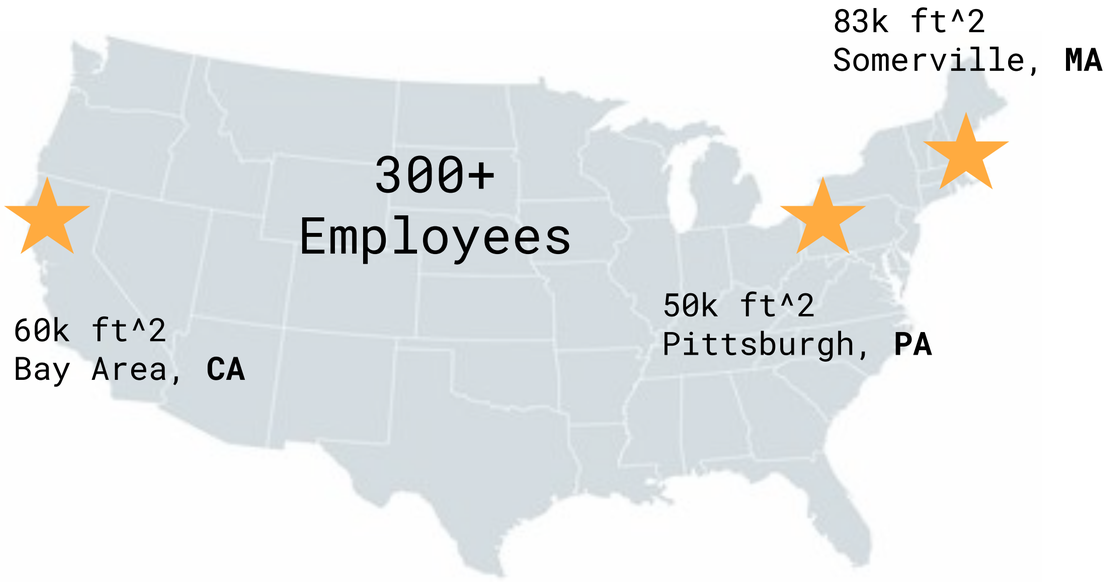
Emerging Topics in Energy Storage

Ted Wiley, President and Chief Operating Officer
NEPPA Annual Conference
August 15th, 2022

Form energy

Energy Storage
For A Better World

Rising to the challenge of climate change with a team that will deliver



LED BY ENERGY STORAGE VETERANS

Decades of cumulative experience in energy storage

- 100’s of MW of storage deployed

OUR INVESTORS: LONG-TERM AND IMPACT-FOCUSED

$367M in venture capital from top investors including: Breakthrough Energy Ventures (BEV), Coatue Management, NGP Energy Technology Partners III, ArcelorMittal, Temasek, Energy Impact Partners, Prelude Ventures, MIT’s The Engine, Capricorn Investment Group, Eni Next, Macquarie Capital

Executive leadership team

CHARLOTTE BEARD
SVP, Finance

- VP of Tile Inc; Director of Energy Products Finance for Tesla
- B.S Accounting, Defiance College

SARAH BRAY
VP, Communications

- Founder, Innovant Public Relations; VP, Clean Line Energy; Sr. Manager, EDPR
- B.B.A., University of St. Thomas

YET-MING CHIANG
Chief Science Officer

- MIT Professor, Founder of 6 companies
- S.B Materials Science, Engineering, MIT

MARCO FERRARA
SVP, Analytics/BD

- VP IHI (ESWare)
- Ph.D. Nuclear Engineering, MIT

MATEO JARAMILLO
Chief Executive Officer

- Founder Tesla Energy, Tesla VP
- A.B. Economics, Harvard

RJ JOHNSON
SVP, Commercial Operations

- Head of Energy Operations, Tesla; VP of Origination, NextEra; US Army
- MBA, University of Chicago

ZAC JUDKINS
VP, Product Development

- VP of Products for SunPower
- M.S Materials Science,Engineering, MIT

BRIAN LEWIS
Deputy General Counsel

- Director & AGC, Facebook; Assistant U.S. Attorney, Oakland
- A.B., Princeton; J.D., Georgetown

