A Renewable Energy Future for

New Hampshire

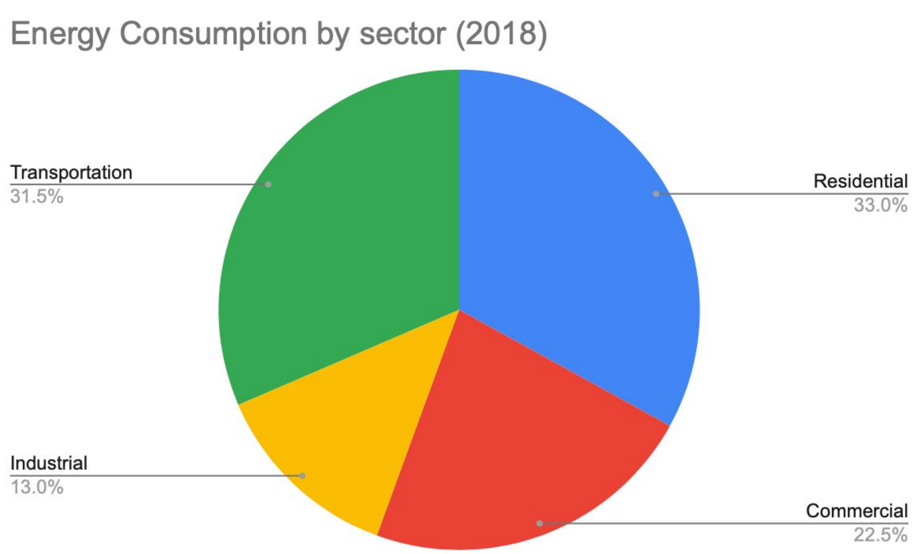
An Action Plan with a Focus on Demand and Consumption

(Oct. 13, 2020)

Foreword (Robert Backus, Peter Somssich, Ken Wells)

The best time to plan for the future is now. Despite our current issues surrounding our health in the pandemic and our severely depressed economy, we nevertheless must not fail to plan for our children and grandchildren's future, and that of our state of New Hampshire.

In 2018 many of this paper's authors were involved in producing the white paper: "A 100% Renewable Energy Strategy for New Hampshire's Future". Its purpose was to be a counterpoint to the "New Hampshire's 10-Year State Energy Strategy Plan" issued by the Governor's office in April 2018. We felt that the plan was grossly inadequate and just an endorsement of the status quo. Our white paper was intended as a tool to inventory all of the NH home grown renewable energy resources that our state already had available. Our state has many realistic opportunities to increase our readily available renewable energy supplies. These include offshore wind installations and the importation of onshore wind and hydropower. Our 2018 white paper also emphasized the desirability of increasing energy efficiency by all users. It focused primarily on in-state electricity generation and usage. But electricity generation accounts for only 45% of the energy that our state produces annually. In this 2020 Action Plan we will focus instead on the much larger amount of energy that is *consumed* in New Hampshire, which is about evenly split between transportation, residential power and home heating, and commercial plus industrial consumption.



In this 2020 Action Plan, we will outline a framework for a comprehensive energy plan. We will discuss why certain components are important to such a framework, and what actions have already been undertaken, or should be undertaken to promote a path to a 100% clean, renewable energy future for our state.

A framework for action on our state's total energy demand must begin with a vigorous attempt to reduce our energy use for electricity, heating and transportation. Since such actions will have an impact on our state utilities, we must find ways of providing the kind of incentives to them that encourage them to partner with us in such an effort. Hand in hand with our effort to reduce our energy demand, we must support in-state development of renewable energy sources, whether by industrial users, municipalities or by residential/community efforts. All energy generators using renewable sources such as solar, wind, hydro and biomass, should be fairly compensated for the energy that they provide to the main grid. In parts of our state where the energy resources and demand are poorly matched, forming collaborative microgrids or "energy islands" could allow adjacent municipalities or regional entities to cooperate. By creating a local microgrid, they will be able to attract new, and support existing businesses, while creating new jobs and reducing the financial burden to taxpayers of the combined municipalities. Furthermore, pursuing the possibility of using energy storage facilities to complement intermittent energy generators, allowing energy to be stored for that time when it is most needed, must be part of any New Hampshire energy independence and reliability effort. Our vision of New Hampshire's transportation system must also change to anticipate more electric cars and trucks (an example of beneficial electrification), as well as vehicles powered by compressed gases such as propane and hydrogen.

During the past two years the NH legislature has attempted to promote numerous initiatives to move us forward on our path to a renewable future. Unfortunately, most of these efforts were blocked as the result of partisan politics and a resistance to change. Any action plan needs to recognize the political and practical realities in New Hampshire, so that we know how to begin. Most of us can agree that a clean, renewable and sustainable energy future is our common goal that we all share. However, different people define the terms "clean", "renewable" and "sustainable" somewhat differently, so the co-editors suggest that we begin work to standardize our language about these concepts. For example, a "renewable" energy source should be one that, with proper management, will not be depleted over time and will continue to be available. Such a definition precludes fossil fuels, such as coal, oil and natural gas, and also nuclear energy as it is currently deployed. A "sustainable" energy source is one that will continue to be available, at a price including externalities such as health and environmental impacts, that society deems affordable. That is why an energy source with volatile prices, that faces depletion, or builds up a toxic waste product is not sustainable. Finally, most people would agree that a "clean energy" source is one that neither generates climate-endangering greenhouse gas emissions (e.g. CO_2 or methane) nor creates any other hazardous waste or consequences.

Because not all of the authors agree on the preceding definitions, and because we wish to be practical with our recommendations for actions, some of the proposals related to energy may not seem to be in total harmony with an action plan which hopes to have as its goal, not just a clean energy future, but a 100% sustainable and renewable energy future for our state. However, we all agree about the great potential inherent in Energy Efficiency and Energy Storage to improve all aspects related to energy. We want to emphasize that a renewable energy future continues to be our goal, but our long journey must begin from our current reality.

We have recruited a group of authors with specific knowledge and expertise in energy topics to explain the importance of these areas for our state and to suggest actions that effectively address those areas. This action plan does not represent a consensus view of all the topics discussed, but gives voice to several points of view that are part of clean energy's political reality. That is why the author of each contributed section is clearly identified; they are representing their own view. When a specific author is not listed, that section was contributed by the coeditors, using the various sources cited. Despite these shortcomings, we believe this action plan provides a good resource for policy-makers and lawmakers to use in setting a course toward our energy future. The authors recognize that climate change is already occurring and prompt adaptation to this fact is imperative. But they also see adaptation as a positive economic opportunity, because New Hampshire's aspiration to a 100% renewable energy goal will bring new opportunities and benefits to all the people of New Hampshire, while mitigating and perhaps helping to reverse the global effects of climate change.

> The cheapest watt of energy is a "negawatt" - a watt of energy *saved*. Because that saved watt was not lost, was not purchased, and was not produced, energy efficiency produces "negawatts" that are the lowest-hanging fruit available to us.
>
> \- Reps Balch & Mann

Definitions

BTM - “behind the meter”, a generator or storage device on the customer’s side of the electric meter, whose output reduces the customer's demand before energy is measured by the utility.

Clean Energy – an energy source that neither releases GHG emissions nor generates waste that is considered hazardous or a pollutant.

CH4 - methane, often referred to as “natural gas”, “city gas” or “fracked gas”. It is a powerful GHG, many times more potent than CO2. However methane leaked to the atmosphere is readily converted to CO2 by combustion or other natural degradative processes.

CO2 - carbon dioxide, a colorless, odorless gas released when wood or fossil fuel is burned. It plays a crucial role in trapping heat in the atmosphere, causing global changes in weather patterns and ocean acidification. It does not degrade over time, but persists unless it is removed from the atmosphere by plants during photosynthesis or artificial means.

(DG) Distributed Generation - rather than centralized power plants with miles of transmission lines to customers, distributed generation relies on many small producers (residential rooftop, small hydro, community solar, etc.) to inject energy at locations spread over the entire grid network, with significantly lower energy transmission losses.

(EE) Energy Efficiency - in general, efficiency is the ratio of energy output (useful work) to total energy (or fuel) input. This ratio is always smaller than 100%, since some heat or energy escapes in every process. One simple way to decrease the amount of heat lost is by improving insulation, as you would on your home or water heater. Another way is to substitute a new process that produces less waste heat (replacing standard incandescent lights with LED lights, or replacing an inefficient appliance).

(GHG) Greenhouse Gas - a number of gasses are able to capture the heat rising from the surface of the earth after being warmed by the sun’s rays. While not the most powerful GHG, CO2 is the most significant because it is persistent and plentiful. While there are natural processes that generate gasses that “control the Earth’s thermostat”, including H2O and CH4 along with CO2, they are not the primary drivers of our current 2% atmospheric CO2 increase per year. Due to human fossil fuel use, CO2 levels have been rising at an ever-increasing rate, dominating increasing global temperature effects.

H2 - hydrogen gas. Commonly and safely transported today in compressed tanks on highway trucks, hydrogen has as-yet unrealized potential for long-term energy storage and for clean transportation in fuel-cell vehicles.

ISO-NE - the Independent System Operator for New England. It operates 24/7 to purchase and distribute electricity all over New England, matching demand in real-time. It also operates the long-distance transmission grid that sends electricity across tall metal towers at extreme high voltage. Its third role is to devise and maintain a 10-year plan of operation. Its operating costs are divided among the New England states, in proportion to the share of electricity they import (their demand) from the ISO grid. Therefore, as other NE states increase their efficiency and in-state distributed generation, they are buying a decreasing share of ISO-NE power. NH's percentage share of ISO's expenses has been increasing because NH energy policies are not keeping up with our neighboring states. This is a significant expense that is reflected on every consumer's electric bill and labelled "transmission charge" or "regional access charge".

(NG) Natural Gas – natural gas, otherwise known as methane or CH4, methane, originates from fossil fuel extraction (e.g. fracking).

(PUC) Public Utilities Commission – state agency whose mission it is to ensure that customers of regulated utilities receive safe, adequate and reliable service at just and reasonable rates.

(RGGI) Regional Greenhouse Gas Initiative - every state from Maryland to Maine is a member of the RGGI agreement (except PA). A small charge added to every electric bill is contributed to a fund dedicated to reducing the emissions of GHG, primarily by supporting energy efficiency programs aimed to cut fuel consumption.(also see SBC)

(RE) Renewable Energy – inexhaustible, because it can be regenerated in a relatively short time span indefinitely, since it relies on the ultimate energy source, the sun. Sources of renewable energy include photovoltaic solar, biomass (forest and agricultural crops), wind and hydropower. Fossil fuels and fissionable materials, although currently available in large quantities today, will ultimately be depleted and therefore are not renewable.

(REF) Renewable Energy Fund – an account receiving revenues through RGGI in the form of ACPs (Alternative Compliance Payments) paid by utilities that fall short of clean energy objectives. The REF is managed by the PUC with the purpose of providing credits to NH renewable energy projects.

(RNG) Renewable Natural Gas – natural gas that is recovered from the gas mixture emitted by landfills, wastewater treatment facilities and agricultural waste products, in contrast to methane originating from fossil fuel extraction (e.g. fracking).

(RPS) Renewable Portfolio Standard – a policy designed to influence the development of renewable resources and technology by requiring electricity providers to obtain a minimum percentage of power they supply to their customers from renewable energy resources by a certain date. In NH the RPS has four classes which include solar, hydro, thermal and biomass energy.

Sustainable - a process or substance is sustainable if a supply is available for our current needs without compromising the ability of future generations to do the same. Sustainability deals not only with production of commodities (energy, lumber, fish or drinking water) at affordable prices, but also addresses the issue of the disposal of waste (carbon dioxide, landfills, nuclear waste, incinerators, sewage)

(SBC) Systems Benefit Charge - a part of the electric bill that is designated to be used to fund state-wide energy efficiency initiatives, grants to insulate low- and middle-income housing and assists low income customers in meeting their energy expenses. This is part of RGGI, and funds the NHSaves program. Typically, it runs out of money every year and the waiting list grows because a large portion of the collected money is currently being diverted by current policy to non-energy efficiency purposes.

(TOU) Time Of Use - a metering and billing tool that adjusts the sales price of electricity based on the time of highest or lowest demand. That is, electricity could be cheaper when demand is low (after midnight) or more expensive when demand is high. Particularly as electric vehicles become widespread, TOU metering could help manage the increased load by encouraging customers to recharge EVs outside of peak hours.

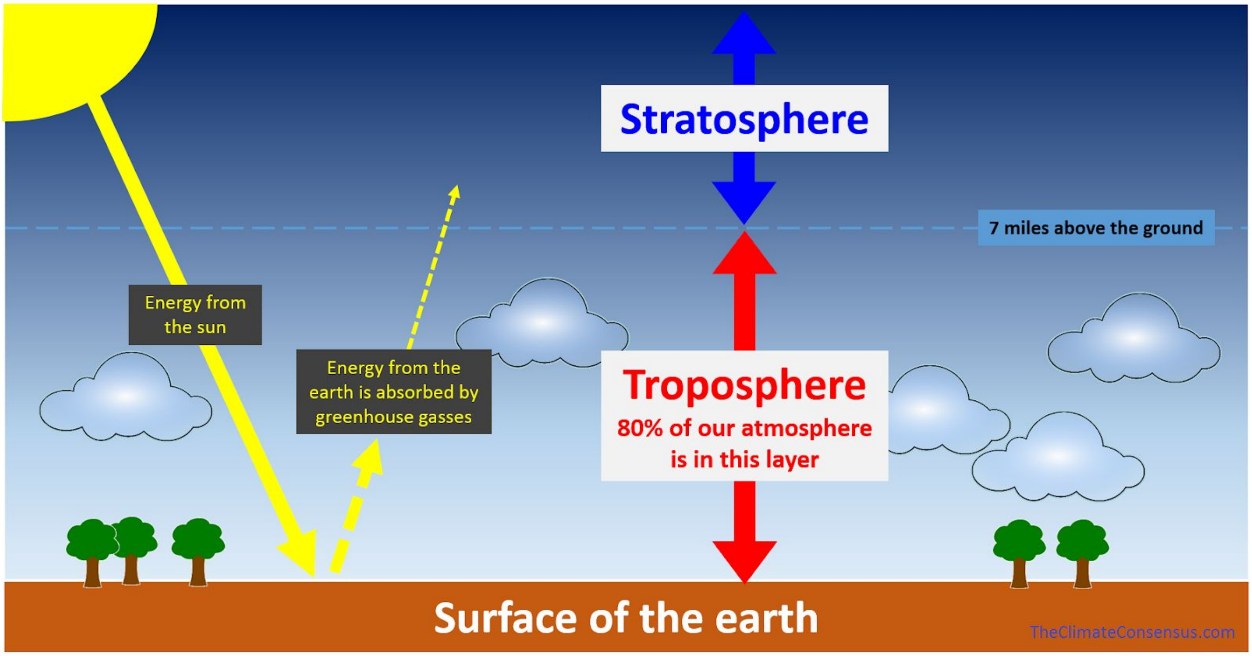
Executive Summary

> Our policies should seek, not the path of least resistance, but a direct path toward the goal of net-zero emissions of greenhouse gasses by 2050.
>
> \- Peter Somssich and Ken Wells

Today there is no longer any debate among scientists about the reality of climate change, nor any doubt that the carbon dioxide emissions from humankind's fossil fuel combustion is causing it. In fact, one of the first reports of the clear and present danger posed by fossil fuel combustion was authored by Exxon in 1979. Where debate exists, it is among policymakers and those whose interests are in conflict with enacting solutions that will reduce greenhouse gas emissions.

