Academics and clean energy experts support a statewide commitment to 100 percent renewable energy

Senator Karen E. Spilka
Chairwoman, Senate Committee on Ways & Means
Massachusetts General Court

April 2, 2018

Dear Chairwoman Spilka and members of the Senate Committee on Ways and Means,

We were greatly encouraged to see the Senate Committee on Global Warming and Climate Change approve an ambitious clean energy omnibus bill in February, including a commitment to achieve 100 percent renewable electricity by 2035 and 100 percent renewable energy economy-wide by 2050. As academics, researchers, industry leaders, and clean energy experts, we urge you to advance *An Act to promote a clean energy future* (S.2302), including a strong commitment to power Massachusetts with 100 percent renewable energy.

Our reliance on dirty sources of energy like oil and gas is harming our health and changing our climate in dangerous ways. While solar and wind energy are growing rapidly, we are still not doing nearly enough to protect our communities from harmful pollution and ensure a safe, stable, and livable climate for future generations.

Recent climate studies show that we need to accelerate our progress towards a future powered entirely by renewable energy as soon as possible. With President Trump and his officials denying the truth about climate change and working to increase our dependence on fossil fuels, Massachusetts must lead the way forward on clean energy along with other states and nations.

An Act to promote a clean energy future sets out a clear pathway toward 100 percent renewable energy on a timeline that is achievable with support from state leaders. By enacting this legislation, Massachusetts can take the steps necessary to avoid the worst impacts of climate change, while building stronger, healthier, and more prosperous communities.

Why 100 percent renewable energy is a necessary goal

Climate change

For decades, we have known that emissions of carbon dioxide and other greenhouse gases from the production and burning of fossil fuels are a major driver of climate change. Many of the impacts that scientists predicted from greenhouse gas emissions are already happening. In Massachusetts, extreme storms have become 81 percent more

frequent since the 1940s.[1] This winter, Massachusetts' coastal communities experienced record high tides and flooding due to a series of extreme storms, exacerbated by sea levels that have already risen by nine inches since 1900.[2]

Unless we move quickly to phase out the burning of fossil fuels, we will see these impacts become much worse. Sea levels could rise by an additional 7–10 feet in the Boston area by the end of this century. By 2070, residents could experience up to 90 days each year with temperatures greater than 90 degrees Fahrenheit.[3] Droughts will last longer, while extreme storms will become more severe.

To avoid the impacts of global warming getting much worse, we must bring our carbon emissions down to zero by mid-century or sooner. Since many countries and many regions of the United States are lagging in meeting these goals, Massachusetts and other leading states and municipalities must eliminate greenhouse gas emissions even faster than the national average. Given the risks of climate "tipping points" leading to even greater disasters, emissions must be reduced as fast as possible by those with the ability to lead.

Public health

Renewable energy strategies that reduce emissions of greenhouse gases also reduce emissions of other air pollutants that can affect local and regional public health. Pollution from the combustion of fossil fuels is linked to a wide range of health problems, including asthma, cardiovascular disease, and premature death. Many of these impacts are felt disproportionately by low-income communities and people of color, as well as residents of neighborhoods that are located near highways, airports, and other highly polluting infrastructure.

Reducing air pollution generally leads to immediate improvements in public health, providing a near-term and local rationale for strategies that will also have long-term and global benefits. A recent report showed that the growth in wind and solar energy from 2007–2015 in the United States had resulted in $29.7–$112.8 billion in health benefits and saved 3,000–12,700 lives.[4] These savings are related to reductions in particulate matter and ozone concentrations, with corresponding reductions in premature deaths, cardiovascular and respiratory hospitalizations, and heart attacks. This is a conservative estimate, as it does not consider other benefits from reducing air pollution, such as a decline in asthma attacks, lost days of school and work, and premature births.

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[1] *When it Rains, it Pours*, Travis Madsen and Nathan Wilcox, Frontier Group and Environment America Research & Policy Center, Summer 2012, <http://www.environmentmassachusetts.org/reports/mae/when-it-rains-it-pours>.

[2] *Climate Ready Boston Final Report*, City of Boston, December 2016, <https://www.boston.gov/departments/environment/climate-ready-boston>.

