Net-Zero New England: Ensuring Electric Reliability in a Low-Carbon Future

Report Briefing

November 16, 2020

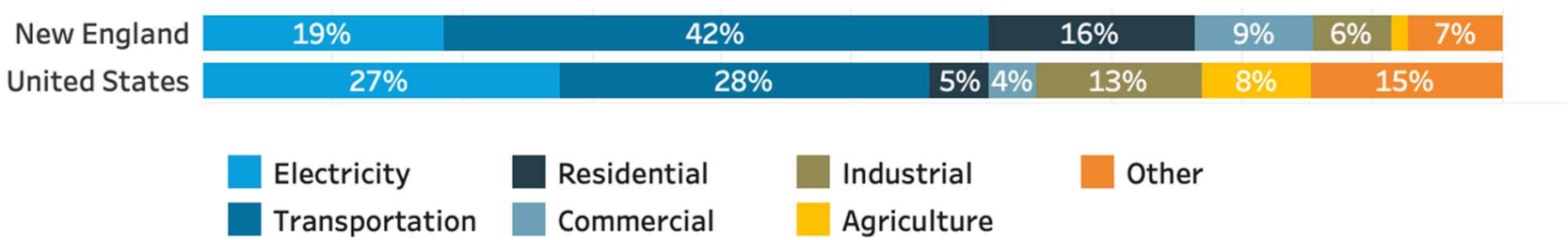
ENERGY FUTURES INITIATIVE

Energy+Environmental Economics

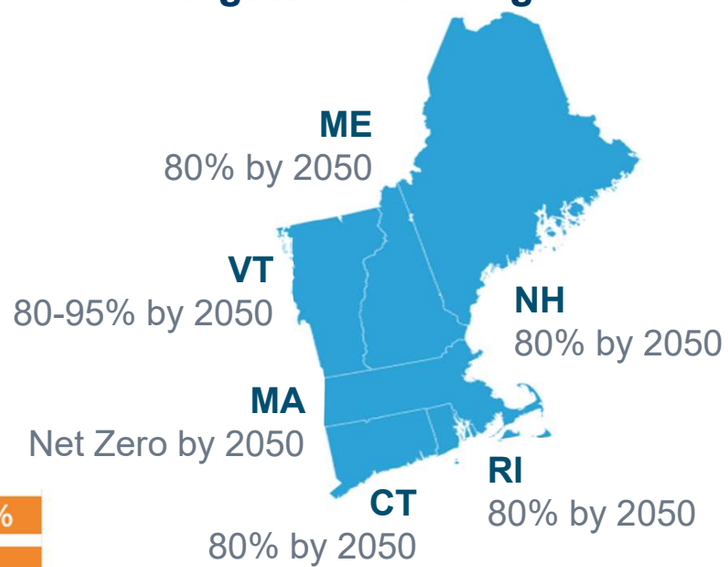
Study Framing

Key Question: How can New England provide affordable, reliable electric power under future scenarios that achieve net zero economy-wide greenhouse gas emissions by 2050?

- The six New England states are pursuing efforts aimed at increasing renewable energy generation and reducing carbon emissions
- The electricity sector will play a key role by providing low-carbon energy to power the New England economy under economy-wide deep decarbonization
- E3 and EFI investigated portfolios of electricity resources to meet deep carbon reduction goals while ensuring reliable electricity
- EFI conducted parallel research into the key breakthrough technologies and the region's innovation capabilities

