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# Decarbonization and Natural Gas

*Will Climate Change Anxiety Undermine a Practical Transition Pathway?*

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NGA Executive Conference
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# Topics

- Reminder: why are we talking about decarbonization
- Why an energy transition seems so infeasible
- How states are reacting (in the Northeast)
- Pathways to decarbonization
- Implications for natural gas, the electric system, and policy

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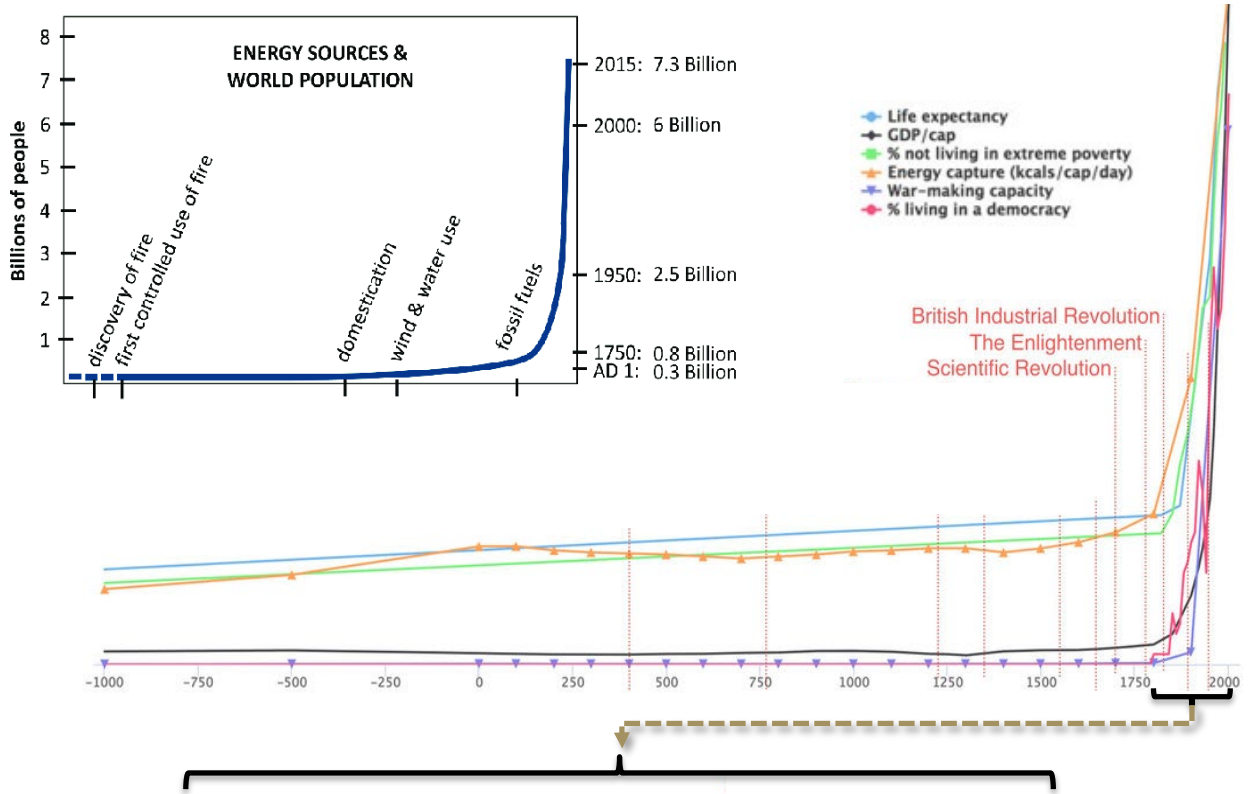
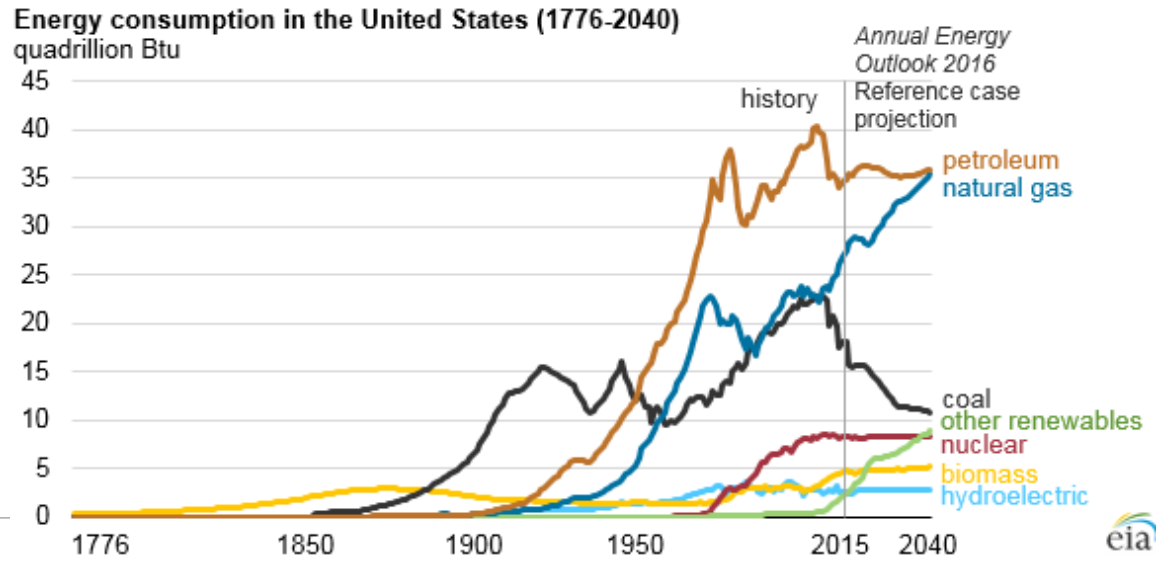
# What got us here?

- 100M – 500M years ago: carbon absorbed and buried
- 5M – 7M years ago: humans
- Up until about 300 years ago: energy = humans, animals, biomass, water, wind
- Over 10-20 generations – fossil fuels, science
- (Just about) everything that has happened since then – population growth, commerce, war, nation building, technological advancement, health, and recreation – is intractably tethered to burning fossil fuels



