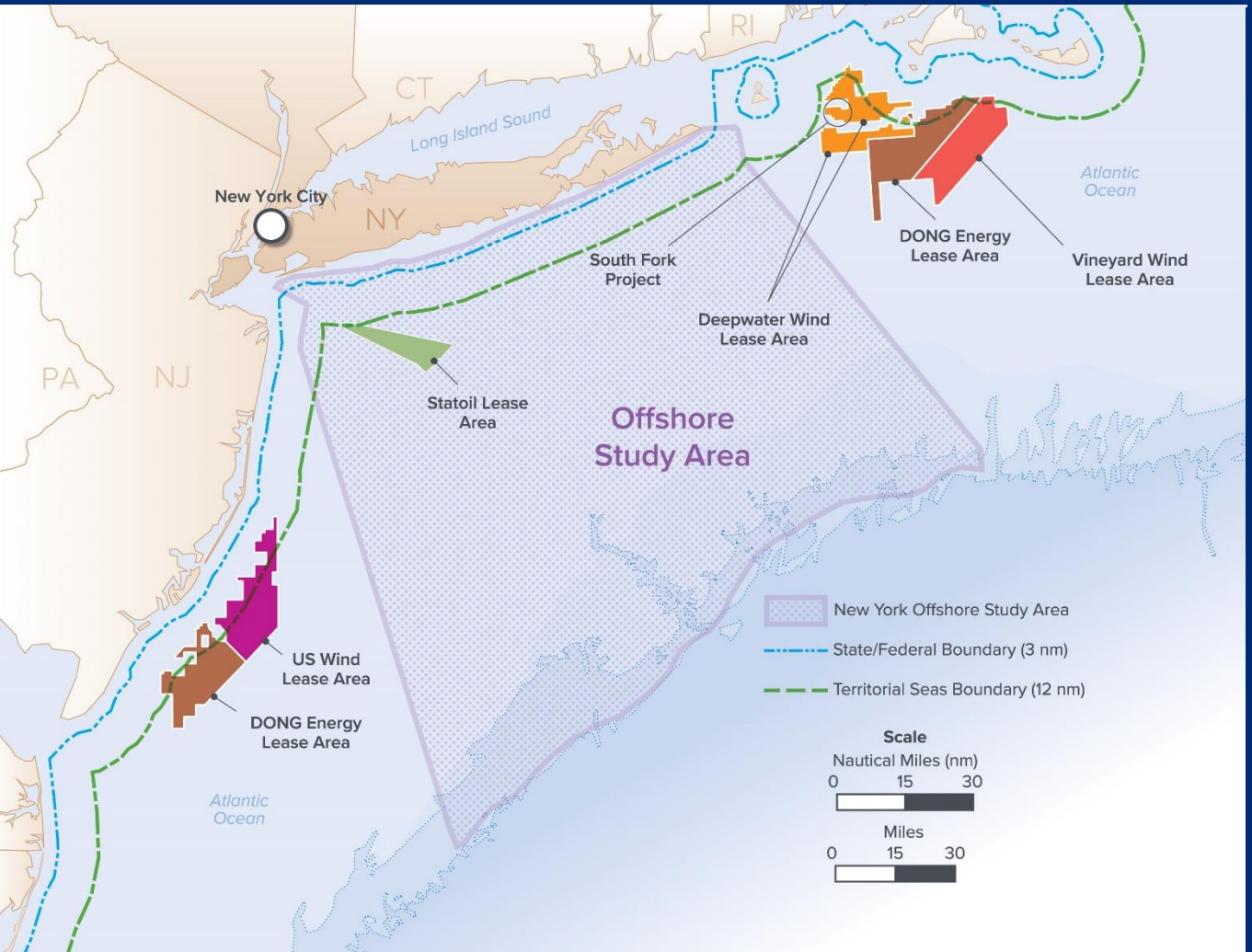
Master Plan Offshore Study Area



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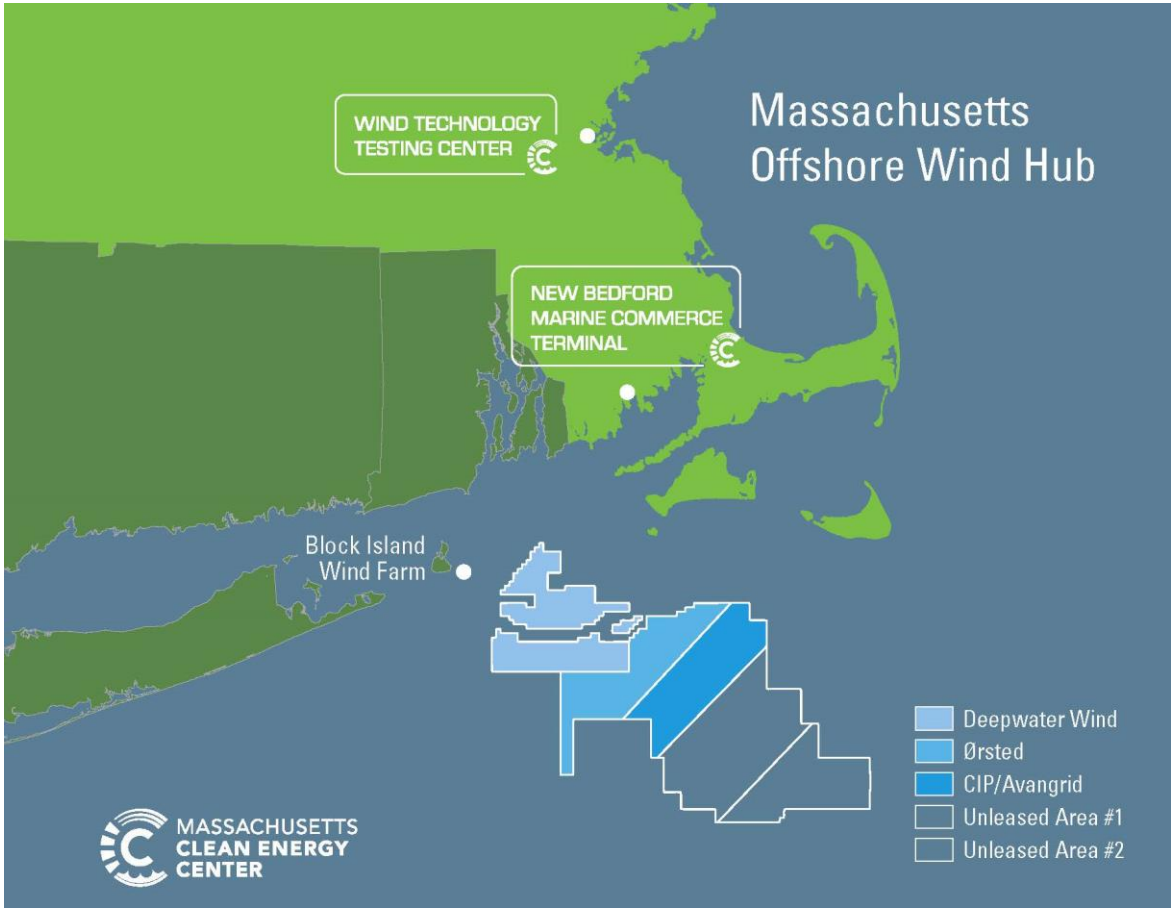
Massachusetts

Pathway to Market: MA Offshore Wind Legislation

In August 2016, Governor Baker signed legislation to launch offshore wind:

- Utilities to solicit 1,600 MW of cost effective OSW, largest state commitment, between 2017-2027
- Size of first solicitation:
  - Requires 400 MW bid
  - Alternate 200-800MW bids
- Transmission options
- Requires costs to decrease over time



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Rhode Island

Rhode Island Updates

Southern New England Offshore Wind Energy Science Forum

- December 11 and 12, 2017 at the University of Rhode Island Graduate School of Oceanography, Narragansett, RI
- This two day event will showcase completed and ongoing research taking place at the Block Island Wind Farm and within Southern New England to improve the management and development of offshore wind energy

Department of Environmental Management

- Recently submitted comments to BOEM regarding NYSERDA Area for Consideration
- Currently reviewing Deepwater Wind's proposed Cod Spawning Survey Plan and Protocol for the South Fork Wind Farm Area
- Will be distributing a VMS report covering multiple WEAs/lease areas (Statoil lease area, Deepwater Wind lease area, Bay State Wind lease area, Vineyard Wind lease area, OCS-A 0502 WEA, & OCS-A 0503 WEA)


Thank You
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NYSERDA

Northeast Offshore Wind Regional Market Characterization

Presented by Bob Grace and Jordan Shoesmith

November 20, 2017

Project Team:

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AWS Truepower
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Prepared for:

New York State Energy Research and Development Authority
Massachusetts Clean Energy Center
Massachusetts Department of Energy Resources
Rhode Island Office of Energy Resources
Clean Energy States Alliance

Sustainable Energy Advantage, LLC

Outline

1. Introduction
2. Objectives of Report
3. Report Contents
4. Results: Regional OSW Deployment Trajectories
5. Analytical Components, Methodology
6. Putting it all together: the OSW Market Assessment

Note:
Most of analysis completed early 2016, with updates.
Industry is evolving rapidly.

Report Objectives

- *What could the scale of near-term and long-term regional OSW deployment be, given the nature of regional OSW resources and supply chain, individual state policy drivers and initiatives, regional energy needs as well as the region's existing resource base?*
- **Primary Objective***:* Develop a forward-looking estimated range of the potential OSW market deployment by 2030, expressed in high and low installed capacity and associated energy production trajectories
- **Secondary Objectives**: Compile & summarize data, other background information on:
  - OSW development potential
  - electric system and market factors
  - state and regional policies, plans and other initiatives
  - … that are relevant to the future potential for building out the OSW resource in the northeast.
  - (as of middle of last year, when the bulk of the work completed; and added the most important updates through a few months ago.)

Report Contents

1) Introduction	• Background, objectives, limitations and organization or report

2) OSW Development Potential and Constraints	• OSW resource potential, lease areas, and development pipeline
	• Barriers and constraints to OSW deployment
	  • Economics, permitting, supply chain, interconnection and transmission
	  • Interconnection infrastructure in New York and New England
	  • Energy production and peak coincidence

3) Potential Demand for OSW: Market Factors	• Regional energy mix and energy demand • Market opportunity created by regional base load retirements • Variable energy resource (VER) penetration
4) Potential Demand for OSW: State & Regional Policies and Plans	• Procurement policies for renewable energy & other resources (e.g., transmission) • Renewable energy & environmental regulations, laws and policies • State energy and climate action plans • OSW-specific goals, laws, policies, regulatory proceedings, proposals, development activities • Proposed legislation • Notable metropolitan/municipal renewable energy goals and initiatives

Report Contents

5) Market Assessment

- Analyze drivers examined in Chapters 1-4 to assess regional OSW market scale
- Determine binding factors and analytical components considered
- Develop OSW deployment trajectories

6) Conclusion

- Interpretation of results and comparison to current planned or targeted OSW procurement volumes in the Northeast
- Discussion of areas for further study (e.g., OSW costs, installation rates, floating OSW)

Appendix

- *Detailed assumptions and methodology of component analyses:*
  - Offshore resource potential components
  - Transmission and interconnection
  - Electric market constraints: VER penetration limits
  - Electric market opportunities
  - Regional and state policies and plans

Results: Regional OSW Deployment Trajectories

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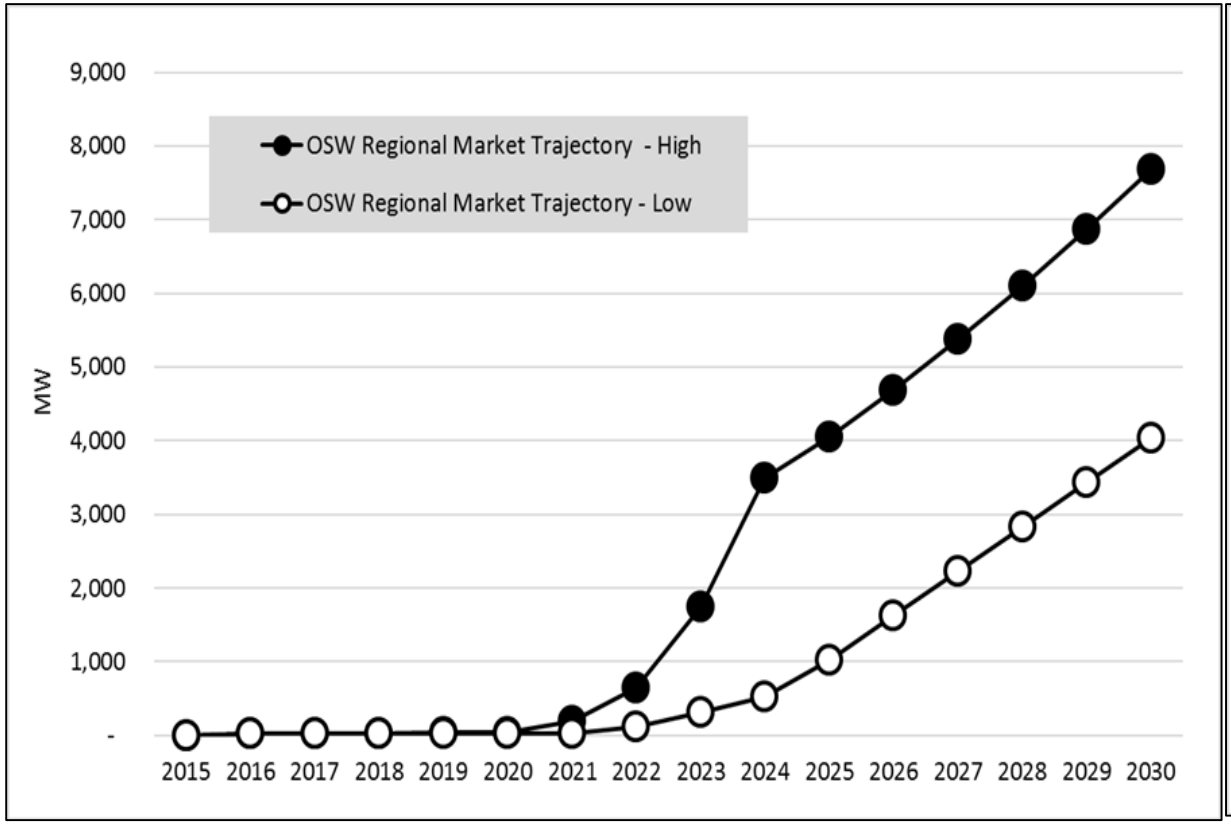
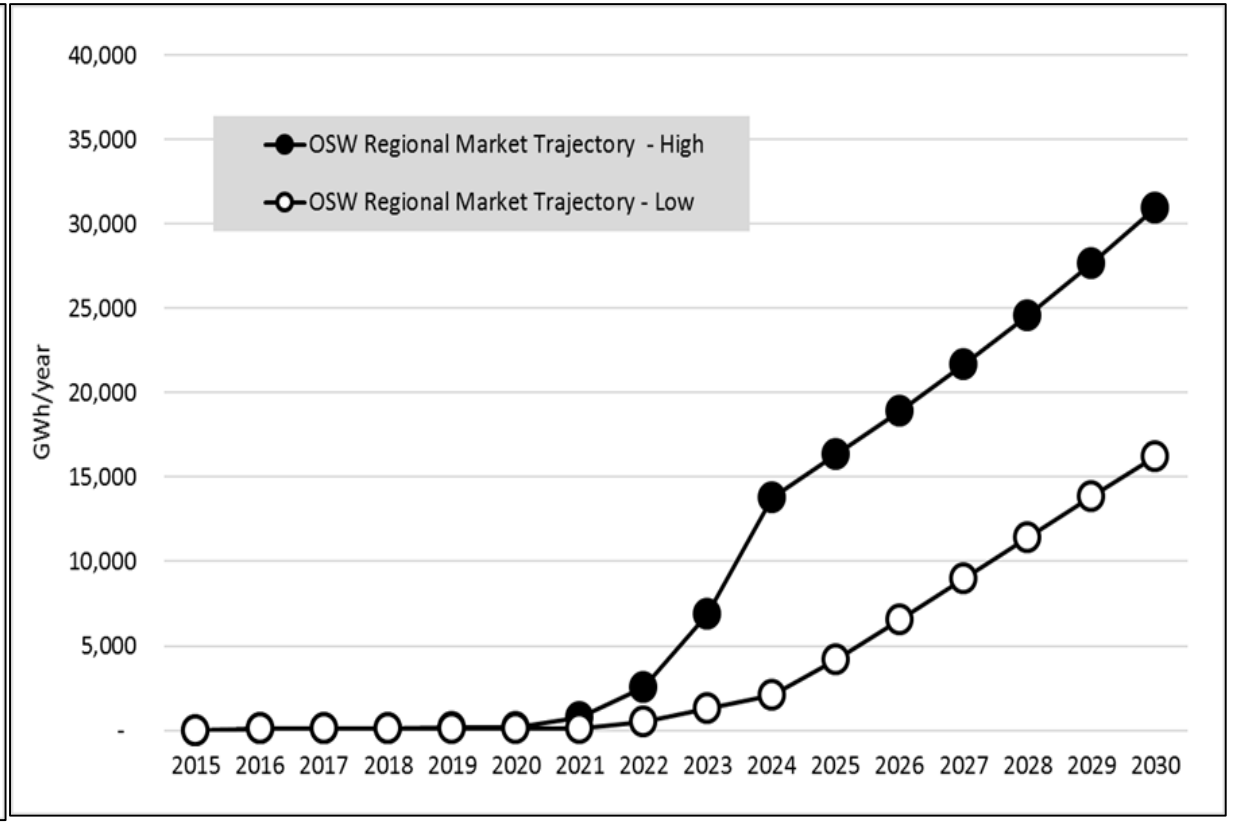
Regional OSW Deployment Trajectories

