CleanEnergy States Alliance

Energy Storage and Offshore Wind:

Unlocking a Critical Piece of the Clean Energy Puzzle

March 15, 2024

Webinar Logistics

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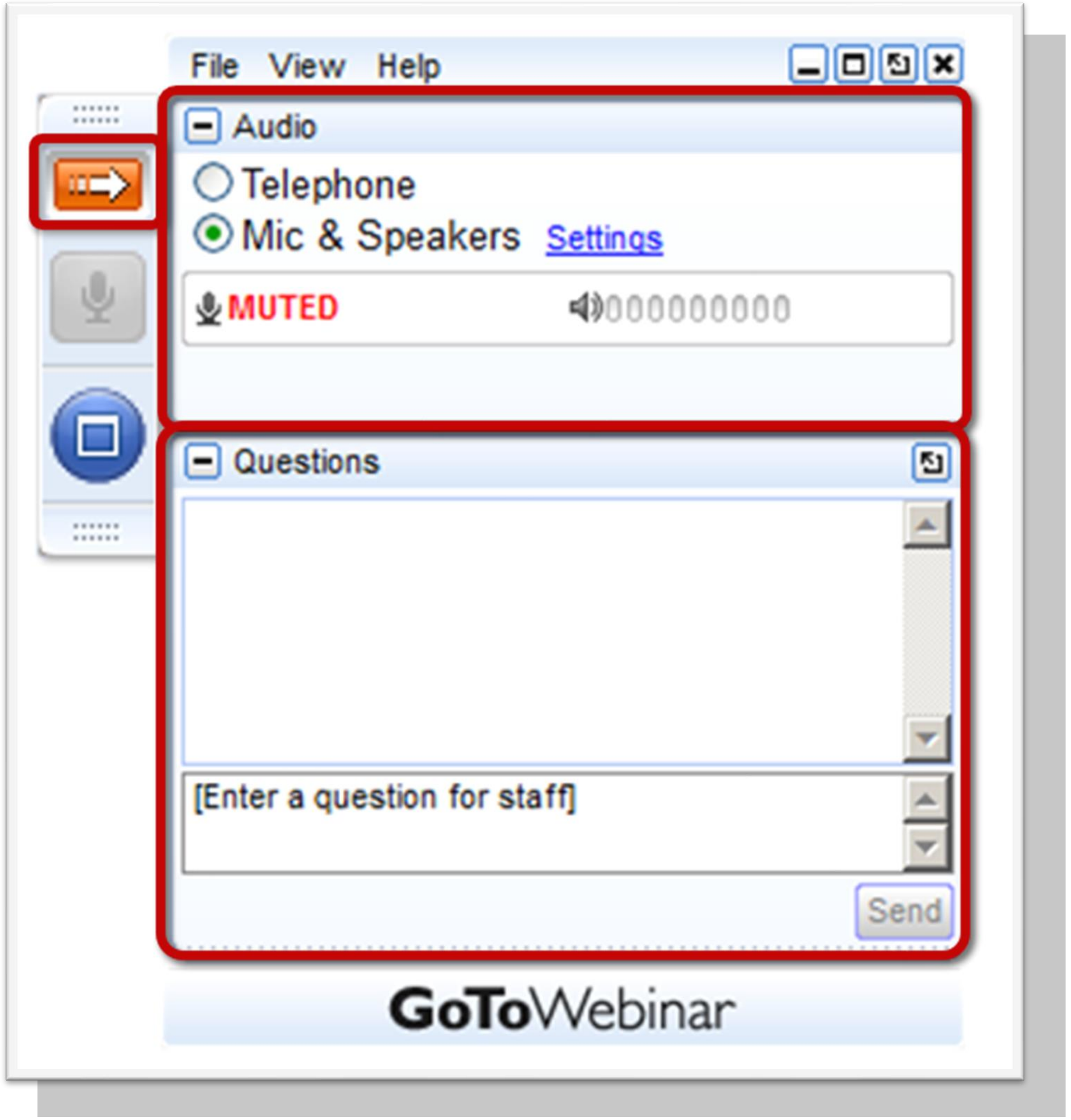


Celebrating 20 Years of State Leadership

20 CleanEnergy States Alliance

The Clean Energy States Alliance (CESA) is a national, nonprofit coalition of public agencies and organizations working together to advance clean energy.

CESA members—mostly state agencies—include many of the most innovative, successful, and influential public funders of clean energy initiatives in the country.

www.cesa.org

Clean Energy States Alliance

www.cesa.org

State of California Energy Commission

Connecticut Green Bank

Department of Energy & Environment

Energy Trust of Oregon

IPA Illinois Power Agency

Governor's Energy Office

State of New Hampshire Department of Energy

Massachusetts Clean Energy Center

Maryland Energy Administration

EGLE Michigan Department of Environment, Great Lakes, and Energy

BPU New Jersey Board of Public Utilities

New Jersey's Clean Energy Program njcleanenergy.com

New Mexico EMNRD Energy, Minerals and Natural Resources Department

New York State NYSERDA

mn Commerce Department

SMUD Powering forward. Together.

State of Rhode Island Office of Energy Resources

Vermont Department of Public Service Clean Energy Development Fund

Virginia Energy

Rhode Island Commerce Corporation

Commissioner Stephanie Garcia Richard New Mexico State Land Office

ICC Illinois Commerce Commission

OEI Wisconsin Office of Energy Innovation

Prairie Island Indian Community in the State of Minnesota

Washington State Department of Commerce

Connecticut Energy & Environment

DOER Massachusetts Department of Energy Resources

Oregon Department of Energy

Colorado Energy Office CEO

Inclusive Prosperity Capital

MassDEP

OPC-DC Office of the People's Counsel

ADVOCACY | EDUCATION | PROTECTION

Energy Storage Policy for States

Providing support to CESA members engaged in developing energy storage policy, programs and regulation.

