

**Reducing CO<sub>2</sub> Emissions in New England**  
*The Imperative of Nuclear Power*

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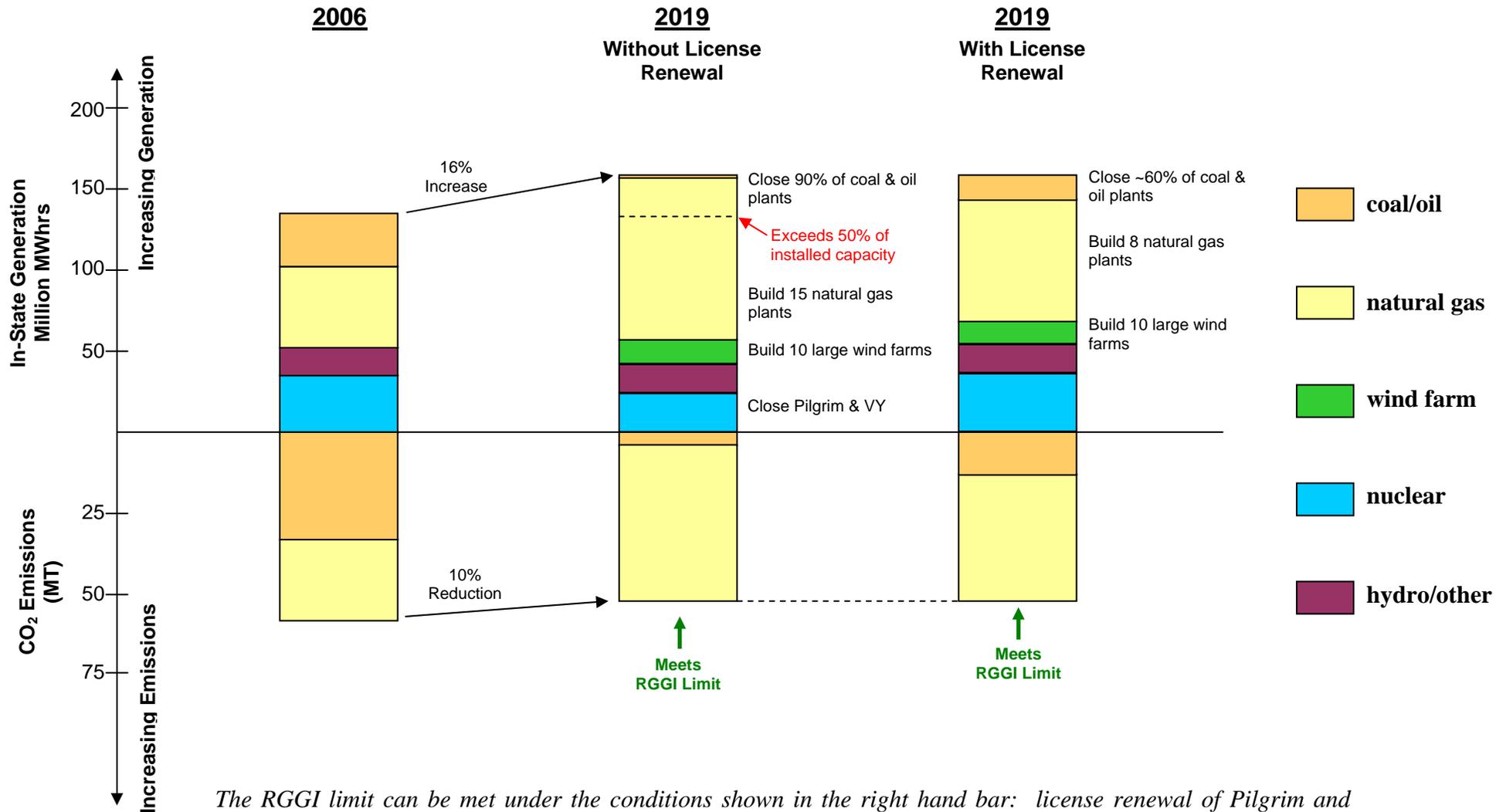
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## Summary & Conclusions