NIDHI THAKAR
VP, Policy & Regulatory

- Sr. Director, Portland General Electric; CA PUC; U.S. DOE
- A.B., University of Maryland, J.D., Lewis & Clark Law School

SOZI TULANTE
General Counsel

- Partner, Dechert LLP; Solicitor, City of Philadelphia; Assistant U.S. Attorney
- A.B., Harvard; J.D., Harvard

TED WILEY
President & Chief Operating Officer

- Co-founder Aquion; US Army
- MBA, Harvard

WILLIAM WOODFORD
Chief Technology Officer

- Director R&D 24M
- Ph.D Engineering, MIT

The Challenge

The electrical grid needs to fundamentally transform to meet the challenges posed by climate change

Intermittency of renewable assets create periods of undersupply

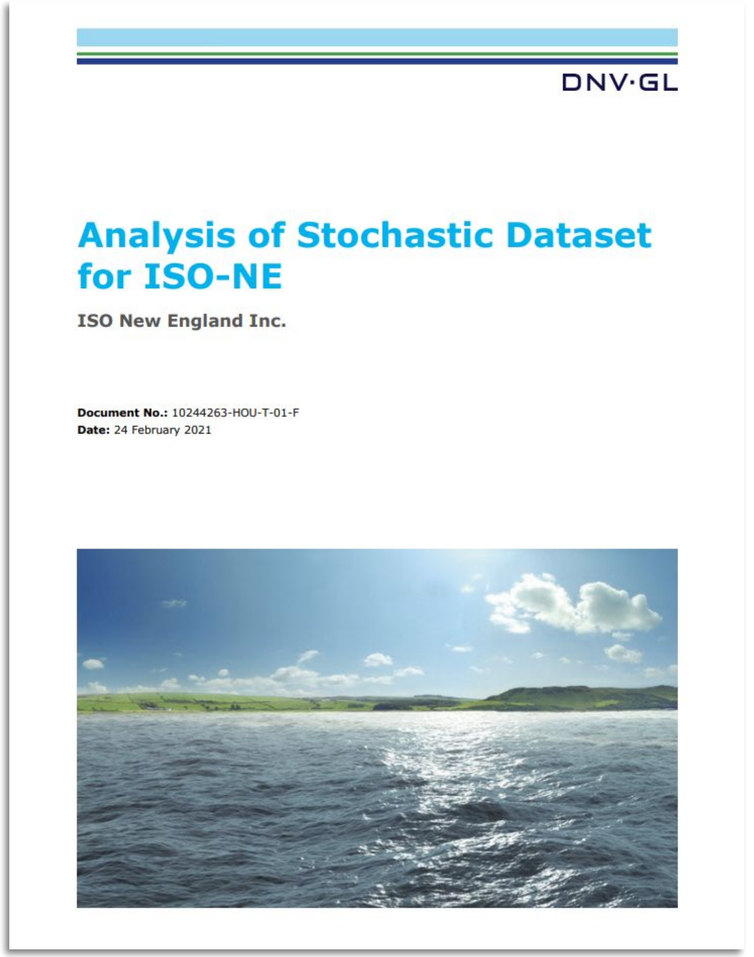
Carbon mandates require retirements and risk stranding fossil assets

Extreme weather events become more frequent and disruptive to customers

Increased transmission need as renewables proliferate

Intermittent Renewable Assets

As renewable deployment increases, grid operators must tackle **renewable lull periods**, which can last 24+ hours.