Activities include knowledge sharing, direct policy support, and independent analysis.

The project leverages other CESA and CEG efforts, including the Energy Storage Technology Advancement Partnership (ESTAP) and CEG's Resilient Power Project.

www.cesa.org/projects/energy-storage-policy-for-states/

Offshore Wind Accelerator

Engaging states in information sharing and networking to advance regional cooperation

Promoting equitable offshore wind development by working with frontline community-based organizations

Communicating offshore wind developments to a wide range of stakeholders.

www.cesa.org/projects/offshore-wind-accelerator

Offshore Wind Power Hub

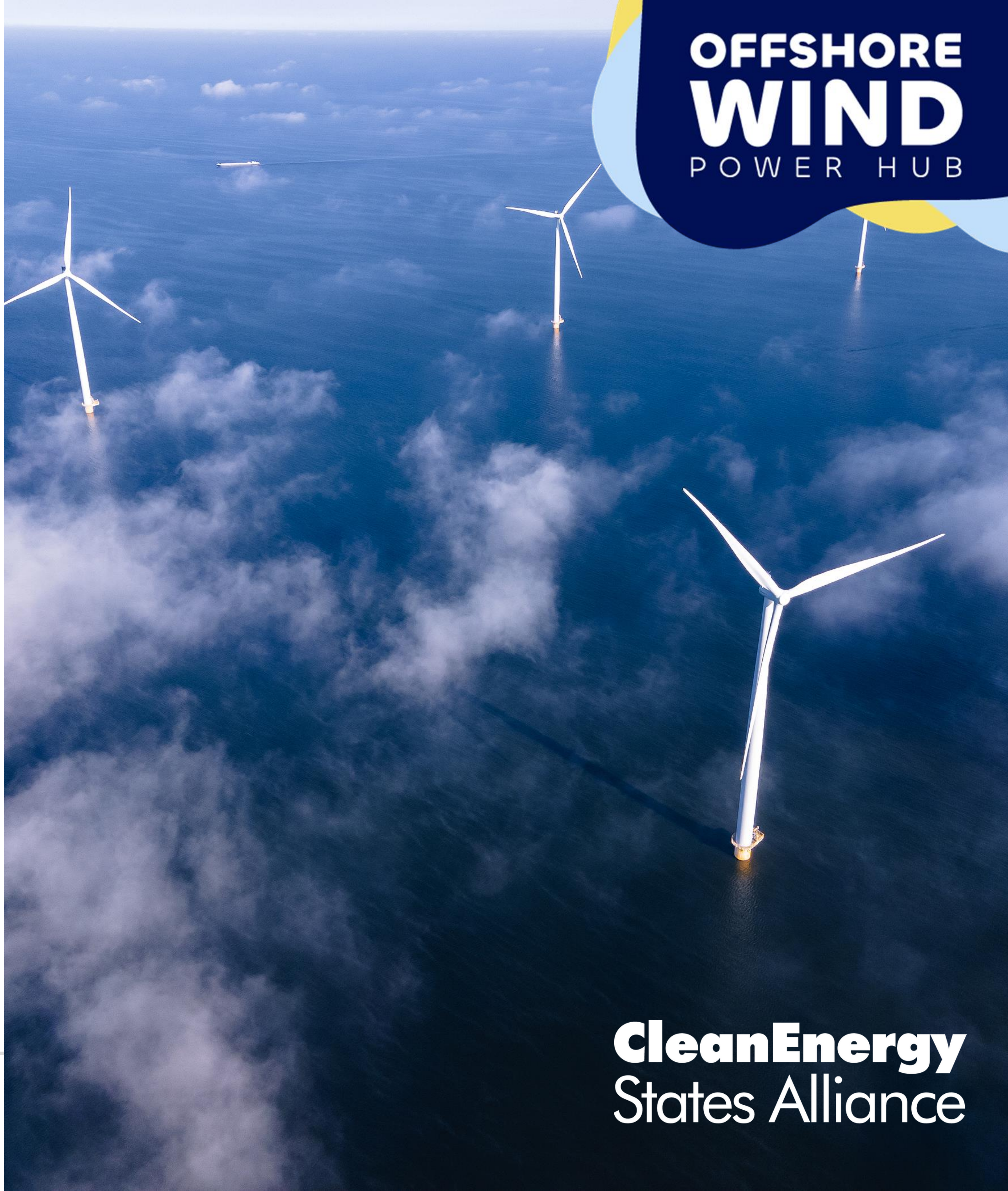
Interactive map tracks policies, projects and lease areas in the US.

Policymakers and offshore wind advocates have access to an exclusive forum and resource library, to enable collaboration and information sharing.