New Hampshire is not "too small to do anything". According to *Losing Earth* author Nathaniel Rich, New Hampshire's own John E. Sununu played a pivotal role in forestalling action that would have curbed worldwide carbon dioxide emissions back in 1989. Now is the time for New Hampshire to take action to right that wrong!

Why does CO2 matter?



As carbon dioxide in the atmosphere increases, heat is trapped near the surface, and the upper atmosphere cools. The growing temperature difference energizes more powerful storms. http://www.theclimateconsensus.com/content/satellite-data-show-a-cooling-trend-in-the-upper-atmosphere-so-much-for-global-warming-right

Notice how the following charts show that in the past 15 years, New Hampshire has already begun to pivot from its reliance on atmosphere-polluting fuels to cleaner energy sources. To meet our objective of 100% clean energy by 2050, projections at 15 year intervals are presented below.

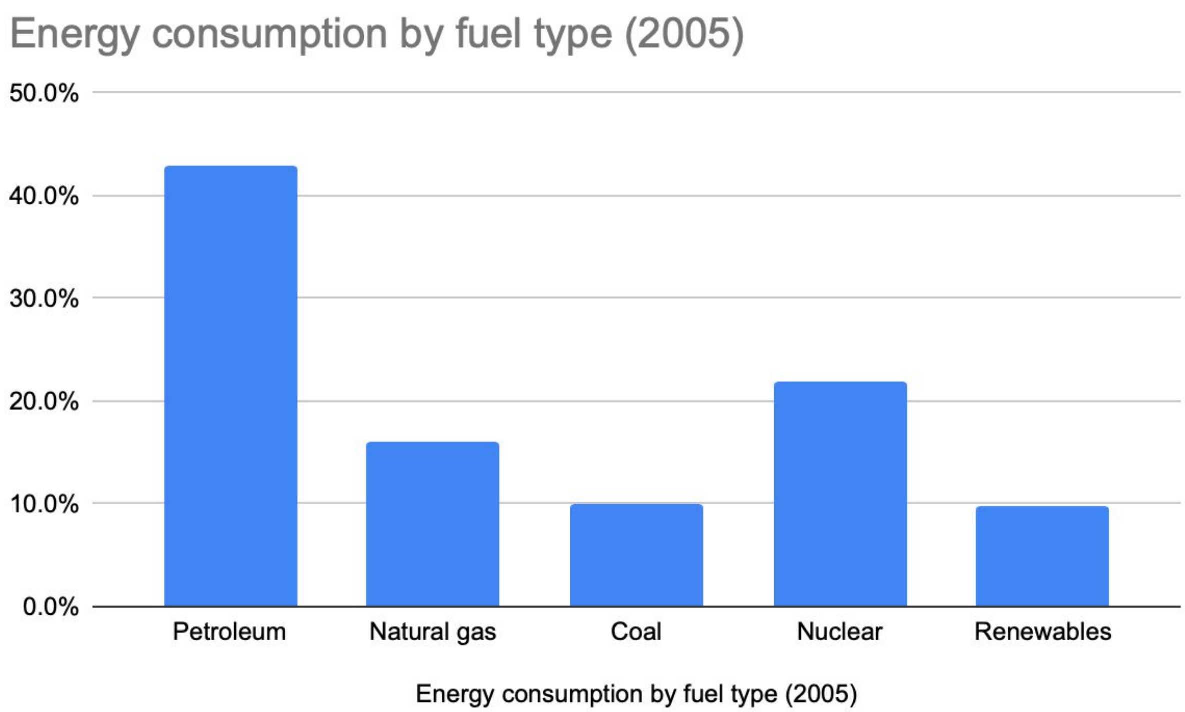
Because offshore wind has the greatest potential energy output, but a likely decade-long lead time, existing energy resources with the lowest pollution must continue to operate. In the near term, the largest GHG reductions can be realized by reducing emissions of the inefficient Transportation sector, while simultaneously encouraging rapid expansion of distributed, net-metered renewable energy resources and energy storage on the consumer, local utility and regional level.

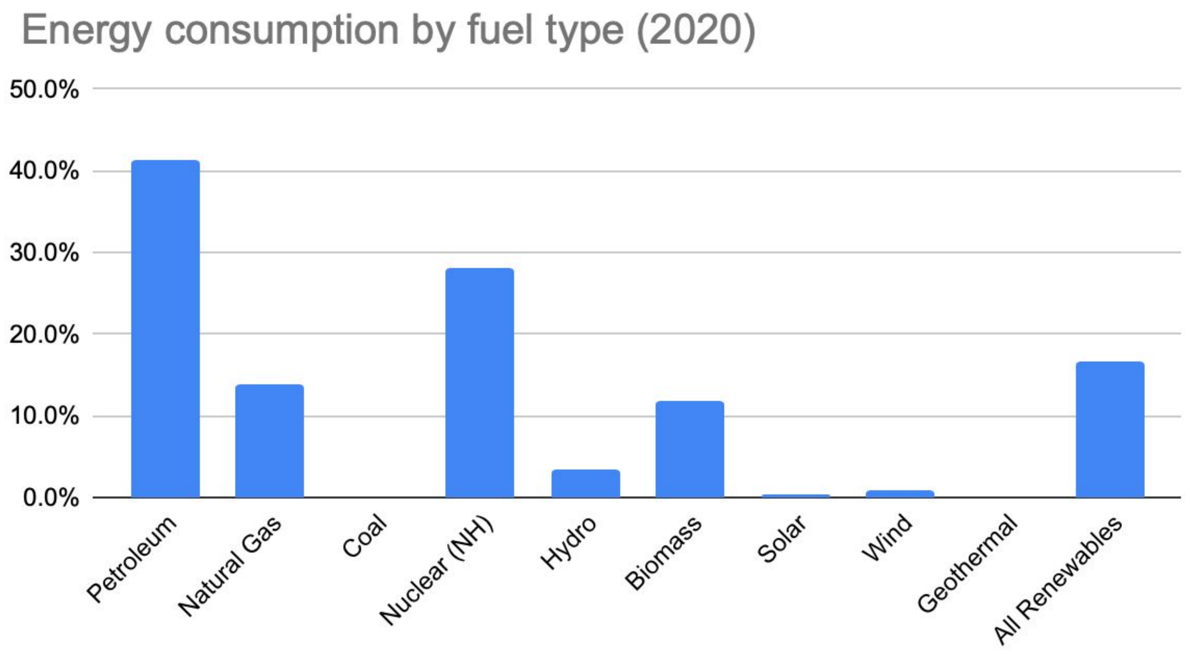
The 2035 projection calls for two things: First, we need a Class 2 RPS goal of 20% of the NH electricity supply to come from solar. This will cover nearly 10% of total state-wide energy consumption, including Transportation. Second, the state's overall energy efficiency should increase from 40% today to 50% by 2035. (based on LLNL & USDOE data).

Both of these are attainable goals: our neighboring states are already on the brink of exceeding 20% solar RPS in the next 5 years, and the projected increases in our efficiency are merely an extension of the steady rate of efficiency improvement New

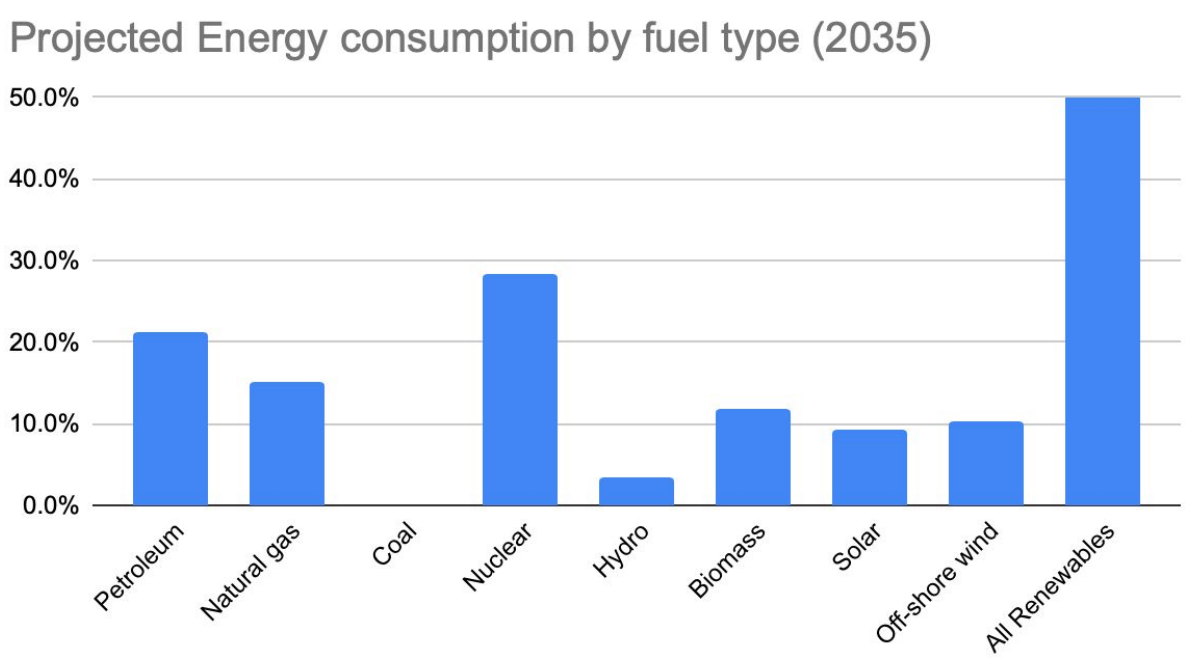
Hampshire has been experiencing during the past decade. It is worthwhile noting that nearly every solar installation in NH has been paid for through individual's or community investments, not by NH taxpayers. This trend of private investment will continue if we just increase the RPS.

As to being able to provide a detailed description of New Hampshire's success fifteen to thirty years from now in harnessing large-scale offshore wind, as well as to being able to foreshadow the coming developments in the fields of energy storage and load management, we will simply quote the inimitable Yogi Berra, "It's difficult to make predictions, especially about the future". Nevertheless, we have included a picture of where NH might source its clean energy in 2050, assuming a steady rate of change - which must begin NOW!

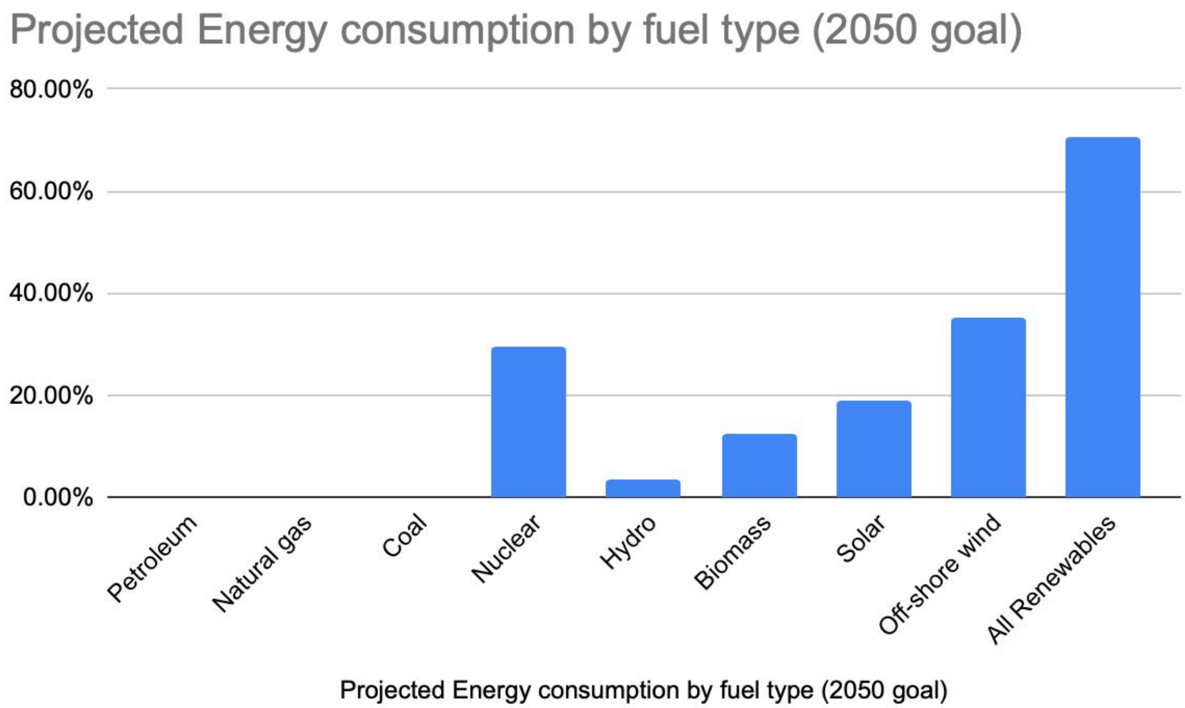




Energy consumption by fuel type (2020)



Projected Energy consumption by fuel type (2035 goal)



The figures above show how rapidly primary energy sources for NH have changed in the 15 years period from 2005 to 2020, and projects how primary energy sources must continue to shift over the next two 15-year intervals to meet GHG goals.

What might the projected timeline look like?

1) Stop coal use today (except for small users such as blacksmith forges). Dispose of coal stockpiles and repurpose the coal-fired installations around their valuable substations, for clean generation and grid-scale storage.

2) Continue to use the nuclear plant for baseload needs, and existing natural gas generators as relatively clean "peaker plants", up until sufficient clean energy generators come online.

3) Restore RGGI funding and use those funds for their intended purpose - fully fund energy efficiency(EE) programs now.

4) Use favorable Net-Metering and Energy Storage policy, to build NH's Distributed Energy infrastructure, preferably using market forces. Raise the Class 2 RPS for solar to at least 20% of NH's electrical generation energy budget by 2035, and create a new RPS Class for energy storage to achieve renewable energy objectives with existing policy mechanisms.

5) Develop offshore wind, with the goal of installing at least three NH-built 12 MW turbines by 2035, and ramping up to deployment of a robust energy-exporting industry in NH by 2050. To accomplish that, wind generation must exceed 231 TBTU (or 2.1 Seabrooks) annually by 2050.

6) Continue to support NH's forestry industry by supporting research into innovative use and stable markets for wood waste.