[3] *Climate Ready Boston Final Report*, City of Boston, December 2016, <https://www.boston.gov/departments/environment/climate-ready-boston>.

[4] "The climate and air-quality benefits of wind and solar power in the United States," Dev Milstein et al., Nature Energy 6, 14 August 2017, <https://www.nature.com/articles/nenergy2017134>.

Achieving 100 percent renewable energy in Massachusetts

Recent progress

Solar, wind, energy efficiency, and other clean energy technologies are growing rapidly in Massachusetts and across the country. Since 2007, the amount of solar energy capacity installed in Massachusetts has increased more than 300-fold.[5]

The economics of both solar and wind power are now so attractive that renewable energy has become the largest source of new electricity capacity added to the grid in the United States for four of the last five years, and was responsible for 60–70 percent of all new additions in 2015 and 2016.[6]

According to Lazard's Levelized Cost of Energy 2017 analysis, the cost of generating electricity from utility-scale solar and onshore wind installations is now comparable to or cheaper than fossil fuel generation.[7]

In recent years, we have seen similar declines in the costs of other technologies that will facilitate an economy-wide transition to 100 percent renewable energy, including energy storage, electric cars, heat pumps and LED light bulbs.

Electric vehicles (EV) are more energy efficient than internal combustion engine (ICE) vehicles, resulting in EV operating costs per mile that are three times lower than operating an ICE vehicle. As battery prices continue to decline, the upfront cost of EVs will follow. A recent UBS report found that the cost of building a Chevy Bolt was $4,600 less than expected, and predicted that the total cost of ownership for an EV (including the upfront purchase price and operating expenses) would fall below ICE vehicles for the first time this year.[8]

Air source heat pumps are now so efficient that they are delivering over 3 kilowatt-hours of heat for every kilowatt-hour of electricity they consume, and are able to keep buildings heated even in temperatures below -10° F. Air source heat pumps for new homes now cost less to install than a fossil fuel heating system.[9]

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[5] *Renewables on the Rise*, Gideon Weissman, Rob Sargent, and Bret Fanshaw, Frontier Group and Environment Massachusetts Research & Policy Center, July 2017, <http://environmentmassachusetts.org/reports/mae/renewables-rise>.

[6] "Renewable generation capacity expected to account for most 2016 capacity additions," Cara Marcy, U.S. Energy Information Administration, 10 January 2017, <https://www.eia.gov/todayinenergy/detail.php?id=29492>.

[7] *Levelized Cost of Energy 2017*, Lazard, November 2017, <https://www.lazard.com/perspective/levelized-cost-of-energy-2017/>.

[8] *UBS Evidence Lab Electric Car Teardown – Disruption Ahead?*, Patrick Hummel et al., UBS, 18 May 2017, <http://www.advantagelithium.com/_resources/pdf/UBS-Article.pdf>.

[9] "The Future of Housing in America," Kevin Ireton, *The Best of Fine Homebuilding* (ISSN: 1936-8135), Winter 2014.

If renewable electricity is used to run heat pumps and electric vehicles, we can heat and cool our homes and power our transportation system without the use of fossil fuels.

Getting to 100% renewable energy

A recent review of seven studies conducted by researchers at universities, government institutions, and nonprofits shows that there are no insurmountable technological or economic barriers to achieving 100 percent renewable energy.[10]

In order to reach 100 percent renewable energy across all sectors of the Massachusetts economy, we must:

- Reduce our total energy consumption by taking advantage of every opportunity for energy efficiency;
- Replace all fossil fuel power plants with clean, renewable generation like wind and solar;
- And electrify all energy used for transportation (with a few exceptions) and for all residential and commercial buildings (e.g., space heating and hot water).

In order to convert all electricity generation to renewable resources by 2035, Massachusetts' renewable portfolio standard (RPS) will have to increase by an average of about 5 percentage points per year from the 2017 level of 12 percent. In order to achieve 100 percent renewable energy economy-wide by 2050, about 3.5 percent of the fossil fuels now used for heating, hot water, and vehicles will have to be converted every year to electricity. These rates of increase are not at all unrealistic if Massachusetts makes a commitment to 100 percent renewable energy soon.