CleanEnergy States Alliance

National Wildlife Federation

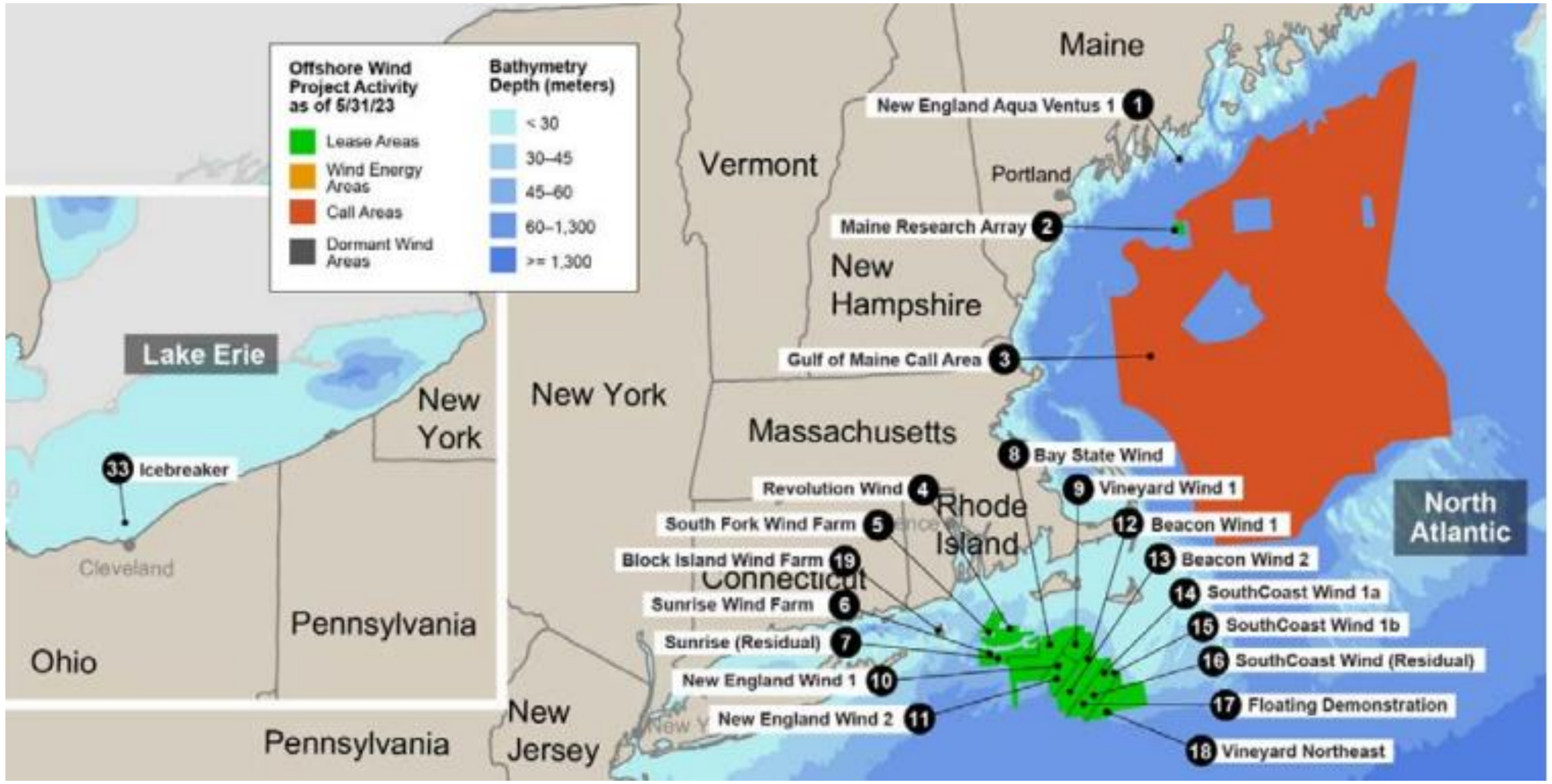
offshorewindpowerhub.org



Offshore Wind in the US: Where We Stand

As of May 2023, the offshore wind project pipeline in the US totaled **52,687 MW** (DOE OSW Market Report).

Northeast states (ME, NY, NJ, MA, CT, and RI) have a collective goal of roughly **32,000 MW by 2040**.



John Frenzl, National Renewable Energy Laboratory (NREL)

Stay up to date on CESA's Offshore Wind Accelerator

CONTACT: VERO BOURG-MEYER - VERO@CLEANEGROUP.ORG OR SAM.SCHACHT@CLEANEGROUP.ORG

NEWSLETTERS: HTTPS://WWW.CESA.ORG/PROJECTS/OFFSHORE-WIND-ACCELERATOR/NEWSLETTER/

THANK YOU FOR YOUR ATTENTION!

Webinar Speakers

Todd Olinsky-Paul
Clean Energy States Alliance

Sam Schacht
Clean Energy States Alliance

Schuyler Matteson
New York State Department of Public Service

Tom Ferguson
Massachusetts Department of Energy Resources

Liz Mettetal
Energy and Environmental Economics, Inc (E3)

CleanEnergy States Alliance

NEW YORK STATE OF OPPORTUNITY. | Department of Public Service

DOER Massachusetts Department of Energy Resources

Thank You

Todd Olinsky-Paul

Senior Project Director

Clean Energy States Alliance

todd@cleanegroup.org

Sam Schacht

Project Manager

Clean Energy States Alliance

Sam.schacht@cleanegroup.org

Energy Storage Capacity Value & Diversity Benefits with Offshore Wind

MASSACHUSETTS CLEAN ENERGY CENTER

DOER Massachusetts Department of Energy Resources

Energy Storage Technology Advancement Partnership Meeting

March 15, 2024

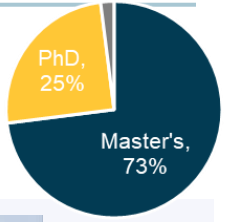
Energy+Environmental Economics

Tom Ferguson, PhD, Energy Storage Programs Manager, DOER

Liz Mettetal, PhD, Director

About E3

100+ full-time consultants | 30 years of deep expertise | Engineering, Economics, Mathematics, Public Policy…