A summary of highlights from the contributing authors:

1) Pursue energy efficiency by restoring the RGGI funds for coordinated EE efforts to reduce demand

2) Build Distributed Energy through Net-Metering enticements to encourage widespread small energy producers

3) Encourage innovation and installation of Energy Storage systems behind-the-meter(BTM), at the local distribution utility scale, and at the regional scale. These will likely use different appropriate technologies at these different scales.

4) Enact policies that encourage utilities, communities and municipalities to develop microgrids, with strategies to provide cybersecurity and emergency reliability, as well as cost savings.

5) Along with updating new building codes for high efficiency, develop multiple attractive ways to "decarbonize" space heating for homes and commercial venues, while maintaining energy diversity.

6) Prepare for electrification of the Transportation sphere, by planning for TOU home charging, providing charging stations, and modernizing the grid to better manage demand. Seek innovative solutions beyond the liquid-fuel paradigm, such as wireless recharging on-the-move.

7) Plan for the retirement of obsolescent power plants and call for federal research into improved reactor designs, such as Molten Salt Reactors.

8) Recognize that biomass energy incorporates a steady supply of wood waste from NH's robust forest management practices. Seek technological improvements to reduce biomass generators' emissions while appropriately realizing economic value (and jobs) from the wood waste.

9) Enact policies that recognize the economic, environmental and operational benefits of private & public investment in solar generators, especially in combination with on-site energy storage.

10) Aggressively pursue offshore wind, especially as turbine manufacturing, deployment and maintenance will provide an extraordinary opportunity for permanent jobs and economic development in NH's Seacoast region, in addition to providing many multiples of the emissions-free energy output of Seabrook Nuclear Power Station. The possibility of bringing energy ashore in the form of hydrogen and other compressed gasses shouldn't be overlooked.

11) Freeze the expansion of all fossil fuel use in New Hampshire, and abolish coal-fired generation entirely.

12) Assign to a new Department of Energy, or to existing agencies (such as NHDES and PUC) the overlapping roles of pursuing environmental goals while also managing consumer energy costs. At the moment, these goals are pursued in isolation rather than in a coordinated fashion, hampering progress for both.

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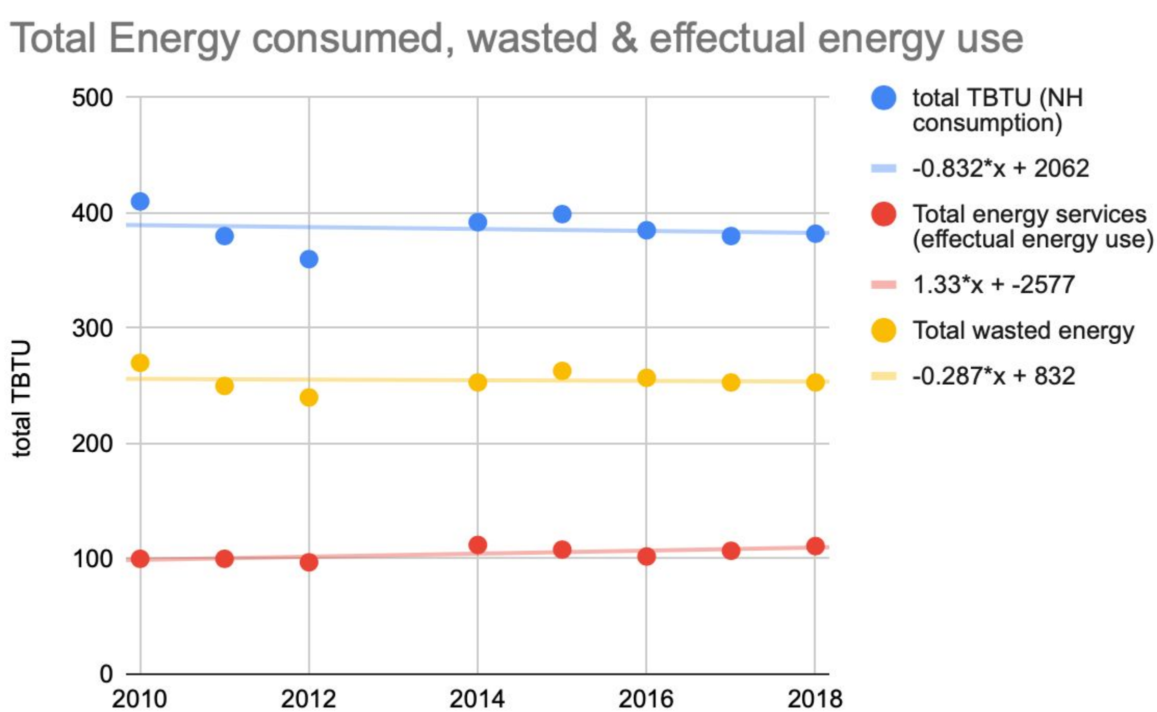
Energy Efficiency in New Hampshire (Chris Balch & John Mann)

Energy efficiency offers the single most important tool in our effort to control energy costs and reduce the climate impacts of current energy production and use. It is the lowest cost option and provides one of the most effective policy measures available in our effort to mitigate climate change.

Energy efficiency is measured in “negawatts,” the only unit of energy that is not produced, transported, or delivered. Every energy equation consists of balancing production and consumption - reducing consumption (by increasing efficiency or reducing waste) enables us to cut our total energy production, with significant benefits to households, communities, the state, our environment and the future liveability of our planet.



In the past eight years, efficiency improvements have driven down consumption while making more energy available for useful purposes. This trend should be strongly encouraged by policy during the next 30 years. (LLNL & DOE data)

Household energy costs make up a significant portion of a homeowner's recurring monthly expenses. New Hampshire homeowners spend approximately $477 per month on their utility bills, chiefly on electricity and heating fuel. As there are approximately

450,000 households in New Hampshire, this results in fully $2.6 billion in total annual residential utility spending. (1)

By switching to energy efficient appliances and making relatively simple home efficiency upgrades, the U.S. Department of Energy estimates that homeowners can save from 15 to 40 percent on their utility bills. For New Hampshire residents that would mean an additional $390 million to $1.04 billion in savings. Other energy efficiency benefits to homeowners include increased property values, enhanced quality of life, and protection from the impacts of rising or fluctuating energy costs. (2)

Communities can also reap very significant cost savings from modest energy efficiency investments. One example of this comes from the town of Wilton, New Hampshire. In 2018 Wilton's Energy Committee researched the benefits of upgrading its streetlights to energy efficient LED fixtures. They found that replacing all 144 town street lights with LEDs (at a net cost of just over $43,000), would generate an annual savings of over $10,000 in town energy costs. This meant a full return on investment in just over 4 years, with the savings accruing annually over the lighting project's expected life span of 25 years. The total savings to Wilton taxpayers over the project's lifetime is anticipated at $207,000 – at 2019's electric rates. Factoring in a standard 4% per annum electric rate increase, the town's net savings will be considerably greater. (3)

Additionally, communities are able to upgrade buildings, heating systems, replace standard lighting in buildings with LEDS, and undertake numerous other measures to reduce energy usage and generate highly cost-effective savings.

At the state level the scale of the savings to be gained is far greater. The chart below illustrates the savings available if every one of the roughly 450,000 households in New Hampshire implemented energy efficiency projects. The numbers presented are based on a typical $477 per month household utility bill.

Savings Percentage	$ Savings/Month	$ Savings/Year (X12)	$ Saved Statewide
10%	$47.70	$572.40	$257,580,000.00
20%	$95.40	$1144.80	$515,160,000.00
30%	$143.10	$1717.20	$772,740,000.00
40%	$190.80	$2289.60	$1,030,320,000.00

Of additional benefit, a significant, but undetermined, percentage of the money saved statewide will remain in the New Hampshire economy rather than leaving the state as payment for heating fuels produced out of state or abroad.

A final statewide advantage of becoming more energy efficient is the resulting overall reduction in electricity demand. New Hampshire's share of the cost of maintaining and upgrading the New England Power Pool's grid infrastructure is approximately 9% of the regional total. Reducing our use of this infrastructure will both reduce greenhouse gas emissions and lower costs for ratepayers. (4)

The environmental impact of upgrading residential energy efficiency practices is significant. Electricity usage accounts for 69% of residential emissions while home heating (overwhelmingly from the combustion of fossil fuels) makes up the remaining 31%. Reducing usage and waste through increased efficiency translates immediately and effectively into reduced greenhouse gas emissions.

Since electricity used for lighting comprises approximately 20% of the average electricity bill, replacing incandescent bulbs with LEDs can reduce the amount of electricity used by 75%. Replacing even one incandescent bulb with an LED bulb in every American home would save enough electricity in a year to power 3 million homes. The reduction in emissions is equivalent to taking 800,000 cars off the road. (5)

Implementing energy efficient change is not difficult. There are two primary mechanisms available to promote energy efficiency improvements - one of which is already partially in place, and one that was proposed in legislation during the 2019-2020 New Hampshire legislative session.

The first is the Regional Greenhouse Gas Initiative (RGGI). RGGI was designed to reduce greenhouse gas production in two ways – via a cap and trade mechanism that raised the price of using fossil fuels in electricity generation (thereby discouraging fossil fuel use), and secondly by generating and disbursing monies to fund energy efficiency projects. In New Hampshire, the second element was unfortunately largely short-circuited. While RGGI generates approximately $17 million annually, only $2.5 million is provided to individual and household energy efficiency projects, and $2 million to municipal projects. The majority of the funds are simply rebated to consumers, with the commercial-industrial sector receiving $7.5 million and residential ratepayers $5 million.

Rebating the majority of the funds largely defeats the second half of the program's purpose. Market pressures may indeed push the commercial-Industrial sector to invest some of their rebated funds into energy efficiency projects, enabling them to reap cost savings. But for residential ratepayers, who receive less than a dollar back on their monthly bill, the funds are unlikely to generate any investments in energy efficiency. If New Hampshire had utilized all of its RGGI proceeds as intended over the 8 years from 2012 to 2020, it would have been able to invest an additional $40 million in energy efficiency.

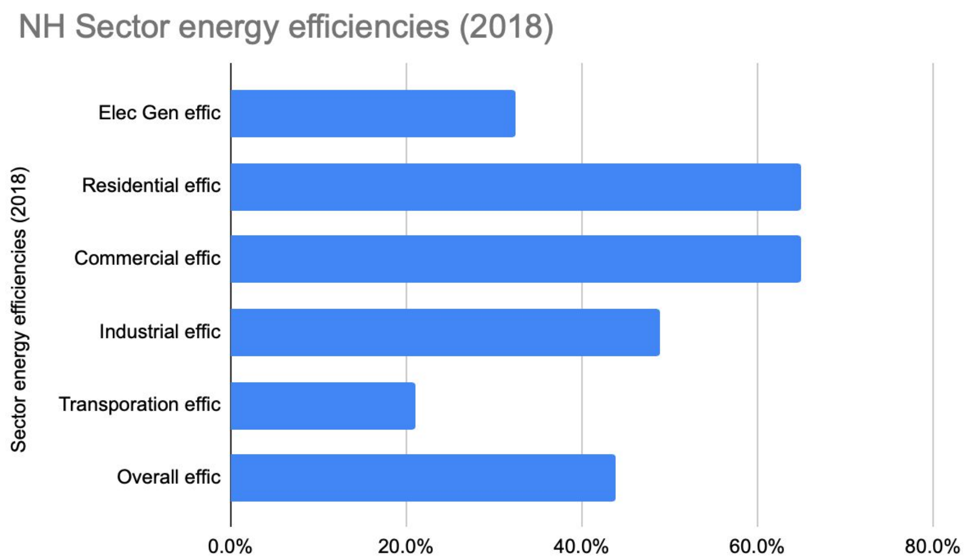
An energy efficiency retrofit averages $5,000 per house, and a conservative number for the consequent heating savings alone is 15%. Over 40% of New Hampshire homes heat with fuel oil, importing 135,000,000 gallons annually. With the $40 million that could have been provided by RGGI, and with homeowners paying 50% of the energy efficiency upgrades to their homes, an additional 16,000 homes could have been upgraded - with a resulting minimum savings of nearly 5 million additional gallons of fuel oil. Since fuel oil averages $2 per gallon, this investment could have prevented the export of $10 million to out of state or foreign oil companies annually. Money that could have been invested or spent locally, improving the New Hampshire economy and the health of its residents while flattening the curve on greenhouse gas emissions.

Although two RGGI related bills (HB1317 and HB1496) came before the New Hampshire House of Representatives in the last session neither was successful due to the Governor's continued policy of vetoing our energy bills.

Another possible mechanism to move energy efficiency efforts forward is a Carbon Fee and Dividend (CFD) or "carbon cashback" program. Although HB 735 proposed this type of program, it was tabled pending further consideration. (6) Such a program would place a steadily rising fee on fossil fuels to account for the full costs of their usage, account for the health and air quality impacts produced by burning these fuels, and create a more level-playing field for all sources of energy.

CFD would refund 100% of the fees generated, minus administrative costs, to every New Hampshire household as an equal share, or dividend. This equal share would cover the increased costs of the fees for fully 3/5 of New Hampshire families, while those in the lowest one-fifth would receive more in dividends than they paid in higher energy fees. Only those with substantial fossil fuel usage (those in the top 2/5 of income earners) would incur some share of the fee increase beyond their dividend. The program's dividends would inject funds into the New Hampshire economy, protect family budgets, stimulate investment in energy efficiency to lower energy use, and build aggregate demand for low-carbon products at the consumer level.

In conclusion, it is clear that there are tremendous benefits from incorporating and expanding the role of energy efficiency in New Hampshire on every level, from the household to the state. Increasing opportunities for energy efficiency must be at the heart of our comprehensive energy and climate action plan.



Transportation efficiency in NH is very low, at 21%, while Residential and Commercial efficiencies lead at 65% efficient. The state's overall energy efficiency is about 44%.