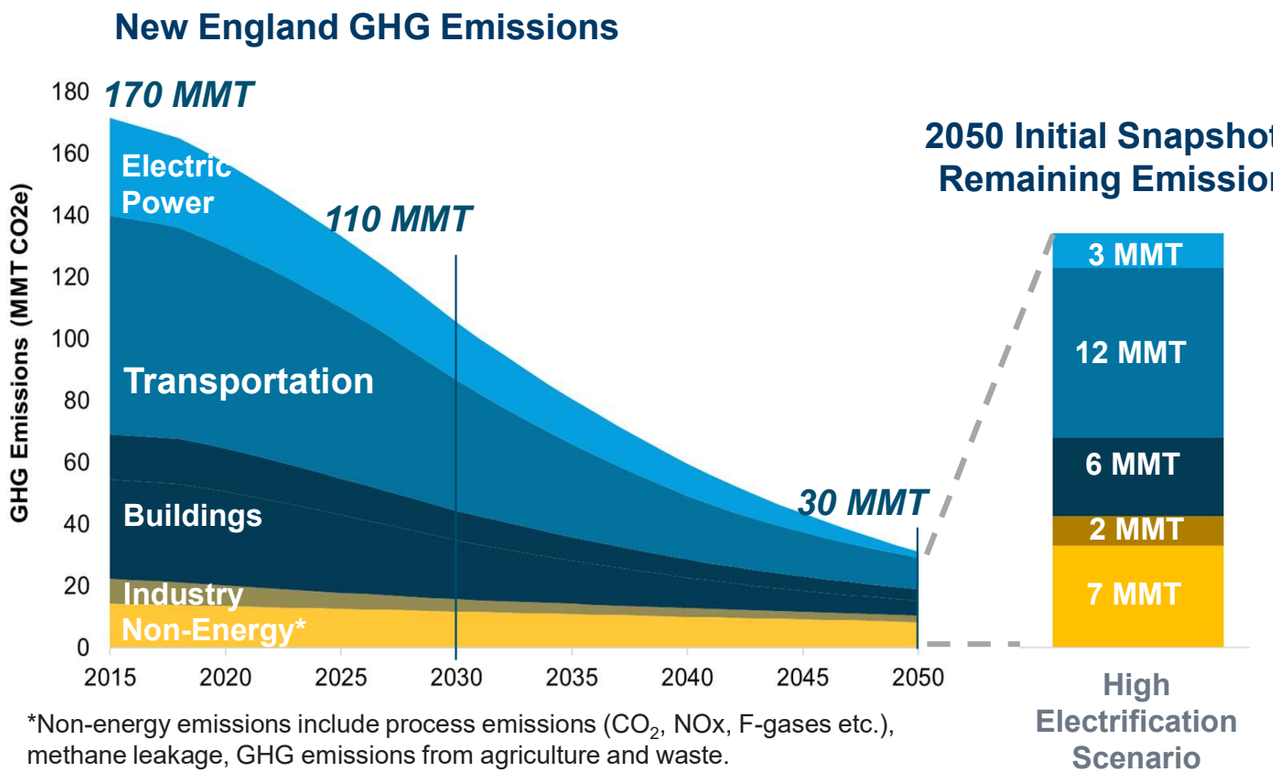


Mid-Century Economy-Wide GHG Emission Reduction Targets in New England



Direct Emissions are Reduced 85% Below 1990 Levels by 2050 in Both Scenarios

- Study assumes New England moves toward “net zero” target by achieving 85% direct emissions reductions relative to 1990 emissions
- Last 15% met through CO_2 removal strategies (30 MMT, not shown)