DNV·GL

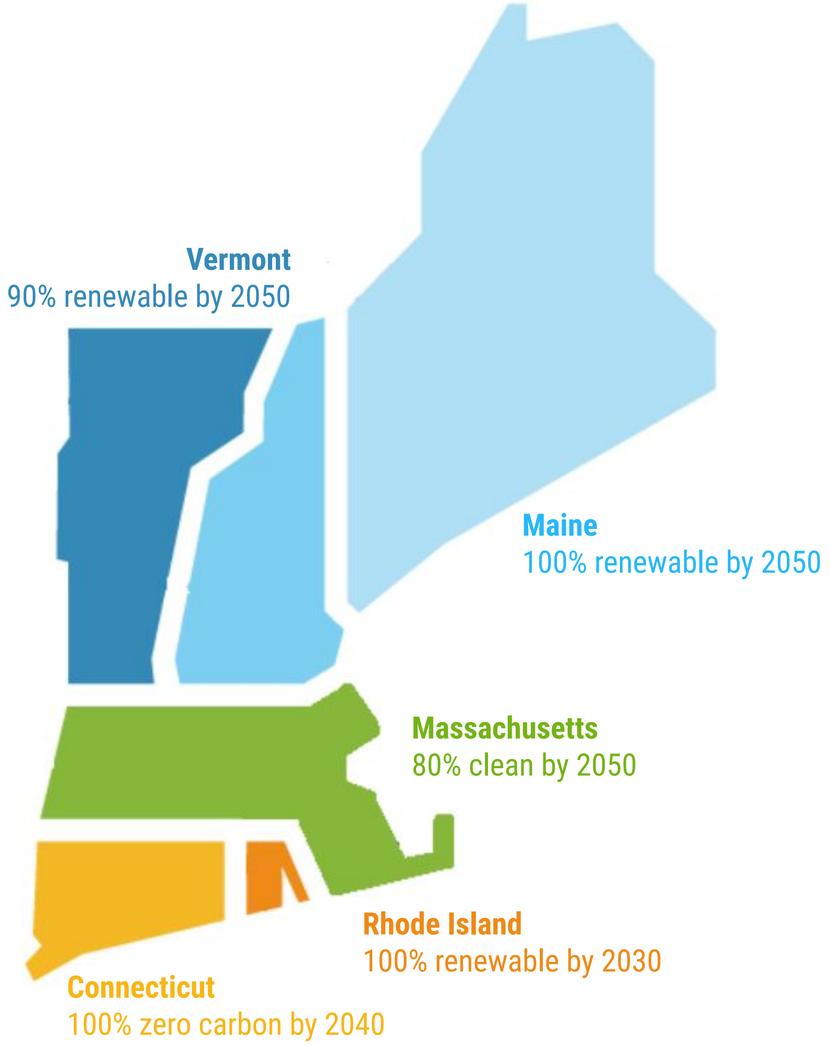
Analysis of Stochastic Dataset for ISO-NE

ISO New England Inc.

Document No.: 10244263-HOU-T-01-F
Date: 24 February 2021

Carbon Mandates & Retiring Fossil

New England states have set ambitious targets to **decarbonize** the electric grid and retire legacy fossil units.



Extreme Weather Events

New England increasingly experiences multi-day periods of **extreme cold and extreme heat.**

The region is highly dependent on fossil resources to **maintain reliability**.

ISO New England's 2021/2022

Winter Outlook

ISO new england

OVERVIEW

ISO New England expects electricity supplies to meet consumer demand this winter if the weather is mild. But certain conditions, including extreme weather, could put New England's bulk power system at heightened risk. Variables that could impact the system this season include:

Weather

Weather is the region's primary driver of energy use. Forecasters expect a warmer than average winter —but prolonged cold snaps are still a possibility.

Global Fuel Supplies

New England generators rely on the delivery of global fuel supplies to produce electricity. The pandemic's impact on supply chains is driving up prices for oil and liquid natural gas around the world —potentially making it harder for resources in New England to replenish their tanks if they run low.

Natural Gas Pipeline Constraints

For two decades, the ISO has raised concerns about the impact of fuel supply issues on electricity supply during periods of extreme cold. Pipeline system constraints limit the availability of fuel for natural gas-fired power plants, as heating customers are served first through firm service contracts.

Since 2013, **roughly 7,000 MW** of non-gas-fired resources have retired or announced plans for retirement in the coming years.

This winter, **more than 3,700 MW** of natural-gas-fired generating capacity is at risk of being unable to get fuel when needed.

BY THE NUMBERS

19,710 MW Estimated peak demand during average winter weather (10°F).

20,349 MW Estimated peak demand during colder than average weather (5°F).

18,756 MW Last winter's peak demand, on December 17, 2020.