San Francisco


New York


Boston


Calgary

E3 Clients

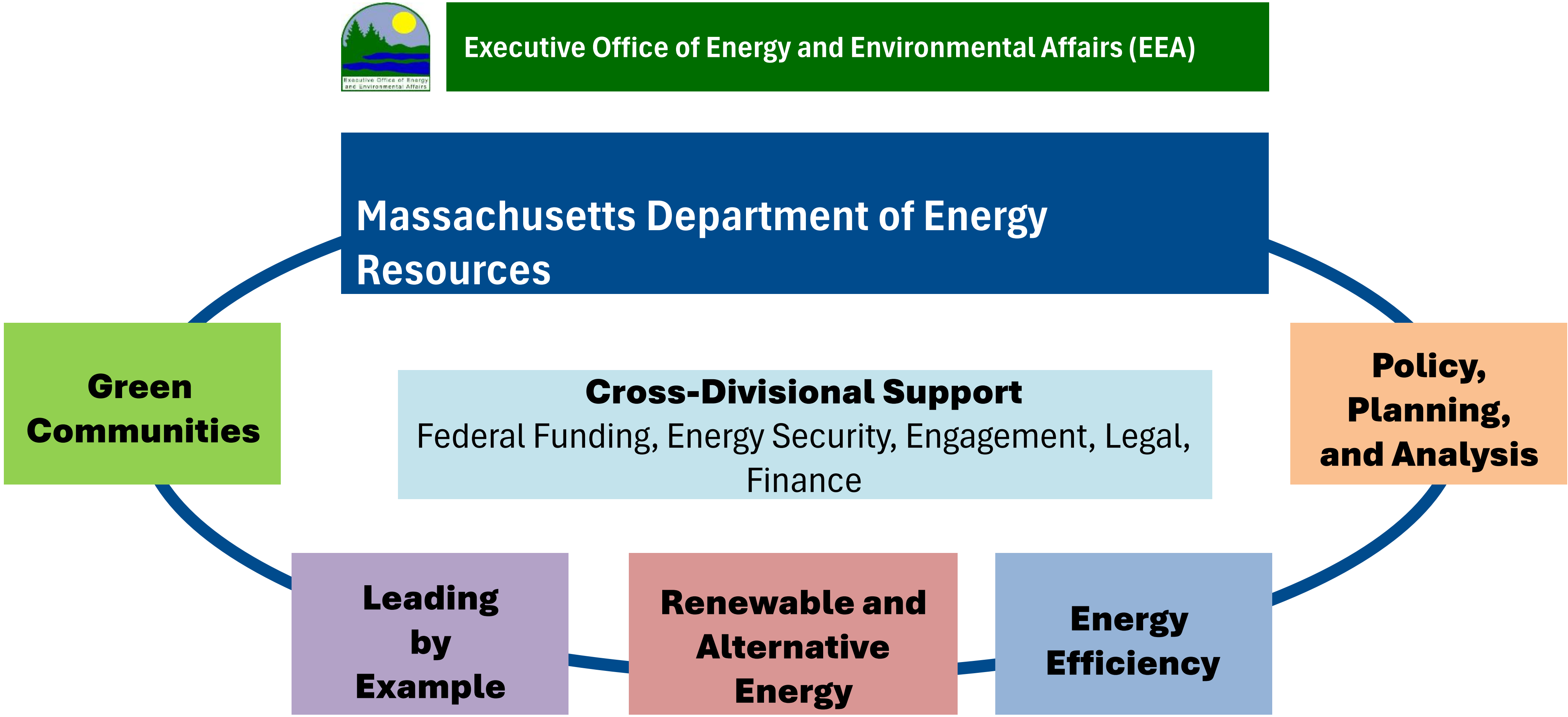
300+ projects per year across our diverse client base

Example Recent Related Projects

- Maine Renewable Energy Goals Market Assessment (2021)
- Net Zero New England: Electric Reliability under Deep Decarbonization (2020)
- New York Energy Storage Roadmap – NYSERDA (2022, 2018)
- New York Peaker Repowering/Replacement Study – NYSERDA (2019)
- Minnesota Dept. of Commerce, Minnesota Energy Storage Cost-Benefit Analysis (2019)
- California Energy Commission, EPC-19-056, Assessing the Value of Long Duration Storage (2020-present)
- Confidential work for a number energy storage owners, developers and investors with a focus on revenue forecasting and market analysis

About DOER

Mission: The Massachusetts Department of Energy Resources (DOER) mission is to develop and implement policies and programs aimed at ensuring the adequacy, security, diversity, and cost-effectiveness of the Commonwealth's energy supply to create a clean, affordable and resilient energy future for all residents, businesses, communities, and institutions.



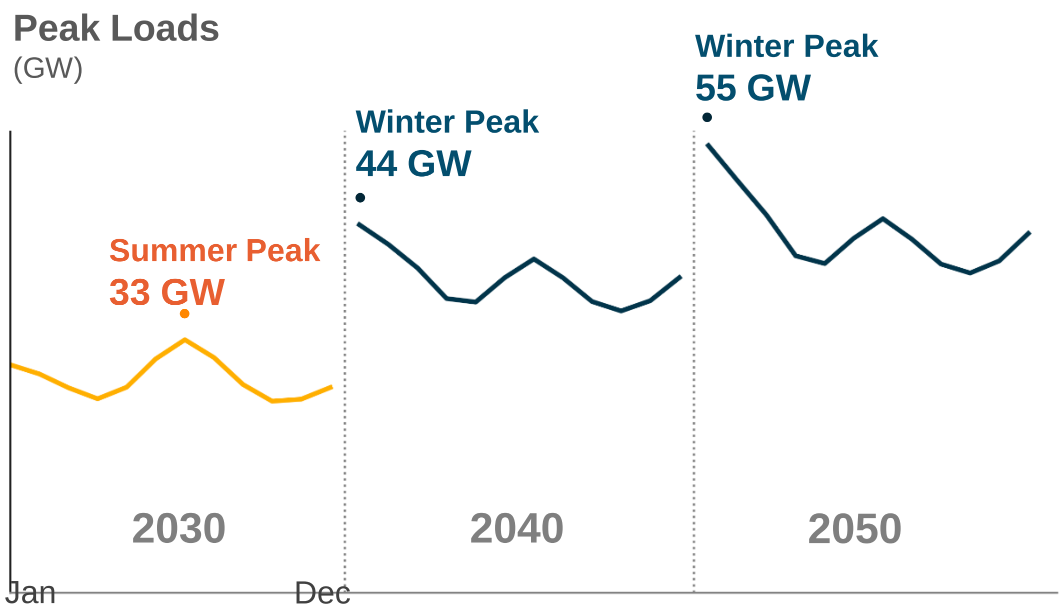
DOER
Massachusetts Department of Energy Resources