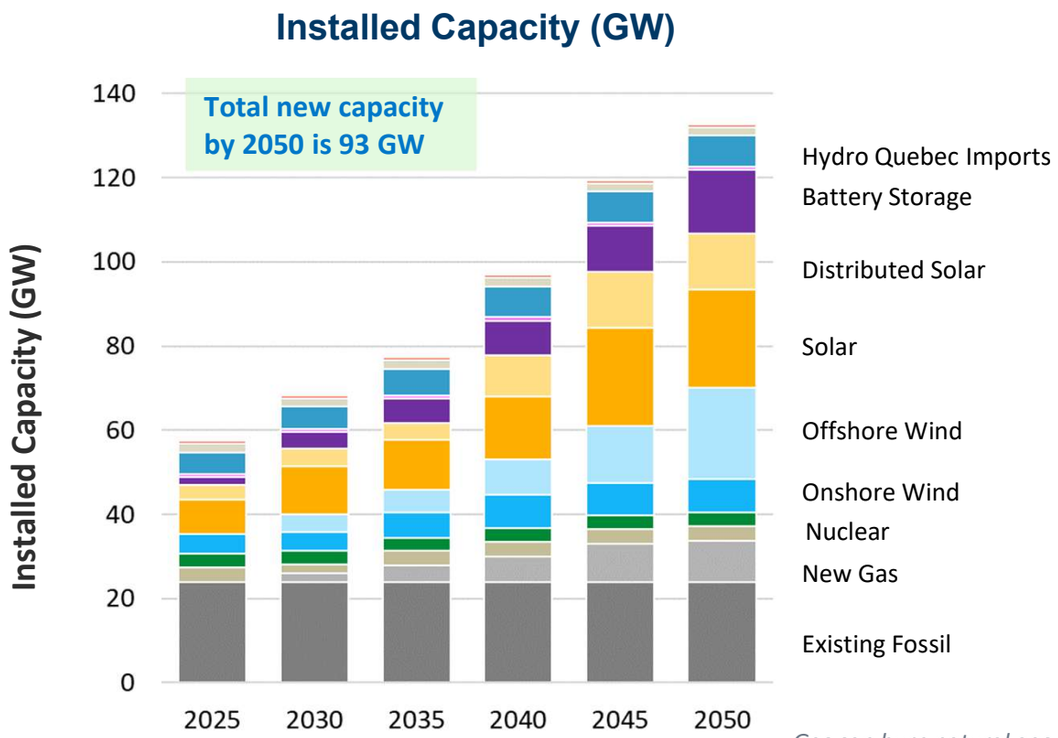


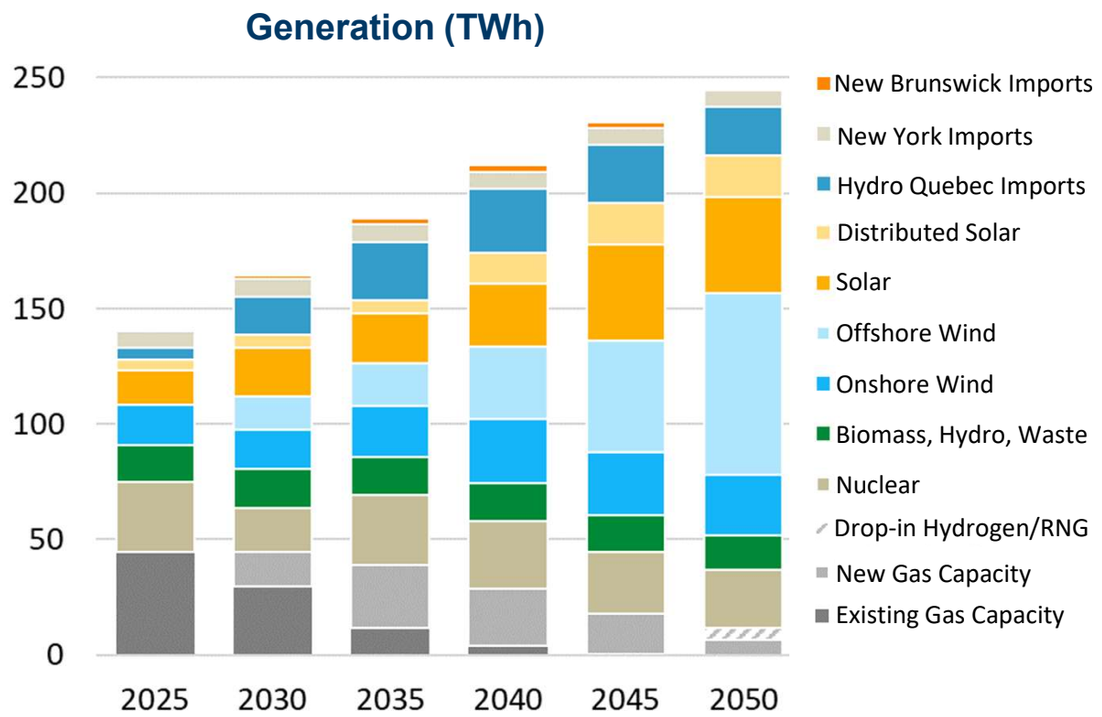
*Non-energy emissions include process emissions (CO_2, NOx, F-gases etc.), methane leakage, GHG emissions from agriculture and waste.

- Emissions reduced from all sectors of the economy
- Emissions ”budget” for the power sector is 2.5 MMT
- Annual demand grows 90%, peak doubles to about 50 GW and becomes winter peaking
- Reliability challenge increasingly characterized by peak heat demand on coldest days

Results: Installed Capacity and Generation

- Capacity additions are mostly renewables and energy storage, particularly solar and offshore wind
- New gas capacity is added and existing capacity retained for reliability, but rarely operate toward midcentury
- Generation becomes dominated by renewables, with additional low/no carbon generation from nuclear, imports, hydrogen/zero-carbon fuel, and biomass, hydro and waste