ENERGY EFFICIENCY SOURCES

(1) US News and World Report: How to Estimate Utility Costs - https://money.usnews.com/money/personal-finance/spending/articles/how-to-estimate-utility-costs

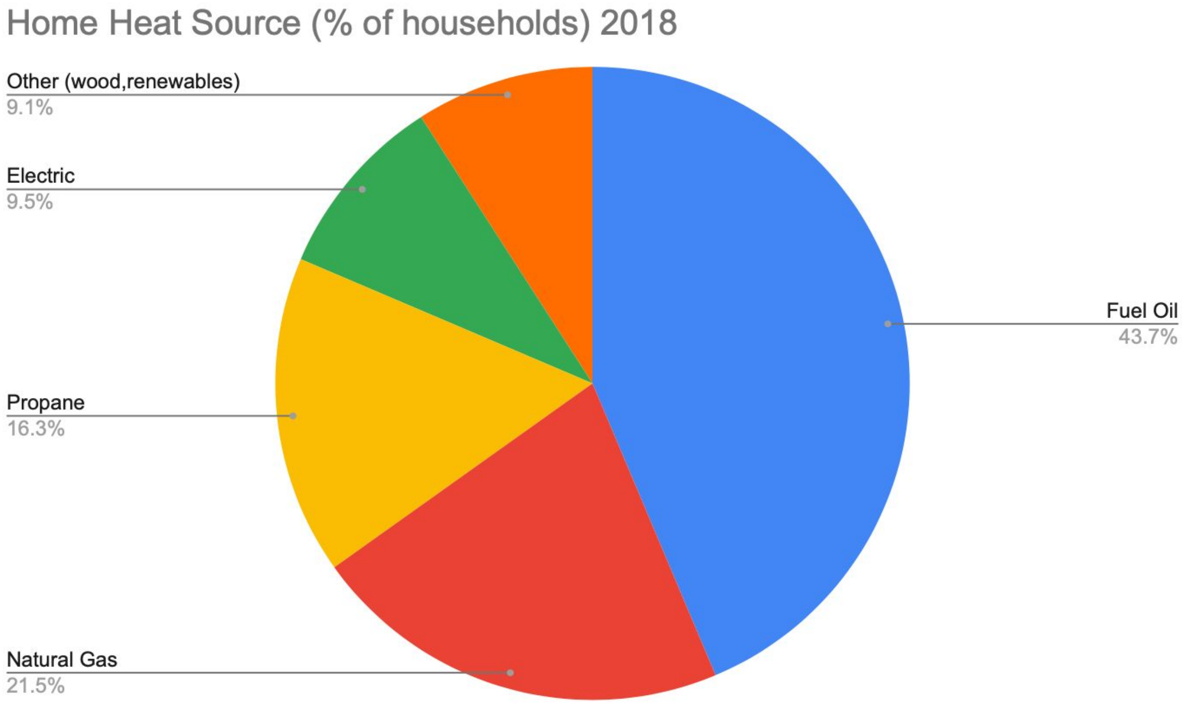
(2) Why conserve energy: the top benefits of energy efficiency- https://www.energysage.com/energy-efficiency/why-conserve-energy/, What's the Average Utility Cost Where You Live? - https://howmuch.net/articles/cost-of-utilities-in-every-state

(3) Wilton, NEW HAMPSHIRE Energy Committee minutes: https://www.wiltonNew Hampshire.gov/government/minutes_and_agendas

(4) US Energy Information Administration: https://www.eia.gov/state/?sid=NEW HAMPSHIRE

(5) The environmental benefits of energy efficiency: https://www.energysage.com/energy-efficiency/why-conserve-energy/environmental-impact-of-ee/

(6) The Basics of Carbon Fee and Dividend - https://citizensclimatelobby.org/basics-carbon-fee-dividend/



Today, at least 80% of New Hampshire homes' heating contribute to greenhouse gas emissions.

Thermal Energy (Peter Somssich)

The prospect of replacing heating oil and natural gas for heating NH homes and businesses has to be looked at long term. There are no obvious short-term opportunities to replace all heating fuels with 100% renewable energy statewide(a). Geothermal and air source heat pumps for homes and businesses are already replacing the BTU's of heat energy otherwise generated by fossil fuels.

Geothermal and air-source heat pumps are ultimately very expandable and, if incentivized by the state, would be able to offset some of NH's heating energy needs. Biofuels are already available to homeowners today. A 20% biofuel mix (containing a vegetable oil component and 80% petroleum heating oil) is not being utilized to the fullest extent possible, even though it burns cleaner, emits much lower levels of pollutants, and could stimulate in-state vegetable oil production. Many other states have already included such biofuels along with cellulosic ethanol (which does not drive up food prices) as part of their agricultural policies.

The use of electricity for baseboard resistance heating was tried in the past but proved to be too expensive for most NH residents. However, new technologies may be changing our attitude about heating homes with electricity. These include heat pumps, geothermal systems and fuel-cells in combination with traditional renewable energy, which make electricity use more viable from both a cost point of view and because of the favorable environmental impact. These technologies, however, are still financially out of reach for many Granite Staters. Our regulated utilities are already involved in energy efficiency programs which include some of these options. They are also evaluating ways to reduce their environmental impact.

In addition, our state's existing pipeline network could one day be used to provide other gaseous fuels, such as H2, to provide for heating needs. When hydrogen is generated from non-fossil fuel sources, such as splitting H2O molecules using solar or wind energy, the resulting H2 fuel is a reliable and zero-emission energy source that could be used for home heating and transportation.

One particularly interesting new fuel for thermal heating is Renewable Natural Gas (RNG), which is currently being captured from landfills, agricultural waste and wastewater treatment facilities. RNG is natural gas produced at various in-state sites and is originally recovered as a methane gas mixture generated by decomposing organic waste. A new potential source of RNG is biomass. A recent report in Renewable Energy World (May 15, 2020) announced that a company in British Columbia, Canada, FortisBC is teaming up with REN Energy to produce usable RNG from waste wood(b).

Decarbonizing the thermal energy sector in New Hampshire is critical to reducing the state's overall greenhouse gas emissions. According to the latest official data(1), the total amount of energy consumed in New Hampshire in a single year adds up to about 324 trillion BTUs. Of that total, approximately one-third, or 106 trillion BTUs, is consumed by New Hampshire end-users in the form of thermal energy, either to heat homes and businesses or for industrial processes (the other two-thirds comes from transportation and electricity consumption). Burning fossil fuels accounts for the vast majority of thermal energy consumed in New Hampshire, and residential consumption of heating oil and other forms of petroleum (propane and kerosene), represents the largest share at more than 36 trillion BTUs annually. So approximately 1/3 of all energy consumed in New Hampshire is in the thermal sector, and approximately 1/3 of that is residential consumption of the most carbon-intensive fuels. Any comprehensive strategy for reducing greenhouse gas emissions in New Hampshire must include a plan to shift homes and businesses toward cleaner sources of thermal energy.

Options for reducing greenhouse gas emissions in New Hampshire's thermal energy sector include:

- Converting homes and businesses currently using emissions-intensive fuels to less emission-intensive fuels like natural gas, where available.
- Targeted strategic electrification of residential and commercial heating load, where appropriate.

- Replacing conventional fuels with low-, zero-, and negative-emissions fuels, e.g. Renewable Natural Gas (RNG) and green hydrogen.

According to D. Maurice Kreis, New Hampshire's Consumer Advocate, "natural gas, sold responsibly as a rate regulated commodity, is compatible with bold climate action"(2). Where natural gas can be made available to end-use customers in the residential, commercial, or industrial sectors without adverse local impacts it makes sense for utility companies to continue providing natural gas to new customers because natural gas emits less greenhouse gases than other fuels like oil or propane. The Environmental Defense Fund (EDF) has developed and endorsed a methodology for calculating the lifecycle greenhouse gas emissions profile of conventionally-produced natural gas, integrating the "social cost of carbon" and ambitious adoption rates of electric air source heat pumps and other alternatives to natural gas, supporting the conclusion that the availability of natural gas for customers who want it reduces greenhouse gas emissions and other pollution(3).

Targeted strategic electrification of thermal energy end-uses represents a significant opportunity for decarbonization as well. Electric air source heat pumps (ASHPs) can help reduce reliance on fossil fuels, but because their mechanism of action involves extracting heat from the outside air, their efficiency decreases as air temperature drops, requiring users to have a secondary backup heating system. Nonetheless, according to the American Council for an Energy Efficient Economy (ACEEE), properly configured ASHPs have the potential to reduce fuel consumption between 52% and 89% even in cold climates, but "should target existing homes that use electricity, propane or heating oil as their space heating fuel, not utility natural gas"(4). Consumer Advocate Kreis agrees that "strategic electrification is best targeted at fuel oil users in the first instance, especially those with no access to natural gas supply. Doing that won't hold back the deployment of renewable energy"(5). Paul Hibbard, an expert on energy system decarbonization and the former chair of the Massachusetts Department of Public Utilities, believes ASHPs can play an important role in reducing fossil fuel consumption, but "in cold climates like New Hampshire they require back-up heating sources," and "heat pumps likely would not reduce the amount of upstream methane emissions caused by heating homes and businesses in New Hampshire" because much of our region's power generation is fueled by natural gas and likely will continue to be into the future(6).

Evidence supports the claim that the production and use of renewable natural gas (RNG) and green hydrogen will enable deeper and faster decarbonization – especially of hard-to-decarbonize sectors like heavy industry and building heat in cold climates – than policy-driven electrification or oil-to-gas fuel conversions alone(7). Emission-free hydrogen and low-, zero-, or negative-carbon RNG can be produced in New Hampshire from abundant local feedstock to provide sustainable fuel for heating homes and businesses, as well as fueling the transportation sector. Studies show that New Hampshire could meet 100% of projected natural gas load by using RNG produced in-state(8). Utilizing green hydrogen and RNG to displace conventional fossil fuels will reduce both upstream and downstream greenhouse gas emissions relative to baseline. At the same time, green hydrogen production will support deeper penetration of offshore wind capacity that would otherwise be curtailed, and RNG production serves as a carbon sink for emissions-intensive sectors and processes like agriculture, landfills, and wastewater treatment. The UK(9) and EU(10) are pursuing aggressive thermal-sector decarbonization through the deployment of green hydrogen to replace existing thermal energy fuel, and the US Department of Energy has developed a Hydrogen Program Plan(11).

Reducing New Hampshire's greenhouse gas emissions to the greatest extent and at the fastest rate will require a dedicated focus to reducing emissions from thermal energy end-uses, in addition to strategies to reduce the carbon intensity of our electric grid and transportation sector. Doing so will require, in turn, a multi-faceted approach to reduce emissions from building heat and industrial processes, including conversions to lower-emitting fuels, strategic electrification, and deployment of new green fuels. None of these pathways are sufficient to cut New Hampshire's thermal energy emissions enough to reach aggressive proposed emissions reduction targets, but developing each of these pathways aggressively in the short-run will build a foundation for the greatest possible long-term reduction of greenhouse gas emissions, and set New Hampshire on a path to net-zero emissions.

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[1] https://www.eia.gov/state/seds/seds-data-complete.php?sid=US

[2] http://indepthnh.org/2020/07/31/granite-bridge-2-0-progress-at-last-on-natural-gas/

[3]http://blogs.edf.org/energyexchange/2019/06/11/new-and-better-way-to-assess-the-climate-impact-of-new- pipelines/

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[5] http://indepthnh.org/2020/07/31/granite-bridge-2-0-progress-at-last-on-natural-gas/

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[8] https://www9.nationalgridus.com/non_html/NG_renewable_WP.pdf
[9] https://www.h21.green/

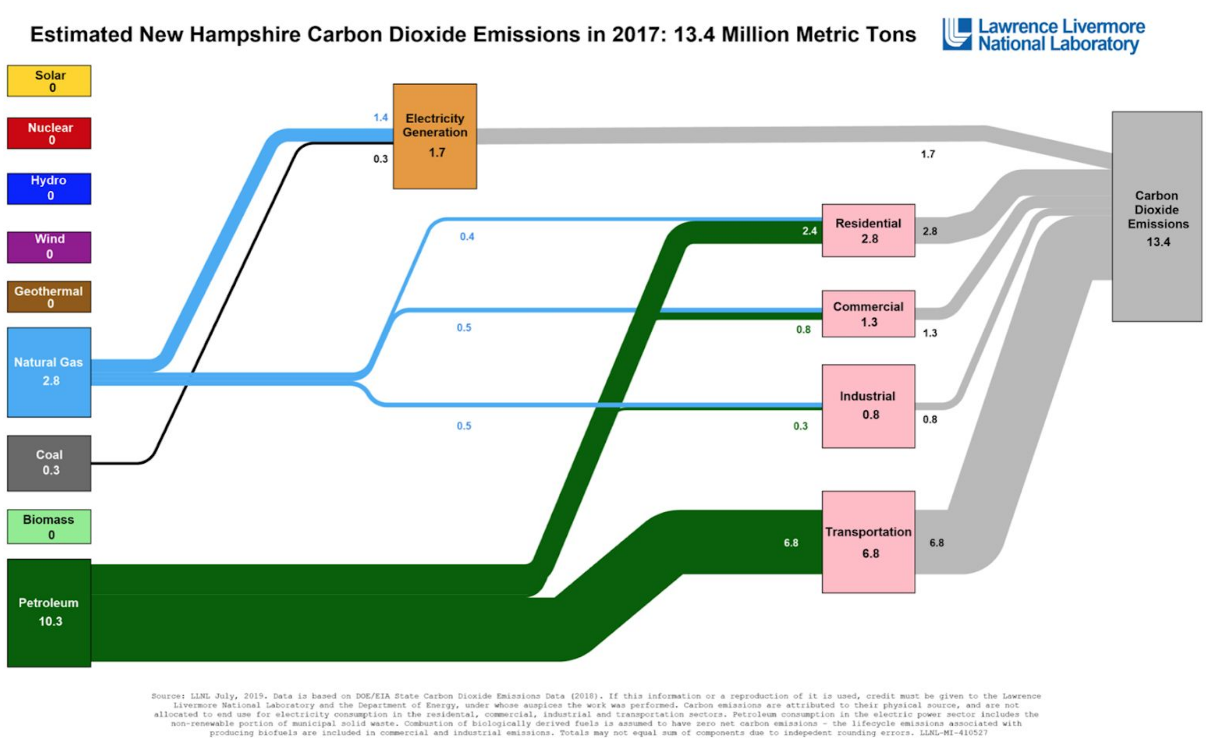
[10] https://ec.europa.eu/energy/sites/ener/files/hydrogen_strategy.pdf

[11] https://www.energy.gov/sites/prod/files/2020/07/f76/USDOE_FE_Hydrogen_Strategy_July2020.pdf

Other Sources:
[a] White Paper 2018: “A 100% Renewable Energy Strategy for New Hampshire’s Future”, Editor: Peter Somssich
[b]http://www.renewableenergyworld.com/2020/05/15/fortisbc-first-purchase-renewable-natural-gas-made-from-wood-waste/
Private communications with a number of stakeholders.

<u>Transportation (David Watters)</u>

Given the success of RGGI and other initiatives, the transportation sector is now the largest source of carbon emissions. Any effort to decarbonize transportation depends on decisions made in Washington by the EPA and through legislation such as the FAST Act, which reauthorizes Federal transportation spending, but there are also efforts that New Hampshire can and must undertake. The move to alternative fuels involves climate, public health, economic and technological factors.



<u>The Transportation sector is the largest contributor to New Hampshire's greenhouse gas emissions.</u>

Many of the efforts in the legislature were stalled by the pandemic, some moved forward, while others this session and in past sessions have been stymied by the opposition of Governor Sununu.