- Intent : bound *most likely* scale of future regional market for OSW
- Considered quantifiable factors that could potentially bound the OSW market, *other than relative cost*
- Why not consider cost?
  - Initial procurement policies & other drivers overcome initial cost premiums
  - OSW cost = a function scale of deployment, market visibility, supply chain, etc. ➔ The analysis considered a *input* to analysis of OSW cost at scale of deployment
  - The obtainable OSW cost when deployed at scale will in turn dictate ultimate scale of the northeast regional OSW market
- Scope & Focus:
  - Northeast = New England, NY + (share of) Mid-Atlantic supply that could feed this region's market
  - Atlantic (Great Lakes potential is additive)
- Steering Committee perspectives:
  - Cautious to not overstate achievable potential
  - Confident that current MA, NY procurement targets will be met

Regional OSW Deployment Trajectories

Low and High Regional OSW Deployment Trajectories (MW and GWh/year)



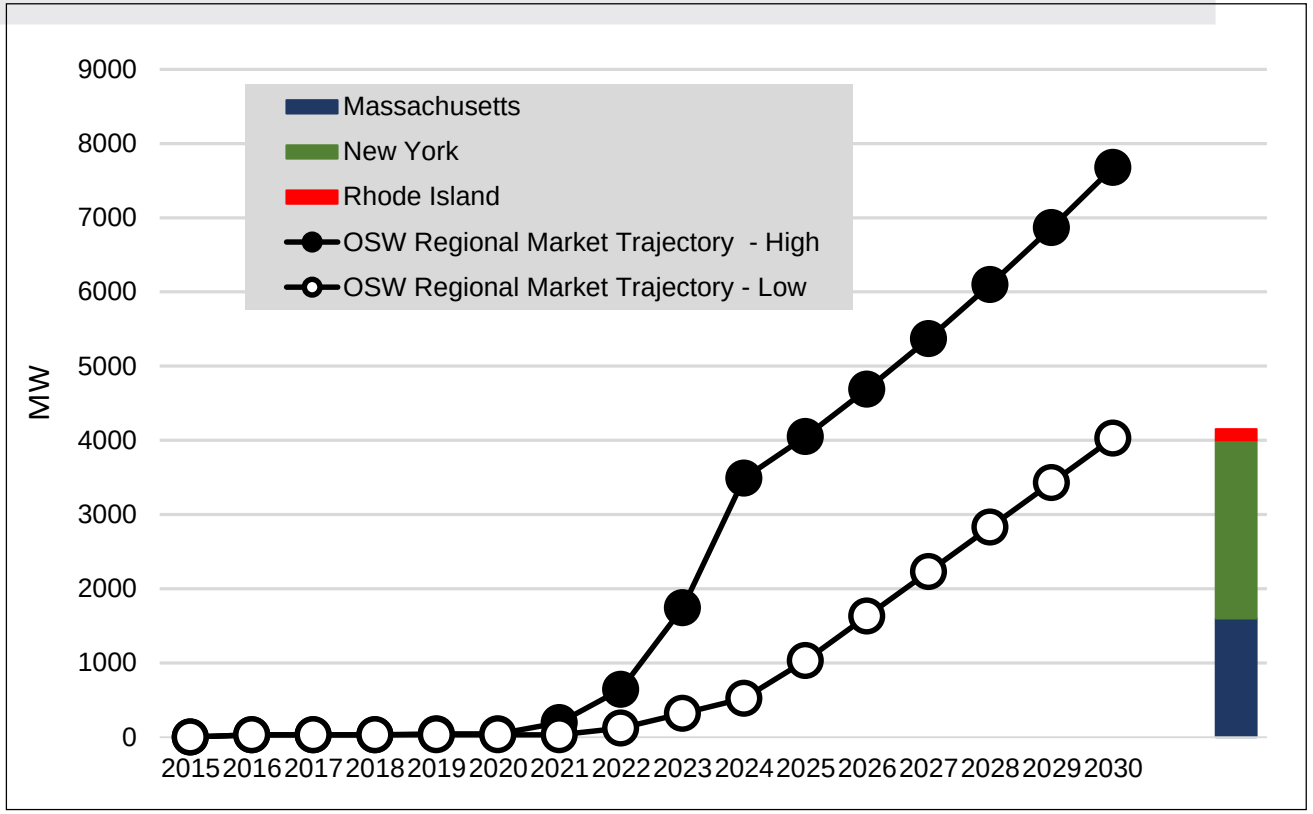


Comparison: OSW Procurement Volumes in the Northeast

Contracting State	MW	Notes:
Rhode Island	100 - 150	Existing long-term procurement statute could lead to contracts for 100 MW to 150 MW of OSW deployment in Federal waters (such contracting is not automatic)
Massachusetts	1,600	In August 2016, Governor Baker signed an Act Relative to Energy Diversity, Section 83C of which requires the state's EDCs to solicit 1,600 MW of OSW by 2030.
New York	2,400	In January 2017, Governor Cuomo announced a state-wide commitment to developing 2.4 GW of offshore wind by 2030.
Total	**4,100 - 4,150**	

New developments not reflected in analysis:
New Jersey: Governor-elect Phil Murphy campaigned on developing 3,500 MW of offshore wind by 2030.

CT Department of Energy & Environmental Protection (Nov. 2017) signals intent to seek proposals from OSW (and other resources) which could drive up to ~270 MW OSW



Analytical Components and Methodology

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Analytical Components and Methodology

Analytical Components

- OSW Characteristics
- Electric System and Market Components
- State and Regional Policies and Plans

Major Factors Analyzed

- Resource potential
- Current development pipeline
- Current and future lease areas
- Feasible pace and density of buildout
- Technology performance characteristics

- Transmission and interconnection infrastructure
- VER penetration limits
- Market opportunities (retirements)

- State-specific RPS policy-driven demand
- Greenhouse gas emissions reduction policy-driven demand
- Other renewable energy policies and plans
- OSW procurement policies and plans

Methodological Approach

- Within each category, authors researched & analyzed data, made assumptions for each factor (range)
- Bottom-up spreadsheet model ➔ assess impacts of each driver, opportunity and constraints (and their interactions)
- Combined baseline data, forecasts & assumptions in each category
  - test impact of high/low assumptions for unknowns
  - determine which factors most likely to bound OSW deployment over time
- Analysis ➔ High & Low OSW Deployment trajectories by 2030
  - High: consider what factors may constrain deployment scale (lesser of)
  - Low: what factors may constrain deployment scale (lesser of), or create a floor

Analytical Components and Methodology

Offshore Wind Characteristics

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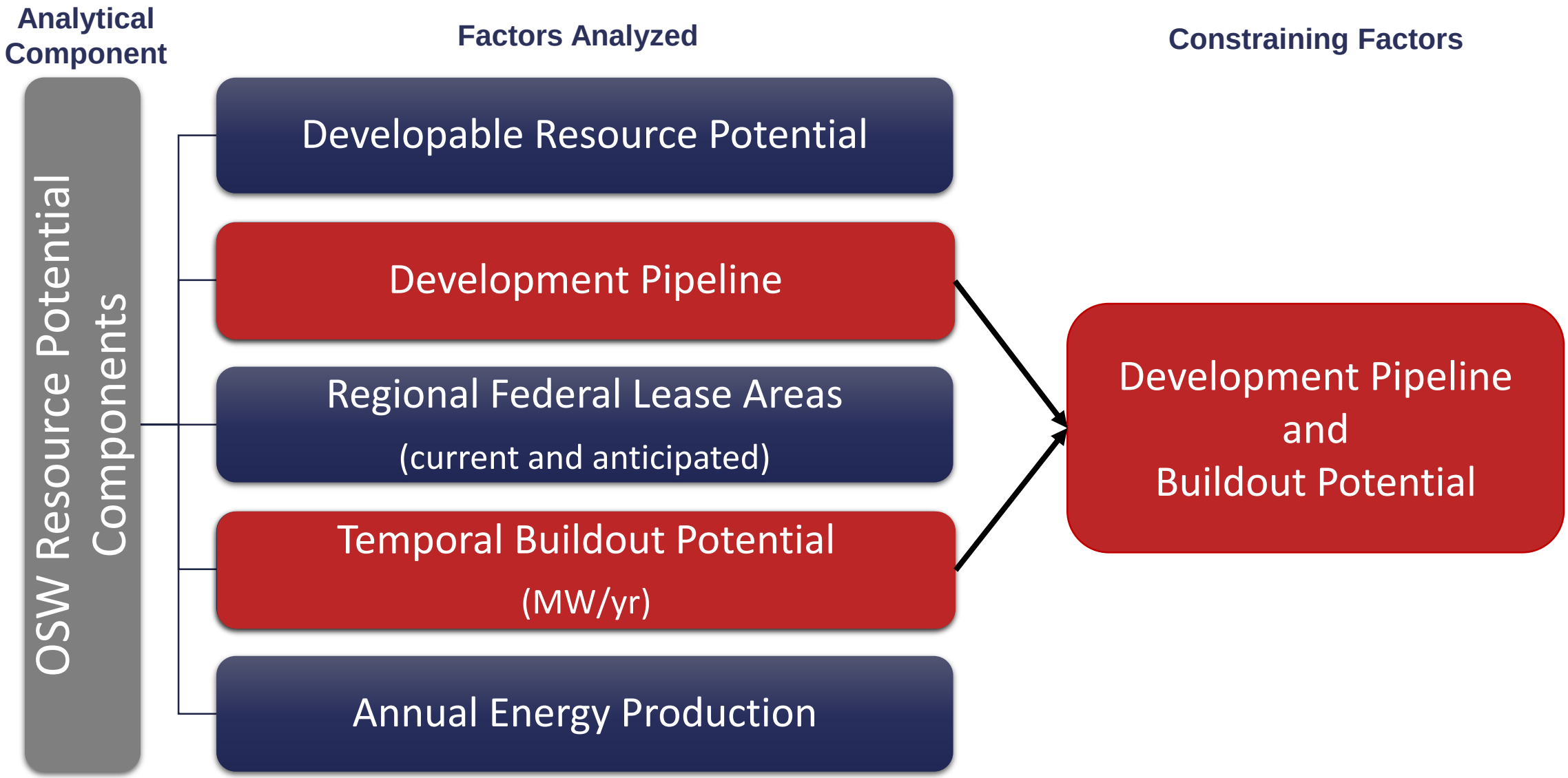
Offshore Wind Resource Potential Components



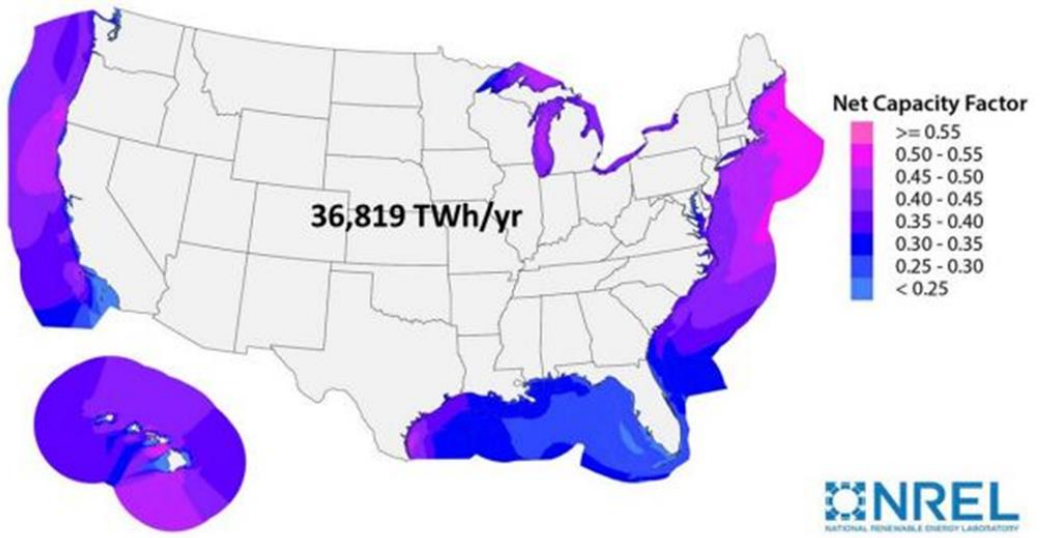
Offshore Wind Resource Potential Components
Resource Potential

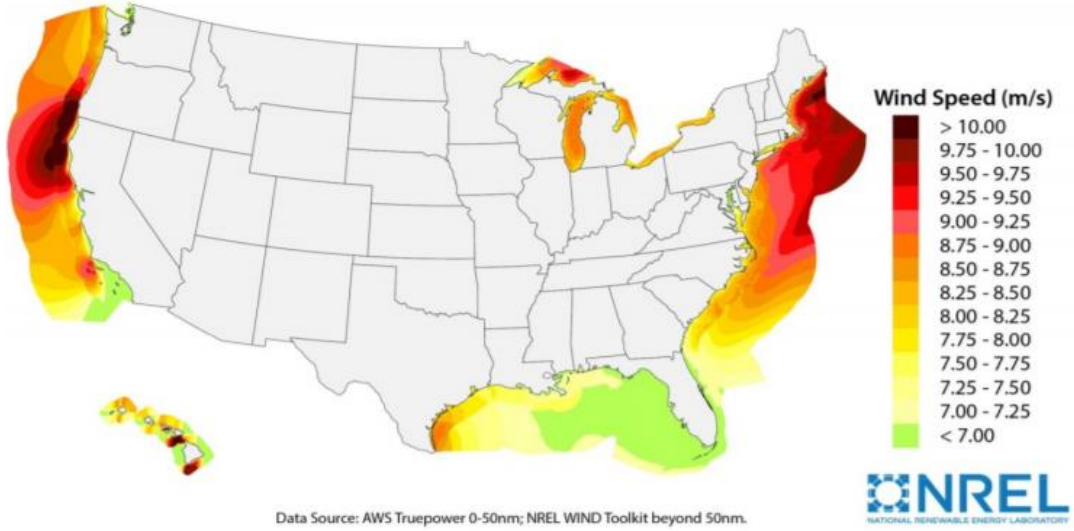
Net Technical OSW Resource Potential between 12-50 nm from Shore