All of these trends are now underway but need to be dramatically accelerated. See the Appendix for an analysis of what it will take to reach these goals in Massachusetts.

Massachusetts must lead the way

Growing momentum for 100 percent renewable energy

To date, more than 60 municipalities in the United States have committed to a goal of 100 percent renewable electricity or 100 percent renewable energy economy-wide.[11]

Cities that own their utilities can simply mandate the amount of power they obtain from renewable energy. The City of Austin, for example, has required that Austin Energy obtain 65 percent of its power from renewable energy by 2025.

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[10] *We Have the Power: 100% Renewable Energy for a Clean, Thriving America*, Travis Madsen et al., Environment America Research & Policy Center and Frontier Group, Spring 2016, <http://www.environmentmassachusettscenter.org/reports/mac/we-have-power-0>.

[11] "Is Your City #ReadyFor100?", Sierra Club, <http://www.sierraclub.org/ready-for-100/cities-ready-for-100>.

Other cities without municipal utilities are also taking big steps toward 100 percent renewable energy. San Diego is the largest city with a legally binding 100 percent renewable electricity goal. The city hopes to use community choice aggregation, joining with other municipal governments to aggregate their electricity demand and choose their energy source. But San Diego Gas & Electric is mounting a public relations campaign against community choice aggregation. This suggests that state-level efforts to restructure utility profit models are essential to the success of cities going 100 percent renewable.

At least seven cities and towns in Massachusetts — Salem, Cambridge, Leverett, Framingham, Lowell, Amherst, and Northampton — have already committed to 100 percent renewable energy, with other municipalities weighing similar commitments.

Additionally, more than 120 leading global companies have pledged to switch to 100 percent renewable energy as part of the RE100 initiative.[12] Several of these companies are based in or have significant operations in Massachusetts, including Biogen, Facebook, Google, Microsoft, and P&G.

Major institutions in Massachusetts are also moving to purchase their energy from renewable sources. Boston University has committed to source 100 percent of its electricity from renewables by the end of this year. Harvard University has also committed to a 100 percent renewable energy goal, and Hampshire College in Amherst, Mass., is already powered entirely with renewable electricity from on-campus solar panels. Last year, Partners HealthCare unveiled plans to purchase energy from a 28-megawatt wind farm in New Hampshire, part of its overall strategy to achieve 100 percent renewable energy by 2025.

Momentum is building for state-level commitments to 100 percent renewable energy as well. Hawaii has passed a law to achieve 100 percent renewable electricity by 2045, and the state's largest electric utility has developed a plan to achieve that target five years earlier. Similar legislation is pending in California, Washington, Pennsylvania, Maryland, and other states.

Massachusetts' legacy of leadership

For decades, Massachusetts has been a national leader in efforts to reduce fossil fuel pollution and expand clean energy production.

In 2001, Massachusetts adopted the nation's first binding limits on carbon pollution from power plants. Massachusetts was also among the first states to adopt stronger vehicle emissions standards in the 1990s.

More recently, the Commonwealth has emerged as one of the top states in the country for solar energy. Massachusetts is leading on solar not because we have more sunshine than other states, but because state officials have embraced pro-solar policies. As a result,

[12] "Companies - RE100," RE100, <http://there100.org/companies>.

Massachusetts is ranked sixth in the nation for total solar capacity, with nearly twice as much solar installed as Texas and more than three times as much as Florida.[13]

Clean energy policies adopted by state leaders can make a real difference in Massachusetts, while setting a bold example for other states to follow.

So far, 56 legislators have cosponsored the 100% Renewable Energy Act (S.1849, H.3395), filed by Senator Jamie Eldridge, Representative Sean Garballey, and Representative Marjorie Decker last January. The goals of this legislation, and most of the provisions to implement the 100 percent renewable energy commitment, are included in the clean energy omnibus bill (S.2302) approved by the Senate Committee on Global Warming and Climate Change.