The Electronic Vehicle Charging Stations Infrastructure Commission is completing its two years of work and will issue a final report with recommendations in November. RFPs using Volkswagen Settlement funding for a DC fast-charge network on major transportation corridors and a level-two charging station in Concord have been issued. A proposal for electrifying school buses has not received responses to date. Other states have been much more successful in these programs, and have provided state support and subsidies, so there is need for legislation for New Hampshire to catch up. Under SB 275, the PUC will soon issue standards for a rate structure for charging stations, and NH public utilities have been very supportive of EV efforts. EV technology is closely connected to developments in autonomous vehicles, and the NH Autonomous Vehicle Advisory Commission has been meeting. The bill to adopt California vehicle emission standards was stalled by the pandemic, and work on it remains to be done with the NHADA. Unfortunately, Governor Sununu vetoed a bill to require state vehicle fleets to move to ZEV, but it will be reintroduced.

The Transportation and Climate Initiative (TCI) is a regional collaboration of 13 Northeast and Mid-Atlantic jurisdictions that seeks to develop the clean energy economy, improve transportation, and reduce carbon emissions in the transportation sector (https://www.georgetownclimate.org/transportation/transportation-and-climate-initiative.html). By statute, New Hampshire cannot join this effort without legislative approval. My bill to create a study to prepare New Hampshire's response to the Memorandum Of Understanding(MOU) passed the Senate, but it was not included in omnibus legislation, so this bill will likewise be reintroduced.

Efforts to decarbonize the transportation sector are linked to the development of offshore wind. With the passage of my SB 668 as part of the HB 1245 omnibus, there will be a legislative commission to promote this industry. It has the potential to provide inexpensive electricity to power vehicles as well as other sectors. It is possible that offshore wind will be used to produce hydrogen, as it is in Europe, which could be used as a transportation fuel, for energy storage, and for certain types of heavy industry. Public transportation is also a significant factor, so progress on rail development and increased funding for bus transportation through the CARES Act and the Ten-Year Highway Plan are important.

New Hampshire health, climate, jobs, and economic advantage depend on the transformation of transportation The New Hampshire legislature needs to move forward aggressively on many transportation issues, often in partnership with other states, New Hampshire Auto Dealers Association, the NH Motor Transport Association, the utilities, and other stakeholders. In the coming session, much will depend on the state budget (road toll collections are down substantially), reauthorization of the FAST Act and passage of all or part of the House "Moving Forward" infrastructure package, which party is in the majority in Concord, as well as who occupies the corner office.

Net-Metering & Distributed Energy (Howard Moffett)

The most critical policy tool for fighting climate change at all levels—local, state, regional, federal, and global—is to promote the substitution of renewable energy sources for fossil fuels in the production of electricity. Using renewables rather than coal, oil or natural gas to produce electric power reduces carbon emissions in all three energy sectors: not just directly in generating electricity, but indirectly in transport (electric vehicles) and space heating (heat pumps) as well. It should be at the top of and list for state policies to fight global warming.

New England has largely weaned itself from coal and oil, but we still depend heavily (over 40%) on natural gas to produce electric power. The transition to renewables will take decades, rather than years, but it is critical to make progress wherever and whenever we can. Along with state Renewable Portfolio Standards, critical to this transition at the state level will be net metering and distributed energy resources, including energy storage.

Net Metering is the most widespread example of substituting renewable power directly for energy from fossil fuels. It's a clunky term for a dramatic but simple idea: a retail electric customer that wants to generate its own power (a "customer-generator") may install renewable generating equipment "behind the meter," produce power for its own use from sun, wind, or water, and sell any surplus or "net energy" it produces back onto the grid.

Many net-metering customer-generators simply want to cover or off-set their own energy needs, but those who can produce more than they use themselves get revenue credit for any "net" exports to the grid at rates set by the Public Utilities Commission in its 2017 net-metering order(1). Customer-generators are credited for net energy sales based on the "default energy rate" charged by their own local utility, e.g., what an Eversource retail customer pays for the energy portion of their monthly electric bill if they buy their energy from Eversource rather than a competitive energy supplier. Energy charges typically account for about half of a monthly electric bill(2). Current net-metering rates run from roughly 12¢/kwh for "small customer-generators" (<100 KW in size, like rooftop PV solar panels) down to 8¢/kwh for "large customer-generators" (municipal, commercial, or industrial customers with generating equipment from 100 KW to 1 MW in size).

Since 2018, bi-partisan clean energy supporters in both House and Senate have been trying to pass an increase in the 1 MW size limit on "large customer-generators," only to have those efforts vetoed by the Governor:

- A 2018 GOP bill to increase the limit to 5 MW won broad support in both the House and Senate, but fell 14 votes short on the House override attempt.
- The 2019 bipartisan House bill, HB 365, passed the House 254-98, and the Senate on a unanimous vote; the House override attempt fell 6 votes short.

- The 2020 bi-partisan version, HB 1218, included several compromises that moved in the Governor's direction, but became a casualty of Covid-19. The GOP Caucus prevented it from coming to a final vote in the House when they refused to extend House legislative deadlines on June 11 in Durham.
- Meanwhile, the House Science, Technology & Energy Committee reported out SB 159, the 2019 version sponsored by Sen. Bradley, with a compromise increasing the net-metered energy required to be consumed "behind the meter" to 50%. The Governor vetoed SB 159 in February; the Senate overrode the veto in March; but on September 16 (Veto Day), the House again failed to muster the necessary two-thirds vote to override, despite the fact that SB 159 received more Republican votes (10) than any other bill vetoed by the Governor.

In April, a fossil-fuel-friendly lobbying group allied with Governor Sununu(3) mounted an unsuccessful challenge to state net metering programs at the Federal Energy Regulatory Commission (FERC). The New England Ratepayers Association (NERA) petitioned FERC to assert federal jurisdiction over all net-metering transactions, which over time could have threatened many if not all state programs. Fortunately FERC dismissed the NERA attempt on procedural grounds(4).

There is still broad support for net metering in both chambers, but the debate has unfortunately turned from policy to brass politics. The Governor has railed at Republican supporters, saying that an increase in size limits would "cost ratepayers hundreds of millions of dollars"—but without ever explaining how those costs might arise, and contrary to the PUC's 2017 finding that there was "little to no evidence of any significant cost shifting" due to net-metering(5).

Distributed Energy Resources and Energy Storage. Distributed Energy Resources (DER) represent a significant evolution in the electric distribution grid, enabling more widespread access to renewables. Sometimes called "Distributed Generation" (DG), DER refers to small-scale technologies (renewable or fossil-fueled) that generate or store electricity at or near where it is used. These technologies range from rooftop solar panels to emergency gas-fired generators serving microgrid campuses to behind-the-meter battery storage units. Dispersed on low-voltage utility distribution networks, DER supplements electric power from large centralized power plants that feed high-voltage transmission lines, helps to stabilize voltage, and reduces electricity line losses at the outer reaches of the electric grid. The PUC is currently seeking to quantify the value of DER in a series of studies initiated as part of the net metering docket, DE 16-576.

Nationally, DER accounts for about one-sixth of the electric generating capacity of centralized power plants, but its share in New England is greater—one-fifth(6) —and growing. Energy storage, a subset of DER, is essential to the grid-scale substitution of renewable energy sources for electricity produced by natural gas, because renewable sources (sun, wind, water) are by their nature intermittent—meaning they produce power reliably only when the sun is shining, the wind is blowing, or the river is running; they cannot be "dispatched" by ISO-New England as can load-following natural gas plants. But except for pumped hydro, the largest energy storage units currently operating in New England are modestly sized: able to store only about 10 MW of electric power for up to a few hours. Until we get commercial batteries or other energy storage technologies at grid-scale (meaning hundreds of MW able to store electricity for days, not hours), natural gas will remain an essential bridge fuel, rather than being phased out in favor of renewables.

A significant energy storage bill, HB 715, passed both chambers and was signed by the Governor in July. It requires the PUC to open a new docket to investigate how to compensate ratepayers, utilities and third parties fairly for energy storage investments on "both sides of the meter," based on avoided transmission and distribution costs, and report back to the Legislature within two years.

<u>References:</u>

(1) Order 26,029 in DE 16-576, issued June 23, 2017. See also RSA 362-A:9 and RSA 362-A:1-a,II-b.

(2)A typical monthly electric bill for an Eversource residential customer using 625 kilowatts per month is based on a unit charge of roughly 19¢ per kilowatt-hour. This unit cost is comprised of the following (rounded) component charges:

- 8¢ for energy;
- 6¢ for "delivery service" (transmission and distribution), of which transmission accounts for roughly 2¢ and distribution 4¢;
- 2¢ for a "customer charge" (administration);
- 2¢ for "stranded costs" (mostly the "Bow scrubber" emission control equipment); and
- 1¢ for "system charges," e.g. Renewable Portfolio Standard and energy efficiency levies.

"Large customer-generators" get credit only for the net energy they export back to the grid, averaging 8¢/kwh, or approximately 40% of the "full retail rate" but more than the variable 2-4¢/kwh wholesale rate (which is appropriate because the energy is being delivered at the retail level). "Small customer-generators" are treated more generously, receiving credit not just for the transmission costs that they avoid altogether but also ¾ of the local distribution costs they would otherwise pay. Both large and small customer-generators pay full customer charges, stranded cost charges, and system charges.

(3)For a comprehensive accounting of the ties between the Sununu family, NERA, and its affiliate Ratepayers Defense Fund, see David Anderson's report at the Energy & Policy Institute website, https://www.energyandpolicy.org/new-england-ratepayers-association/.

(4)FERC held that the NERA petition failed to present a concrete dispute between two parties that could properly be decided by a declaratory order. For a compelling and thorough discussion of the legal and theoretical basis for state net metering programs, see the Protest Brief filed by the National Association of Regulatory Utility Commissioners (NARUC), in which the New Hampshire Public Utilities Commission joined, at bit.ly/2MZUdcT.

(5)Order No. 26,029 at p. 68.

(6)See ISO-NE's 2020 Regional Electricity Outlook, at https://www.iso-ne.com/static-assets/documents/2020/02/2020_reo.pdf, at pp. 12-14.

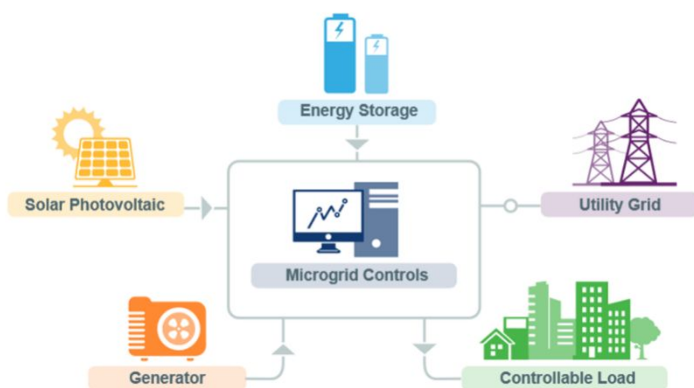
Microgrids in NH (Tom Rooney & Peter Somssich)

Why Microgrids ?

The definition of a microgrid is neither particularly new nor complex; in 2012 the U.S. Department of Energy (DOE) described a microgrid as:

> ***A group of interconnected loads and distributed energy resources with clearly defined electrical boundaries that acts as a single controllable entity with respect to the grid [and can] connect and disconnect from the grid to enable it to operate in both grid-connected or island mode.*** [1]

In other words, a microgrid is any localized electric system that can disconnect from the traditional, centralized grid to operate autonomously. The core components of a microgrid include energy consumers (loads), distributed energy resources (DERs), and a control system.



While the basic composition of a microgrid is relatively straightforward, business models, value streams, and ownership structures are much broader in practice. In the

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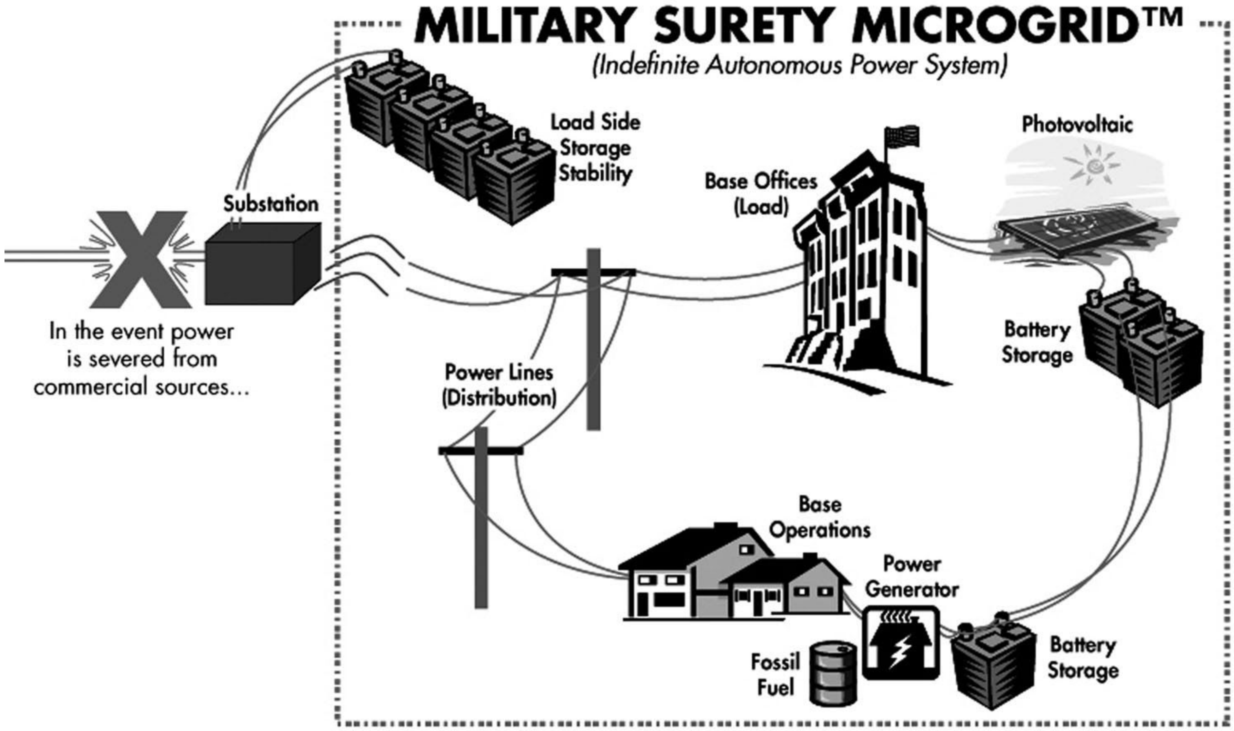
simplest sense, microgrids are generally established as either 1) single-user or 2) multi-user. The former is located entirely at one site and owned by one entity, while the latter represents a network of facilities and DERs and can be owned and operated by either a local community, the utility, a third-party, or a combination of these stakeholders.



Primus Power, a manufacturer of grid-level energy storage solutions, has received a contract to develop an energy storage system that will be used with a microgrid at the United States Marine Corps Air Station (MCAS) in Miramar, California. Courtesy Sandia National Laboratories.