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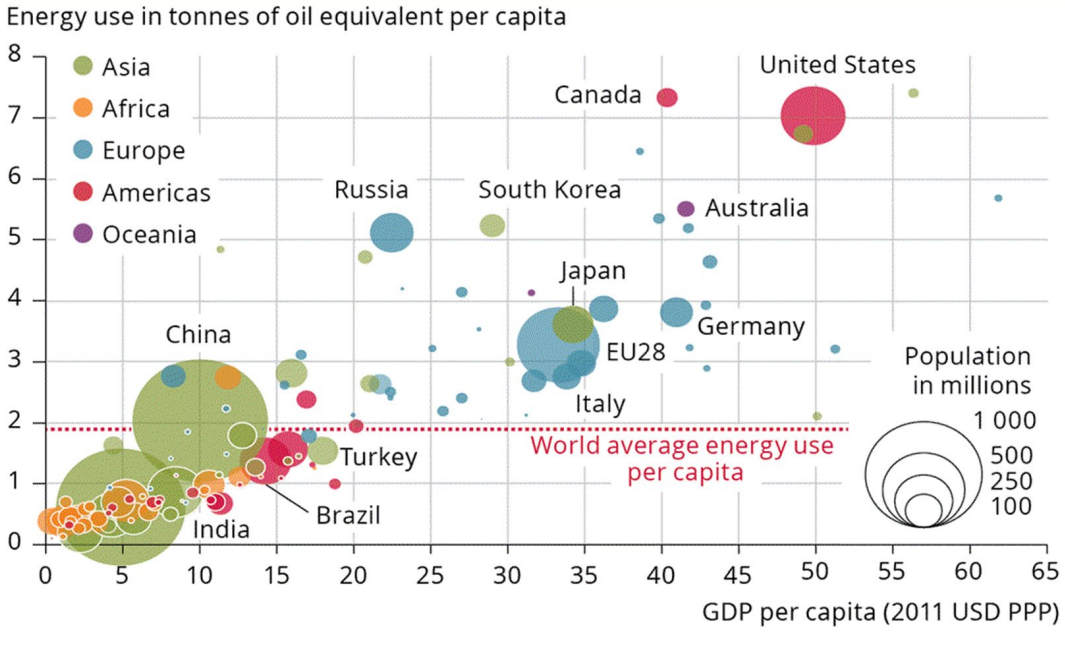
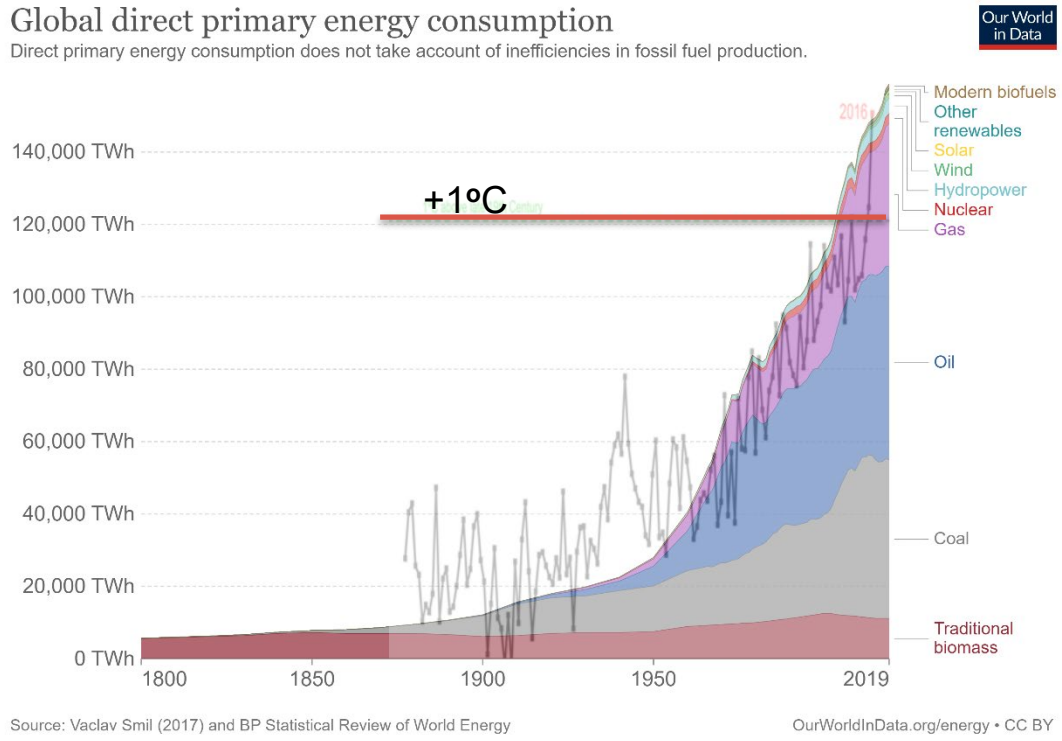
# Why is decarbonization so hard?

- Strong links
  - Well being = wealth = energy
    - The link between energy, the economy, and human well being is absolute
  - Energy = fossil fuels
    - Always has, still does, everywhere
  - Fossil fuels = GHGs = potential disaster, for economies, societies, environment
    - States (and now the federal government?) accept the risks and urgency
- Policymakers are taking *real* action
  - Laws & mandates, not goals or targets
  - Economy wide
  - Minority of states, majority of US economy
  - Banking on rapid technological advancements to carry on to other states
    - Solar/wind, storage, transmission, H, RNG…



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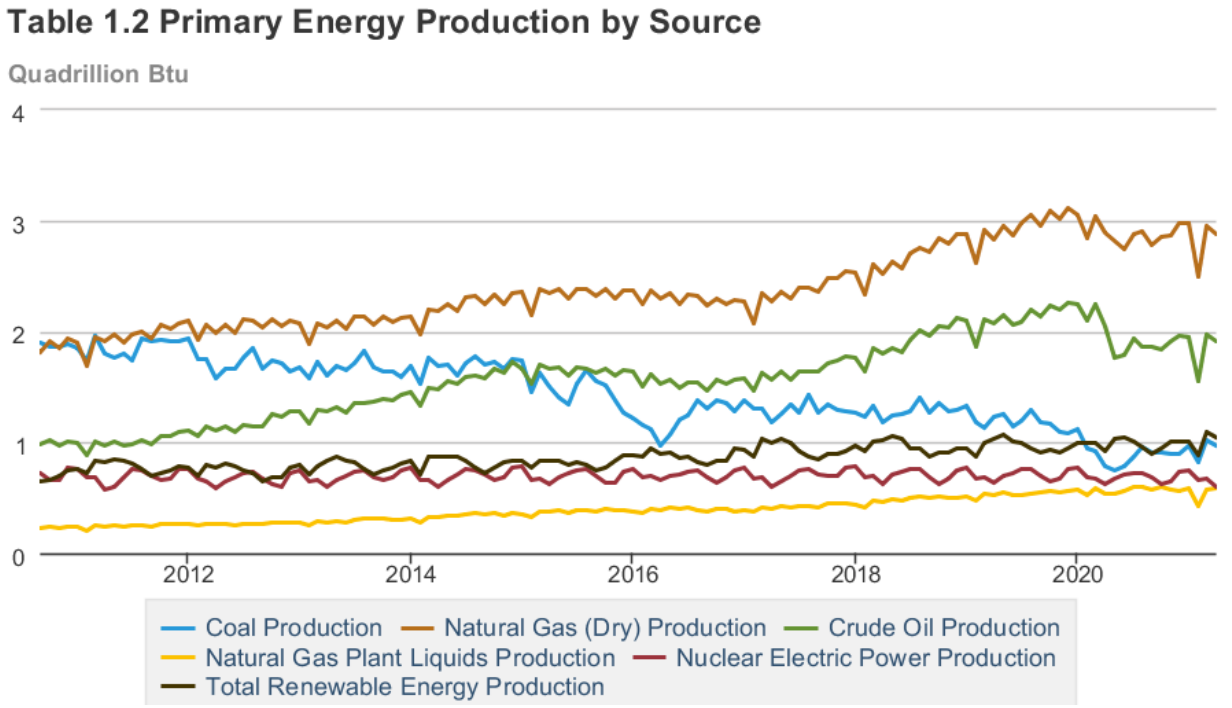
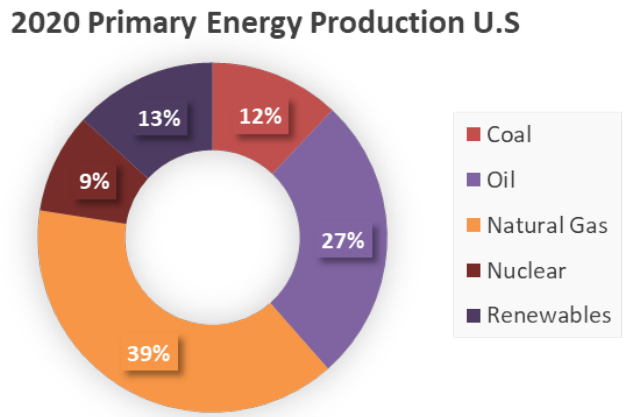
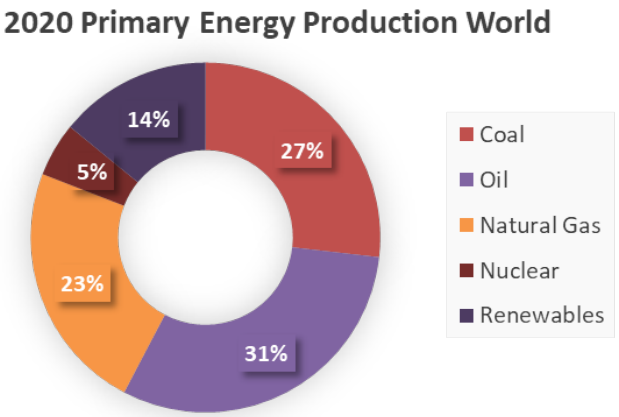
# Why is this so hard?