22,818 MW Record winter peak demand, during a January 2004 cold snap.

AN ISO NEW ENGLAND ANALYSIS

To enhance situational awareness entering this winter, the ISO compared expected consumer demand levels and other system conditions with three historical weather scenarios.

In winter weather similar to:	The ISO anticipates:
2020-2021 • Mild weather, no extreme temperatures	Reliable system operations, no emergency procedures
2017-2018 • Temperatures below normal for at least 13 straight days in all major New England cities	A possibility of limited emergency procedures
2013-2014 • Several cold snaps lasting 4+ days, with one 10-day stretch at or below freezing	The implementation of all available emergency procedures is possible

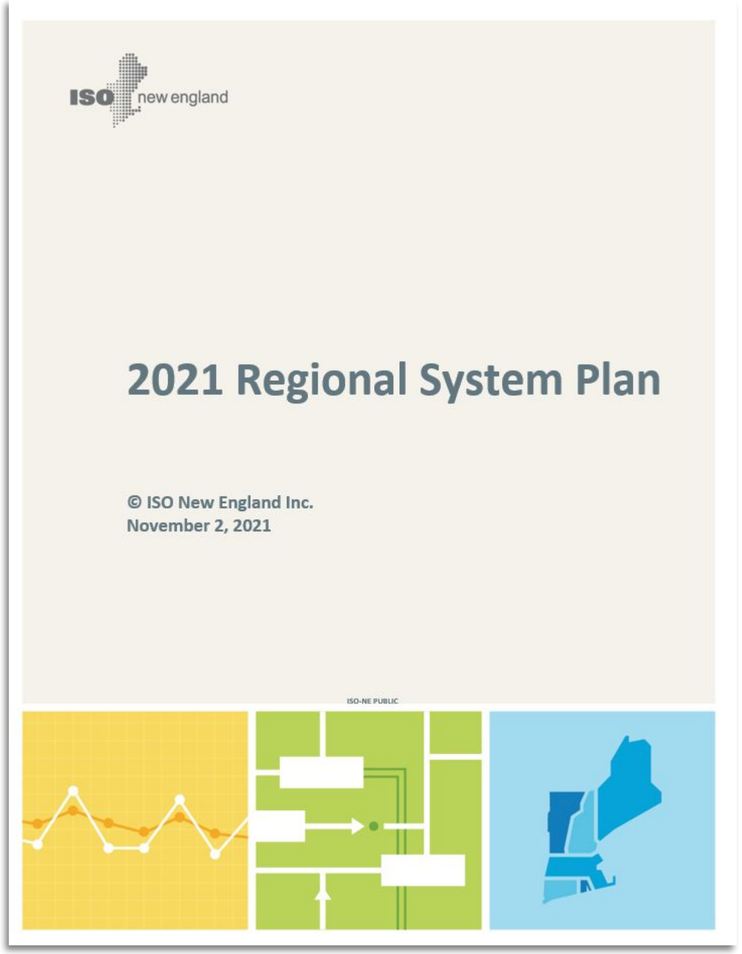
The ISO would not expect emergency actions to be necessary if generators are able to replenish their fuel supplies and if there are no unexpected generator or transmission outages.

For more information, please visit ISO New England's website at www.iso-ne.com.

ISO New England's 2021/2022 Winter Outlook

Transmission Upgrades

As the New England grid transforms, the transmission and distribution system will require **substantial upgrades** to accommodate new renewables.