State	Gross Potential (MW)	Net Technical Potential (MW)
CT	-	-
ME	56,530	44,659
MA	82,704	65,336
NH	460	363
NJ	42,061	33,228
NY	42,888	28,776
RI	8,364	6,608
Total	233,007	178,970

Source: NREL 2016 Offshore Wind Energy Resource Assessment for the United States

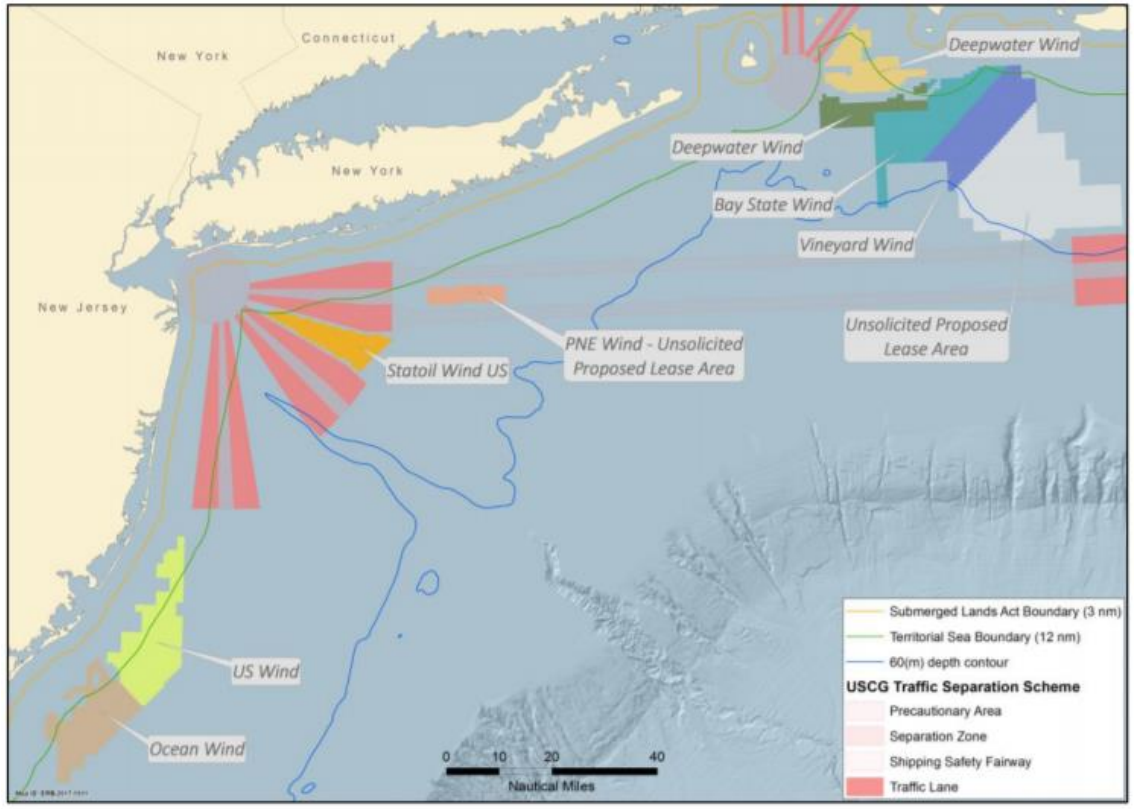
For perspective: 2030 regional peak demand projections: ~62 GW (summer), ~ 46 GW (winter)





Offshore Wind Resource Potential Components
Lease Areas

Northeast Federal Lease Areas*



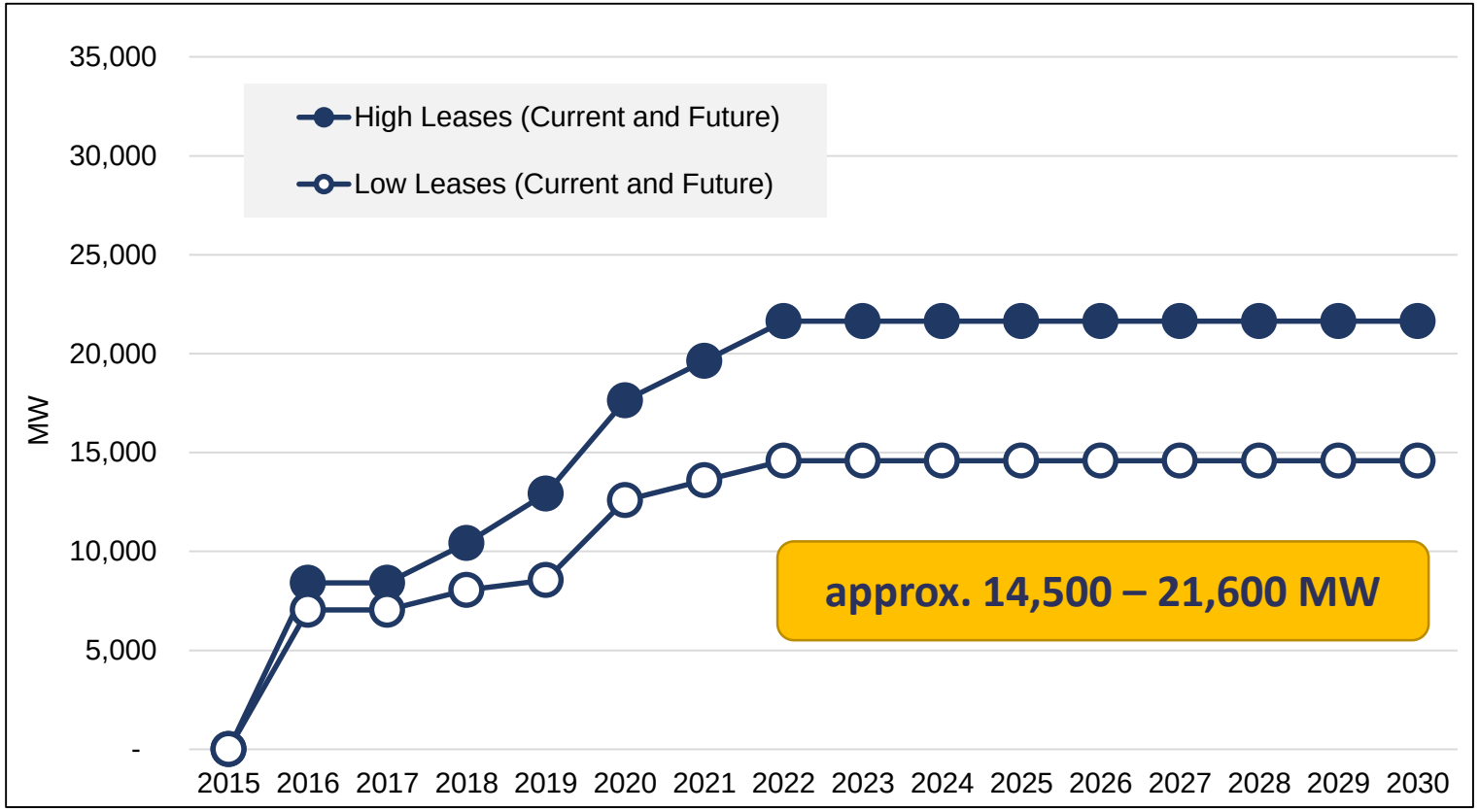
*map excludes Cape Wind Lease Area

Current Lease Areas	Lease	MW	Area (km^2)	Year Leased
Portions entirely leased				
Cape Wind	OCS-A 0478	468	119	2010
RI/MA WEA (Deepwater Wind)	OCS-A 0486 & 0487	2,001	667	2013
MA WEA (DONG)	OCS-A 0500	2,277	759	2015
MA WEA (Vineyard Wind)	OCS-A 0501	2,025	675	2015
NY WEA (Statoil)	OCS-A 0512	1,000	321	2016
NJ WEA (US Wind)	OCS-A 0499	2,226	742	2016
NJ WEA (DONG)	OCS-A 0498	1,947	649	2016
Unleased areas				
MA WEA	OCS-A 0502	3,012	1,004	TBD
MA WEA	OCS-A 0503	1,707	569	TBD
Total		**16,663**		

New info: NY has requested 4 new areas

Offshore Wind Resource Potential Components

Low and High Federal Lease Area Potential



Assumptions

Lease Area Category	Capacity (MW)
Current Lease Areas – Leased	~7,300
Current Lease Areas – Unleased	~4,700
Future Lease Areas	8,000
NJ Lease Areas (Current & Future)	~3,200
Total	**~23,200**

Lease Area Category	High Case	Low Case
Current Lease Areas – Leased	100%	100%
Current Lease Areas – Unleased	100%	75%
Future Lease Areas	100%	50%
New Jersey Lease Areas (OCS-A 0499)	50%	0%

Regional OSW Projects under development

Project Name (Developer)	Capacity (MW)	State	Development Status
Aqua Ventus I (Maine Aqua Ventus I GP LLLC)	12	ME	Permitting / Initial Dev.
Atlantic City Windfarm – Phase I (Fishermen's Energy)	24	NJ	Dormant
Bay State Wind (DONG Energy and Eversource Energy)	1,000	MA	Early Planning
Block Island Wind Farm (Deepwater Wind)	30	RI	Operational
Cape Wind (EMI)	468	MA	Dormant
Deepwater ONE (Deepwater Wind)	210 - 1,200	RI/MA	Early Planning
(US Wind)	~ 1,500	NJ	Early Planning
Ocean Wind (DONG Energy)	1,000	NJ	Early Planning
Revolution Wind (Deepwater Wind)	96 - 288	RI/MA	Early Planning
South Fork Wind Farm (Deepwater Wind)	90	RI/MA	Permitting /Initial Dev.
Empire Wind (Statoil)	1,000	NY	Early Planning
Vineyard Wind (Vineyard Wind LLC, Copenhagen Infrastructure Partners, and Avangrid Renewables)	400 - 1,600	MA	Early Planning

Total: 5,330 – 8,212 MW

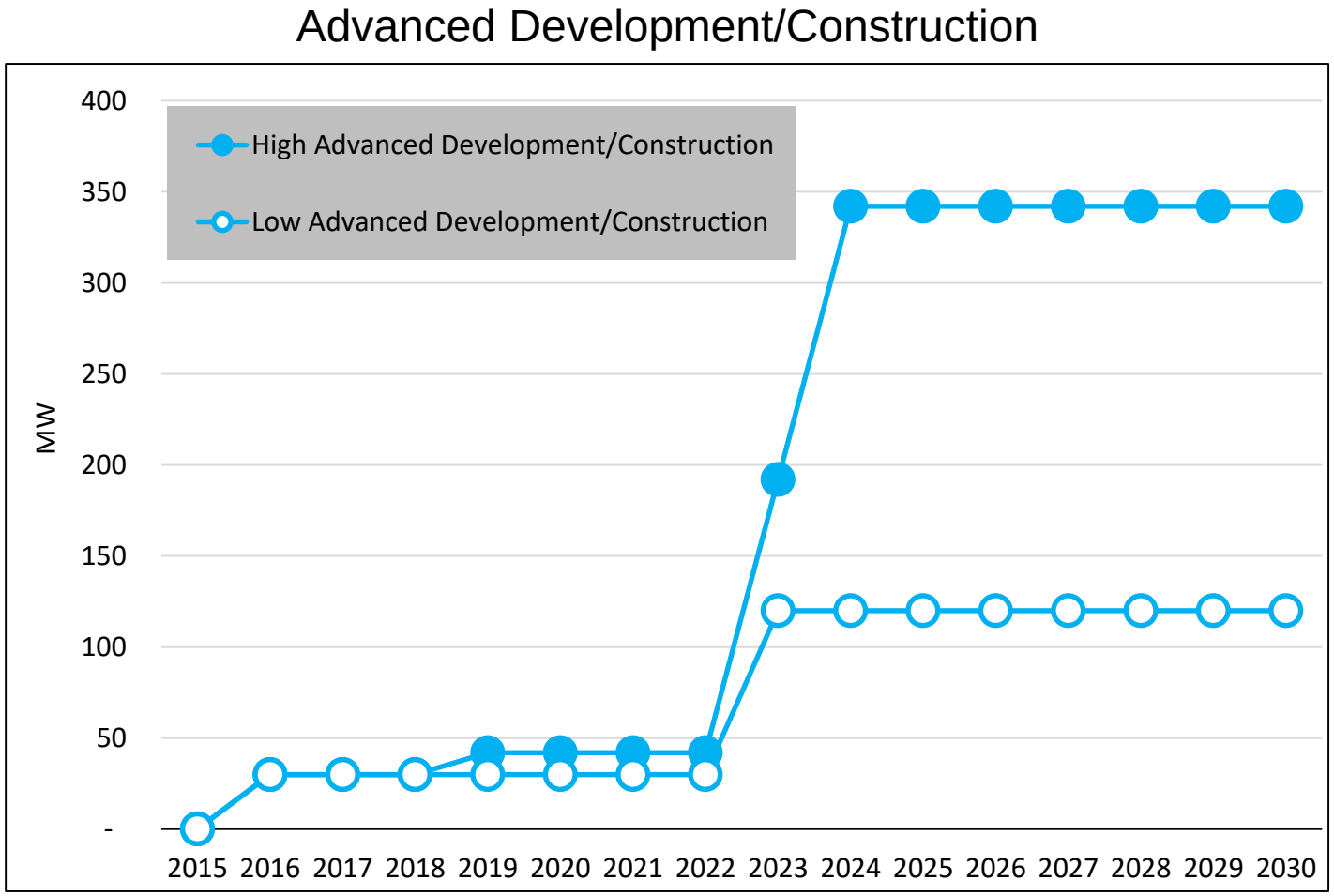
Offshore Wind Resource Potential Components
Advanced Development and Construction

High Case

Project	Capacity (MW)	COD
Block Island Wind Farm	30	2016
Aqua Ventus	12	2019
Deepwater ONE – South Fork	90	2023
Deepwater ONE – Expansion*	210	2024

Low Case

Project	Capacity (MW)	COD
Block Island Wind Farm	30	2016
Deepwater ONE – South Fork	90	2023