- What drives states' targets?
  - Scientific consensus (IPCC)
    - Stay in the 1.5-2°C range to avoid catastrophic social, economic, and environmental outcomes
    - Doing this requires achieving *net zero* $CO_2$ by mid-century
- Despite progress, a long way to go
  - Fossil fuels dominates energy use, in the world, in the US, *and in the Northeast*
  - Past ten years has made matters worse
- This will not be easy
  - Transition timelines are inconceivable relative to historical change in the energy sector
  - The technological solutions for full decarbonization are not readily apparent
- But: don't count on policy retreat
  - The science will not change for the better

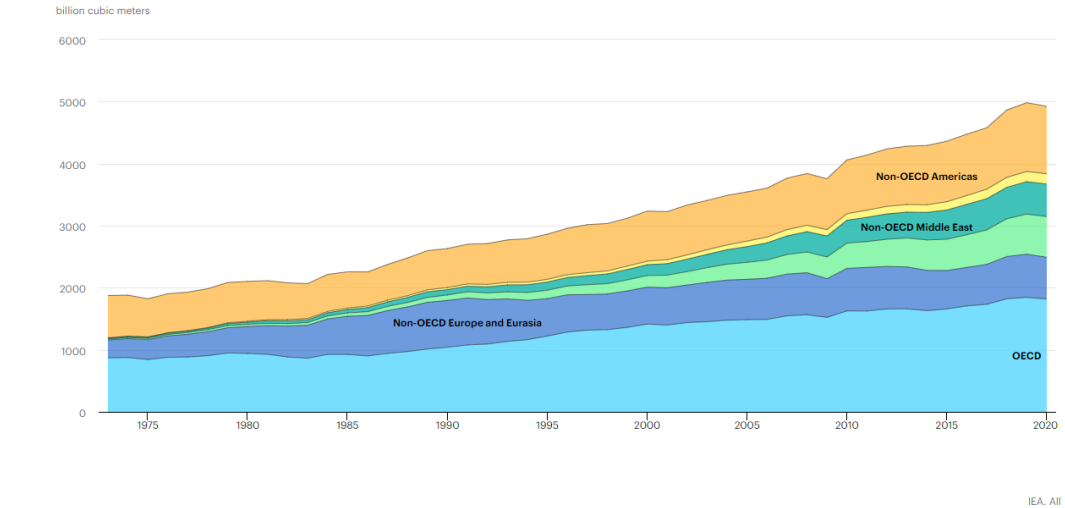


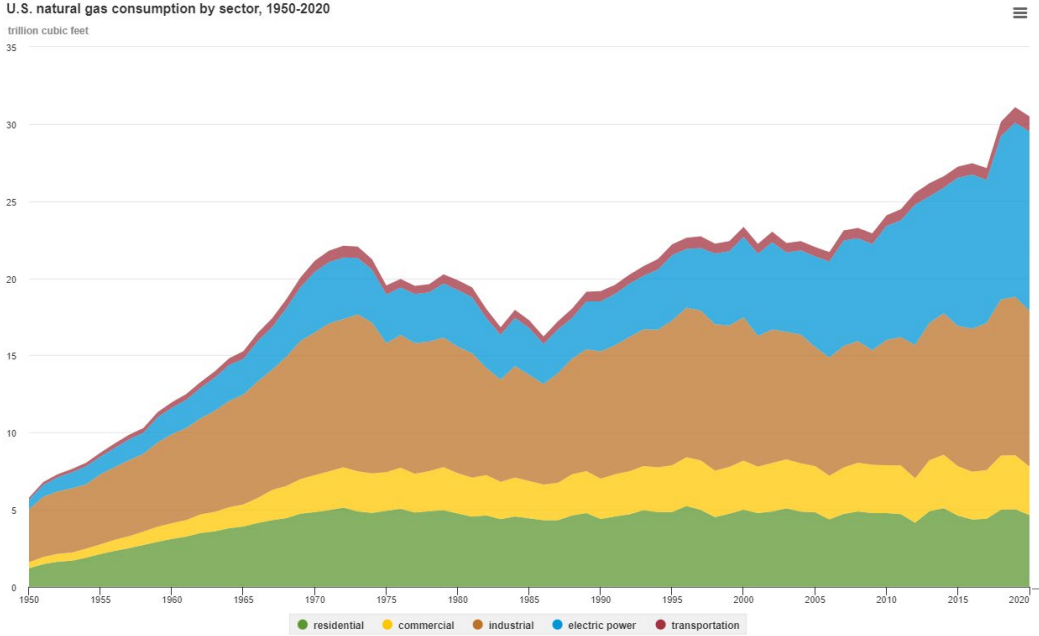



# Natural Gas Isn't Gone, Yet

World natural gas demand by region, 1973-2020

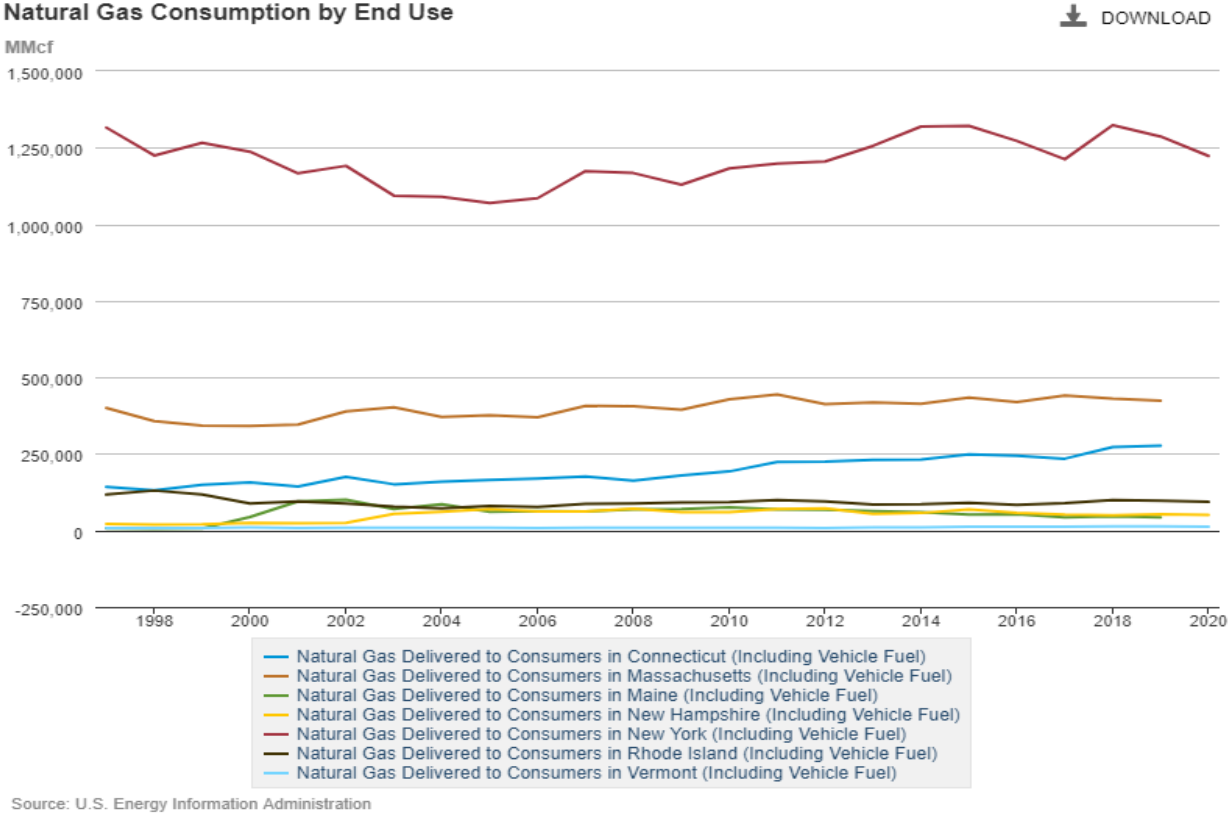



U.S. natural gas consumption by sector, 1950-2020




Source: U.S. Energy Information Administration, *Monthly Energy Review*, Table 4.3, April 2021, preliminary data for 2020
Note: Transportation includes pipeline and distribution use and vehicle fuel.

Natural Gas Consumption by End Use




Source: U.S. Energy Information Administration

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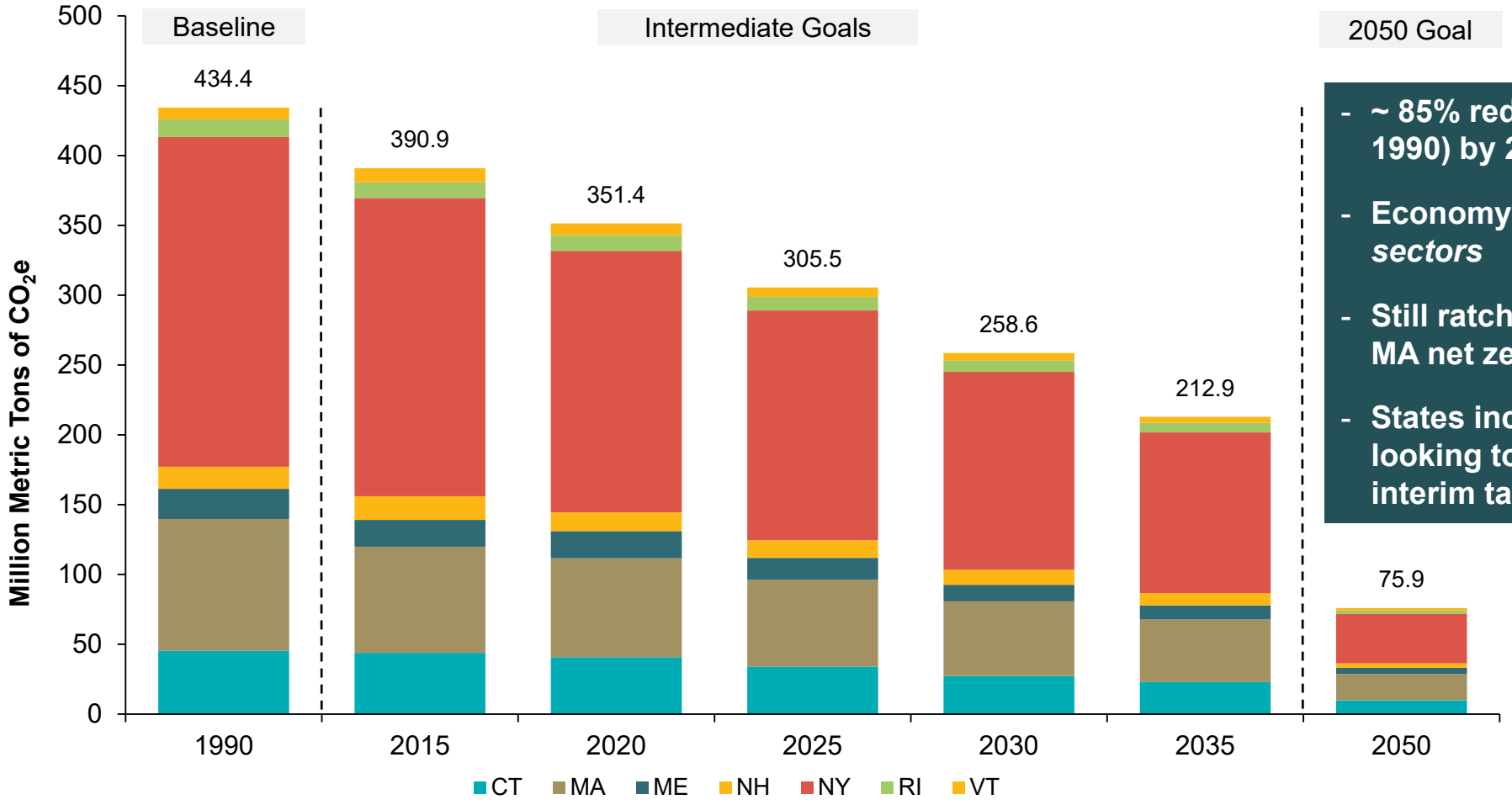
# Northeast State Goals for Decarbonization to 2050