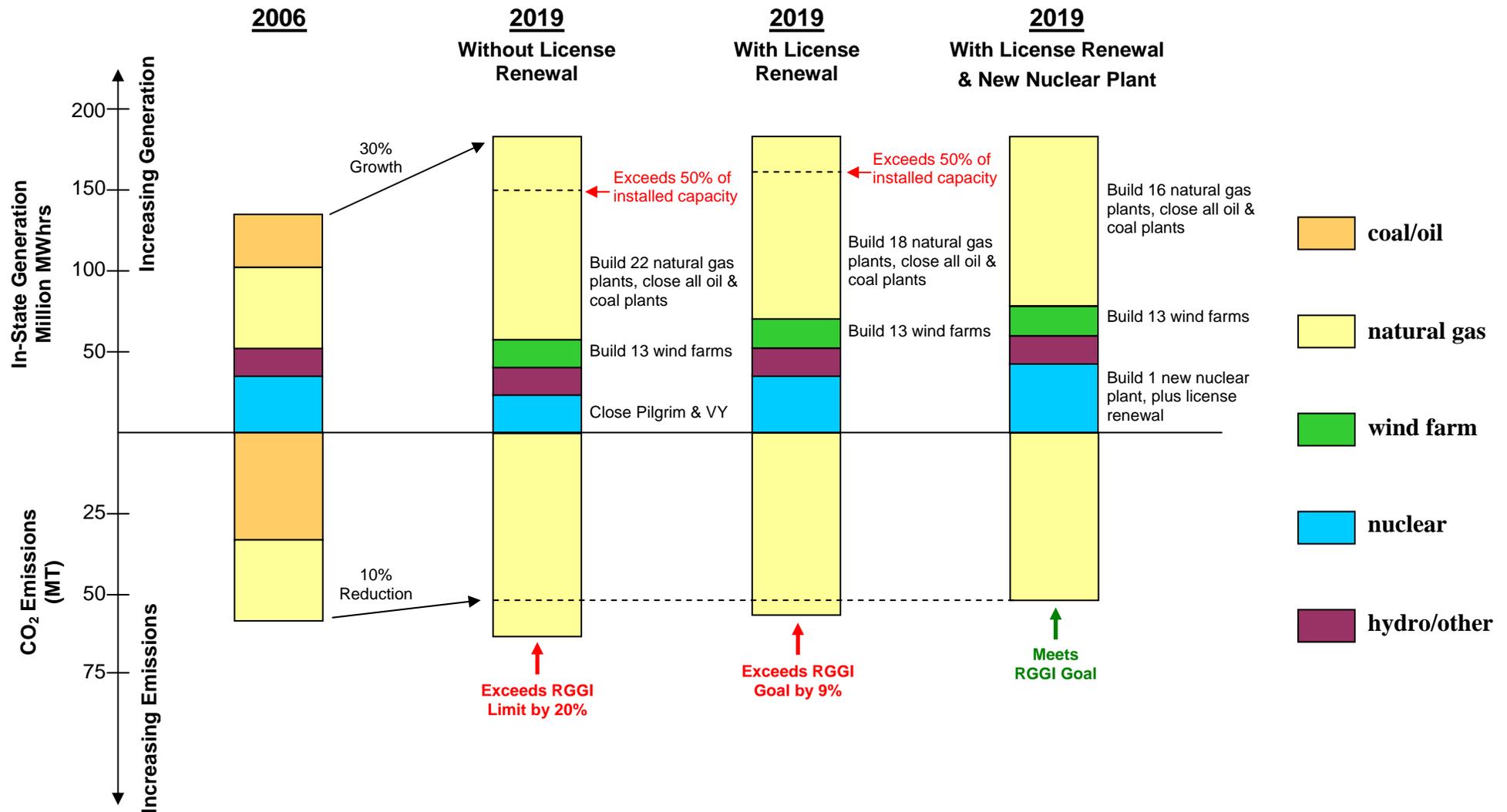
- This assessment demonstrates the strategic importance of nuclear energy in meeting New England's commitment to reduce greenhouse gas emissions under the Regional Greenhouse Gas Initiative (RGGI). Specifically, this assessment demonstrates the importance of renewing the licenses of the Pilgrim and Vermont Yankee nuclear power plants, continuing the operation of Seabrook and Millstone 2 and 3, and building new nuclear generating capacity, if New England (the six states operate within a single regional grid) hopes to meet the RGGI CO<sub>2</sub> emissions limit (10% reduction from 2006 levels) by the 2019 deadline.
- Like the other RGGI states, those comprising the New England region face a particularly daunting challenge: simultaneously reducing CO<sub>2</sub> emissions, complying with grid reliability standards and meeting growth in electricity demand. This assessment considers the implications of a low-growth scenario (21% increase in electricity demand by 2019) and a high-growth scenario (36% increase in electricity demand by 2019).
- It is not possible to achieve the desired CO<sub>2</sub> emission reductions without New England's nuclear power generation operating at least at its current level. Even with unprecedented levels of new renewable generating capacity, substantially increased reliance on natural gas and premature closure of oil- and coal-fueled plants, it is necessary to renew the licenses of Pilgrim and Vermont Yankee to meet the RGGI limit and reliability criteria in the low-growth scenario. In the high-growth scenario, meeting the RGGI limit will require license renewal of Pilgrim and Vermont Yankee, plus the addition of a new nuclear plant.
  - **Low-Growth Electricity Demand Scenario:** Meeting the RGGI CO<sub>2</sub> emissions limit would require aggressive efficiency measures, premature shutdown of more than half the region's oil and coal-fired plants, construction of eight 500-megawatt natural gas plants and ten 400-megawatt wind farms, *plus* license renewal of both Pilgrim and Vermont Yankee. Without license renewal, meeting the RGGI limit is only possible by relying on natural gas for two-thirds of the region's electricity, which would be excessive.
  - **High-Growth Electricity Demand Scenario:** Meeting the RGGI CO<sub>2</sub> emissions limit would require license renewal of Pilgrim and Vermont Yankee nuclear plants *plus* the construction of one new nuclear plant and ten large wind farms. All coal and oil -fired units must also be retired and 16 new natural gas-fired plants constructed.