* Recent news: not selected in recent LIPA RFP

Offshore Wind Resource Potential Components
Temporal Buildout

Assumptions

	High Case	Low Case
Buildout of Lease Area Potential by 2030	75%	50%

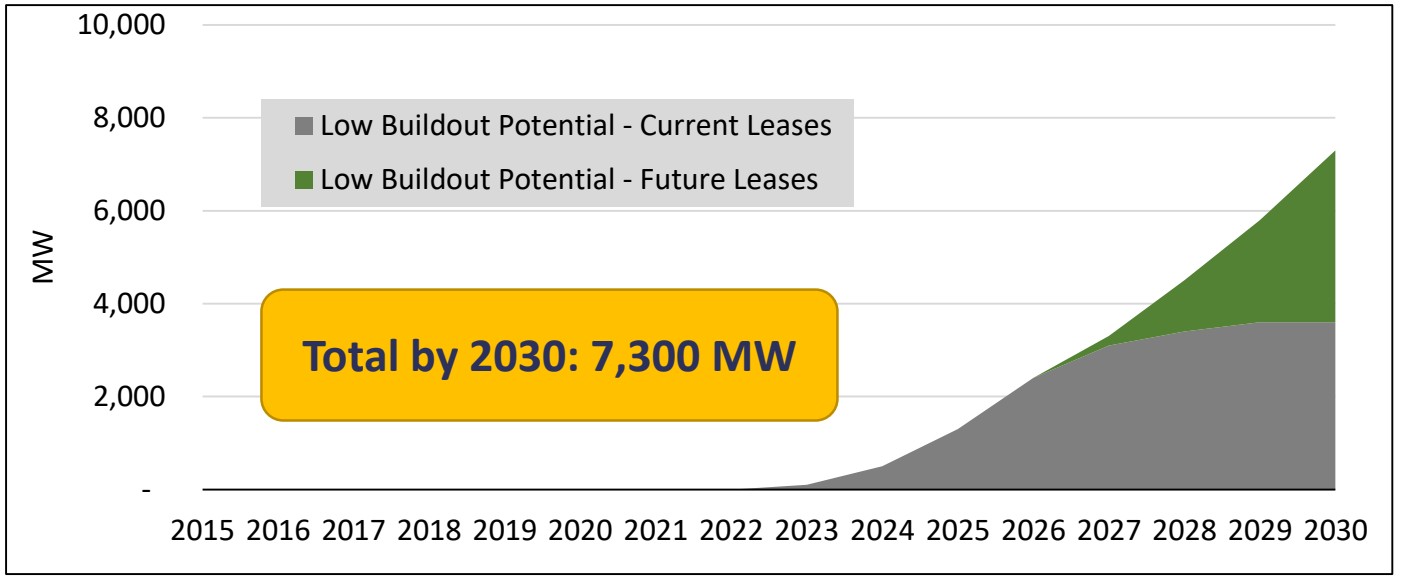
Factors considered:

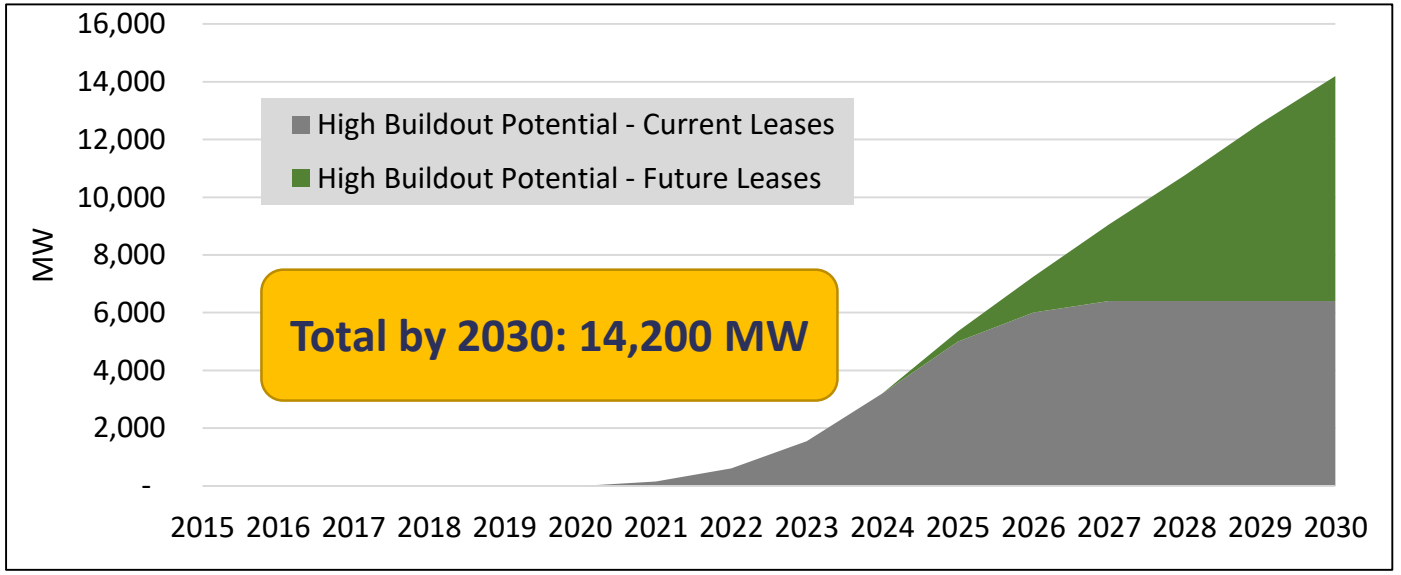
- Type and number of ships, crews and facilities available;
- Methods employed for construction, transportation and installation of turbine foundations and components; and
- Industry experience.

Maximum Buildout Rate*

(MW/yr)	High Case (Start Year)	Low Case (Start Year)
300	2021	2023
400	2024	2026
500	2027	2029

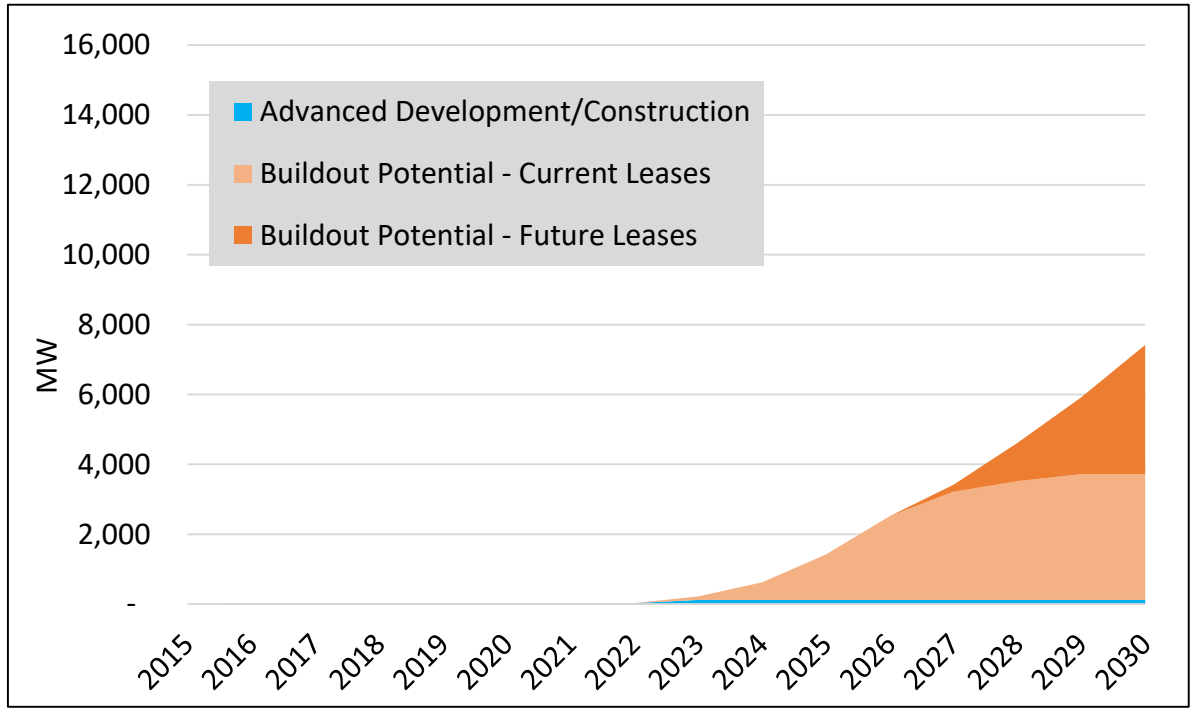
* Recent industry experience suggests that this *could* be conservative





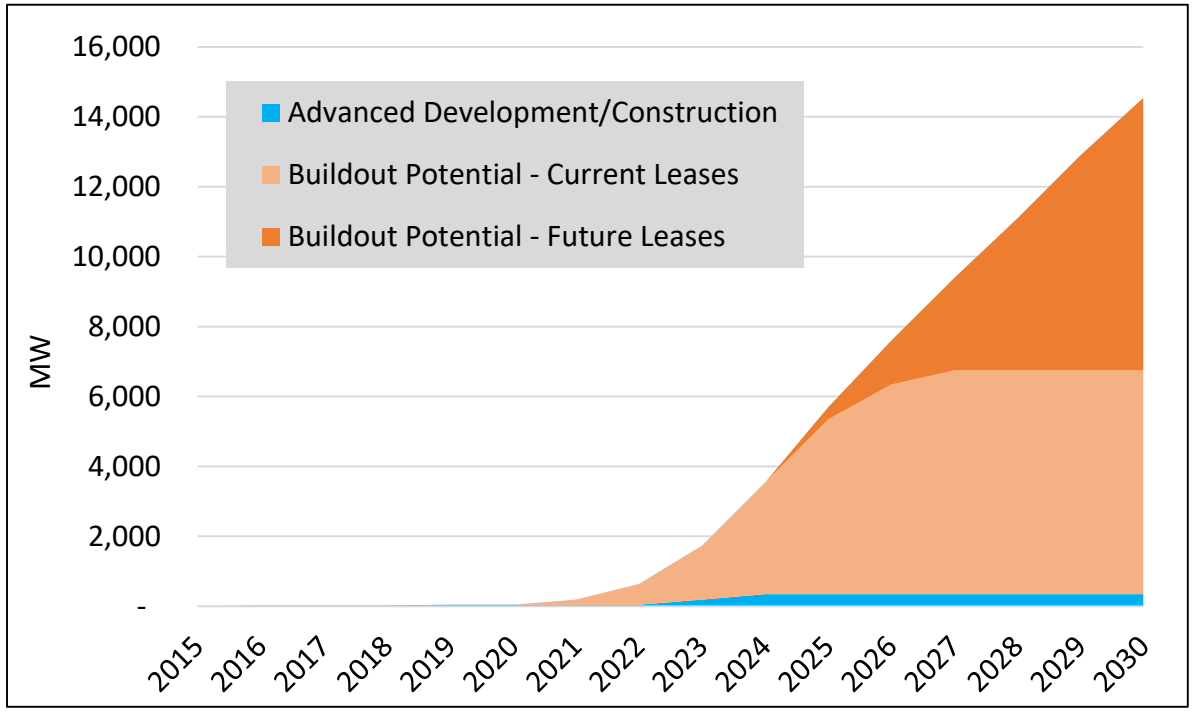
Regional OSW Development Pipeline & Buildout Potential

Low Case Trajectory



Total by 2030: 7,400 MW (29,700 GWh)

High Case Trajectory



Total by 2030: 14,500 MW (57,900 GWh)

Analytical Components and Methodology
Electric System and Market Components

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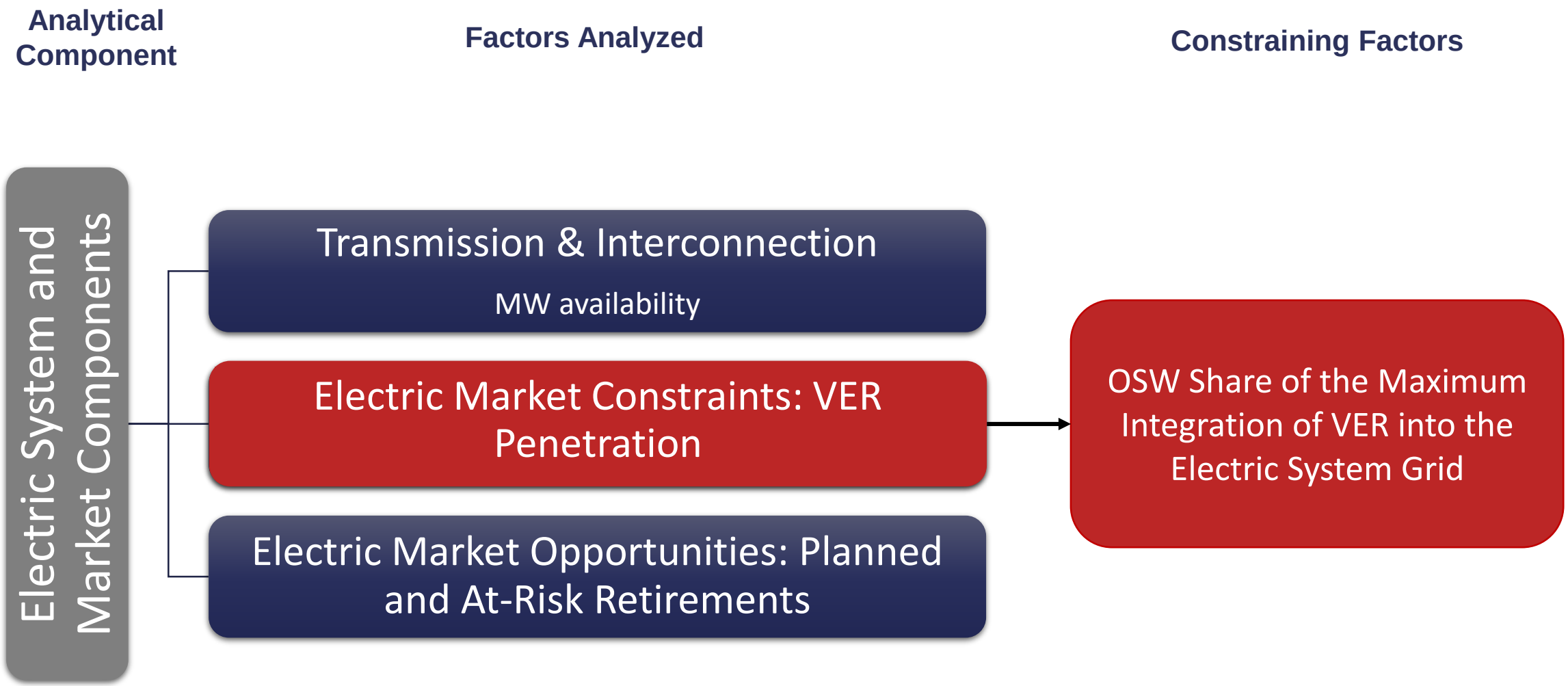
Electric System and Market Components



Electric System and Market Components
Transmission & Interconnection (T&I)

Case-specific assumptions include:

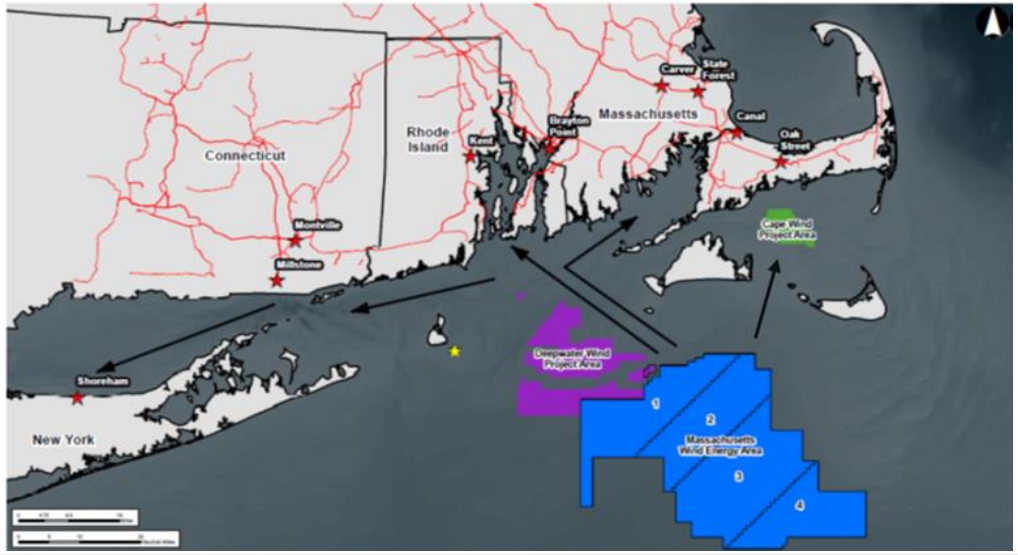
- **Low Case:**
  - Interconnection capacity available now, without material network upgrades;
  - interconnection capacity from assumed generator retirements becomes available in the given retirement year; and
  - interconnection capacity becomes available from "at-risk" fossil fuel generation units in 2025.
- **High Case:**
  - All Low Case assumptions; plus
  - interconnection capacity that becomes available with material network upgrades (incl. est. timing)