- Ultimate goals, estimated interim levels




- ~ 85% reductions (from 1990) by 2050
- Economy-wide; *all sectors*
- Still ratcheting down – MA net zero by 2050
- States increasingly looking to binding interim targets

**Sources:** CT DEEP, MA DEP, ME DEP, NH DES, NY DEC, RI DEM, VT DEC.

# The (Futile) Soapbox

- Ideal: price GHG emissions (carbon price or cap/trade), let the market sort it out, at the lowest cost
- *The obvious conundrum:* carbon pricing at levels needed to meet mandates is not likely to become the primary basis for meeting Northeast state climate targets
  - Politically suspect, at best
  - The numbers would have to be high – very high – for it to work
  - Supportive policymakers, legislators, governors remain too few
  - Opposed by key groups and industries, including those that benefit from entrenched policies
- The only things *more obvious*:
  - This is crazy
  - Because of this, consumers and businesses will pay *substantially* more to get to net zero outcomes

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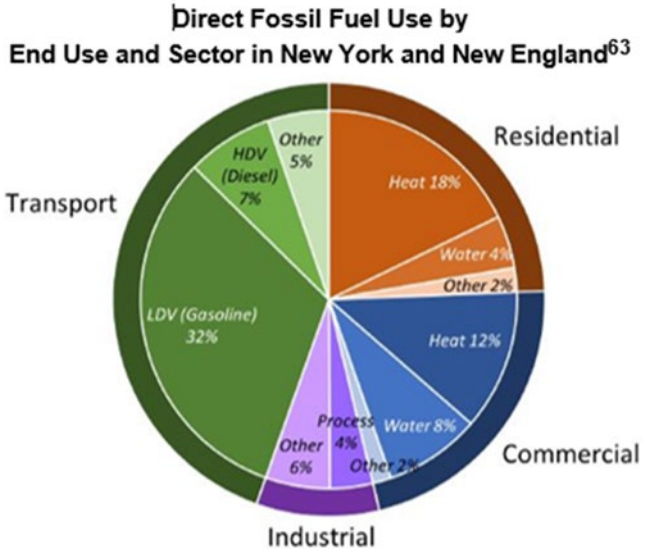
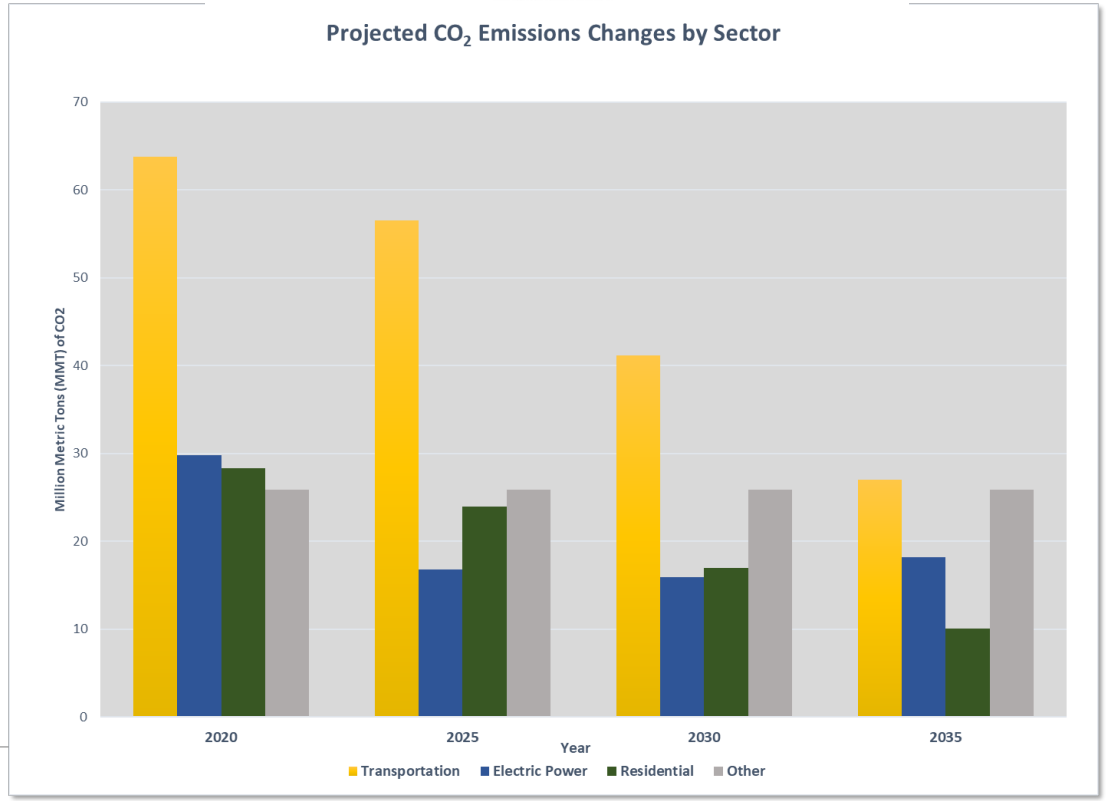
# The Pathway?

- Result: disparate (and desperate) mix of not well-coordinated policy approaches
  - Energy efficiency, long-term contracts, net metering, RPS, CES, building codes, tax policy, stimulus…
- Pathway du-jour: convergence around one idea for decarbonization of the economy
  - Electrification of transportation sector through organized buildout of vehicle charging (roadside and at-home), and direct subsidies for EV purchases
  - Electrification of building sector, through heat pump requirements in new construction, and funding for replacement of existing non-electric heating
  - Simultaneous rapid decarbonization of electric sector
  - R&D support for “holy grail” technologies (RNG, H, carbon capture and storage, modular nuclear etc.)



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# Building Sector

| State/Mitigation Measure | Heat Pumps/ Electrification | Energy Efficiency/ Weatherization | Appliance Efficiency | Updated Building Codes | Sustainable Building Materials | Biomass/Wood Heating Fuel | Combined Heat and Power (CHP) | Hydrogen | RNG | Battery Storage |
|---|---|---|---|---|---|---|---|---|---|---|
| Maine | X | X | X | | X | X | X | | | |
| New Hampshire | | X | X | X | X | X | X | | | |
| Vermont | X | X | X | X | X | X | X | | | |
| Massachusetts | X | X | X | X | | X | | X | | |
| Rhode Island | X | X | | X | | | | | | X |
| Connecticut | X | X | X | X | | X | X | | | |
| New York | X | X | X | | | X | | X | X | |
| New Jersey | X | X | X | X | | | X | | | |
| Pennsylvania | X | X | X | X | | | X | | | |
| Delaware | X | X | X | X | | | | | | |
| Maryland | | X | X | X | | | X | | | |
| DC | X | X | X | X | | | X | | | |

- Difficult sector to transition, yet remains a focus of states
- A lot of existing inventory with relatively long useful lives
- Technological and cost uncertainty around heat pump performance
- GHG benefits differ across fuels; Value of transitioning gas in buildings is questionable at best