# Meeting RGGI Limit Under Low Growth Electricity Demand



*The RGGI limit can be met under the conditions shown in the right hand bar: license renewal of Pilgrim and Vermont Yankee (and continued operation of three other nuclear plants), premature retirement of more than half the region's existing oil- and coal-fired capacity, and construction of 10 new wind farms and eight new gas-fired power plants. Without license renewal (middle bar), meeting the RGGI limit is only possible with an excessive dependence on natural gas.*

# Meeting RGGI Limit Under High Growth Electricity Demand



*In the high-growth scenario, New England cannot meet the RGGI CO<sub>2</sub> limit (see middle two bars) even by renewing the licenses of its operating nuclear plants, retiring all oil- and coal-fired capacity, and building large numbers of new wind farms and gas-fired power plants. The RGGI limit can be reached (right-hand bar) with license renewal of Pilgrim and Vermont Yankee (and the continued operation of three other nuclear plants), construction of one new nuclear plant, substantial expansion of wind capacity, considerable expansion of gas-fired capacity, and retirement of all oil and coal-fired plants.*

## Introduction

- The Regional Greenhouse Gas Initiative (RGGI) is a cooperative effort by 10 northeastern states to reduce greenhouse gas emissions from the generation of electricity. Last year, a “model rule” or limit was established to reduce these emissions by 10% from their current levels by 2019.
- New England generates all of its electricity. In fact, it is a net exporter of this commodity --- generating about 6% more electricity than it consumes.
- This analysis evaluates the challenge facing the New England states in meeting the RGGI limit for CO<sub>2</sub> emissions while meeting two other fundamental criteria:
  - **Meeting electricity demand growth:** Over the past nine years, electricity demand has grown by ~2.2% per year in the region. If this pace continues, demand will be almost 36% higher in 2019 than it is today. Since 1990, however, growth in electricity demand has averaged 1.4% per year. This rate, which is more in line with the projections of the US Department of Energy and regional transmission organizations, would require 21% more electricity by 2019.
  - **Ensuring reliability:** This assessment assumes that near-term renewable generating resources will be large wind farms (similar in size to the region’s proposed Cape Wind Project), which operate intermittently and, like all intermittent resources, require back-up generating capacity. Several independent assessments have found that grid reliability can be compromised if intermittent sources of electricity represent more than 15-20% of installed capacity. In addition, relying on natural gas to fuel more than 50% of installed electric generating capacity could also compromise grid reliability because gas pipeline and LNG release capacity may not be adequate to deliver enough supply to meet electric sector demand during peak demand periods (a situation that has *already occurred* in New England during winter cold snaps).

## Summary of Nuclear Power Plants in New England

<b>Nuclear Plant</b>	<b>2004 to 2006 Average Capacity Factor<sup>1</sup> (%)</b>	<b>2006 Generation (MWh)<sup>2</sup></b>	<b>Current License Expiration</b>	<b>Comment</b>
Vermont Yankee	98	5,106,523	March 2012	Submitted license renewal application in January 2006
Pilgrim	95.7	5,829,658	June 2012	Submitted license renewal application in January 2006
Seabrook	91.6	9,397,856	October 2030	
Millstone 2	90.0	6,502,158	July 2035	License renewal approved in November 2005
Millstone 3	91.5	10,087,288	November 2045	License renewal approved in November 2005

- Calculations by the Nuclear Energy Institute show that the four nuclear power plants operating in New England avoided the emission of 21.3 million metric tons of CO<sub>2</sub> in calendar year 2006, compared to the fossil fuels that would have been used to generate electricity in the absence of nuclear power.
- Nuclear energy currently accounts for more than 26% of New England's electricity generation.