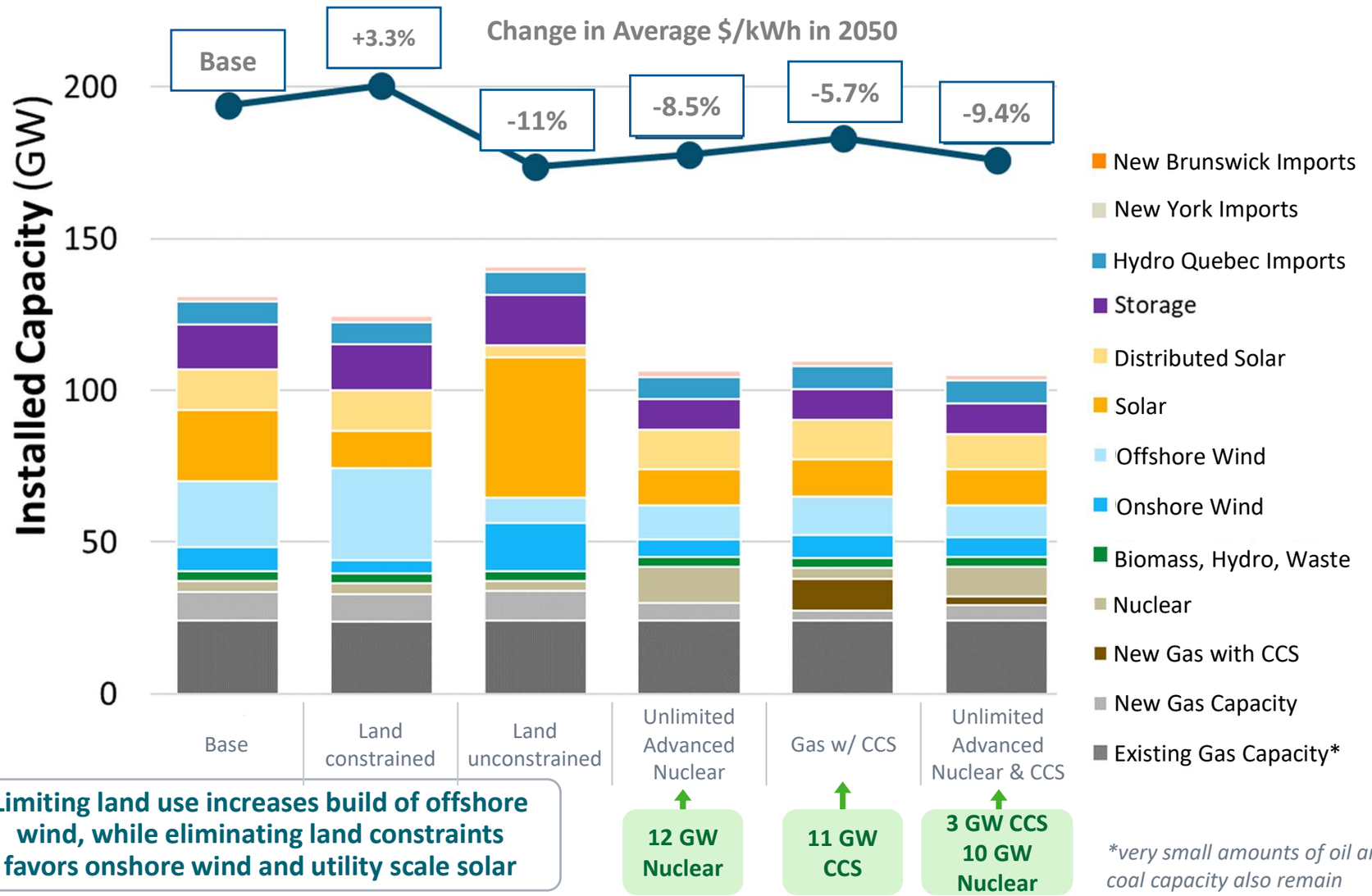




Gas can burn natural gas and/or hydrogen blend

2050 Sensitivity Comparison of Installed Capacity and Average Costs

All cases achieve 2.5 MMT/y 2050 GHG electricity sector emissions, consistent with economy-wide "Net Zero"



Limiting land use increases build of offshore wind, while eliminating land constraints favors onshore wind and utility scale solar

12 GW Nuclear

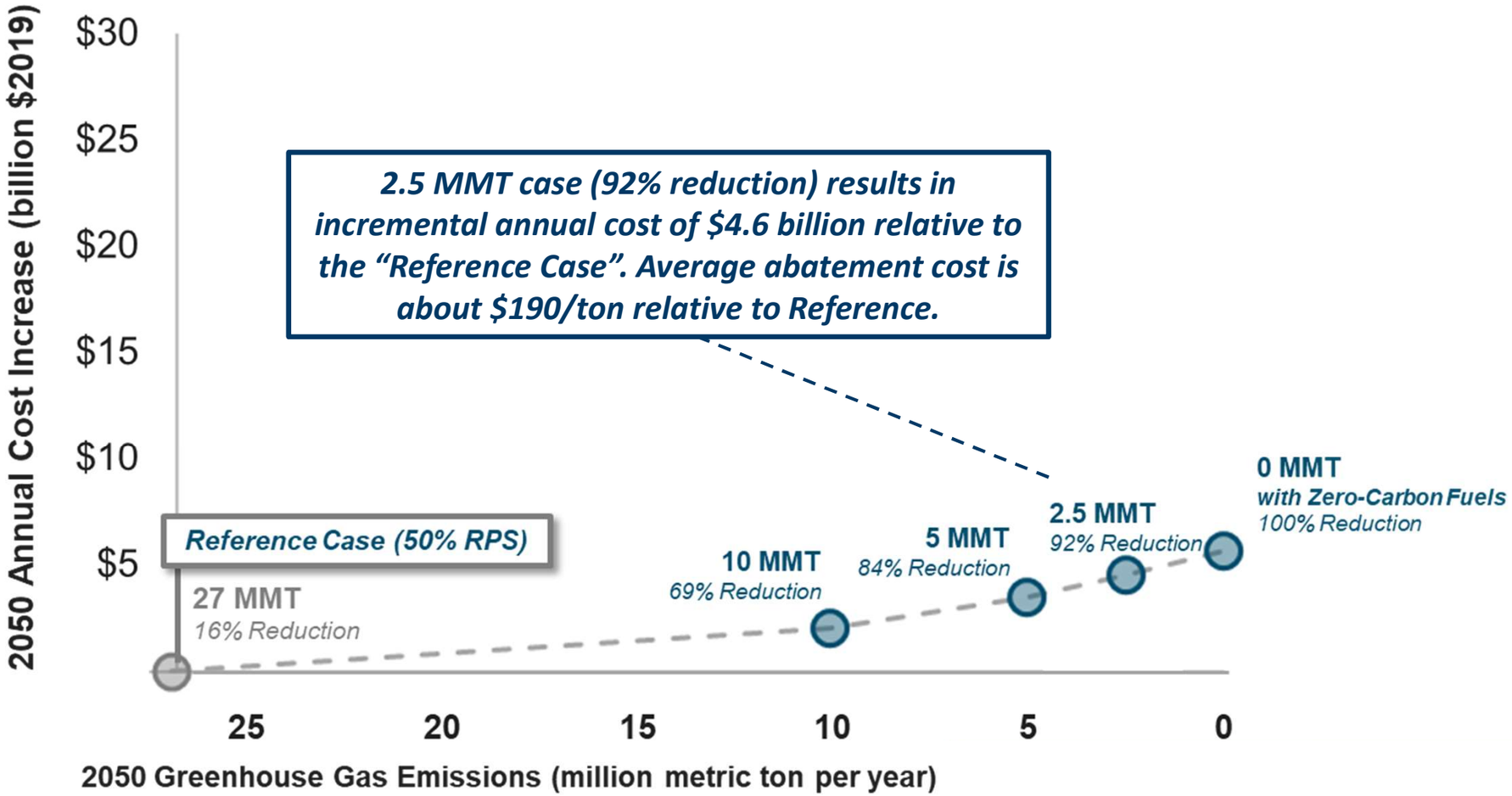
11 GW CCS

3 GW CCS 10 GW Nuclear

**very small amounts of oil and coal capacity also remain*

- A cost-effective, reliable, and decarbonized grid requires firm generating capacity
- Cases with broader sets of available resources have lower costs and lower technology risks
- The region must build and maintain large amounts of renewable energy and other infrastructure to reach its climate goals
- Achieving the commercialization of emerging technologies can be aided by leveraging regional innovation capacity