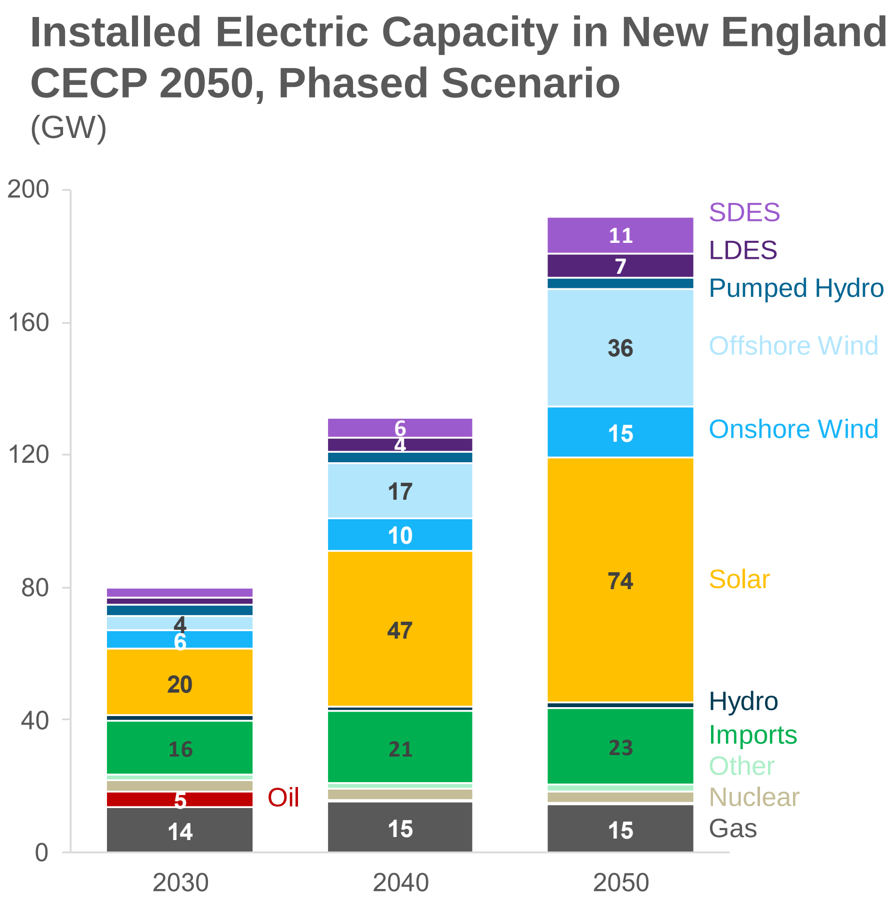
2022: Climate Bill, CECP, and Storage

- **Legislative Requirement**: August 11, 2022
  - Section 80 of Chapter 179 of the Acts of 2022 ("An Act Driving Clean Energy and Offshore Wind") requires DOER, in consultation with MassCEC, to conduct a study on the current status of energy storage and the potential role of mid- and long-duration energy storage (MDES and LDES, respectively).
- **Clean Energy and Climate Plan for 2050 (CECP)**: Released December 2022
  - Lays out Commonwealth's Plan to achieve Net Zero in 2050 in an equitable and just manner
  - Calls for collective GHG emission reductions of 85% relative to 1990 levels
    - Electric sector reduction of 93%
    - Requires 2.5x increase in electric sector load relative to 2020 and over 50 GW of solar and wind
  - 2050 CECP Phased Scenario was basis for reliability modeling, relates to potential role for MDES and LDES

Study leverages the state's CECP 2050 portfolio to evaluate the potential for LDES to provide reliability

- E3's resource adequacy modeling is based on New England's projected loads and installed electric capacity from the Phased Scenario
- System transitions to winter peaking by 2040, with a peak of 55 GW by 2050