<sup>1</sup> Data from Nuclear Energy Institute

<sup>2</sup> Data from Nuclear Energy Institute

## To Meet the RGGI Limit Under the Low-Growth Scenario ...

- **Increased conservation/efficiency:** In this scenario, the region must reduce growth in electricity demand from its recent trend (over the last 9 years) of ~2.2% per year to 1.4 % per year (consistent with the region's average growth since 1990). Achieving this reduction would be challenging, given that the region already leads the nation in efficiency investment.
- **Build 10 large (400 MW) wind farms:** These new wind farms would produce more than double the electricity currently generated by non-hydro, renewable facilities within the region, and would supply about two-thirds of the growth in electricity demand. A new wind farm (the size of the proposed Cape Wind Project) would need to come online almost every year, an unprecedented rate of siting, permitting and construction.
- **Build new gas-fired plants, retire older fossil-fueled plants:** Three new natural gas-fired plants (500 MW each) must be built to meet the growth in electricity demand not covered by the wind farms. Because even high-efficiency combined-cycle natural gas plants have CO<sub>2</sub> emissions, 60% of the existing coal- and oil-fired plants must be retired to offset the increased CO<sub>2</sub> emissions from the new gas-fired plants. As a result, about five additional natural gas plants must be built to replace the coal and oil fired plants that shut down.
- **License renewal of nuclear plants:** All five nuclear plants within the region must continue operating to meet the RGGI limit. Of the five, only Pilgrim and Vermont Yankee require license renewal within the RGGI compliance deadline. The original 40-year operating licenses for the other nuclear plants have either already been renewed or do not expire until after the 2019 RGGI compliance deadline.

## However ...

- **Without license renewal:** In the absence of license renewal, Pilgrim and Vermont Yankee would close before 2019. In that case, the region would need: 10 large wind farms and 15 new gas-fired plants. This would cause natural gas to account for about two-thirds of the region's installed generating capacity, which is highly undesirable from a grid reliability perspective. On top of this new construction, 90% of existing oil and coal-fired capacity within the region would have to be shut down.

## To Meet the RGGI Limit Under the High-Growth Scenario ...

- **Build 13 large wind farms:** A new 400-MW facility (the size of the proposed Cape Wind Project) would have to come on-line at a pace that exceeds one per year, an unprecedented rate of siting, permitting and construction.
- **Build one new nuclear power plant:** The substantial growth in electricity demand requires new nuclear capacity to be built in addition to license renewal and continued operation of existing nuclear plants.
- **Retire all oil and coal-fired plants and build 16 gas-fired power plants:** Shutdown of all coal and oil - fired facilities would be required to reduce CO<sub>2</sub> emissions from current levels and meet the RGGI limit. New gas-fired plants would be required to meet the demand growth that would not be met by both the wind farms and the new nuclear plant and to replace the coal and oil-fired generating plants, which have higher greenhouse gas emissions.

## However ...

- **Without new nuclear generating capacity:** Without additional nuclear generating capacity, even with continued operation of all existing nuclear plants, the region would not meet the RGGI limit. Even 13 large new wind farms (the size of the proposed Cape Wind Project), retirement of all oil- and coal-fired plants and construction of up to 22 new gas-fired plants (at a pace of almost two per year) would not be sufficient.

## Methodology & Assumptions

- This assessment employs the methodology used in a 2005 study of the RGGI states. That study, *The Role of Nuclear Energy in Reducing CO<sub>2</sub> Emissions in the Northeastern United States*, remains a useful reference for background information and perspective.
- The analysis does not attempt to simulate dynamic market conditions or economic considerations. It simply adds new renewable, gas-fired and nuclear capacity as necessary to meet new demand, and retires oil and coal-fired capacity as needed to achieve the necessary reductions in CO<sub>2</sub> emissions.
- Several key assumptions were made in performing this assessment. These assumptions are intended to be pragmatic and generally favor non-nuclear options to achieve the RGGI emission limit:
  - Existing hydro and other renewable generation remain at their current levels of production with no CO<sub>2</sub> emissions.
  - A relatively high capacity factor of 40% was assigned to new wind farms, with new construction limited to 15% of in-state installed capacity minus existing renewable generation (hydro was not considered as part of the 15% installed capacity limit).
  - The analysis maximized construction of wind farms when forecasting new construction and generating plant retirements. Nuclear plant license renewal and new nuclear plant construction were only applied if the RGGI goal or grid reliability criteria could not be met.
  - The region currently exports the equivalent of ~6% of its generation (in other words, generating more electricity than it consumes). By 2019, New England was considered as a non-exporting region (which significantly reduced the challenge of complying with the RGGI limit in both the low and high electricity demand growth scenarios).
  - New England's electricity generation and CO<sub>2</sub> emissions for 2005 (the most recent data available) were used as a proxy for 2006, which is the starting point of this assessment.