From various regional & national published and unpublished studies

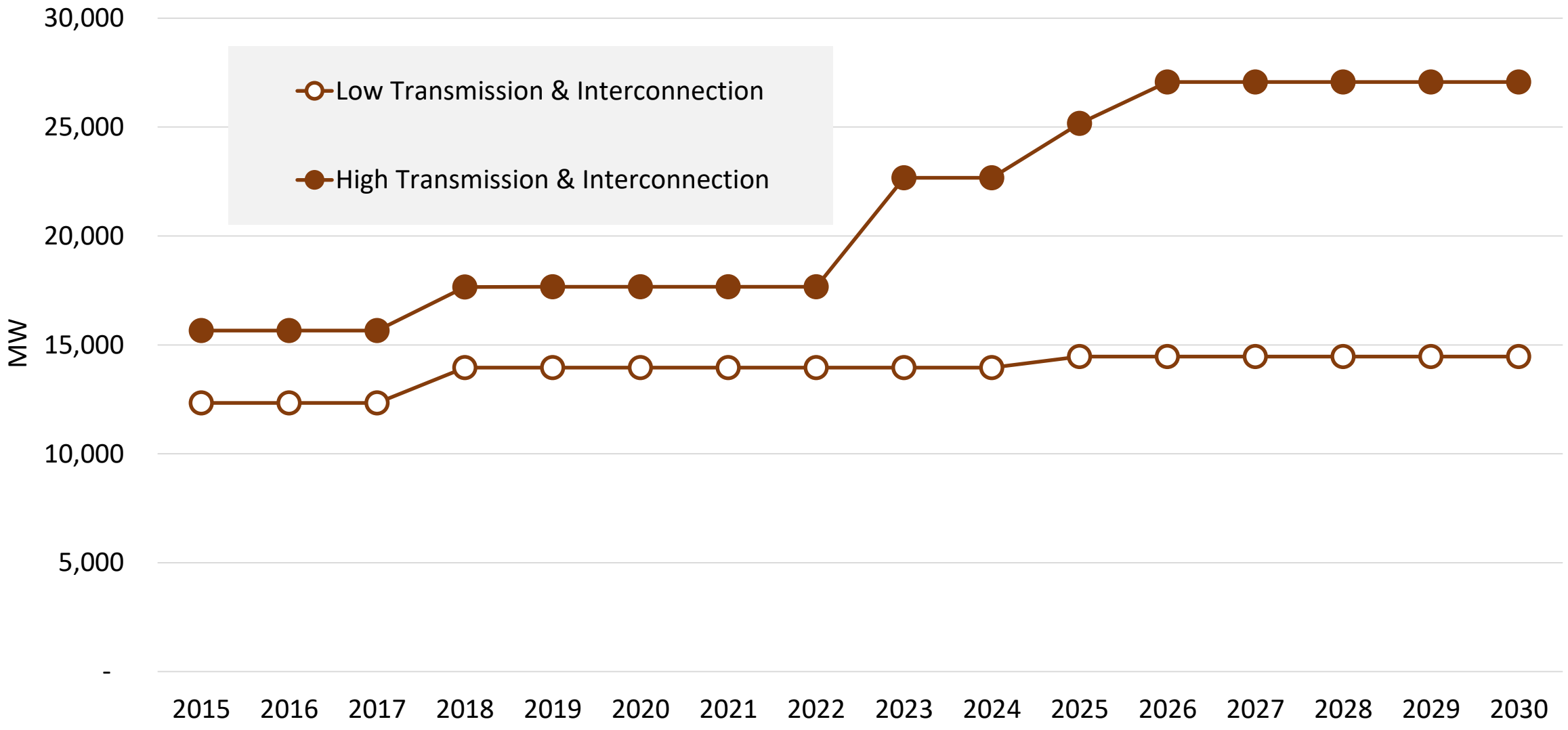
Map from ESS OSW Transmission Study (2014) for MassCEC

T&I – Maximum Available Capacity (MW)

State	Low Case	High Case
Connecticut	4,500	6,500
Maine	100	2,000
Massachusetts	4,620	9,000
New Hampshire	1,295	1,506
Rhode Island	2,000	3,000
New York	1,944	5,067

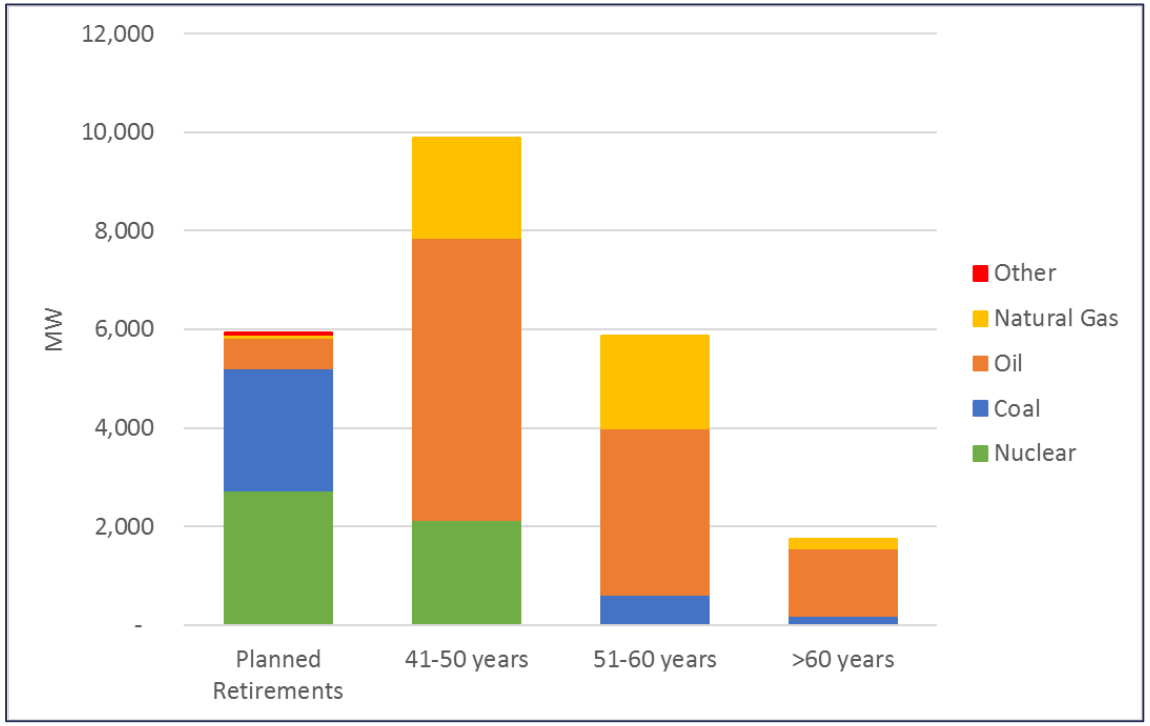


Electric System and Market Components
Transmission & Interconnection



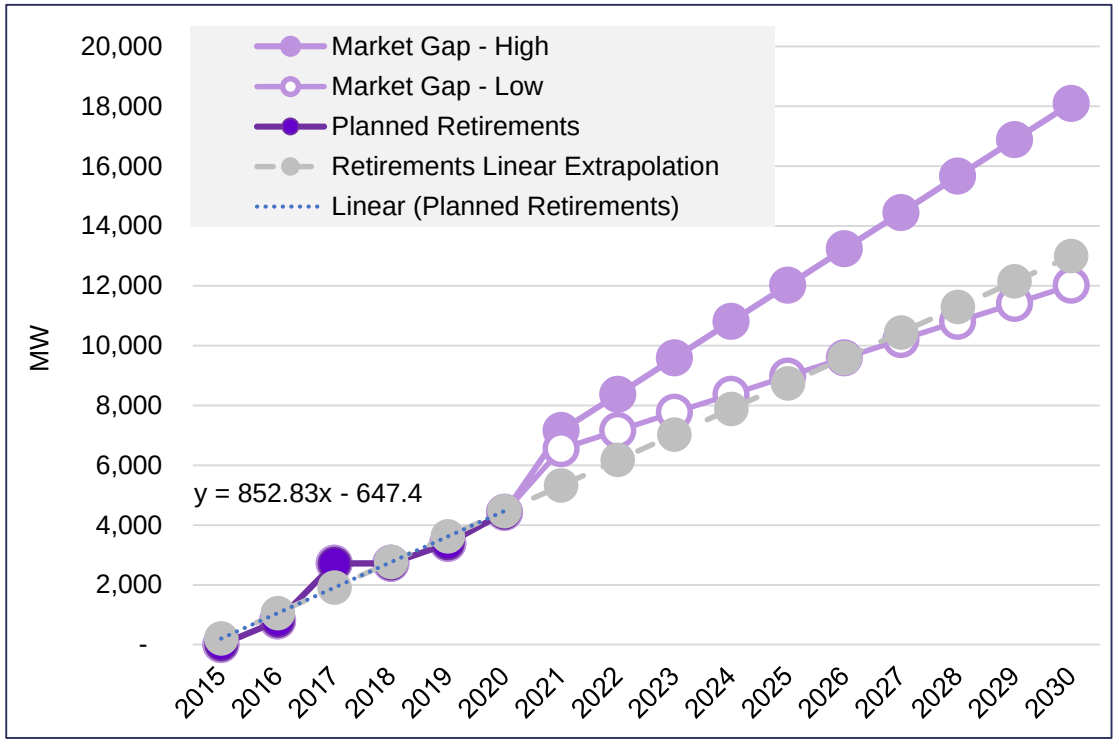
Electric System and Market Components
Electric Market Opportunities: Planned and At-Risk Retirements

Planned & At-Risk Retirements



- Up to 23 GW of retirements (planned and at-risk)
- At-risk retirements based on:
  - ISO-NE developed list for Strategic Transmission Analysis; and
  - Assumed all baseload generating units in New York greater than 50 MW whose operational age will be 40 or older by the year 2020 based on 2015 NYISO Gold Book data

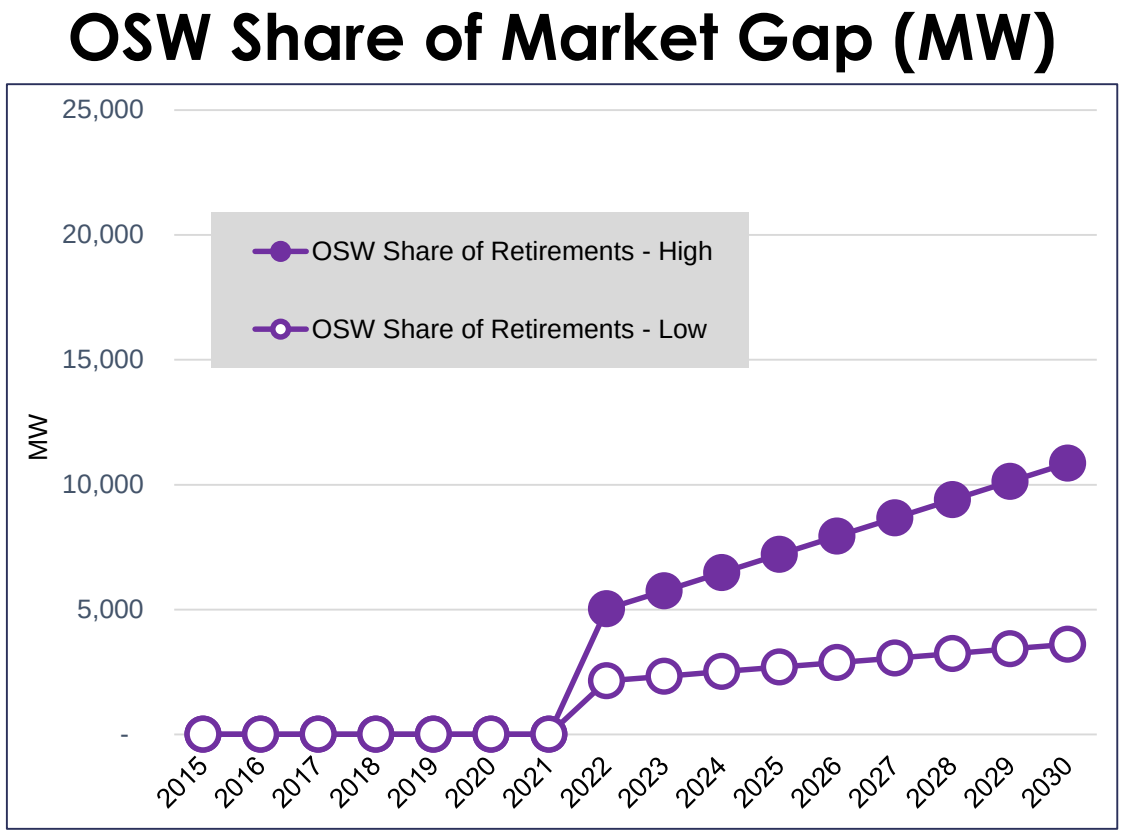
Electric System and Market Components
Electric Market Opportunities: Planned and At-Risk Retirements



Assumptions

	Low Case	High Case
Planned Retirements (MW)	5,940	
At-Risk Retirements (%/year of At-Risk Capacity)	4%/year	8%/year
At-Risk Retirements (MW)	6,077	12,155
Total Market Gap (MW)	**12,017**	**18,100**

OSW share of 'Market Gap' from Retirements



By 2030, OSW share of retirements could be between 3,600 MW and 10,800 MW

- Assumptions for share of market gap that could be filled by OSW:
  - OSW can begin filling the market gap no earlier than 2022
  - Low Case: OSW can replace 30% of baseload/cycling retirements
  - High Case, OSW capable of replacing an upper bound of 60% of baseload/cycling retirements

Electric System and Market Components
Electric Market Constraints: VER Penetration

- Practical limits exist to how much variable generation can be successfully integrated into regional electric grid
  - Advances in energy storage technology and grid integration could expand these limits
- OSW market penetration further constrained by competition with other energy resources (solar PV, land-based wind, large hydro, natural gas) contracts & commitments ➔ reduce market demand for additional VERs
  - Other resources may 'box out' OSW
- Assumptions to estimate total GWh/year of OSW that market could integrate successfully include:
  - Projected energy demand
  - Existing procurement & distributed generation policies
  - Technical penetration potential of VERs (NREL Renewable Electricity Futures study, 2012)
  - Assumed OSW share of VER penetration (range)