ISO-NE stresses the need for non-emitting dispatchable resources

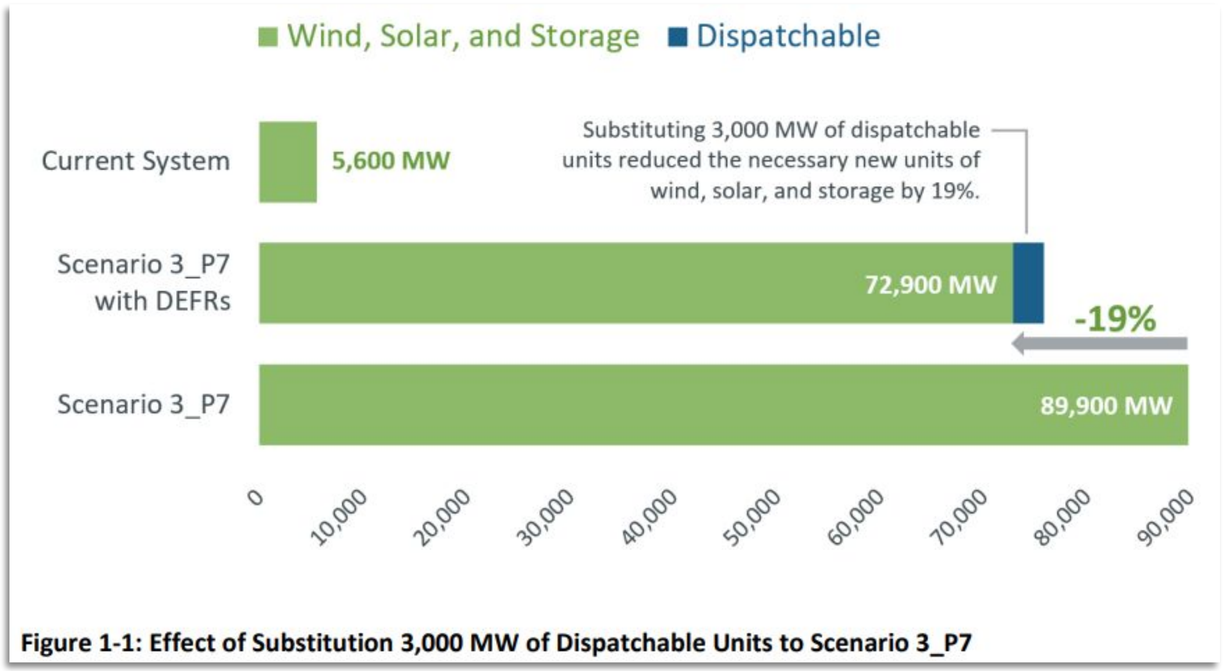
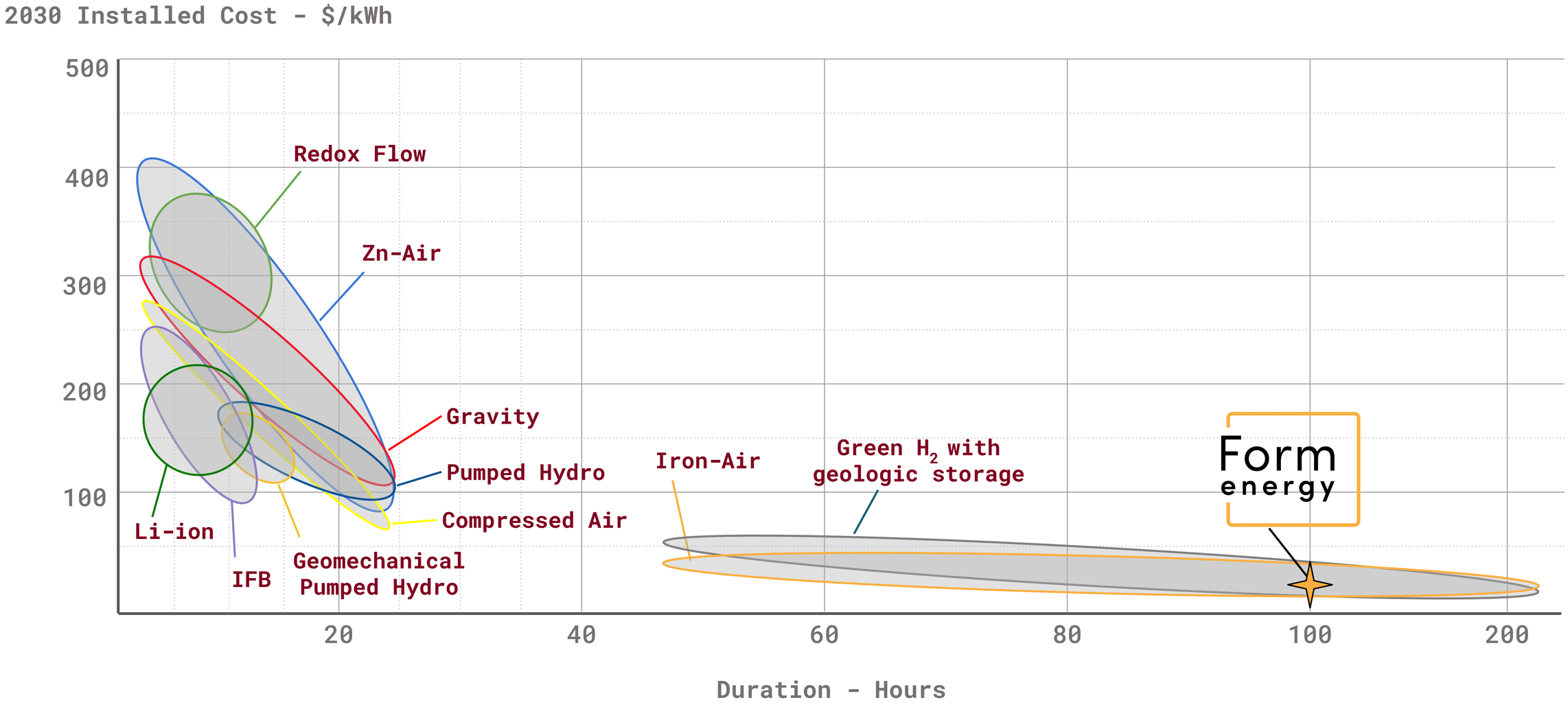