A good example of microgrids are military facilities like the Portsmouth Naval Shipyard, which would continue to operate even if the main grid goes down. Energy generation within the microgrid can be provided by both older fossil-fuel (coal, oil and gas) sources as well as newer renewable energy resources (solar, wind, hydro and battery storage), allowing the microgrid to provide the power that it needs to operate without the main grid. Within the microgrid, however, backup energy sources can be shared and old energy resources can be replaced with newer ones when appropriate. This is the flexibility that a microgrid offers its users.

The benefits of a microgrid--similarly numerous and diverse—include but are not limited to the following:

Resiliency and Reliability. Microgrids can improve resiliency by forming a self-sustained local electrical power system, or “energy island” that can keep critical facilities and emergency services up and running in the event of an outage.

- Microgrids can provide energy safety and security and mitigate the impacts of extreme weather events by providing emergency housing and public health emergencies, as well as protecting against emerging digital threats
- Microgrids can reduce the duration and frequency of outages by providing grid-support services

Economic and Operational: Microgrids provide a wide range financial benefits to both the end-user and the utility and can enhance the operations of the existing power system through improved control, management, and dispatch of a diverse set of DERs.

- Microgrids can lower customers' operating expenses through energy arbitrage, demand charge management, and net-metering.
- Microgrids can offset the need for new transmission and distribution lines, provide ancillary/grid services such as frequency/voltage support, as well as generate revenue by participating in New England ISO's day-ahead and real-time energy markets
- Other opportunities for microgrids would include areas that include many small towns that agree to create a microgrid in support of basic and emergency services, but also in support of economic development which would not be possible with only the individual town's participation. Towns in NH with a low population density could form partnerships to enhance their economic viability and encourage more economic development.

Environmental and Organizational. Microgrids can provide environmental benefits, support state and local energy policy, and provide a platform for research and development of advanced energy technologies and practices.

- Microgrids can lower greenhouse gas emissions by facilitating the integration of clean energy technologies as well as eliminating the usage of fossil-fuel powered backup generation.
- Microgrids can support the goals outlined in New Hampshire's 10-Year State Energy Strategy[2], which includes the following goals:
    - Cost-effectiveness and economic growth
    - Energy Security, reliability, and diversity
    - Environmental protection
    - Maximize existing systems
    - Stakeholder engagement and inclusion
- Microgrid development can contribute to local, state, and national advancement of industry knowledge and can inform the future deployment of advanced technologies, business models, and best practices.

Given the pace of technological advancement in microgrid applications and the significant opportunities they can offer, it is time for NH to take a serious look at how the

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state can benefit today from the potential applications of microgrids. Companies are already working in our state on these projects; for example, TRC recently partnered with Eversource to develop a conceptual design for a microgrid for the University of New Hampshire in Durham. More importantly, these companies are also working directly with out-of-state towns, cities, and agencies on microgrid projects and other grid modernization efforts. As NH's grid continues to transform, it is prudent that NH leadership invests into the human and organizational infrastructure needed to guide and support the State's efforts and interests.

Action Item:

As a first step, a study committee envisioned by 2020 House Bill 1301 should be tasked with identifying the current opportunities to apply microgrids in service of a more resilient, flexible and more energy efficient main grid, but also in the service of our NH towns and cities. Since microgrids would operate behind the meter, i.e. not as an infrastructure project of the transmission grid, but as a complement to load and demand reduction measures, the NH utilities would need to be significant partners in any such undertaking.

The experience gained from the UNH microgrid project should be used to identify other opportunities in NH for a microgrid project.

References:

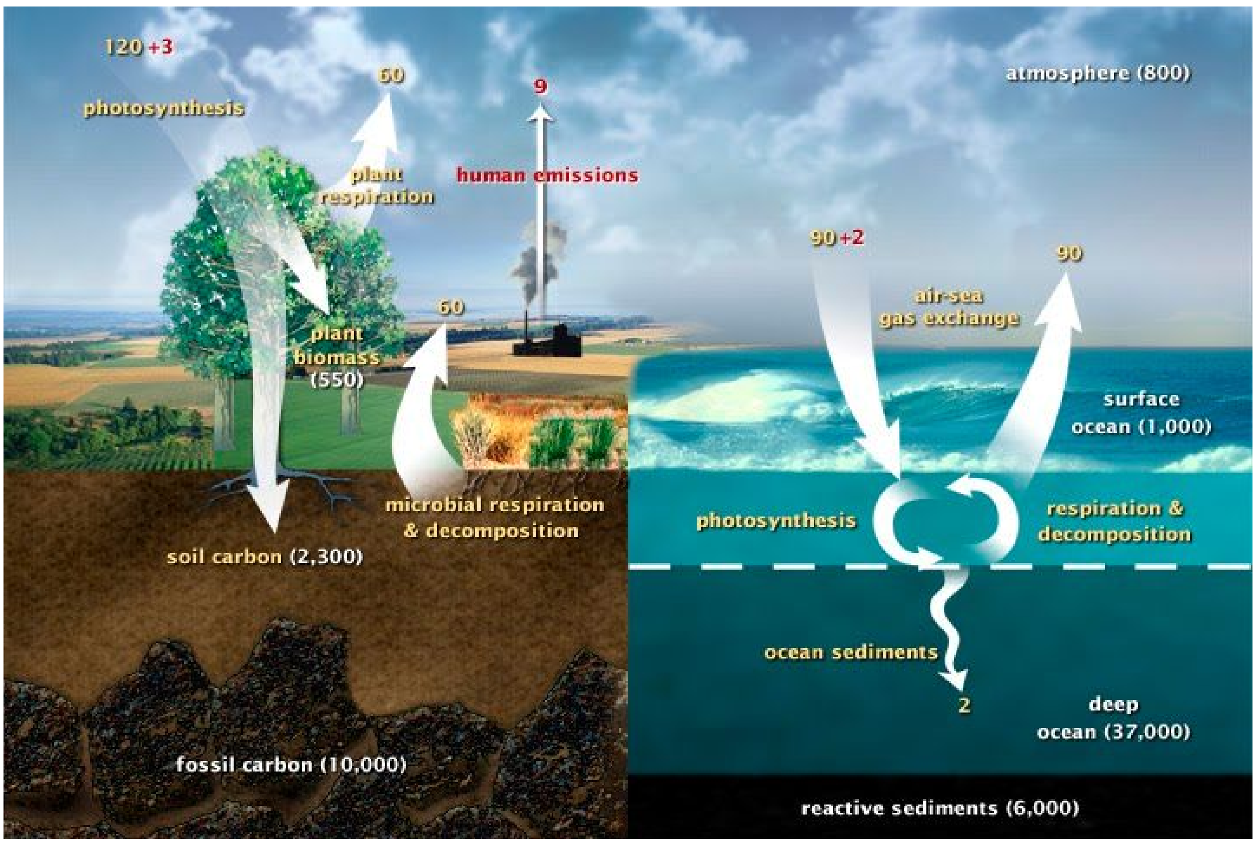
[1] U.S. Department of Energy "2012 Microgrid Workshop Summary Report" Office of Electricity Delivery and Energy Reliability. July 2012. https://www.energy.gov/oe/downloads/2012-doe-microgrid-workshop-summary-report-september-2012

[2] https://www.nh.gov/osi/energy/programs/documents/2018-10-year-state-energy-strategy.pdf

Biomass Energy (George Saunderson)

Probably the first thing to say about biomass energy in New Hampshire is that it is going to be a transitional, or bridge, power source. Once we have enough solar and offshore wind capacity, coupled with battery storage, it is going to be very hard for any other energy source to compete because sunlight and wind are free.

That said, biomass can play an important role as a source of "base-load" renewable power because New Hampshire has a very healthy and vast forest system, thanks in part to a culture of forest stewardship and the land conservation organizations such as the Society for the Protection of New Hampshire Forests. The health of New Hampshire's forests depends on the ability to "thin the forests" of low-grade wood.



This diagram of the fast carbon cycle shows the movement of carbon between land, atmosphere, and oceans. Yellow numbers are natural fluxes, and red are human contributions in gigatons of carbon per year. White numbers indicate stored carbon. (Diagram adapted from U.S. DOE, Biological and Environmental Research Information System, 2011.) https://earthobservatory.nasa.gov/features/CarbonCycle/page1.php

It is important to understand the "Carbon Cycle" on earth. The total amount of carbon on earth has traditionally stayed about the same, but it has cycled around earth in different forms, staying about in the same place for periods of 100 to 200 million years.

The largest carbon storage areas are rocks, fossil fuels, and deep-ocean water and sediments. Natural processes such as rain, rock weathering, and volcanic explosions release bits of carbon from these reservoirs all the time. This is the slow carbon cycle.

In the last 75 years we humans have disrupted this cycle by burning fossil fuels extensively. That, and the population of the world going from 2.5 billion people in 1950 to 7.75 billion people in 2020, has added to the problem.

Photosynthesis by land plants, which in New Hampshire's case includes 4.6 million acres of forests, powers a seasonal cycle of carbon movement around the world, known as the fast carbon cycle.

Every spring and summer these forests and plants absorb carbon dioxide from the air and water as they photosynthesize storing that carbon in the form of cellulose and lignin. Throughout the year, as all living things decompose or die, they return carbon dioxide to the environment. Fortunately, in New Hampshire forest growth exceeds natural mortality and removals (i.e. harvesting) by 92 million cubic feet annually. The fast carbon cycle is a completely sustainable perpetual cycle that has gone on forever. Humans have added stored carbon dioxide to that fast carbon cycle as well in the last 75 years by burning fossil fuels and deforestation. Keeping our forests thinned and growing robustly helps combat the slow carbon burning problem.

Wood stoves for home heating are a fact of life in New Hampshire. Burning manufactured wood pellets, which are much cleaner to burn, in newer pellet stoves, would greatly reduce the amount of carbon that New Hampshire is returning to the Earth's atmosphere. Perhaps subsidizing several pellet operations and their products around the State, coupled with newer stoves should be considered.

A trailer carrying between 25 and 30 tons of wood chips from a logging job, enough for about one hour of electric generation, is emptied at the Springfield Power biomass plant in Springfield, N.H., Wednesday, August 1, 2018. The facility is one of the 6 independent biomass plants that have been impacted by Sununu's veto of SB 365 that would have required utilities to purchase a portion of their electricity from the biomass plants. (Valley News - James M. Patterson, Geoff Hansen photo) Copyright Valley News. May not be reprinted or used online without permission. Send requests to permission@vnews.com.

It is probably unrealistic to think that the 6 major biomass power plants that we have recently lost in New Hampshire will be replaced. The cost of such projects, and the short life that such biomass plants would have competing with solar, wind and existing dam-produced electricity is a real problem. There are, however, new and smaller and very efficient portable wood-fired power plants that can be moved from location to location, which both decreases the transportation costs of biofuel plants and allows for much reduced start-up costs. Such power plants are manufactured by Air Burners Inc. That coupled with distilling facilities, using wood chips to produce biodiesel are real possibilities for the future biomass applications.

A 2017 Plymouth State University study identified many of the beneficial economic impacts that the biomass industry has for New Hampshire. A few are highlighted below:

- 161 direct jobs at biomass power plants ($11.6 million/yr. in payroll) , direct economic impact
- 583 support jobs ($28.1 million/yr. in payroll) supply industries, e.g. logging, indirect economic impact

- 228 addition job, community business jobs ($11.2 million/yr. in payroll), induced economic impact
- Grand total of 932 jobs ($50.9 million/yr. in payroll)
- Economic output to the state's economy is $254 million/yr.
- Contribution of $7.3 million/yr. tax revenues to state and local governments
- Tourism: the forest-based recreation industry represents $3.1 million/yr. in economic activity.

Biomass Sources:

Rural Biomass Energy 2020 by Qingfeng Zhang

Biomass Energy by Elizabeth Kaajnik

Biomass Energy by Carol Hand

Good Forestry in the Granite State by UNH Cooperative Extension, and the N.H. Division of Forest and Lands

Forest Inventory and Analysis Data by USDA, U.S. Forest Service

Working Lands Study 2020 by Plymouth State University, July 2020

Future of Nuclear Energy (Kat McGhee)

Nuclear power, the steady-state energy source that is rarely discussed, might warrant a closer look in the 21st century. Nuclear engineers have had decades since the 1950's choice of the original light-water reactor design to address the concerns of a skeptical public. But, when Pentagon admiral Hyman G. Rickover decided to use the naval propulsion lab's, light-water reactor design for land-based power plants, he truly helped codify their shortcomings and stymie the potential that was rightly hyped in the early days as a *safe, plentiful, clean and low cost* per kW energy source.

First, let's get to know the electric plant in our own backyard and where it fits into our current energy portfolio.

According to the US Energy Information Administration (EIA) facts sheet for 2020, the electricity contribution in NH breaks down as: 1.9% Coal, used for peaking plants, 2.4% other, which includes both Wind and Solar, 6.9% hydro, and this infrastructure is pretty much built out to its potential (although Canadian hydro projects have been contemplated as a way to grow this segment).

Next, comes Biomass at 8.1%. The Science, Technology & Energy Committee learned during recent testimony that the biomass industry grew up working in cooperation with the NH Forestry Society, supporting healthy forests and a sustainable, multi-million-dollar New Hampshire biomass economy. Last year's veto of the biomass bill not only dismantled NH biomass, it paved the way to argue for greater fossil fuel (gas) infrastructure, a long time goal of Big Oil and Big Gas.

Gas currently makes up 20% of our electric generation and the argument goes that we need gas as a bridge fuel, because it is 'cleaner'. But, saying gas is cleaner than coal or oil, is the same argument cigarette companies used to say 'light' cigarettes were preferred by doctors as a way to keep people hooked on smoking. We need a realistic transition plan away from higher dependency; a fuel source that contributes to the problem of emissions must be seen for what it is, a non-sequitur.

Finally, 60.8% of our electric generation comes from the Seabrook plant. We don't use all the energy the plant produces; we sell the excess power to other New England states in order to help them meet their clean energy standards under the Regional Greenhouse Gas Initiative. The Seabrook plant helps NH meet its own RGGI emissions' targets and contributes to lower electric costs by providing steady-state power. But the math of nuclear power's contribution to the New Hampshire clean energy portfolio is more significant still. The number that caught my attention is the percentage of New Hampshire's non-greenhouse gas emitting power that comes from Seabrook. That number is 87%. If we close Seabrook, we will have to increase our renewables from 7.3% (current levels of hydro, wind & solar combined) to replace that lost 87%. We'd have to achieve a total of 94.3% renewables, if we are to avoid increasing our emissions. In a state like New Hampshire, where investment dollars are few and the appetite for taxes anorexic, we need to be sure we do not take the benefits of nuclear power for granted at this critical stage in our energy history. It's not about whim or preference or fears that are not born out by facts, it's about emissions.

Now that we have some numbers for context, let's go back to where the technology is and how it might help us plan for the future.