The national landscape demands strong action in the states

Despite the conclusive body of evidence linking global warming and climate change to human actions, and despite the growing frequency and severity of storms like Hurricanes Harvey and Irma, President Trump and his administration are turning their backs on climate action. The Trump administration is moving to roll back federal limits on carbon pollution from power plants and vehicles, while encouraging the expansion of fossil fuel extraction on public lands.

With the federal government moving in the wrong direction, it is up to states like Massachusetts to lead the way forward. Our climate and our health can't wait.

Please act expeditiously to pass *An Act to promote a clean energy future*, including commitments to achieve 100 percent renewable electricity by 2035 and 100 percent renewable energy economy-wide by 2050. With your leadership, we can take bold steps toward a future powered entirely by renewable energy, and help ensure that our children inherit a safe, healthy, and livable planet.

Sincerely,

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[13] *Lighting the Way 4: The Top States that Helped Drive America's Solar Energy Boom in 2015*, Gideon Weissman, Bret Fanshaw, and Rob Sargent, Frontier Group and Environment America Research & Policy Center, July 2016, <http://www.environmentamerica.org/reports/ame/lighting-way-iv>.

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Appendix: The pathway to 100 percent renewable energy

The way to get to 100 percent renewable energy for Massachusetts is to reduce energy needs by optimizing energy efficiency in all sectors, to electrify or otherwise convert to renewable energy nearly all energy uses for transportation and buildings (e.g., space heating and hot water), and to replace fossil fuel power plants with renewable generation from sources like wind and solar. All of these trends are now underway but need to be dramatically accelerated.

The main goals in the 100% Renewable Energy Act are for renewable energy to supply:

- 100 percent of electricity needs by 2035;
- 80 percent of all energy needs by 2040;
- and 100 percent of all energy needs by 2050.

In order to convert all electricity generation to renewable resources by 2035, the renewable portfolio standard (RPS) will have to increase by an average of about 5 percent per year from the 2017 level of 12 percent. Based on recent estimates, we would need to add approximately 2,100 MW of new solar and 2,500 MW of new wind capacity on average each year to serve Massachusetts.[14] To achieve this, state officials should increase the RPS as soon as possible by an average of 5 percent or more each year.[15] State leaders should also put in place other state policies to incentivize or require all utilities[16] and their customers to contract for more new renewable projects in New England, as well as increase the energy efficiency of their customers. In addition, more energy storage and real-time pricing will be needed to manage intermittency.[17]

To meet the goals for the remainder of our energy use, almost 50 percent of the following end-uses will also need to be electrified, converted to other forms of renewable energy, or saved through energy efficiency by 2030, and almost 60 percent by 2035:

- natural gas and fuel oil now used for heating buildings and related uses
- gasoline and diesel oil now used for transportation.[18]

To reach these levels, about 3.5 percent of these fossil fuel uses will have to be converted every year to electricity.[19] This will require a very rapid ramp-up of electric vehicles, heat

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[14] These estimates of new capacity are based on the estimates in the 2015 paper "100% clean and renewable wind, water, and sunlight (WWS) all-sector energy roadmaps for the 50 United States" by Jacobson et. al. (Energy Environ. Sci., 2015, 8, 2093), which are 46,214 and 38,218 MW of wind and solar, respectively, divided by the 18 years remaining through 2035. These estimates include the impact of electrification. Source: http://web.stanford.edu/group/efmh/jacobson/Articles/I/USStates.xlsx.

[15] This 5% average reaches the same 100% level by 2035 as the series of gradual step increases specified in S.1849.