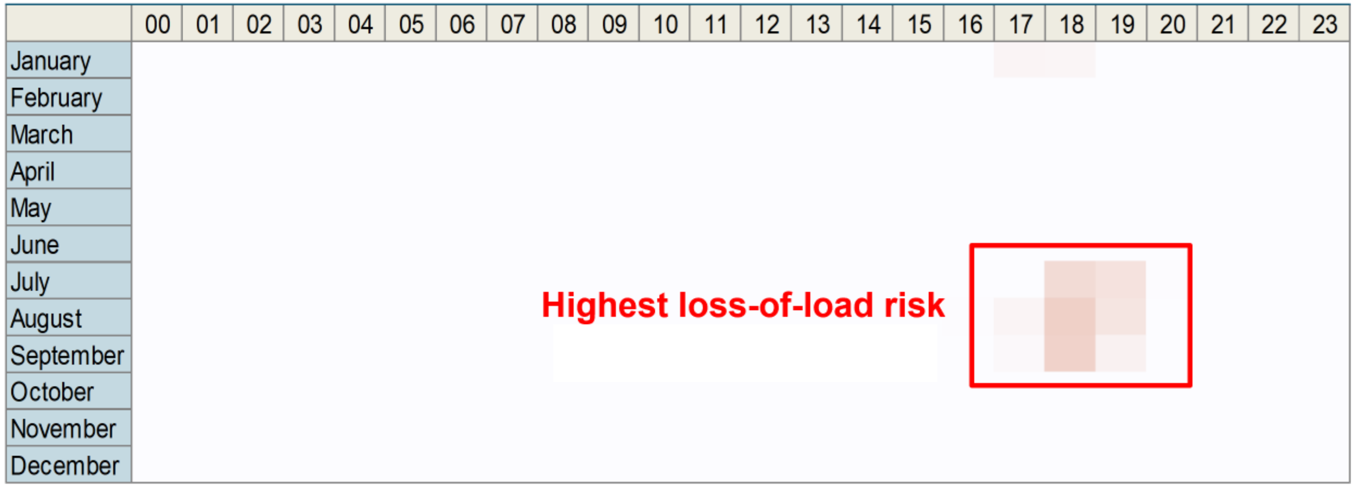




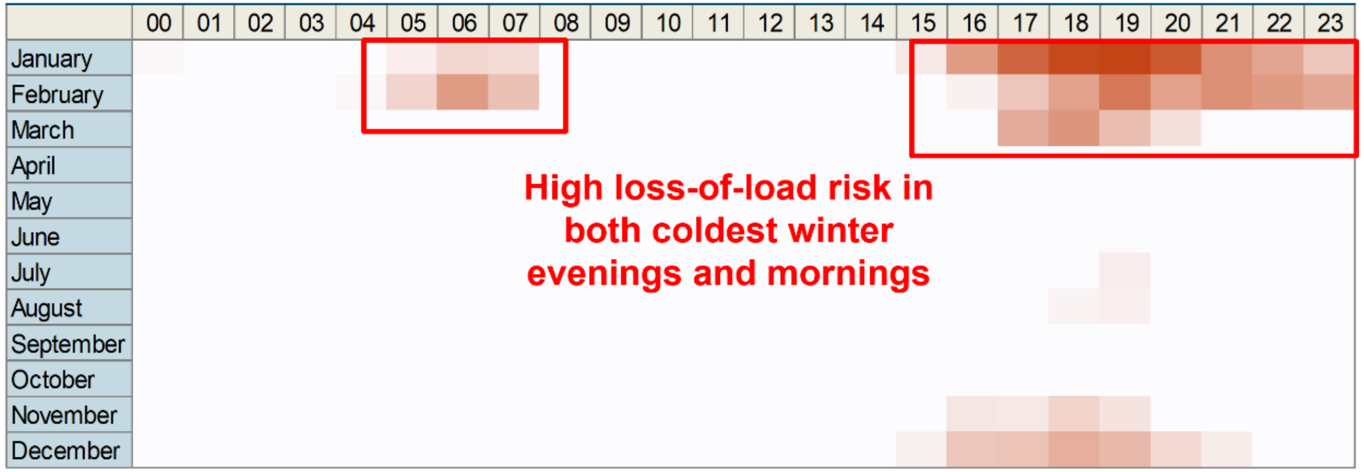
Key Finding: Evolving Reliability Risks

- **In 2030, New England system peak load grows to 31+ GW but remains summer peaking**
  - Renewable output has shifted net peak into the late afternoon & evenings
- **By 2050, New England peak grows to 50+ GW winter peak, with highest resource need spread over longer windows**
  - Opportunity for storage resources to support large loss-of-load risk in winter events and into the morning
- **Energy storage of varying durations can mitigate the Commonwealth's grid reliability risks as it decarbonizes**