Electric Market Constraints: VER Penetration

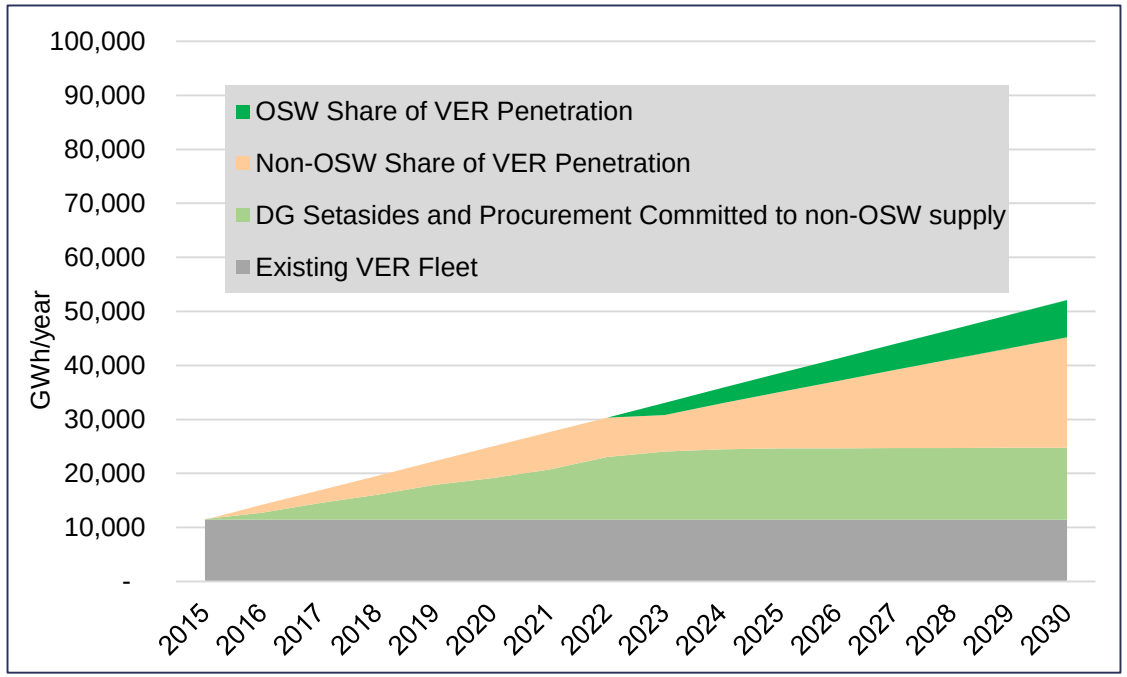
Major Assumptions

Input	Low Case	High Case
Base VER Fleet - 2015 (MW)	11,500	
DG carve-outs and procurements committed to non-OSW supply*	Unavailable to OSW	
Load forecast (ISO-NE CELT & NYISO Gold Book)	Base Case	High Case
VER penetration rate of total incremental uncommitted market demand by 2030 (increases over time) (NREL RE Futures Study)	18.1%	27.4
OSW share of residual incremental VERs (of post-2022 VER penetration) (benchmarked to NREL 80% RE-ETI Low Case scenario from NREL Futures Study (~21%))	25%	70%
DG carve-outs and non-OSW procurements	High Case	Low Case
Incremental OSW penetration start year	2023	2021

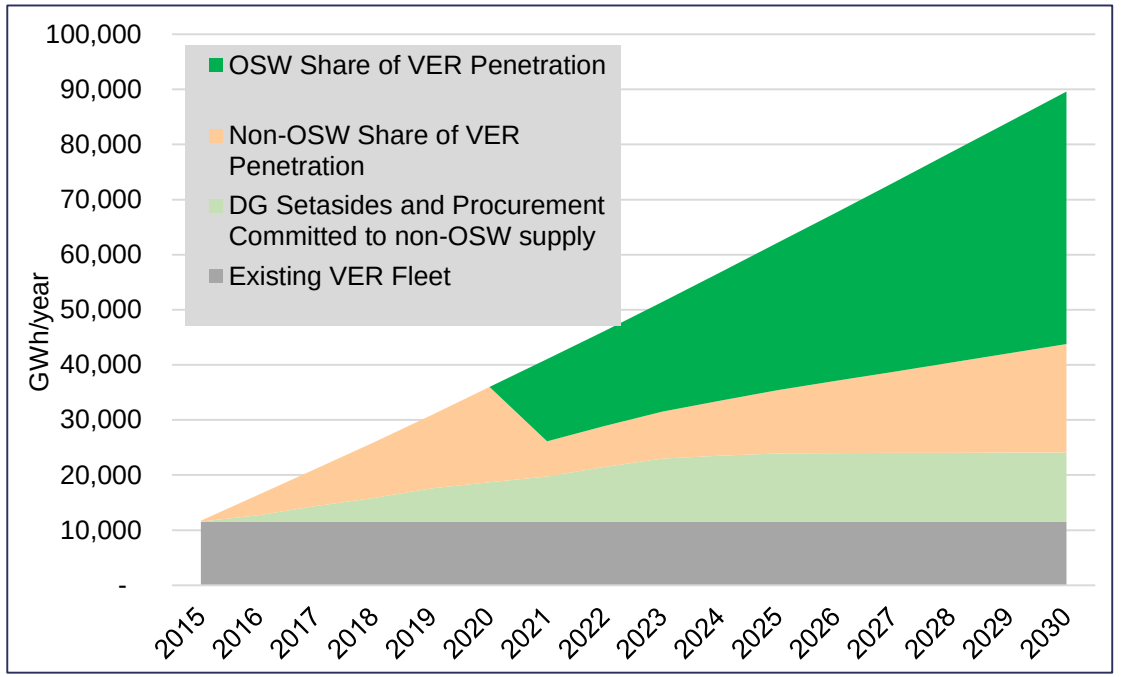
* Analysis predated Massachusetts Section 83D procurements; does not *explicitly* capture any supply surplus that could result from such procurement.

Electric System and Market Components
Electric Market Constraints: VER Penetration

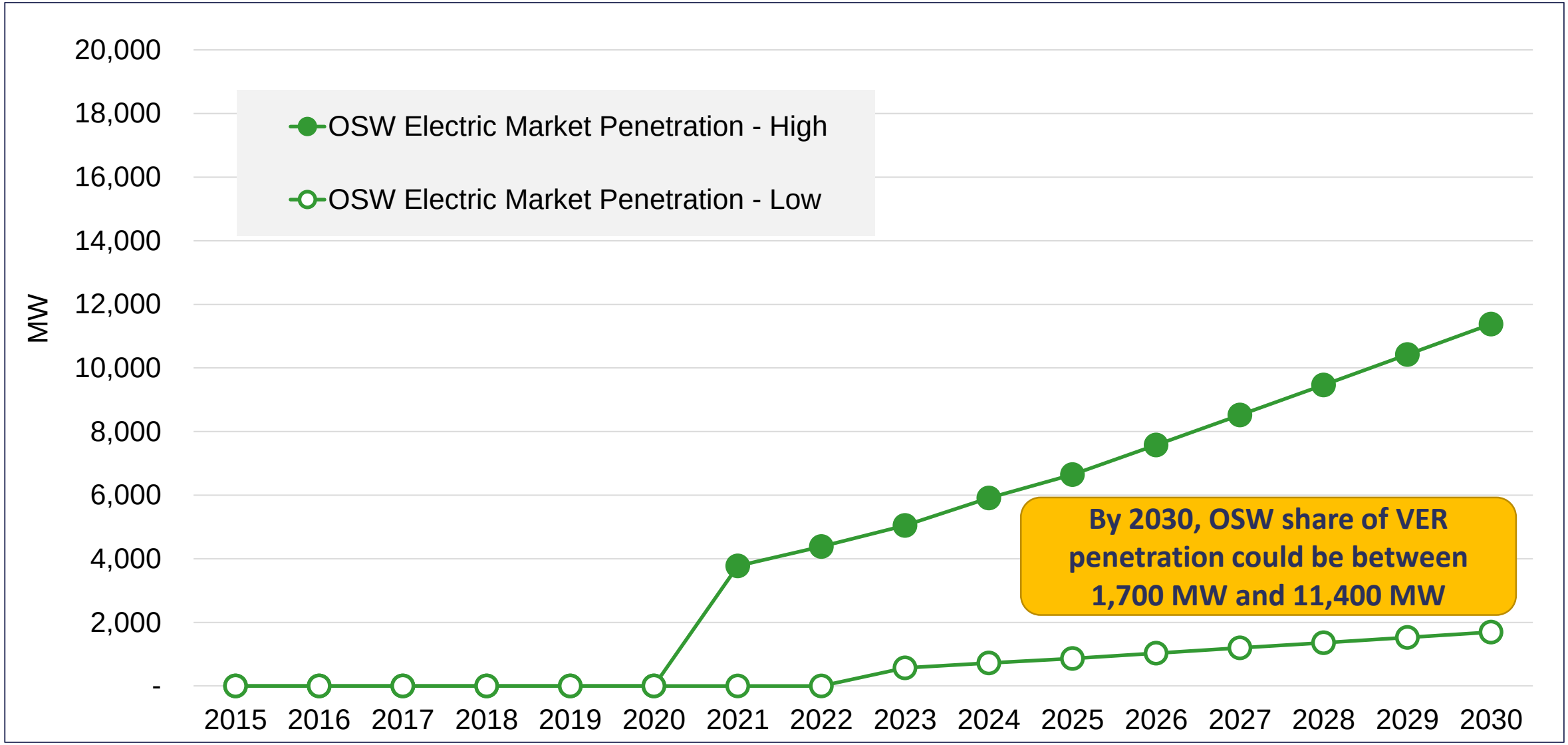
Low Case Trajectory



High Case Trajectory



Electric System and Market Components
Electric Market Constraints: VER Penetration



Analytical Components and Methodology

State and Regional Policies & Plans

- Regional RPS Demand for Offshore Wind
- Greenhouse Gas Policy-Driven Demand
- Offshore Wind Goals, Plans, Procurement Targets, and Contracting Policies

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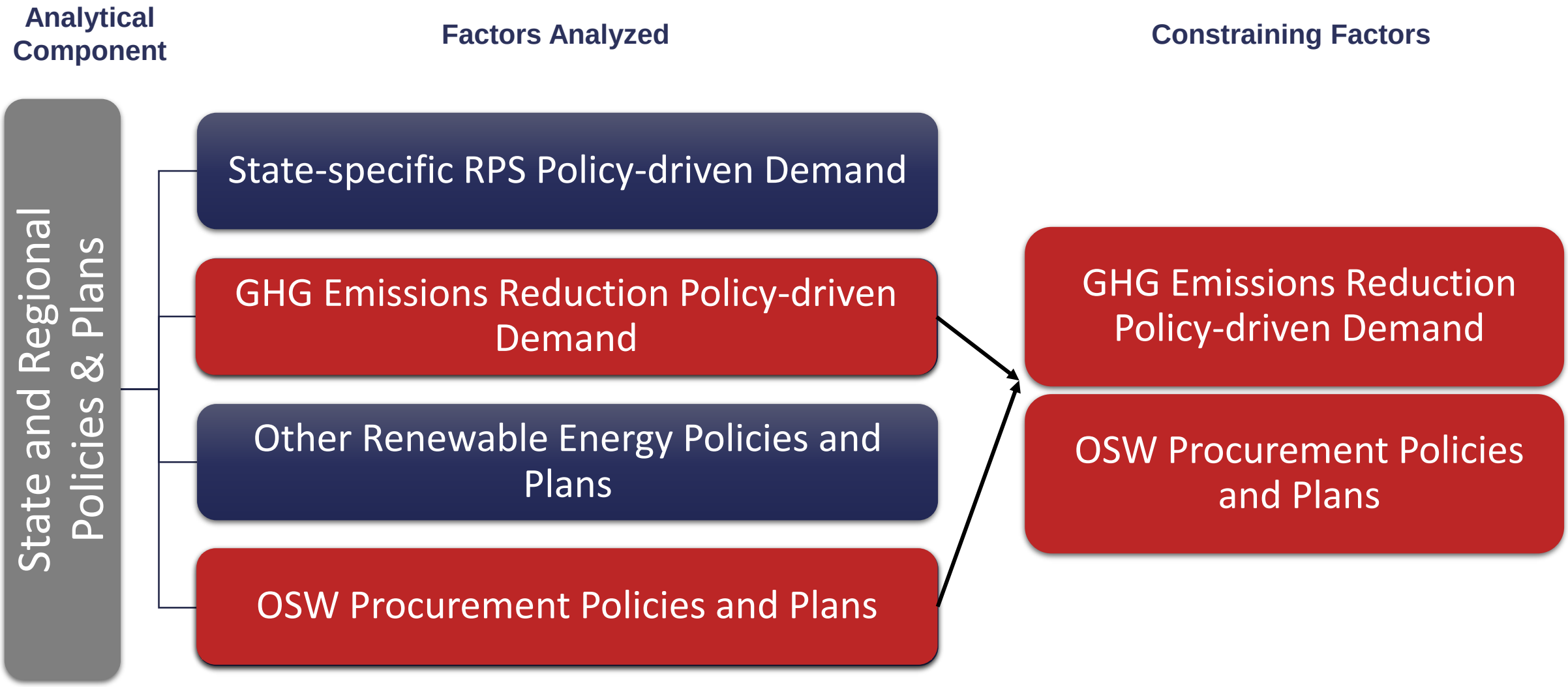
State and Regional Policies & Plans



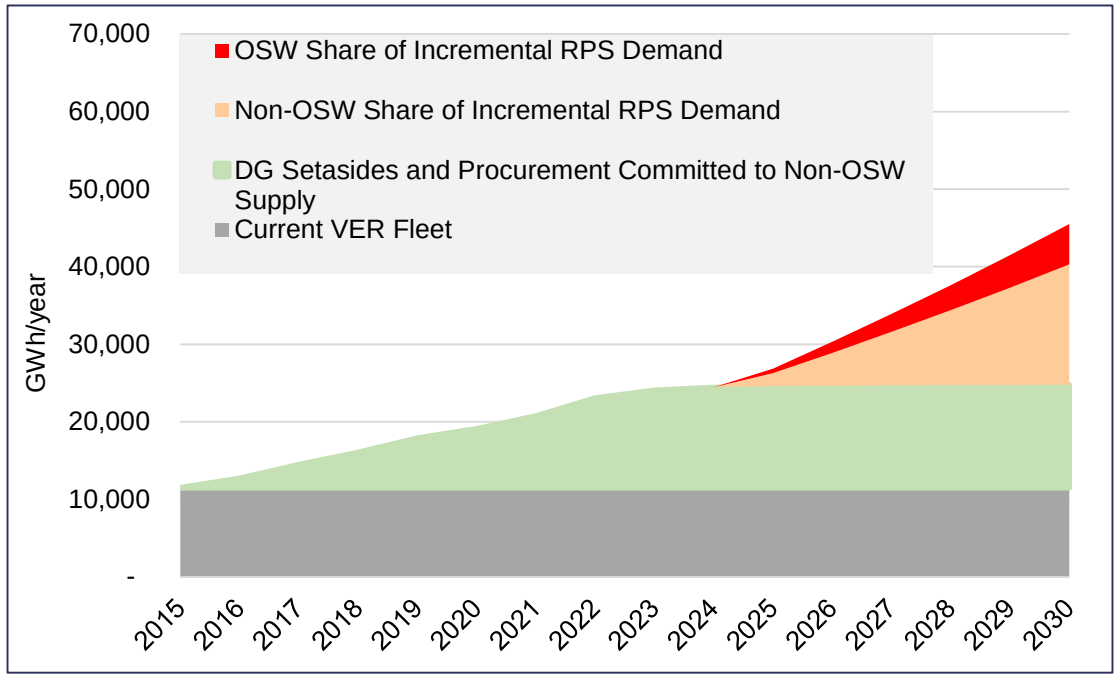
State and Regional Policies & Plans
State-specific RPS Policy-driven Demand

- Share of future market to be served by OSW based on :
  - Time at which OSW can enter the market
  - Existing & other incremental (non-OSW) renewable generating fleet meets RPS demand until the first year OSW available to meet incremental RPS targets (2022)
  - Incremental RPS demand in New York, Massachusetts, Rhode Island, New Hampshire, Connecticut
    - NY Clean Energy Standard: 50% by 2030
    - MA RPS*: *assumed* 2% annual increase 2018+
    - RI RES: 1.5% annual increase 2020+
    - CT RPS: *assumed* 30% by 2030
  - The OSW share of residual incremental RPS demand after 2022 assumed (by authors) as:
    - 25% in the Low OSW Penetration Scenario
    - 50% in the High OSW Penetration Scenario

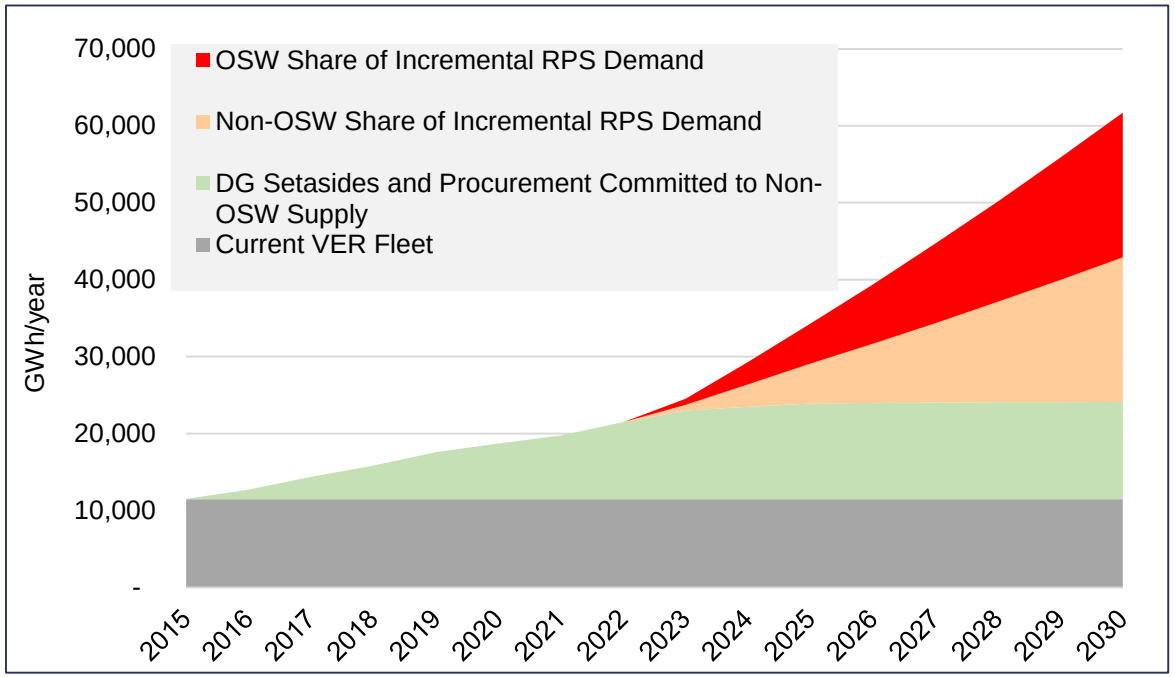
*Analysis did not *explicitly* include additional demand for RPS resources resulting from Massachusetts Clean Energy Standard adopted by Dept. of Env. Protection.