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# Relative GHG Benefits in Building Sector

- Switching to heat pumps *can* result in emissions reduction
  - Regardless of existing fuel type (if gas, oil, or propane)
  - Even after accounting for emissions increase from increased electric demand
  - But several important factors:
    - Power system is nearly always gas on the margin in New England, muting benefits of switching from natural gas
    - Potential need for **supplemental heating** can swing the needle for gas switching from cost and emission perspectives
    - Suggests a focus on a fuel prioritization for heating electrification

**Net Emissions Reduction (MT $CO_2$) Per Average New England Household**
**Switching from Gas, Oil, and Propane to Electric Heat Pumps**

| | Fuel Type | | |
|---|---|---|---|
| | **Gas** | **Oil** | **Propane** |
| Annual Fuel Used for Heating in Average NE Home (Therms or Gallons) | 831 | 588 | 913 |
| Average Decrease in Fuel (MMBtu) | 83 | 81 | 83 |
| $CO_2$ Gas Composite Heating Emission Factor (kg / MMBtu) | 58 | 88 | 74 |
| Emission Reduction (kg CO2) | 4,862 | 7,200 | 6,140 |
| **Total Emissions Decrease (MT $CO_2$) Per Average Household** | **4.86** | **7.20** | **6.14** |
| Annual Electricity Used for Heating in Average NE Home (kWh) | 9,925 | 9,925 | 9,925 |
| Total Increase in Gas Demand (MMBtu) | 58.1 | 58.1 | 58.1 |
| $CO_2$ Gas Composite Electric Emission Factor (kg / MMBtu) | 58 | 58 | 58 |
| Emission Reduction (kg CO2) | 3,347 | 3,347 | 3,347 |
| **Total Emissions Increase (MT $CO_2$) Per Average Household** | **3.35** | **3.35** | **3.35** |
| **Net Emissions Reduction (MT $CO_2$) Per Average Household** | **1.52** | **3.85** | **2.79** |

**Sources**: American Community Survey, US Census Bureau, 2017; Source Energy and Emissions Analysis Tool (SEEAT).

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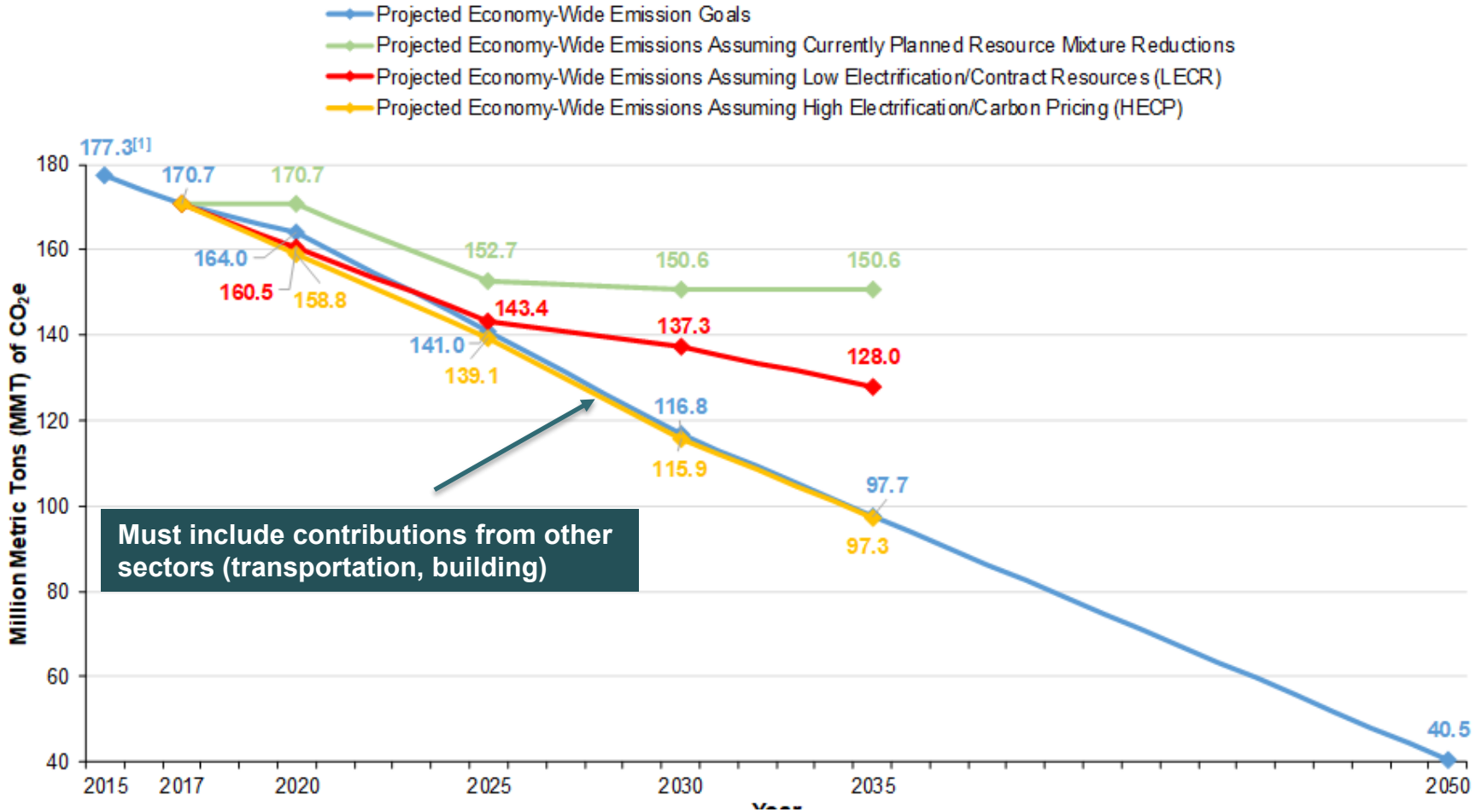
# Policy Focus: Electrification

## New England Emission Reduction Standards Compared with Emission Reductions from Renewable Resource Additions and Increased Electrification