2050 Electricity Sector Abatement Costs under High Electrification Loads



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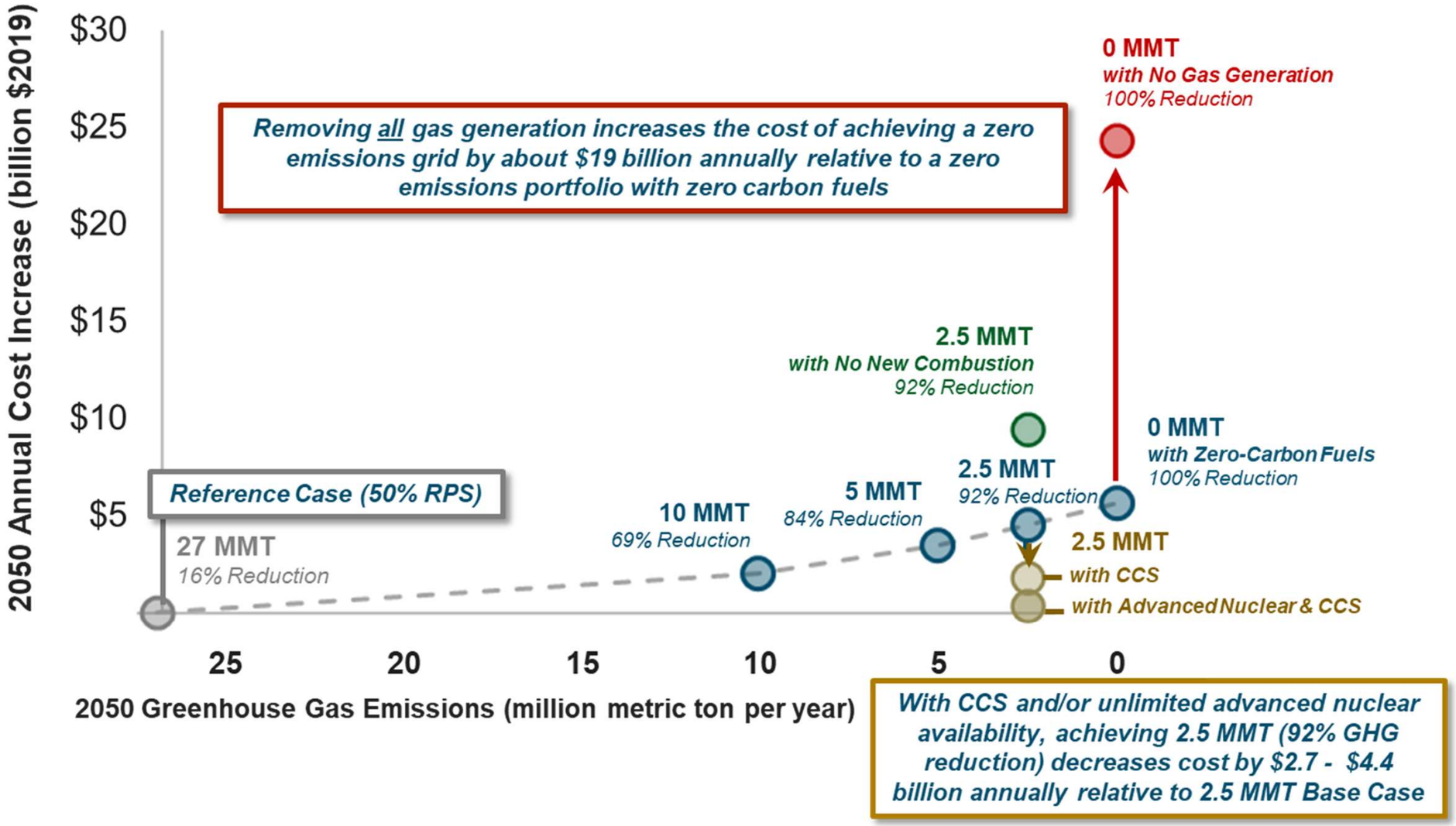
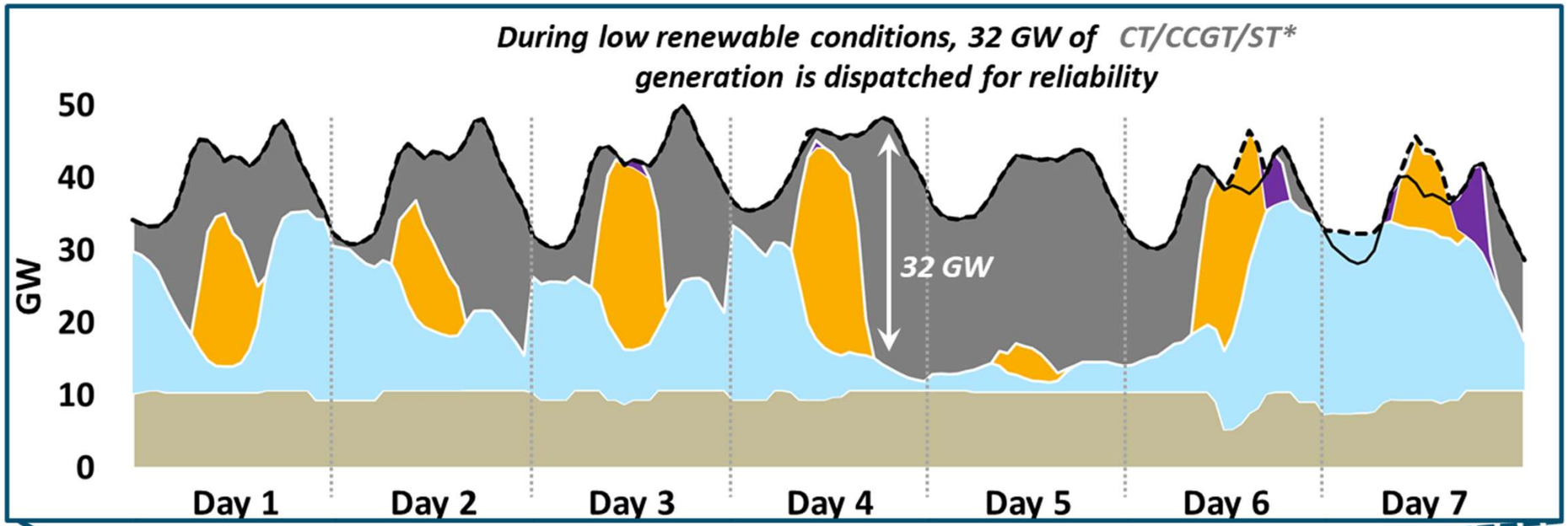
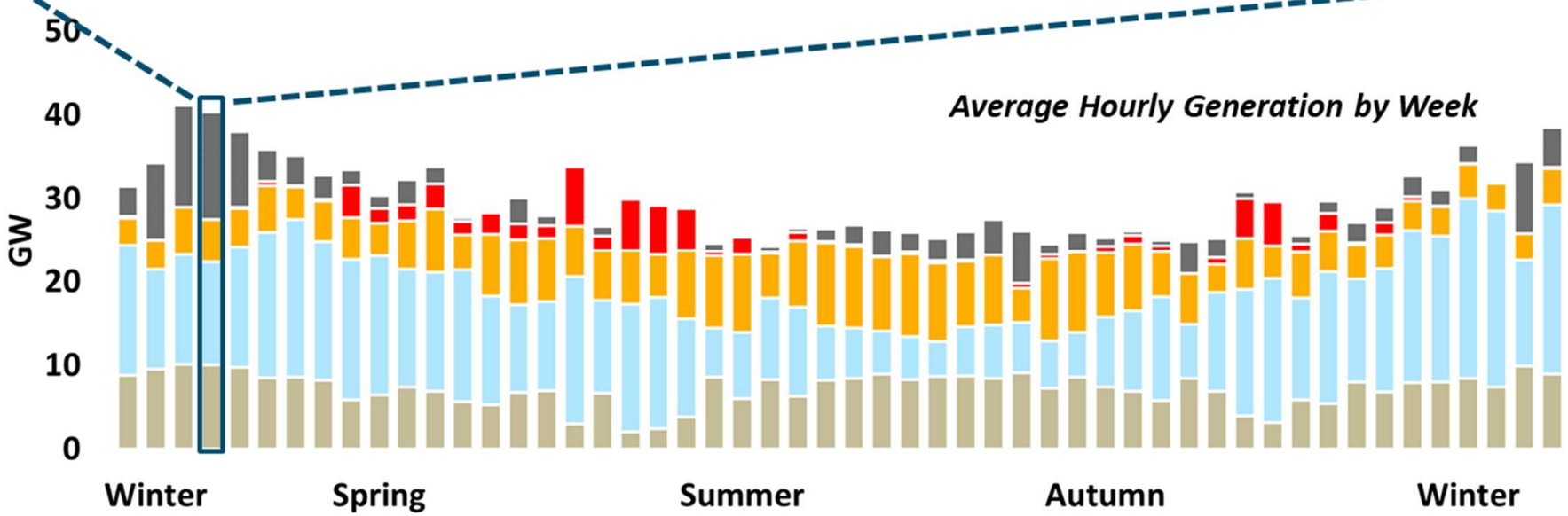