Light water reactors work great for the submarines for which they were designed, but they were an expensive, clunky and inefficient retrofit for base-load electric power plants. That doesn't mean they didn't perform as advertised. Nuclear fission produces a great deal of power, for a very small amount of fuel and even with the inefficiencies of the 'wrong' reactor design, the waste from nuclear is the lowest of all the other base load fuel options (oil, coal and gas).

Though nuclear plants run at around 95% 'capacity factor', only closing for maintenance, fuel efficiency is often only about 3% in a light water design. This means at the end of its fuel cycle, when the reactor requires refueling, nearly 97% of its fissile material is unused. That left-over, radioactive waste is currently stored safely in special cement storage cylinders on site. But that inefficiency of fuel-use got engineers wondering why we couldn't reuse the spent fuel that is already co-located at US sites. That prompted them to revisit the benefits of 'the other' design that was built and tested successfully for 6 years at the Oak Ridge National Lab in the 50s, the Molten Salt Reactor (MSR).

If we were to leverage existing spent-fuel stores, with proven MSR technology, we could supply enough clean electricity to power the entire world for several hundred years without harvesting any additional rare earth minerals (uranium, thorium…). Though thorium as a fuel source is plentiful and cheap if we need it and there are new ways to mine uranium from seawater as well!

Here's a perspective from the current President of the American Nuclear Society (Mary-Lou Dunzik-Gougar) in the August 2020 Nuclear News.

> *'This month, the topic is 'clean.' Clean can mean something different for each audience. If carbon is your concern, nuclear is as clean as wind power and cleaner than all other power types when you consider emissions across the entire life cycle of the energy source. As the data from the U.S. Department of Energy and the Breakthrough Institute confirm, nuclear is also a winner in terms of land usage, fuel footprint (inverse energy density), and material usage. Because of low material land usage (for both power plants and fuel production), it follows that the amount of waste produced by nuclear power is also the smallest. Higher-energy-density fuels release higher-density waste streams, but all energy production creates some sort of harmful waste.'*

Nuclear power being a higher-density fuel stream is another reason to revisit its next-generation technology. It was nuclear energy's non-emitting, reliable base load power that prompted the investment in a fleet of 9 New England plants in the first place. Our inability to pivot away from fossil fuel dependence is heavily tied to the fact that base load sources are still more reliable for maintaining the electric grid, than intermittent power sources, coupled with batteries.

There are companies selling MSRs today, and Canada, India, China and Korea are among the countries investing in next generation plants. The benefits of the MSR are many. First, they can load follow, eliminating the need for dirty peaker plants. They operate at atmospheric pressure, so expensive pressure vessels are not needed. The reactors are designed to be walk away safe, without human intervention, so again, the risks of older style reactors have been mitigated to solve for public concerns. Finally, MSR's burn 97% of their fuel, the opposite of light water efficiency, leaving significantly less waste and that waste has a half-life for radioactivity of hundreds of years, not thousands. And the amount of energy produced is so significant, the cost of energy goes way down.

But the most interesting innovation in next-generation nuclear power technology is the discovery of a method to extract uranium from seawater. So, even if we opt not to reprocess our existing nuclear waste for fuel, advances in fission technology mean that molten salt reactor companies are ready to deliver reliable, high efficiency (97% vs. 3 % with today's designs) clean plants at a fraction of the cost of traditional plants and power them in renewable ways. MSR Reactor designs by companies like Terrestrial Energy of Canada and Moltex Energy of the UK are being readied in proximities as close as the Point LePreau, New Brunswick, Stable Salt Reactor (waste burner) located just over the border from our neighboring state of Maine.

Though recent US policy seems blithely ignorant of the eminent dangers of atmospheric warming, it is important policymakers understand the latest technological advances that can meet the ever-expanding electric needs of a modern grid. The IPCC concludes that nuclear needs to be part of the solution to keep the lights on while we aid the planet. Next-generation nuclear is worth a second look, if only because it has given us over 50 years of clean power, without one civilian death.

Solar Energy (Dan Weeks- Revision Energy)

1. **Renewable Portfolio Standard (RPS)**: New Hampshire currently derives **0.77%** of state electricity from solar (GTM, Q1) with **120 megawatts** (MW) of installed capacity. By comparison, Maine derives 1.1% of electricity from solar, Vermont derives 14.3%, and Massachusetts derives 15.4% due to substantially higher RPS and net metering values established by each state's PUC/DPU. The NH PUC is still years away from completing its value of distributed energy resources (DERs) study required in 2017.

   Policy Option: RPS is a proven tool for promoting private-sector investment in clean energy. Although NH's 2007 RPS has already resulted in substantial reductions in carbon pollution, the solar goal of 0.7% RPS through 2029 is extremely low relative and out of step with climate science. Setting RPS goals of 50% clean energy by 2030, 80% by 2040, and 100% by 2050 to avert the worst effects of climate change would result in tens of thousands of additional jobs across solar, wind, storage, and other technologies while reducing energy costs and driving billions of dollars in local economic investment.

2. Net Energy Metering (NM): New Hampshire's net metering value for distributed energy resources is 20-50% lower than neighboring states for small customer-generators (<100kW) and 40-60% lower for large customer-generators (100kW-1MW) even though the primary NH distribution utility is shared with MA and all six New England states are managed by the same transmission grid. NH is the only state that does not allow NM over 1MW.

Policy Option: NM is critical to the growth of small-scale renewables in NH by allowing families, businesses, nonprofits, and municipalities to offset their energy needs with solar, wind, and hydro at a fraction the retail cost. The NH PUC has found net metering benefits all ratepayers by diversifying the energy mix, reducing transmission costs, and increasing the available supply of electricity during peak demand. Raising the NM cap from 1MW to 5MW and raising the small-large customer generator threshold from 100kW to 500kW with data-driven NM values established by the PUC would enable the growth of onsite and offsite clean energy generation to meet a revised RPS.

3. NH Renewable Energy Fund (REF): Since the REF-funded Solar Rebate Program was introduced by the PUC in 2011 as NH's only state incentive, 548 small businesses, schools, nonprofits, and municipalities have received critical funding to enable small-scale projects. With NH solar penetration now in excess of the 0.7%

RPS, utilities are no longer providing non-compliance payments into the REF and the PUC has had to cut C&I rebates 93 percent from $150,000 per project in 2018 (50 cents per watt) to $10,000 in 2020 (20 cents per watt).

Policy Option: In the absence of longer-term RPS and NM reforms, restoring state rebates to their 2019 value of $50,000 (40 cents per watt), if not their 2018 value of $150,000, would enable significantly more small-scale clean energy projects, especially during the present economic recession. A simple transfer of some or all of the $5 million Clean Energy Fund committed by Eversource as part of its divestment settlement with the state would provide ample resources for the REF. The fund has gone unspent since 2017.

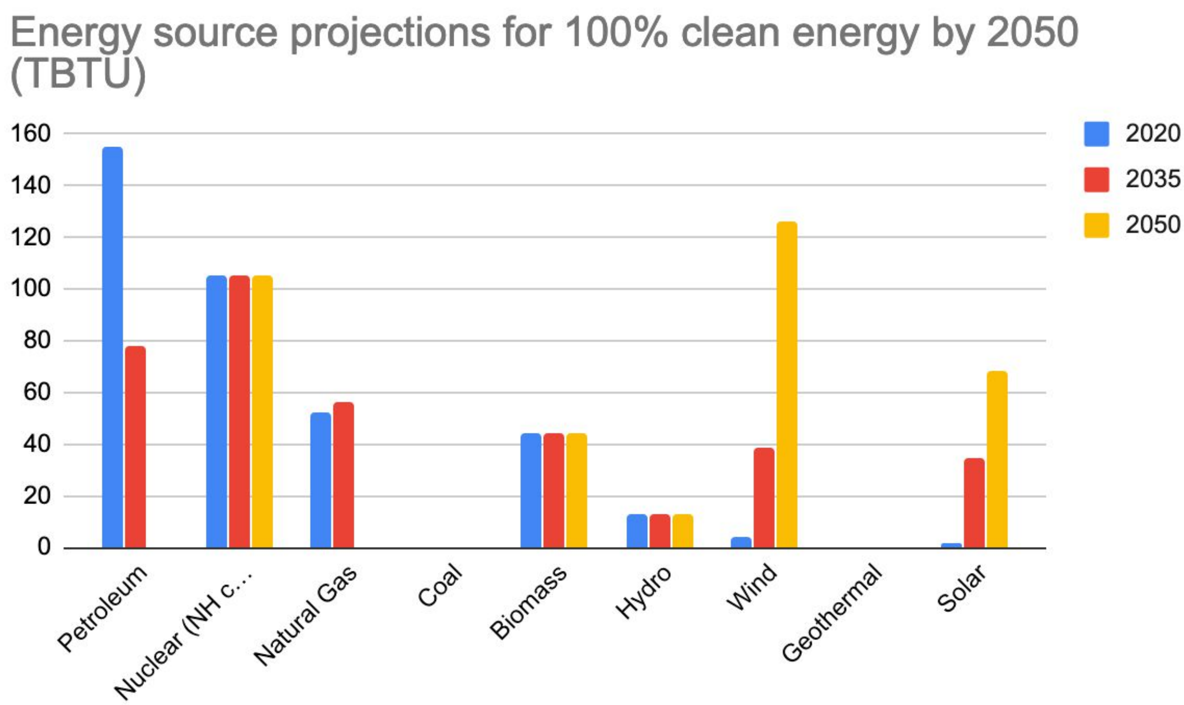
4. Renewable Energy Credits (RECs): New Hampshire's low 0.7% RPS through 2029 combined with the unfair utility practice of "sweeping" unclaimed RECs to avoid non-compliance payments has resulted in a depressed market for Class II (solar) RECs. RECs declined from $50-$60 per 1,000kWh of solar electricity generation around 2016 to $3-$5 in early 2019, with a partial rebound by late 2019 as demand from private institutions increased.

Policy Option: Ending the utility practice of "sweeping" unclaimed RECs owned by clean energy generators to meet RPS would support a rebound in REC prices and encourage more NH small businesses, towns, and nonprofits to install solar projects.

5. Clean Energy Jobs and Regulations: New Hampshire has seen $305 million in direct solar investment since 2010 with a peak of more than 1,200 jobs across 85 solar companies in 2017. Solar jobs dipped to a low of approximately 800 in early 2019 with a partial rebound by Q1 2020 before the Coronavirus pandemic resulted in substantial additional job losses. Short-term economic impacts are exacerbated by the scheduled step-down in the federal Investment Tax Credit (ITC) for solar from 30% in 2019 to 10% in 2022. By comparison, Massachusetts has more than 10,000 direct solar jobs and has seen $7.1 billion in direct investment, aided by the removal of antiquated regulations and by far-sighted state investments in clean energy workforce development and grid modernization.

Policy Options: In addition to the options outlined above, NH policymakers can enable clean energy job growth and private investment by establishing robust virtual net metering for community solar farms; ensuring third-party energy suppliers permit net metering instead of requiring default supply; extending the voluntary property tax exemption for solar and storage statewide; supporting more efficient and standardized permitting of distributed renewables without blanket barriers to adoption in certain communities; requiring Non-Wires

Alternatives (e.g. demand-response and distributed solar+storage) be considered in place of traditional utility capital investments; promoting policies that designate small-scale renewables as load reducers to lower ISO Transmission charges and benefit all ratepayers; modernizing our outdated electric distribution and transmission systems through deployment of a clean-energy "smart grid" with time-of-use rates for effective integration of distributed renewables, battery storage, and electric vehicle; and requiring Integrated Resource Plans from utilities every three years that track grid modernization, climate resiliency, distributed generation, beneficial electrification and efficiency against state goals.



Offshore Wind Power (Doug Bogen- Seacoast Anti-Pollution League (SAPL))

Opportunity and Potential Toward a Sustainable Energy Future for NH

There is a revolution taking place just off the Northeast U.S. coast, a key part of a necessary transition away from the fossil fuels that threaten our future climate. The siting and installation of huge offshore wind turbines and other ocean technologies promise to provide the bulk of our power needs in future decades. As with all renewable power sources, these technologies once installed will harness practically free energy for a resilient, reliable and safe power grid throughout our energy-starved region.

The Northeast coast, and the Gulf of Maine in particular, turn out to be among the best regions in all of North America for offshore wind development.

While wind is fairly consistent throughout the Gulf, existing deep-water ports and marine industrial facilities are not – there are only so many available to build and maintain the numerous offshore wind farms needed to tap this resource. Facilities in Maine and states south of us are gearing up to provide staging areas for massive offshore wind development, yet to date there has been no similar effort here. Why is New Hampshire currently missing out on this offshore energy rush?

Currently, there are no offshore wind turbines along the NH coast or anywhere in the Gulf of Maine – and only one small wind farm, off Rhode Island, anywhere in the country – despite several projects initiated off the Maine coast in previous years. The one project that is moving forward in the Gulf is the UMO-led AquaVentus 12 MW floating turbine pilot project to be sited off Monhegan Island, which was re-approved by the Maine PUC and Governor Mills last year. South of Cape Cod is a whole different story, with multiple projects amounting to several thousand megawatts committed to by several NE states, all to be built over the next decade.

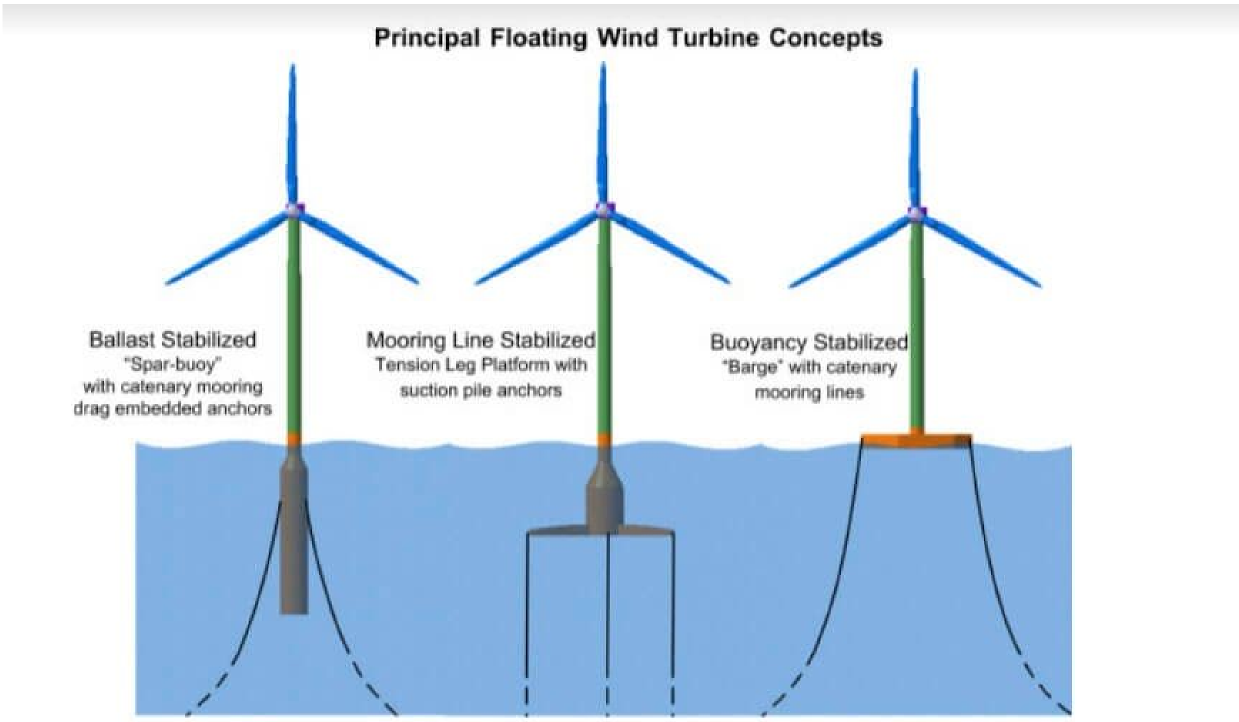
As a result of growing public pressure and business interest, Governor Sununu requested initiation of a federal Bureau of Ocean Energy Management (BOEM)-led intergovernmental task force and stakeholder process for offshore wind last year. At BOEM's request, the task force subsequently included participation by Maine and Massachusetts officials and focused on the whole Gulf of Maine. The first meeting of the task force met in Durham last December, though a subsequent meeting has yet to be scheduled.