Electric System and Market Components
State-specific RPS Policy-driven Demand

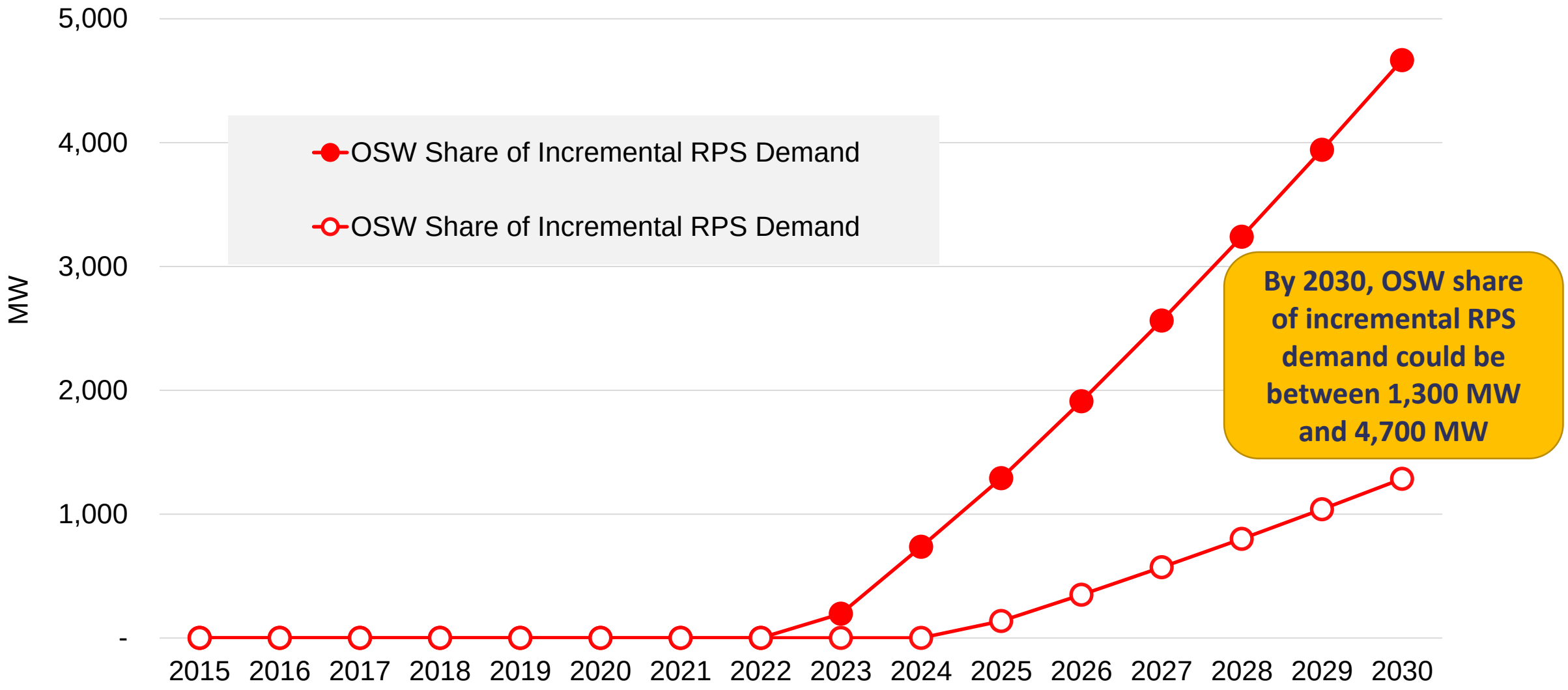
Low Case Trajectory



High Case Trajectory



Electric System and Market Components
State-specific RPS Policy-driven Demand

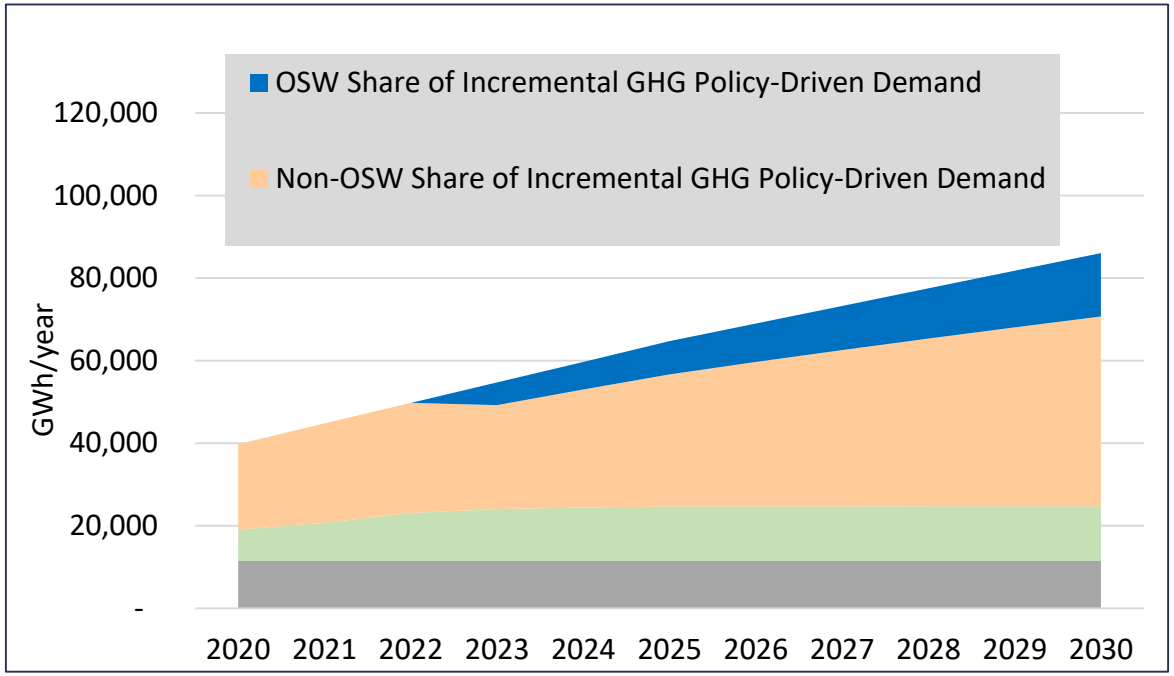


State and Regional Policies & Plans
GHG Emissions Reduction Policy-driven Demand

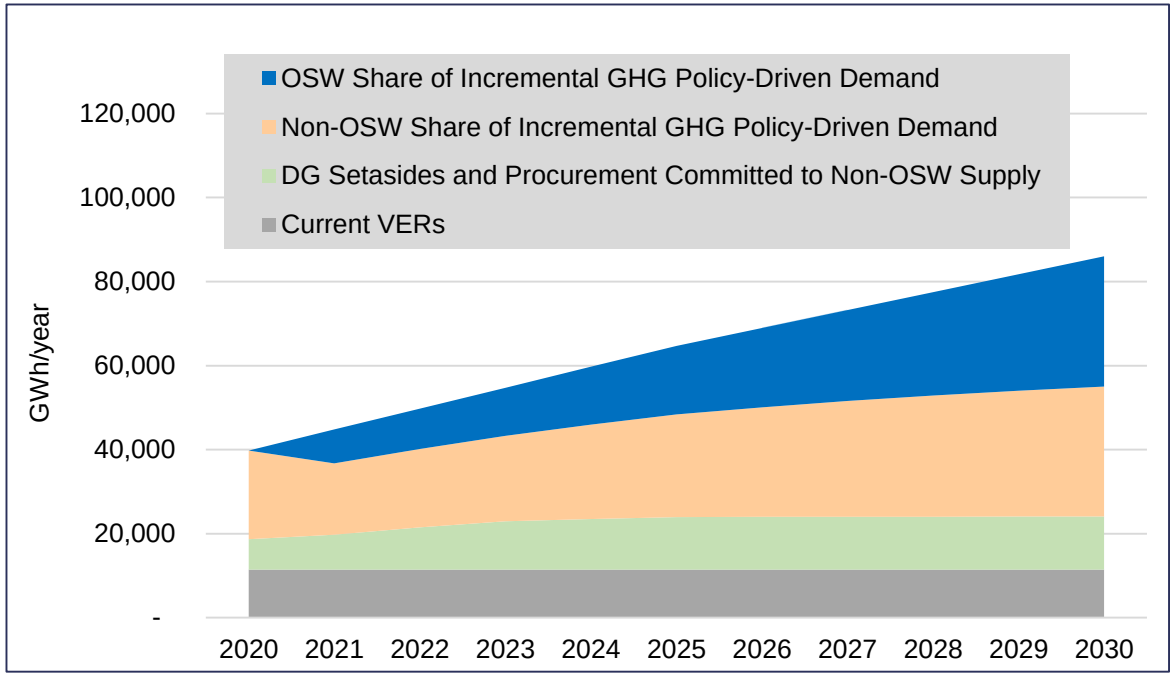
- Aggressive regional greenhouse gas emissions reduction policies ➔ likely upper bound on policy-driven OSW demand
- Key assumptions:
  - Recent study of quantity of VER's required to achieve regional GHG reduction targets of 40% by 2040 (Synapse Energy Economics, RGGI Opportunity 2.0 Study, 2016)
    - Study projected GWh/yr of VERs (wind & solar) by state
    - Used as starting point for analysis
  - Policies & procurements driving non-OSW supply (boxing out OSW)
  - Authors assumed ramp up of OSW share of *residual incremental* demand for VERs to achieve state GHG emissions reduction targets from 2022 to 2030:
    - Low: ramp up to 25%
    - High: ramp up to 50%

Electric System and Market Components
GHG Emissions Reduction Policy-driven Demand