Critical Week Dispatch in High Electrification Base Case



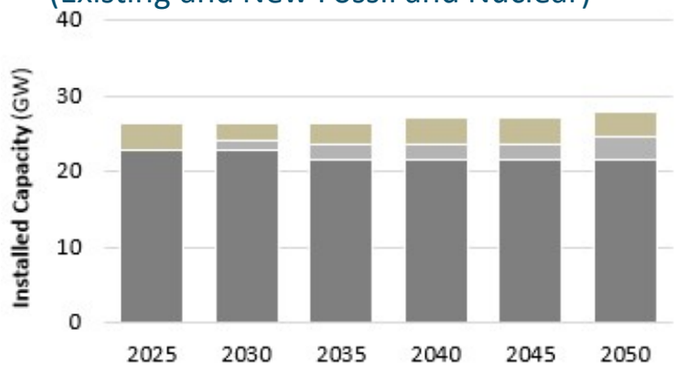


Imports, Hydro, Biomass, Nuclear
Curtailment
Wind
CT/CCGT/ST
Solar
Load + Reserves
Storage Discharge
Load + Reserves + Charging

Role of Firm Generation

- The model retains significant gas and other fossil resources for reliability, but capacity factors decline substantially, with limited gas quantities burned by 2050
- In the future, firm generation can be provided by combustion-based generation, nuclear, or emerging long-duration storage technologies
  - Low-carbon firm generation may be achieved through reliance on zero-carbon fuels (hydrogen or biogas), nuclear, or by coupling generation with carbon-capture and storage

High Fuels Scenario – Firm Capacity
(Existing and New Fossil and Nuclear)



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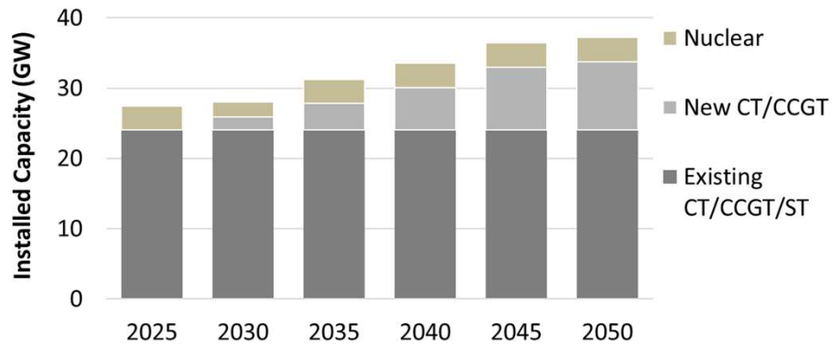
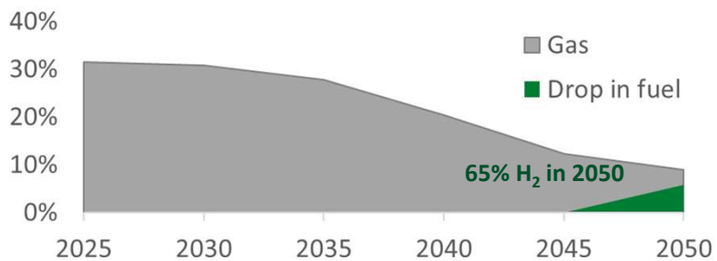


High Fuels Scenario - Gas Capacity Factor (%)



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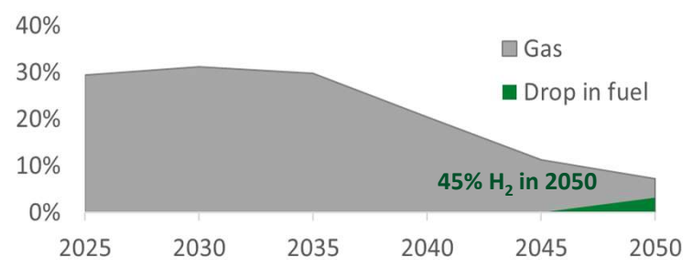
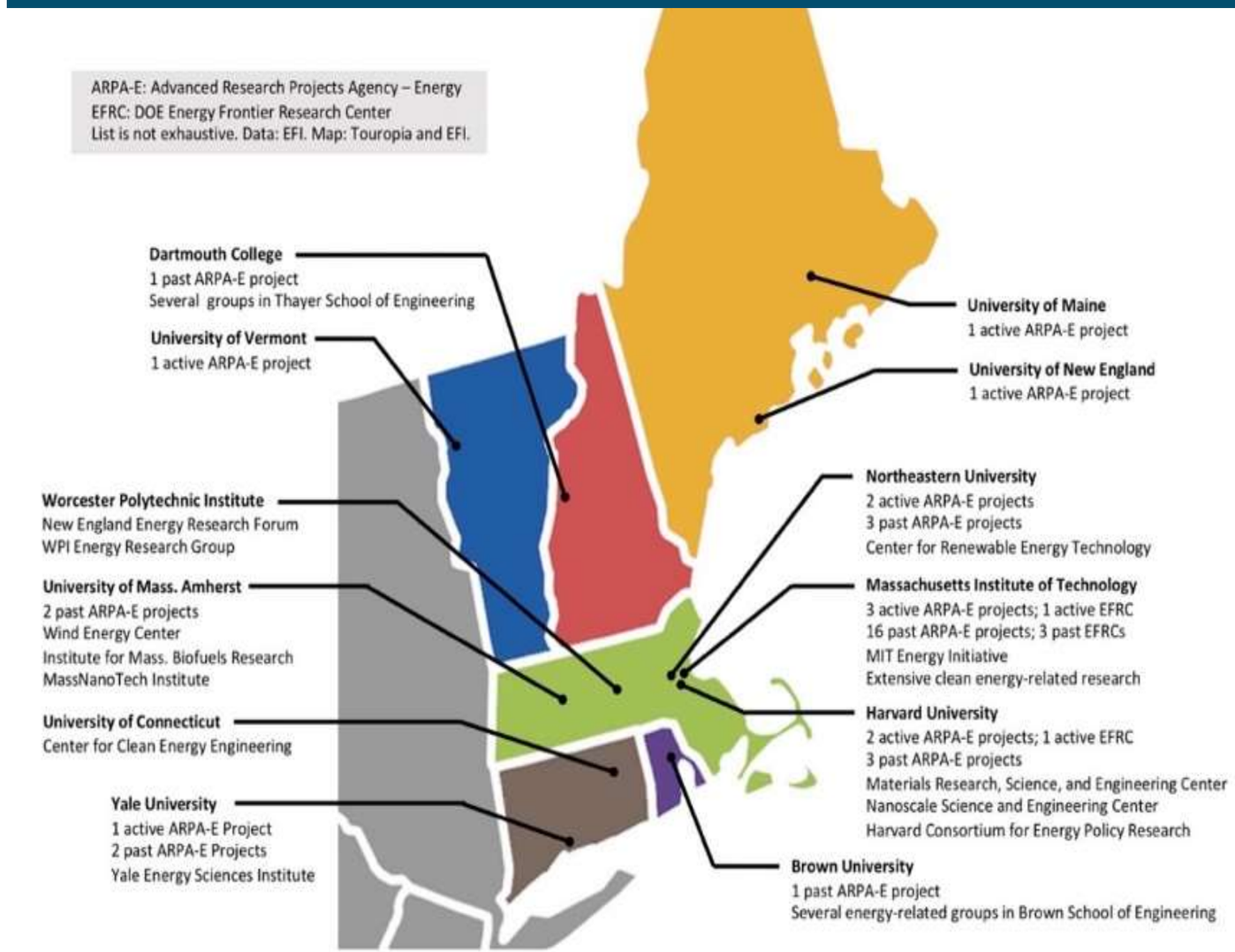