Month-hour System Firm Resource Needs



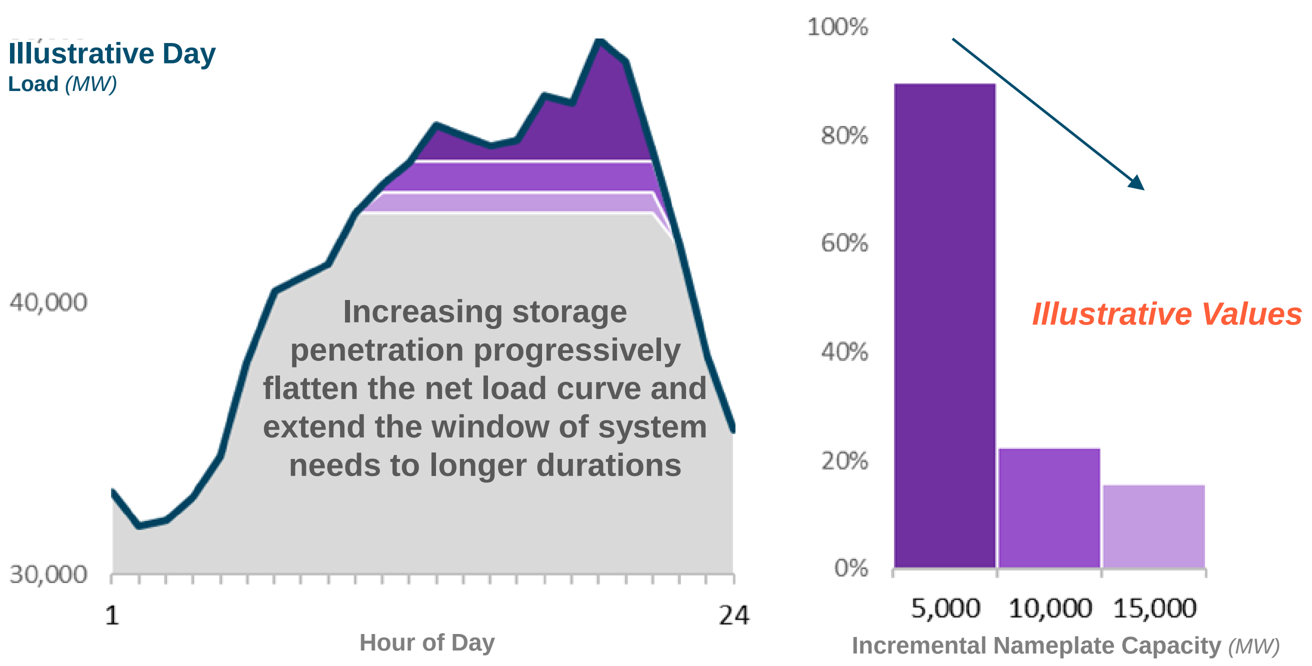
Month-hour System Firm Resource Needs



Storage ELCC is a function of penetration and duration

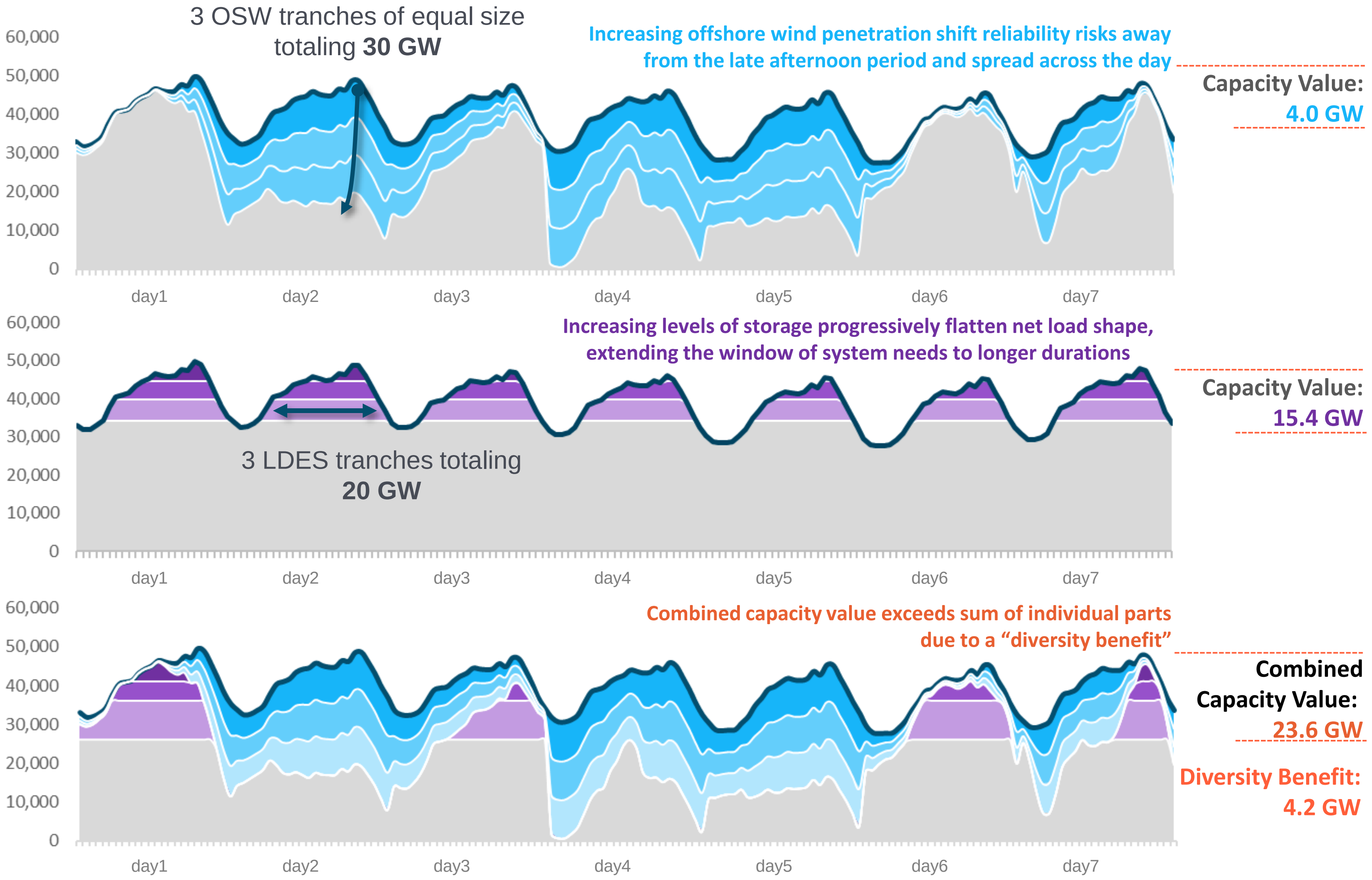
+ **Effective load carrying capability ("ELCC") measures a resource's contribution to the system's needs relative to perfect capacity, accounting for its limitations and constraint**
  - Variable and energy-limited resources can provide significant resource adequacy contributions
+ **Energy storage resources exhibit saturation effect where their capacity value declines as more resources are added to the system**
  - Determined by its ability to dispatch over a sustained duration before getting depleted, energy storage capacity value can decline sharply after a certain penetration

Illustration of Declining ELCC for **8-hour Energy Storage** as a function of Penetration