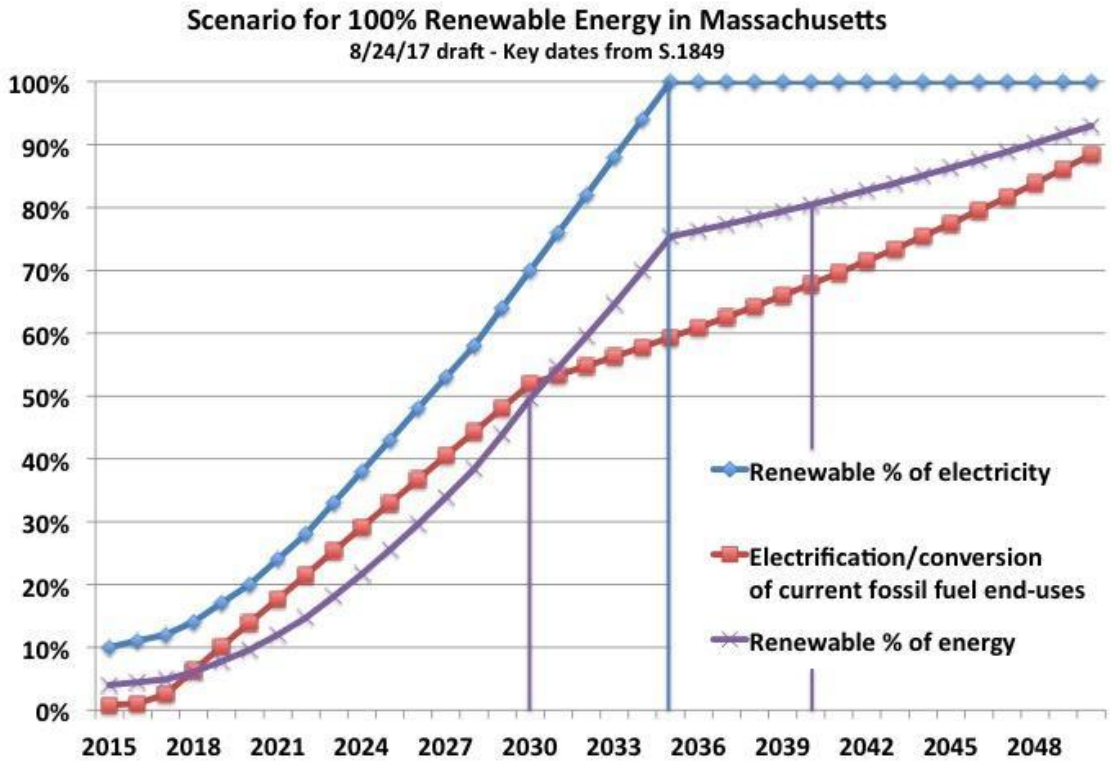
[16] Including utilities that are currently exempt from the RPS requirements.

[17] By the time we reach very high levels of renewable penetration (e.g., >75% after 2030), new storage and grid management technologies can be expected to have become feasible to support the remaining progress to 100% renewable electricity.

[18] Airline travel and some trucking and shipping, for which electrification may not be feasible, would convert to renewable biofuels.

pumps and other electric technologies for heating and cooling. New state, regional, and federal policies will be needed to achieve this electrification. These policies include carbon pricing, incentives and requirements to purchase these technologies, and tougher state limits on greenhouse gas emissions from other forms of transportation still using fossil fuels.

One scenario is shown in the following chart for the increases that will be required in renewable electricity (blue line with diamonds) and electrification (red line with squares).[20] The purple line with "x" marks shows the resulting percent of all state energy use supplied by renewable energy – reaching 50 percent in 2030, 75 percent in 2035, 80 percent in 2040 and 100 percent by 2050.



These rates of increase are not at all unrealistic if we start soon. From May 2016 to May 2017, the annual rates of increase in wind and solar capacity installed in New England were 65 percent and 39 percent, respectively.[21]

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[19] This linear 3.5% electrification rate is assumed through 2030 because the starting point is near zero. Beginning in 2031, a 4% escalation rate is used for electrification in this scenario.

[20] This scenario is a simplified model, not a comprehensive program or a prediction.

[21] See https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=epmt_1_17_a . In May 2017, wind and solar contributed 3.2% and 3.8% to regional generation (for a total of 7%), based on http://isonewswire.com/updates/2017/6/20/wholesale-electricity-prices-and-demand-in-new-england-may-2.html.

At the same time, this pathway to 100 percent renewable energy will require a major mobilization of policies, planning, and public and private investment. Transformation will be needed in public attitudes and behavior as well as in technologies and policies. Finally, mobilization will be needed at the municipal and community levels as well as by the Legislature.