**Sources:** Analysis Group study (Cavicchi, Hibbard)

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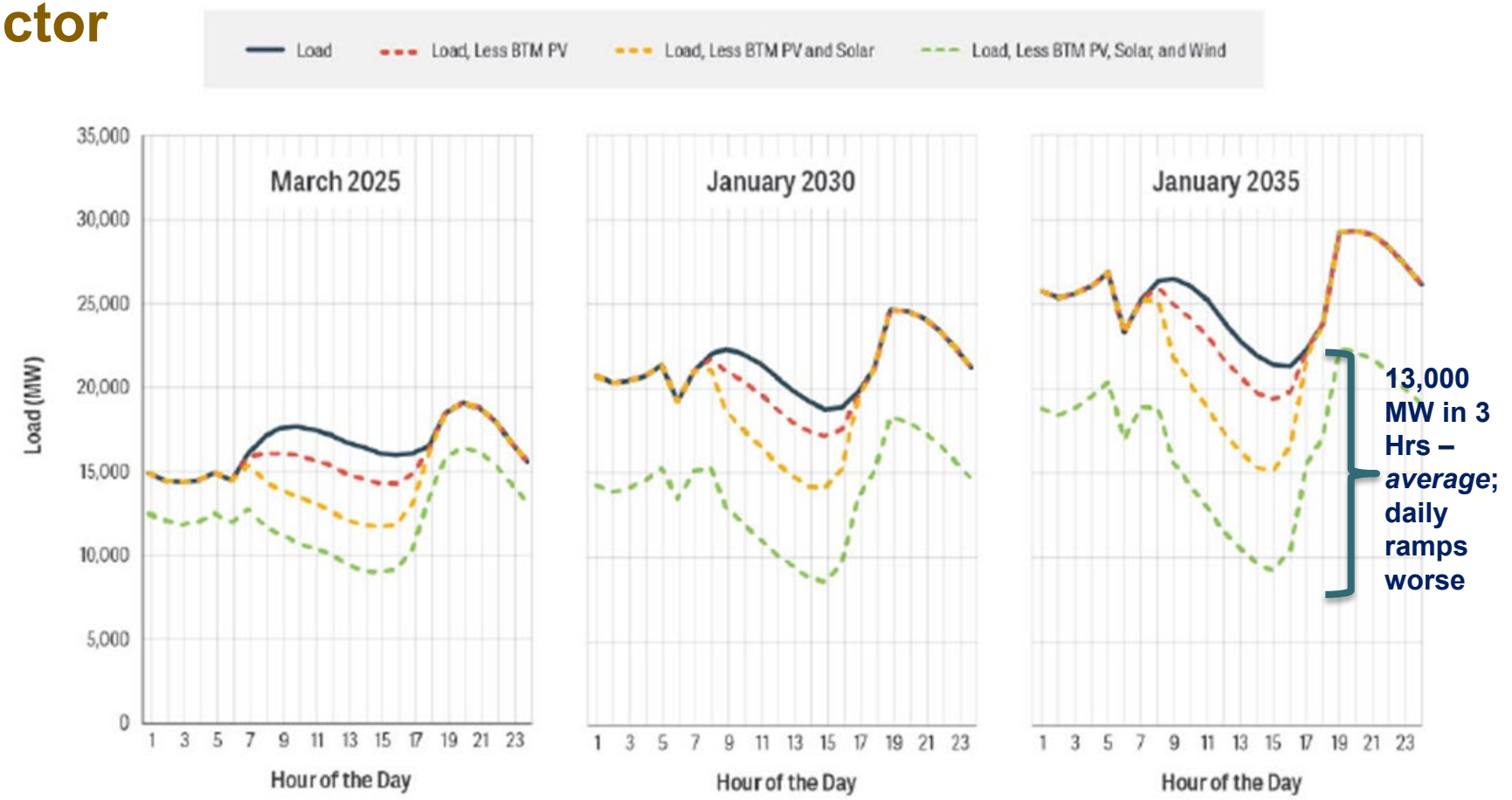
# Impact on Electric Sector

- EV most significant GHG reductions (when do folks charge?)
- Heating benefits flow from oil, propane, wood conversions (*not so much* natural gas)
- Peak quickly shifts to winter
- Major load ramp challenges emerge within a decade
- Gas generation remains <u>vitally</u> important absent economically viable alternative (e.g., RNG, H)