Figure 1-1: Effect of Substitution 3,000 MW of Dispatchable Units to Scenario 3_P7

Substitute 3 GW of dispatchable resources

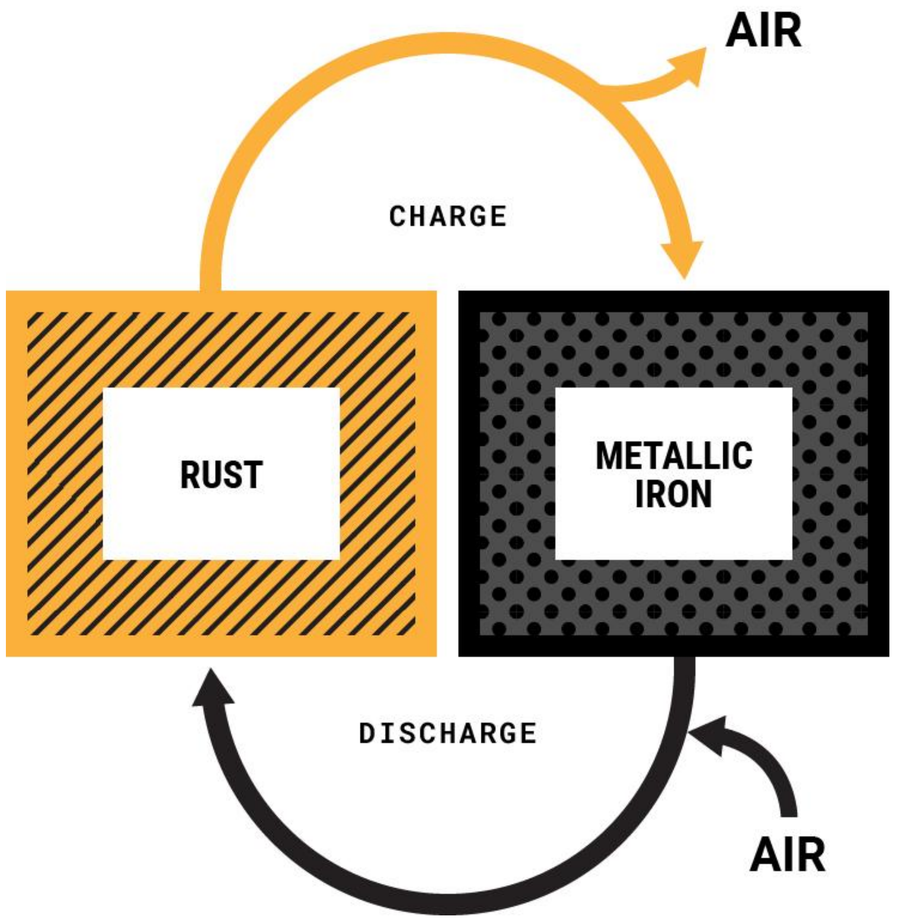
Reduce need for new clean resources by 19% (17 GW)