The Value of Regional Innovation

- Meeting New England's midcentury decarbonization targets will be very challenging, requiring major investments in all sectors of the economy starting immediately
- A regional strategy that harnesses local innovation capacity and resources can provide optionality and address region-specific challenges & priorities
- New England's innovation resources include some of the country's strongest cleantech firms, universities, laboratories, and workforce

Selected Academic Innovation Assets in New England



Building an Innovation Agenda for New England and Identifying Critical Breakthrough Areas

- Biofuels, hydrogen, and energy storage are strong suits for New England based on local innovation capacity
- Looking at key breakthrough areas is the first step to creating an innovation agenda and serves several purposes:
  - Clarify what innovation needs to happen to make modeled results possible
  - Show how innovation can reduce the cost of achieving 85% reductions, allow more than 85% reductions before turning to CDR, and provide more CDR options
- Chose areas that can address challenges identified by prior modeling and analysis
  - e.g. the needs for firm low-carbon electricity and negative emission technologies

Identified Breakthrough Areas

- advanced nuclear
- long-duration storage
- renewable fuels

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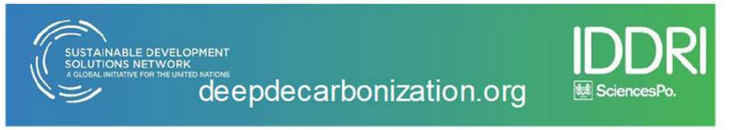
E3 has worked with a wide range of clients to understand the challenges of deep carbon reductions and high renewable penetration

- United Nations Deep Decarbonization Pathways Project
- California:
  - Carbon Reduction Pathways studies
  - Landmark 2014 study of 50% RPS goal for PG&E, SDG&E, SCE, LADWP, SMUD, CAISO
  - 100% RPS studies for LADWP, SMUD, Calpine, The Nature Conservancy
  - Support for California CPUC IRP process
- Deep carbon reduction and 100% renewables planning in a diverse group of regions:
  - **New York:** NYSERDA, NYPSC
  - **Hawaii:** HECO
  - **Canada:** Nova Scotia Power, Atlantic provinces
  - **Upper Midwest:** Xcel Energy
  - **Pacific NW & Desert SW:** numerous utilities
- Asset valuation and strategy support for resource developers in multiple jurisdictions



About the Energy Futures Initiative (EFI)

EFI is a nonprofit clean energy think tank founded by former Secretary of Energy Ernest Moniz dedicated to harnessing the power of innovation to create clean energy jobs, grow economies, enhance national and global energy security, and address the imperatives of climate change.

Some of EFI's work:

- An Action Plan for Carbon Capture and Storage in California: Opportunities, Challenges, and Solutions (October 2020): Provides policymakers with options for near-term actions to deploy carbon capture and storage (CCS) to meet California's climate goals.
- Optionality, Flexibility, and Innovation: Pathways to Deep Decarbonization in California (May 2019): Identified 33 pathways for California to meet its 2030 low-carbon energy goals, and outlined a California-specific innovation agenda for midcentury.
- Advancing the Landscape of Clean Energy Innovation (February 2019): Co-produced with IHS Market and sponsored by Breakthrough Energy, assesses energy technologies based on four criteria—technical merit, market viability, compatibility with other energy systems and consumer value.
- Clearing the Air: A Federal RD&D Initiative and Management Plan for Carbon Dioxide Removal Technologies (September 2019): Outlines a 10-year RD&D initiative to bring innovative CDR technologies to commercial readiness at a gigaton scale, at technology-specific cost targets, with minimal ecological impacts. Sponsored by the Linden Trust for Conservation and ClimateWorks.
- Regional Clean Energy Innovation (February 2020): Analyzes how state-level policy efforts to accelerate local clean energy technology innovation can complement federal activity on climate and energy while creating local economic development opportunities.