**Figure 2: Average Ramp-Ups for the Month that the Peak Ramp Occurs**
**High Electrification – Winter Season**

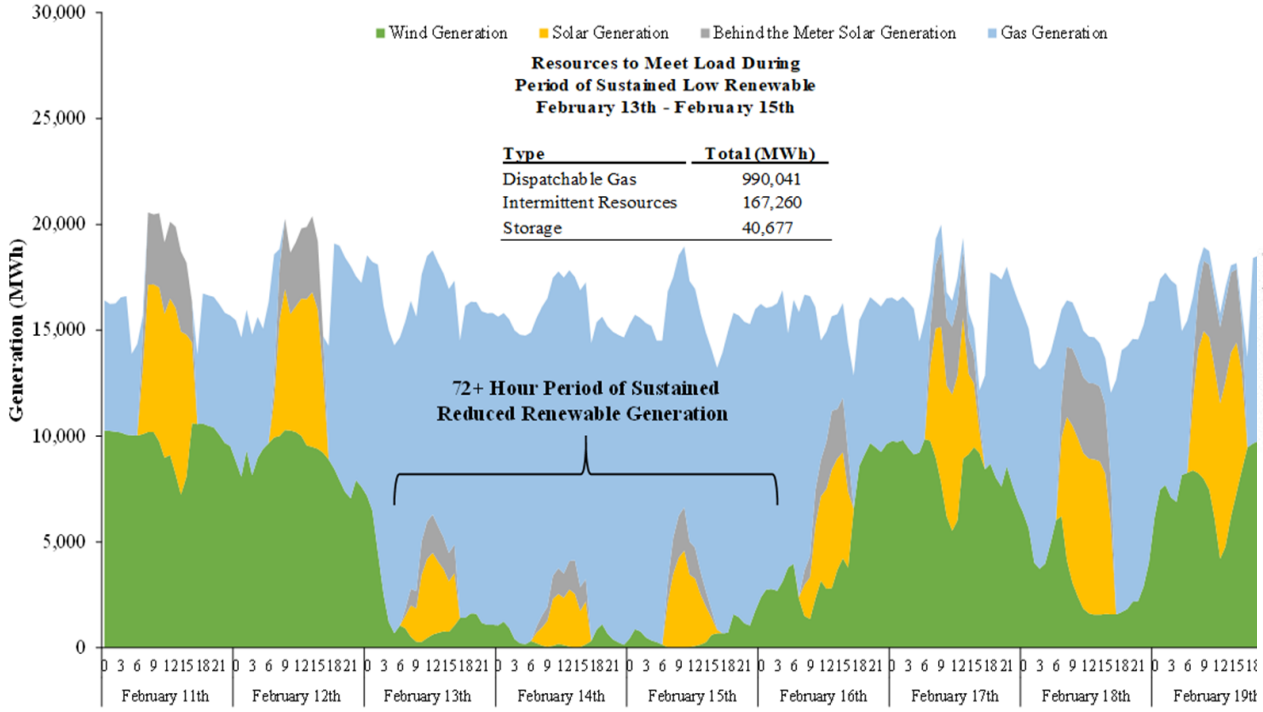


# Power System Operational Challenges

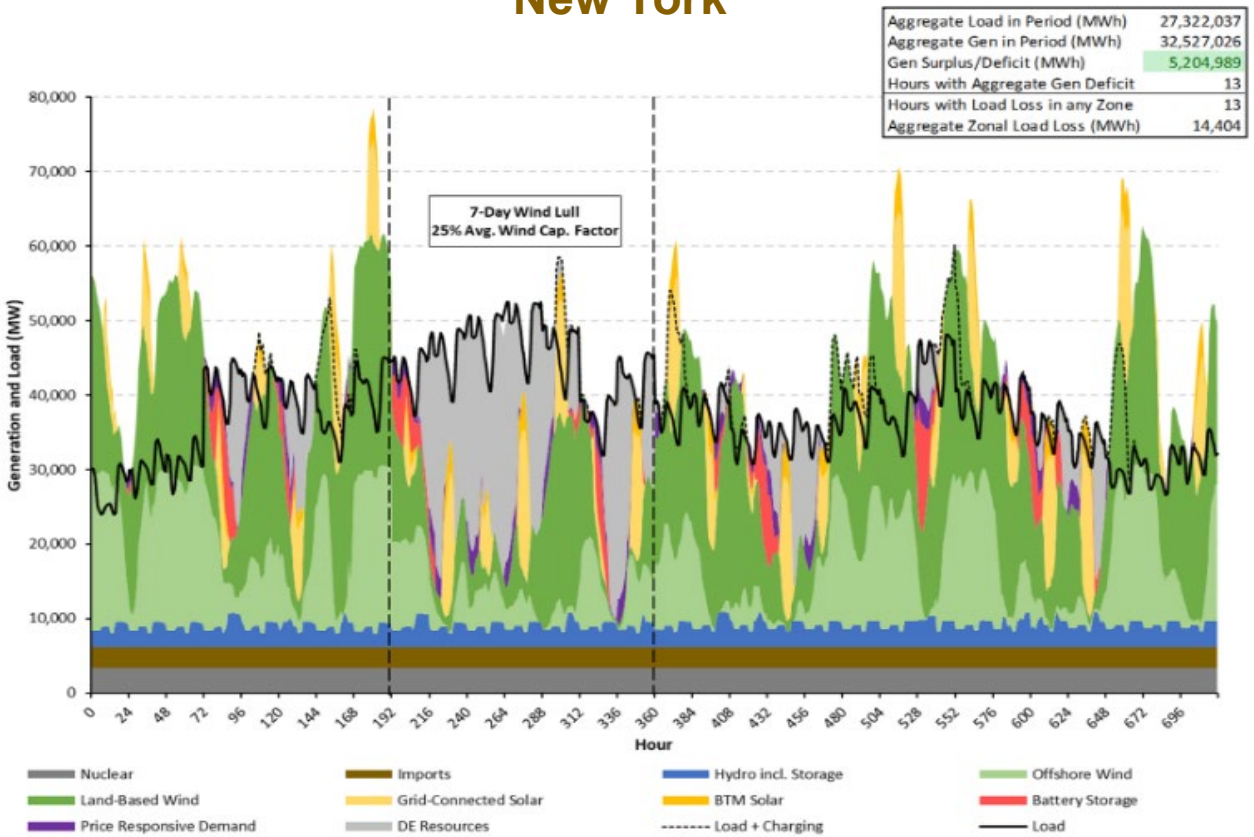
Analysis Group studies of rapid expansion of variable resources in New England and New York

In both cases, multiple extended periods of low solar/wind output, when even extensive storage capacity insufficient to meet reliability needs

## New England




## New York



# Through the Looking Glass

- Possible result – over next **10-15 years** in Northeast U.S.
  - Rapid increase in demand as electric sector acts as GHG sponge for transportation, building sectors
  - More frequent and severe major weather events (coastal storms, ice storms, severe heat)
  - Changing load profile – shift to winter peak, demand highest in early evening (no sun)
  - 5-10 GW on- and off-shore wind
  - 5-10 GW grid-connected and BTM solar
  - 1-3 GW HVDC hydro, with questionable availability in cold weather
  - 1-5 GW Battery storage?
  - Loss of coal and oil-fired resources; no new natural gas infrastructure, challenges to siting even transmission
  - Loss of some gas resources, and stored energy (oil tanks, LNG)?
- Does this seem plausible to anyone?

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# Implications for Energy Infrastructure (esp. Natural Gas) in the Northeast

- Avoid the temptation to "just say no" - carefully assess the role of natural gas in the transition
  - An economically-prioritized path to decarbonization would likely lean on the important transitional role of natural gas
    - In supporting electrification of the transportation and other sectors
    - In sustaining power system reliability and "having the back" of rapid renewable integration
    - In mitigating the cost of a rapid transition while technologies evolve to capture the later – and undoubtedly more difficult – phases of decarbonization
  - Certain factors can guide policy approach
    - Zero-carbon resources, technologies, practices must grow rapidly
    - There will be an important residual electricity supply need for 1-2 decades (at least), likely natural gas
    - In the building sector, there is a rationale for prioritizing electrification policies and investments to
      (1) new applications before existing, and
      (2) oil/propane/wood/baseboard electric heating *before* gas




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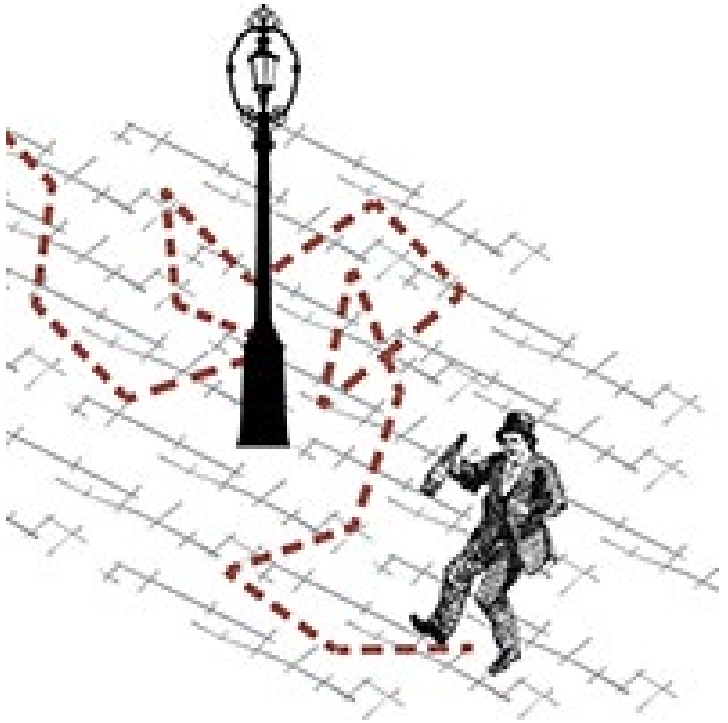
# Wrap Up



- The destination is known (…more or less)
  - 2040 – 2050
  - GHG emissions ~ 80% - 100% less than now
  - Across all sectors of the economy
  - Will require actions/technologies not currently in play

- A random walk to compliance is not an option
  - States are being proactive, evaluating LT pathways
  - Challenge: *increasingly* difficult to forecast beyond 5-10 years
    - Emerging technologies in all sectors (H, RNG, storage, OSW, EVs, heat pumps…)
    - Accelerating changes in cost factors, operational capabilities; breakthroughs possible
  - Resource-specific policies and investments today will soon look outdated
  - There are real reliability challenges as the electric sector absorbs other sector demands
  - All will be affected by the transition – consumers, businesses, shareholders
  - The price tag of inefficient policy will be extremely large
  - A more rationale approach to natural gas infrastructure must emerge

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