Form MDS is the only technology targeting multi-day duration without geographic constraints



Rechargeable iron-air is the best technology for multi-day storage

Reversible Rust Battery



COST

Lowest cost rechargeable battery chemistry.
Less than 1/10th the cost of lithium-ion batteries

SAFETY

No thermal runaway (unlike li-ion)
Non-flammable aqueous electrolyte

SCALE

Uses materials available at the global scale needed for a zero carbon economy. High recyclability.

RELIABLE

100+ hr duration required to make wind, water and solar reliable year round, anywhere in the world.

Modular design enables easy scaling to GWh systems

Cell

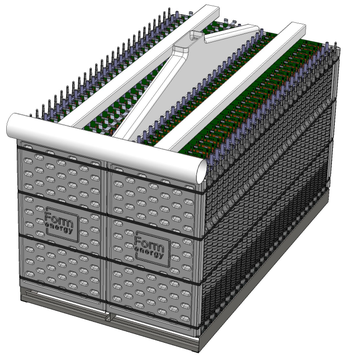
~0.10 kW / 10 kWh

~1m x 60 cm

Electrodes + Electrolyte

Smallest **Electrochemical** Functional Unit

Battery Module



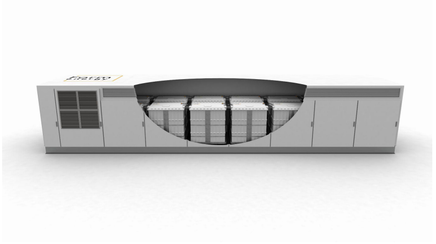
~5 kW / 500 kWh

~2.3 x 1.3 x 1.3m

~50 **Cells**

Smallest Building Block of **DC** Power

Enclosure



~50 kW

8.6’ x 40’