Storage ELCC is a function of rest of the portfolio, particularly offshore wind

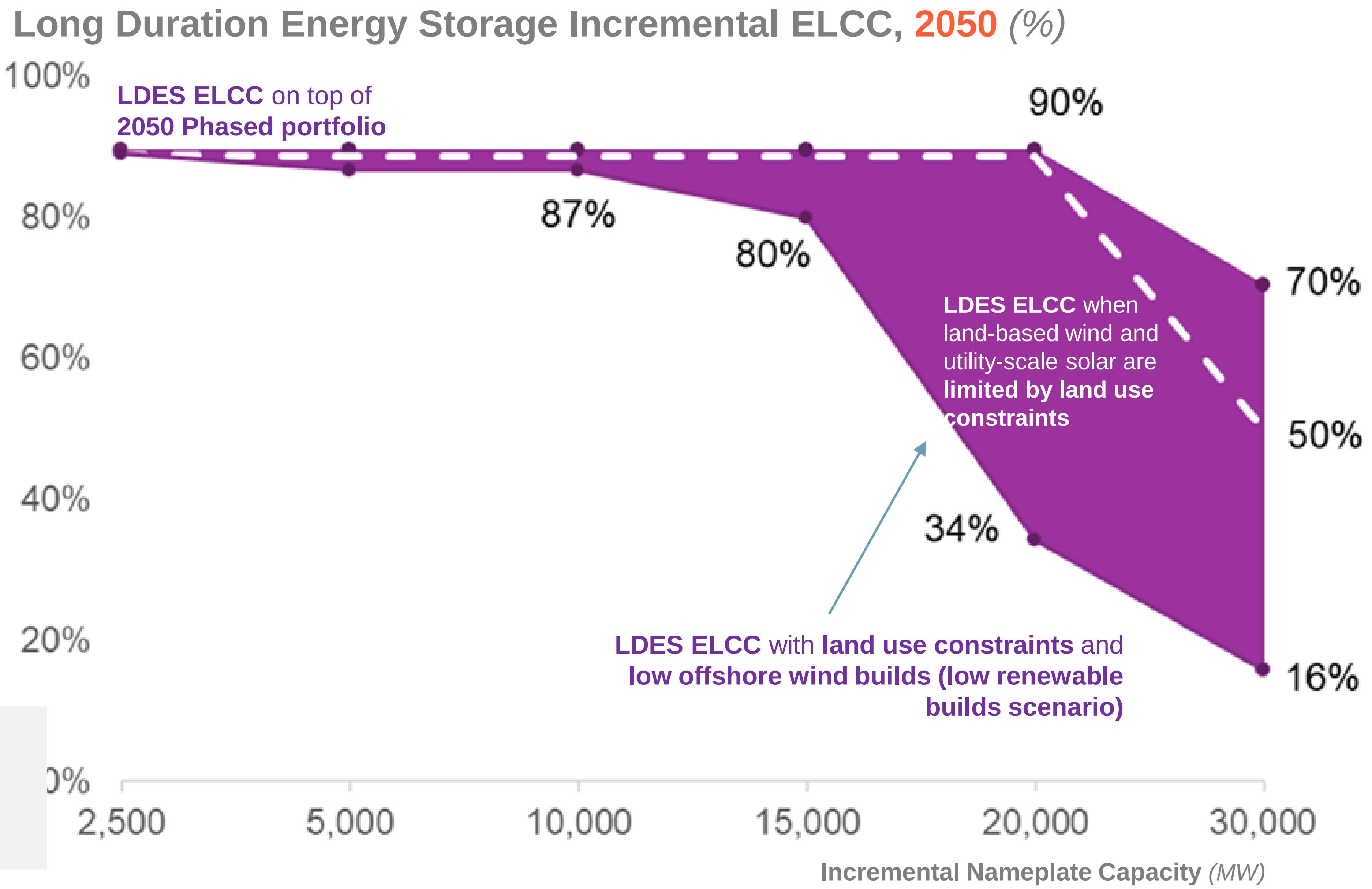
- **Storage ELCC, especially LDES, is dependent on the amount of renewable energy in the portfolio**
  - The **complementary interaction** between renewable and energy storage resources can create **diversity benefit** where a total ELCC is greater than the sum of its parts
- **Diversity benefit between offshore wind and LDES is a main driver of LDES ELCC, especially at high penetration**



Long Duration Energy Storage ELCC in 2050

- **LDES ELCC is high for the first 15+ GW of storage**
- **In 2050, the difference between LDES ELCC under CECP Phased Portfolio vs. Lower Renewable Builds scenario is substantial, but only at higher penetrations**
  - After 15+ GW, LDES recharging capability is limited, and the system requires storage to dispatch even longer for effective peak-shaving

Scenario reflects:
- 11 GW short/mid duration storage on system
- Renewable range from low renewable to CECP 2050
- Solar: 22-62 GW; OSW: 11-30 GW; LBW: 9-11 GW



Diversity benefit between LDES and offshore wind becomes evident at high penetrations

- **The "diversity benefit" of offshore wind and energy storage, particularly at longer durations, is most significant at higher penetrations**
  - Assumes all other renewables and energy storage resources (including utility-scale solar, land-based wind, SDES, and MDES) are included in the portfolio
- **Together, offshore wind can support needs in the late afternoon, allowing LDES to further shave that peak and shift excess energy generation to meet the extended needs into the morning hours**
  - Can also support extended low-renewable periods, given the abundance of high winter capacity factor offshore wind for charging

LDES Incremental ELCC *(%)*, **2050, fixing OSW penetration**

	LDES (MW)						
OSW (MW)	0	2,500	5,000	10,000	15,000	20,000	30,000
0		90%	89%	89%	77%	27%	16%
2,500		90%	90%	90%	73%	27%	16%
5,000		92%	91%	90%	73%	31%	16%
10,000		89%	89%	89%	87%	50%	17%
20,000		90%	90%	90%	87%	87%	36%
30,000		89%	89%	89%	89%	89%	70%

OSW Incremental ELCC *(%)*, **2050, fixing LDES penetration**

	LDES (MW)						
OSW (MW)	0	2,500	5,000	10,000	15,000	20,000	30,000
0							
2,500	67%	67%	67%	64%	57%	58%	58%
5,000	45%	47%	49%	50%	50%	56%	56%
10,000	21%	20%	19%	18%	32%	52%	54%
20,000	12%	12%	13%	13%	13%	32%	51%
30,000	6%	6%	6%	6%	7%	9%	42%

Diversity benefit between OSW and LDES *(%)*, **2050**

	LDES (MW)						
OSW (MW)	0	2,500	5,000	10,000	15,000	20,000	30,000
0	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2,500	0.0%	-0.2%	0.0%	-0.6%	-1.5%	-1.0%	-0.7%
5,000	0.0%	0.6%	0.8%	0.3%	-0.8%	0.2%	0.1%
10,000	0.0%	-0.2%	-0.3%	-0.5%	1.6%	5.3%	4.2%
20,000	0.0%	0.0%	0.1%	-0.1%	1.4%	8.8%	11.1%
30,000	0.0%	-0.1%	0.0%	-0.1%	1.3%	7.6%	15.3%

Thank you!

Questions?