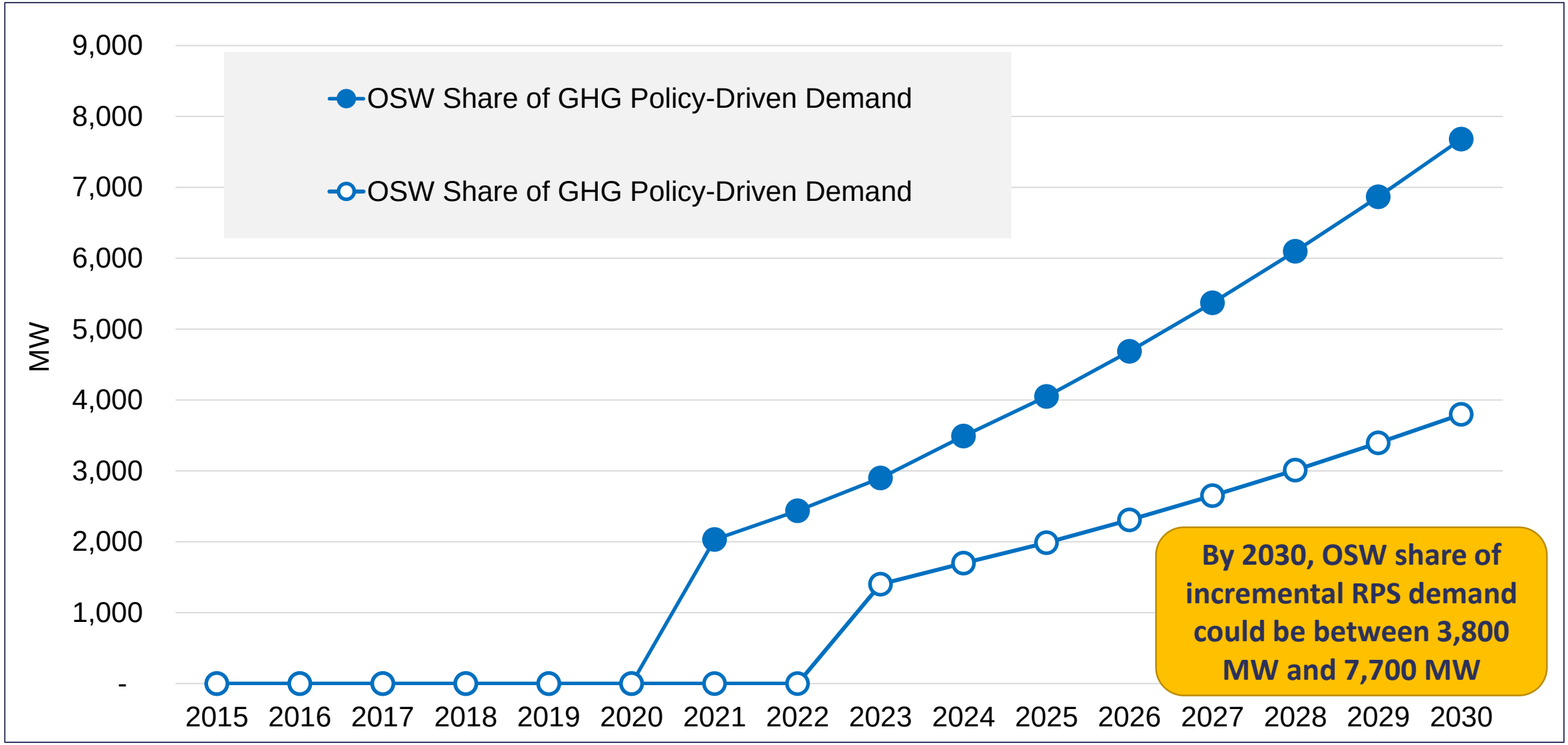
Low Case Trajectory



High Case Trajectory



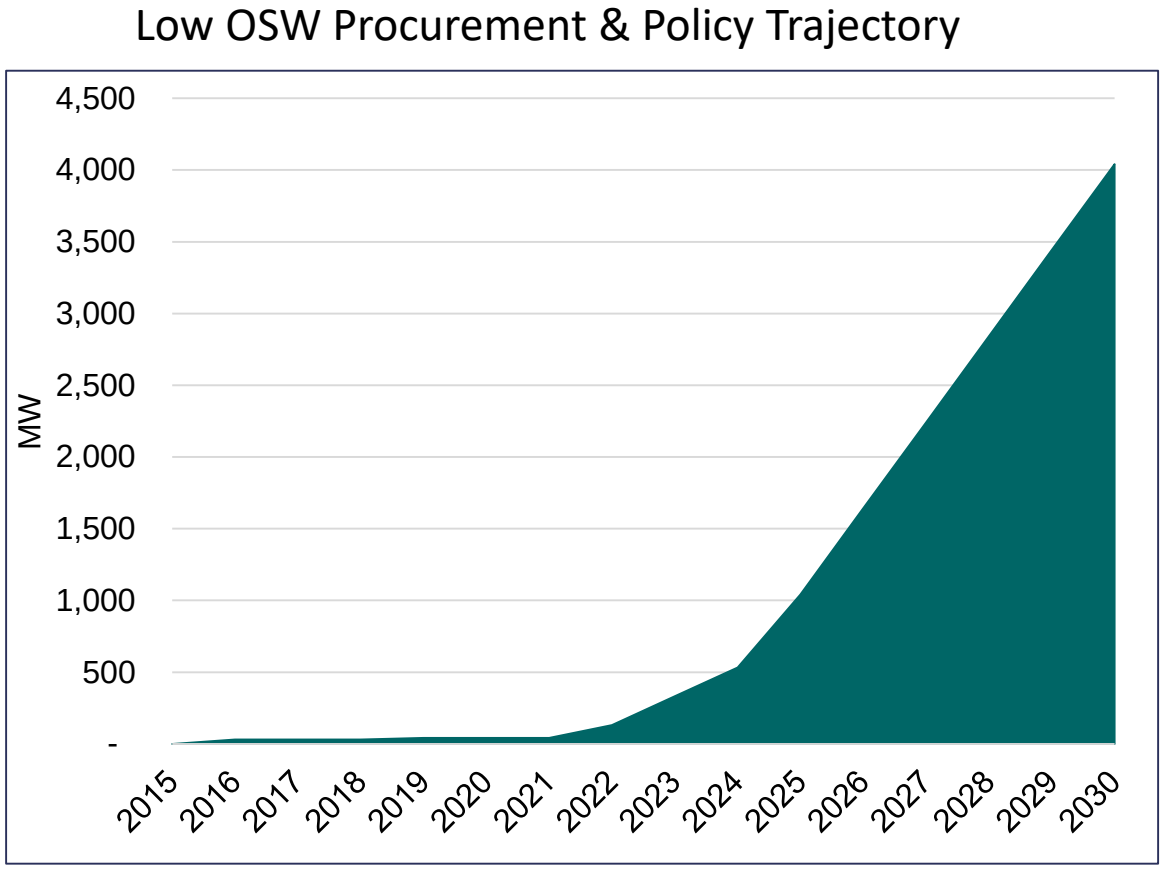
Electric System and Market Components
GHG Emissions Reduction Policy-driven Demand



State and Regional Policies & Plans
OSW Procurement Policies and Plans

- State and regional policies ➔ indicative of the increasing level of commitment to GHG reductions, renewable energy expansion, and OSW deployment
- Policies vary widely in timing, form and application (pilot programs, statutory procurement goals, aspirational and non-binding targets)

Variables	Low Case (MW)	High Case (MW)
Development Pipeline	30	42
MA OSW Procurement by 2030 (Section 83C of An Act to Promote Energy Diversity)	1,600	
NY OSW Procurement by 2030 (Gov. Cuomo commitment to developed 2.4 GW by 2030)	2,400	
Total	**4,030**	**4,042**



Putting it all together: the OSW Market Assessment

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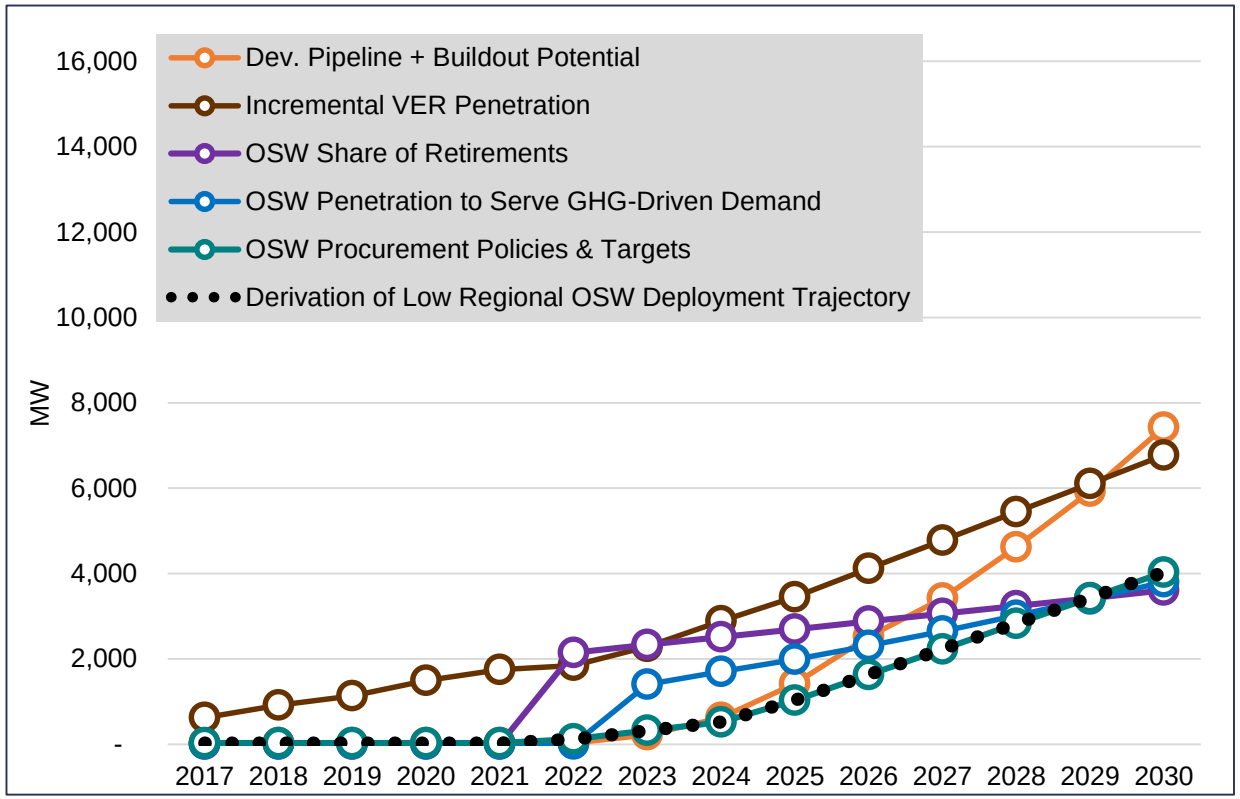
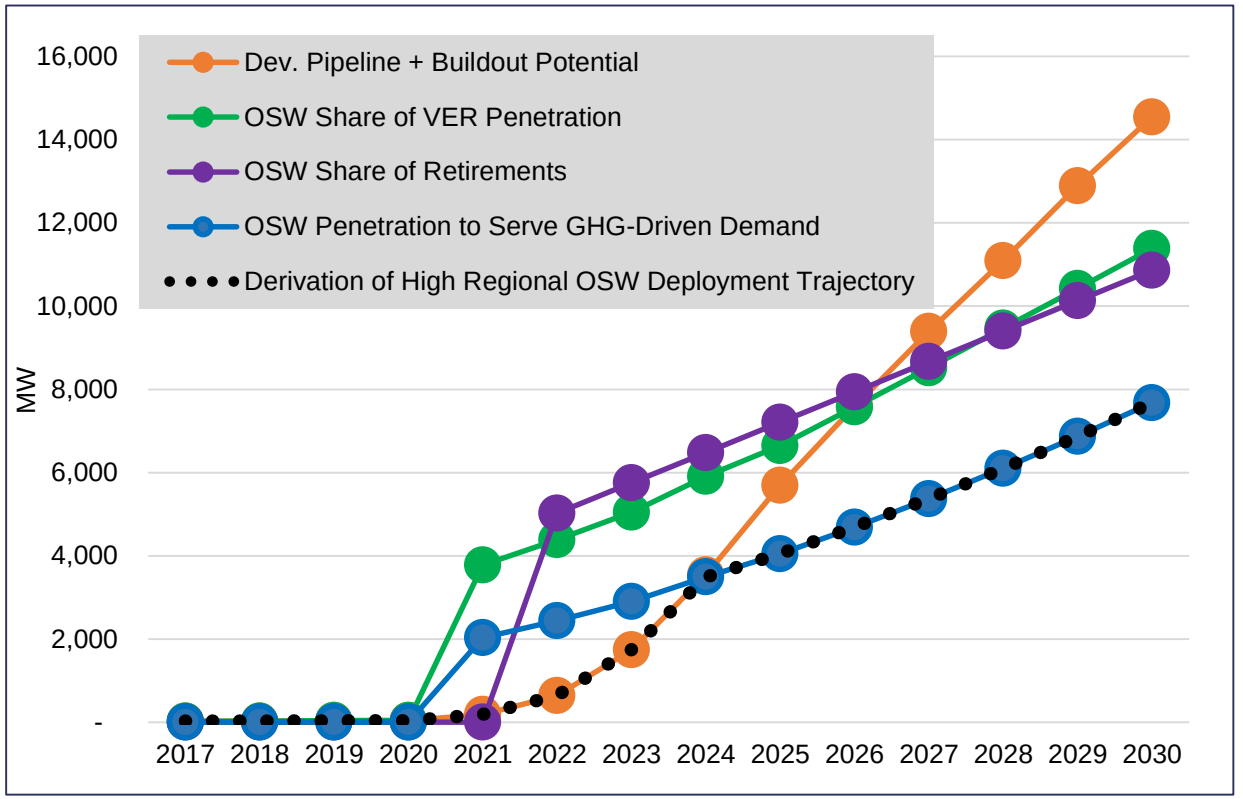
Derivation of Regional OSW Deployment Trajectories

Low Case Trajectory



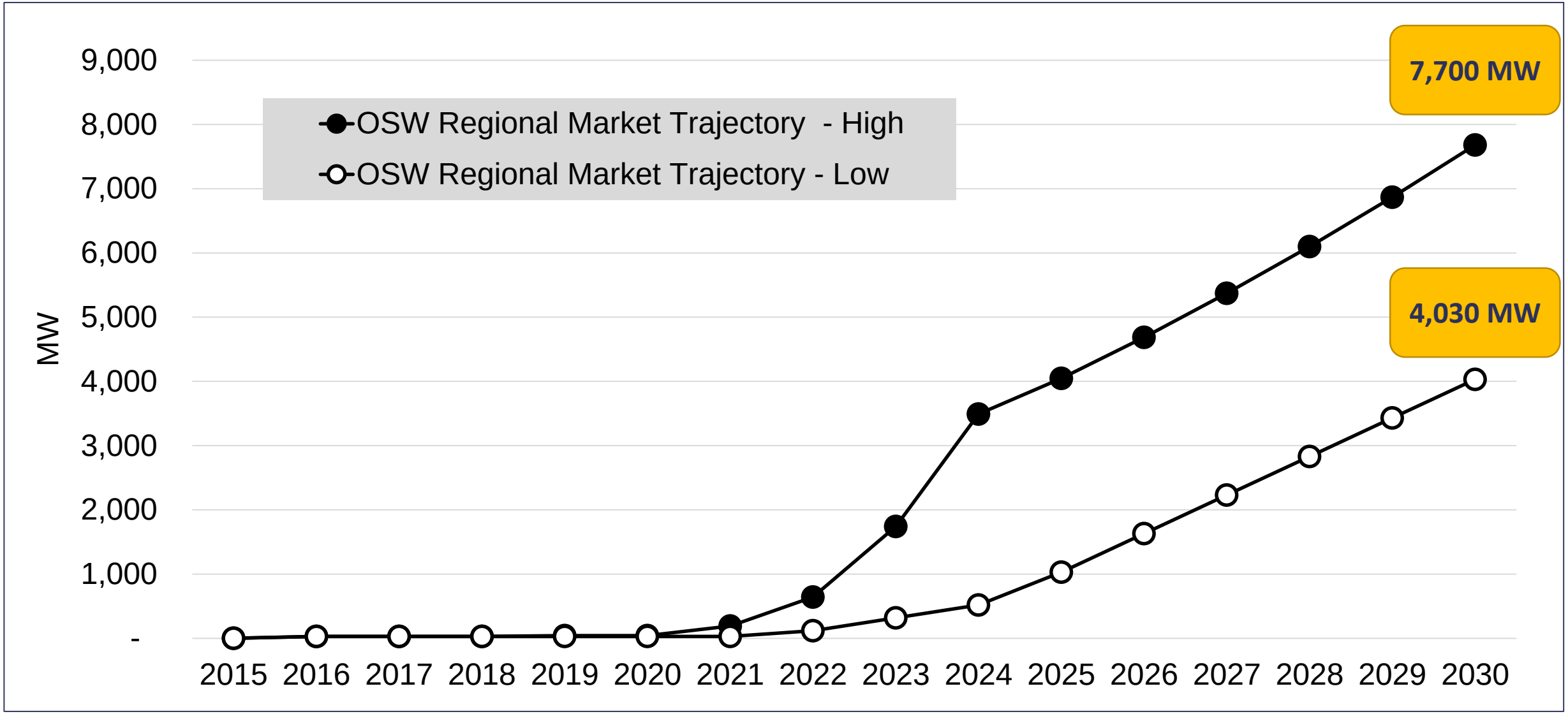
High Case Trajectory



Conclusion, Takeaways, Considerations

- OSW deployment trajectories assembled by combining component analyses
- High OSW Deployment trajectory derived as the lesser of:
  - Development Pipeline & Buildout Potential
  - VER penetration
  - GHG policy-driven demand
- Low OSW Deployment trajectory based on trajectory of planned procurements and procurement targets for OSW in the region
  - Targets exceed (and overcome) constraints inherent in the other analytical perspectives
- *New developments in the northeast, and advancements in OSW industry (post-dating the analysis), suggest the increasing probability of an upward shift in the trajectory envelope*

Regional OSW Deployment Trajectories



Questions?

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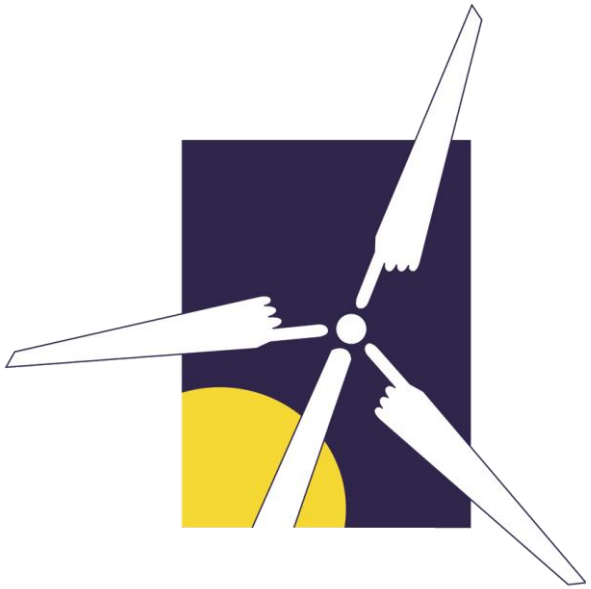

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U.S. Job Creation in Offshore Wind

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