~10 **Modules**

Product Building Block with **integrated module auxiliary systems**

Power Block

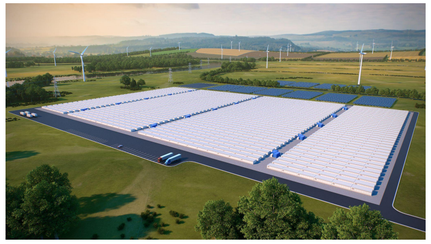
3.5 MW / 350 MWh

<2 acres

~50 - 100 **Enclosures**

Smallest independent system and **AC Power** building block

System



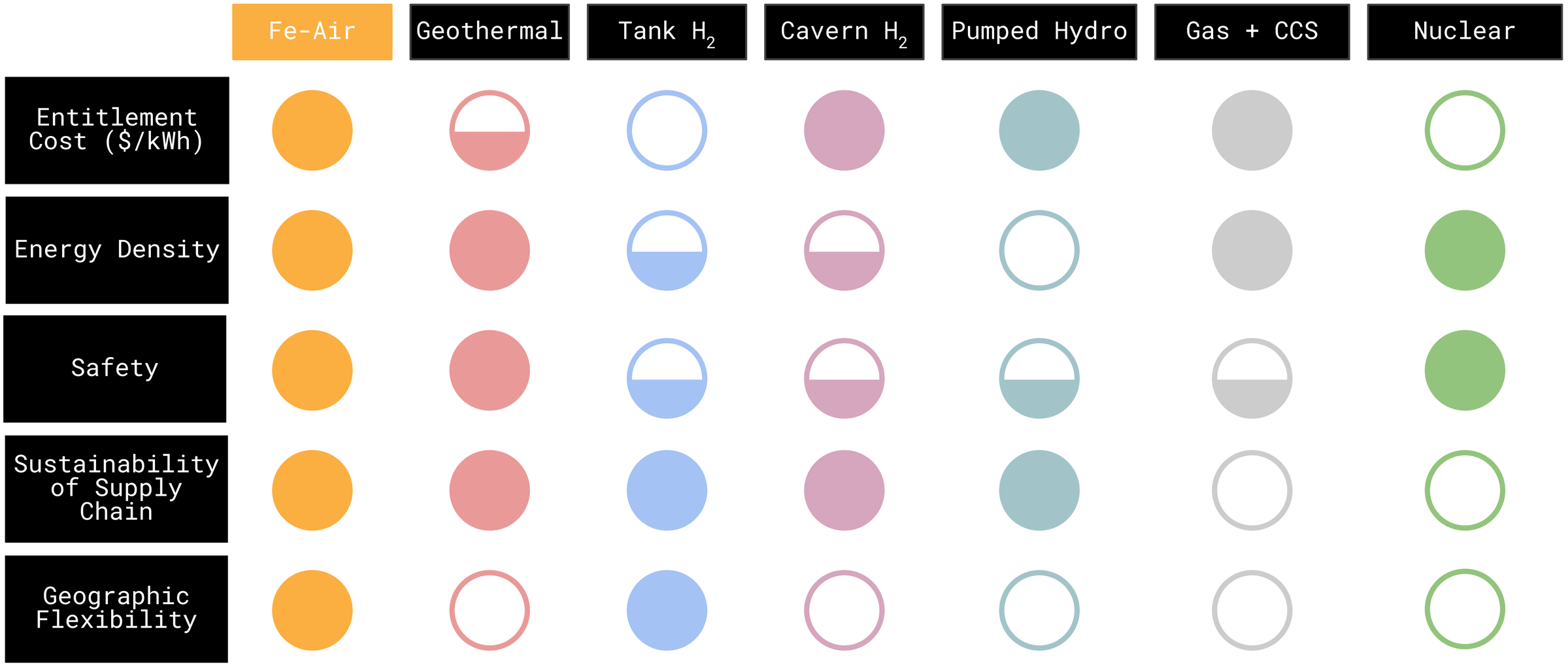
100+ MW / 10 GWh

50+ acres

10s - 100s of **Power Blocks**

Commercial Intent System

Form Energy's battery delivers on core competencies as compared to other clean, firm technologies



Form Energy's path to transform the global grid

2023/2024

- **Prove Technology at Scale**
- 1-10 MW scale projects
- Demonstrate value in real world environment

2025

- **Initial Commercial Projects**
- 10-100+ MW scale projects
- Demonstrate bankability

2026

- **Full Scale Installations**
- 100+ MW scale projects
- Bankable coal and gas replacement

2030s

- **Deep Decarbonization**
- GW-scale projects
- Meet carbon goals and manage risk

Piloting → **Scale-Up** → **Expansion** → **Global Transformation**

30 years after commercial availability, global lithium-ion manufacturing capacity was 500 GWh/yr in 2020.

Form Energy will exceed that scale before 2030.

How to Build a Market for Long-Duration Storage in New England

- Support the development of non-emitting, reliable, low-cost technologies.
- Deploy initial projects via funding and procurement programs.
- Continue to set ambitious climate goals, including targets for storage.
- Evolve markets to value firm resources and multi-day storage.

The Solution: **Storage**

Together, existing and novel storage technologies can address all of these problems

Intermittency of renewable assets create periods of undersupply

Carbon mandates require retirements and risk stranding fossil assets

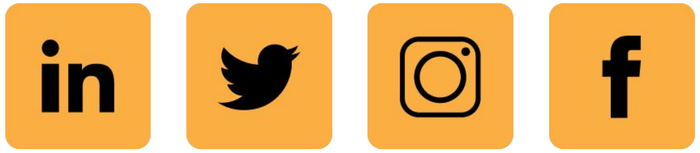
Extreme weather events become more frequent and disruptive to customers

Increased transmission need as renewables proliferate

Thank You!

Ted Wiley

President & Chief Operating Officer



30 Dane St.
Somerville, MA 02143
1 (844) 367-6462
info@formenergy.com
www.formenergy.com