The Hywind Scotland project comprises five 6-MW Siemens Gamesa turbines. This image shows the turbines being installed on floating foundations in Stord, Norway. Courtesy: Siemens Gamesa

On the legislative side, Sen. Watters crafted a bill this year (SB 668-FN) to create an offshore wind development commission, an offshore wind development fund and an Office of Offshore Wind Industry Development - though the fund was subsequently removed from the bill as it was incorporated into omnibus HB 1245 passed/signed this summer. The commission and Office are charged with investigating and recommending opportunities for economic development and job creation at Portsmouth Harbor and other locations, job training and workforce needs, supply chain development and other needs for offshore wind development.

<u>Power Potential – Facts and Figures</u>

With our proximity to the windy waters of the Gulf of Maine, NH is well-suited to take advantage of the vast potential of clean, sustainable energy off our shores. The potential for offshore wind in the Gulf – state boundaries being almost irrelevant once federal waters are entered – is practically unlimited. A 2010 US Dept. of Energy (DOE) study, further refined in 2016, determined that there is about 200 GigaWatts (GW) in theoretical offshore wind power potential within 50 miles of the Gulf of Maine coast, with over 3 GW in NH “waters” alone (which only extend to about 20 miles out). A 2017 DOE economic study determined that there is 2000 MW (more than Seabrook's capacity) of wind power with “economic potential” immediately off New Hampshire's coast over the next decade, as well as about 85 GW total available in neighboring Gulf of Maine waters. While “closer is better” is preferable with regard to power line transmission issues, it should be noted that New York, Connecticut and Rhode Island have already committed to obtain hundreds of megawatts of offshore wind power from federal waters off neighboring states due to siting limitations off their shores.



***Selsam Innovations / U.S. Windlabs* Announces New Deepwater Offshore Patent:**

Newly patented designs are already being commercially implemented in European waters.
https://www.windpowerengineering.com/new-u-s-patent-granted-for-floating-marine-wind-turbine/

Due to technological improvements as well as up-scaling, the "standard" power capacity of offshore turbines has tripled in less than a decade and larger designs (12 MW or more per turbine) are expected to be realized in the next few years. Additionally, since most waters in the Gulf of Maine are deeper than is practical to exploit using pier-based turbines, floating platform designs will be key to establishing wind farms any farther than immediately off our shores. Fortunately, various floating system designs have been proven in waters off Portugal, Norway, Maine, France and Scotland – with the latter consisting of a 5-turbine grid-tied permanent wind farm up and running for several years now. Floating systems also have the potential for more efficient and cost-effective mass-production, since they can be assembled at shore or a drydock and then towed to the wind farm site.

Lastly, offshore wind farm construction costs have decreased dramatically in recent years, with the "Vineyard Wind" project expected to save Massachusetts ratepayers $1.4 billion over other power sources in the 20-year life of the project. In total, 2300 MW of offshore wind projects have been contracted at the same federally-approved site in the next few years, making southern New England the offshore wind capital of the country by the mid-2020s. [Since the author wrote this, Massachusetts Speaker pro temp Patricia Haddad' reported an additional contract for 800MW and legislation pending for 3600MW expansion. - ed.]

Given these trends, coupled with expected additional economic efficiencies from regional supply line development and investment in other infrastructure, New Hampshire could technically expect to be able to provide for 100 percent of its energy needs by 2040 with offshore wind alone. Combined with onshore wind, solar power and other existing and expected renewable development, a fully sustainable energy future for NH could be expected to come even sooner. With enough governmental direction and leadership, developing the renewable energy off our shores could ensure a bright energy future for the Granite State.

Action Items:

1. Support and implement the recommendations of the Offshore Wind Development Commission and Office of Offshore Wind Industry Development. These newly created institutions complement the efforts of the intergovernmental task force, and implement their recommendations could lead to the creation of thousands of jobs and economic opportunities around the state

2. Renewable Portfolio Standard update and possible “carve-out” targets for offshore wind. As described elsewhere, the state RPS targets are greatly in need of updating, and could set a specific percentage for offshore wind to encourage planning and implementation to benefit our state. Class I in the RPS deals with wind power, and could be increased substantially over time as offshore wind development progresses.

3. Procurement of Offshore Wind Power for In-state Utilities/Community Power programs. To complement or in place of an RPS target for offshore wind, the Legislature should consider direct state procurement of offshore wind from New England waters (as other NE states have already done) and/or further assist municipal efforts to do so.

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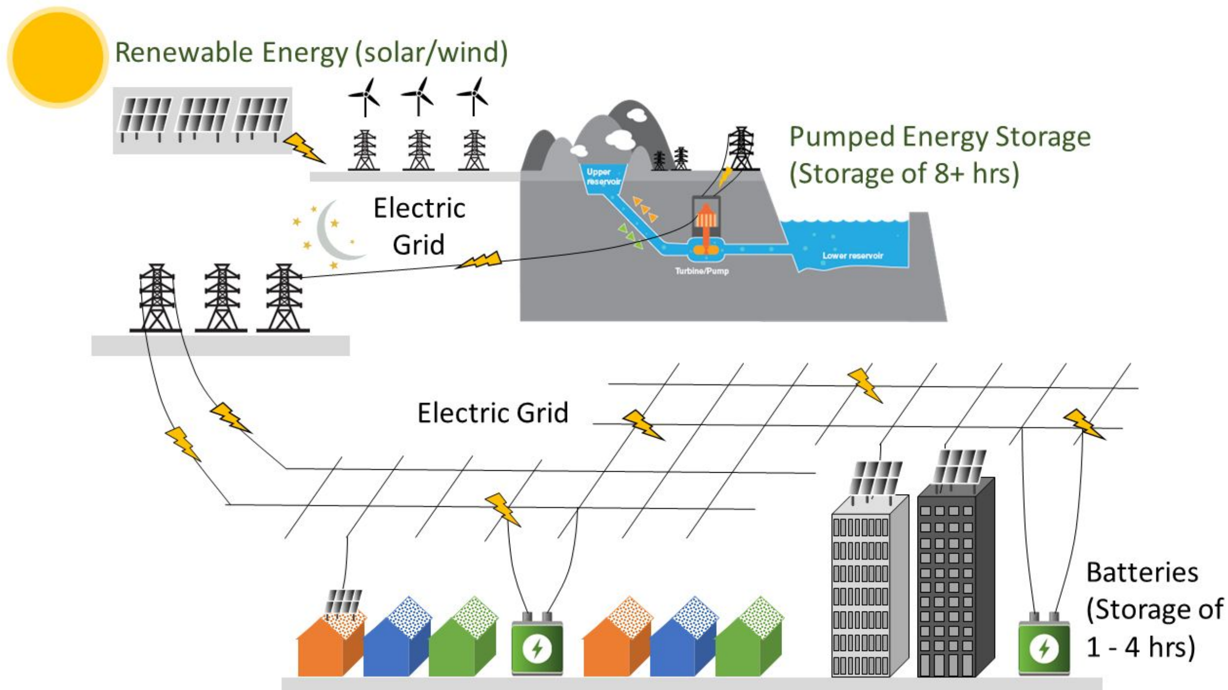
Energy Storage (Lee Oxenham)

Energy storage offers myriad benefits to New Hampshire's residents, economy and environment. First and foremost, energy storage is a force multiplier for all forms of renewable energy – the powerhouse of our future clean energy grid. Almost as importantly it debunks the fossil fuel lobby's claim that renewables are unreliable due to their intermittency.



Approved in 2018, this San Diego County Water Authority project uses a combination of pumped hydro (not unlike NH's Comerford Hydro Dam) and distributed batteries to increase renewable grid capacity.
https://www.sdcwa.org/sites/default/files/Batteries%20and%20Pumped%20Storage-updated.png

Increasingly cheap battery storage enables us to capture the energy when it is produced and release it when it is needed, freeing us for the first time from the "just in time" need to constantly balance electrical generation and load (usage) on the grid.

Energy storage can help keep millions of NH's energy dollars in-state, relying on local, renewable energy sources like wind, water and solar, rather than sending our wealth away, out of state and out of the country in exchange for polluting and climate-destroying fossil fuels. Further, storage opportunities can stimulate new investment and employment in the state, attracting a key and much-needed younger demographic. Energy storage can also reduce the cost of both supplying and delivering electricity, directly reducing energy costs for NH families and businesses.

By enabling greater use of renewable energy and reducing demand for fossil fuels energy storage improves air quality and reduces air pollution, including greenhouse gases, toxic chemicals, and particulate matter. This is a boon to public health as it reduces respiratory and cardio-vascular disease, and premature deaths across the state. By reducing greenhouse gas emissions, energy storage also plays an important role in mitigating the climate crisis. It does this by cutting demand for the fossil fuels which produce the greenhouse gases that are driving the crisis. Energy storage will also play a vital role in the future creation of microgrids that can ensure continued electricity to critical infrastructure and public services in climate-induced emergencies like floods, wildfires, tornados and hurricanes.

Critically, energy storage also has the ability to significantly reduce NH's peak demand for electricity and thereby save consumers money. Peak demand has been a perennial driver of electricity prices as the electrical system had to be overbuilt to meet those fleeting moments of maximum demand, rather like building a road system to meet the needs of Friday 5pm on the July 4th weekend. Highly polluting fossil fuel plants are paid to remain in service in order to ensure their availability at times of highest usage – further driving up costs to the system and consumers. Replacing these plants with battery storage can eliminate the dirtiest of our power producers – saving us money and improving public health, particularly in the most heavily impacted communities.

Energy storage provides a beneficial alternative at a fraction of the cost of traditional power plants and power lines. Indeed, a study the Massachusetts Department of Energy Resources commissioned found that every $1.00 spent on energy storage ultimately saves consumers $1.70 to $2.40 - roughly a two-to-one return on investment. (MDOER) [xi)]

Energy storage's great potential has yet to be realized, however, despite steep price reductions over the last 5-10 years. This is largely due to the difficulty in monetizing many of the key services storage provides – without which businesses have little incentive to make the investment.

Enabling a utility to forego the construction of new distribution infrastructure could save consumers millions of dollars, just as eliminating the need to build a new transmission line could save consumers tens, if not hundreds, of millions of dollars. But our present system of utility compensation does not properly incentivize the utilities to choose this option and invest in cheaper energy storage. Neither are non-utility energy storage developers able to monetize the full value of their investments, despite the fact that these make it possible for the utilities to avoid enormous outlays on transmission and distribution costs.

Which leads us to HB 715 - one of the few Democratic energy priorities to successfully pass both Houses and be signed into law by the governor in 2020. This bill directs the PUC to open a formal proceeding to investigate how energy storage projects can be compensated for avoided transmission and distribution costs. This proceeding can be a game changer – producing the regulatory changes needed to open the still highly regulated electricity market to greater competition and innovation,

As a part of HB 715's mandate to investigate the manifold ways in which energy storage benefits the electrical system the new law specifically directs the PUC to examine the costs and benefits of a "bring your own device" (BYOD) program. BYOD compensates individual consumers with energy storage systems for the benefits their systems provide to the electrical grid. This incentivizes the deployment of new, distributed renewable energy resources at the same time that it increases grid reliability and resiliency. HB 715 likewise directs the PUC to investigate the ways in which a BYOD program can be implemented; and "any statutory or regulatory changes that might be needed to create, facilitate, and implement such a program."

Finally, HB 715 requires the PUC to report its findings and make recommendations to the standing committees of the House and Senate with jurisdiction over energy and utility matters – providing an opening for future legislative action.

And most importantly for you on the campaign trail - this provides you with an opportunity to proclaim your commitment to take action on the climate crisis, cut energy bills and improve public health. How? By taking part in the PUC proceeding and supporting the recommendations which will follow.

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Summary and Observations

As was underscored in the “Energy Efficiency” section, the first priority must always be to use all available tools to reduce demand for energy. Combining new technology with integrative design gives us the most powerful way to tackle our energy requirements for the proper supply of clean energy. The value of demand reduction to meeting our goal is dramatically demonstrated in the graphic in Appendix 1.

New Hampshire homeowners spend about $477 per month for all their utilities. With approximately 450,000 households in NH, that amounts to an annual statewide utility bill of $2.6 billion. The United States Department of Energy estimates that energy efficiency appliances and home upgrades could save homeowners 15 - 40% on their annual utility bills. Here in NH, a 40% reduction represents savings of more than $1billion! Just a 10% reduction in utility use would save a typical NH household $572 each year. Programs to surrender inefficient old appliances such as refrigerators have been very popular, and have resulted in recouping the purchase price through energy savings within the first year.

Reducing demand improves quality of life and benefits the environment, in addition to reducing home utility bills and Greenhouse Gas emissions (GHG). Recently, the town of Wilton decided to invest in more efficient LED street lighting to reduce the town’s energy demand, which resulted in a Return-On-Investment (ROI) of just 4 years. Now the savings will continue for at least another 20 years of the LED’s warrantied life.

Energy efficiency projects are not difficult - they could be as simple as replacing a lightbulb. The Regional Greenhouse Gas Initiative (RGGI) is intended to provide substantial funding for energy efficiency programs (particularly to low-income households), but in a disappointing political maneuver the majority of NH RGGI funds for energy efficiency have been diverted to a small monthly rebate (91¢) on a typical consumer’s electric bills. Significant home efficiency projects could be accomplished, if the diverted funds collected were all reinvested in energy efficiency.

At least two bills in the 2020 legislative session attempted to address the issue of diversion of RGGI funds: HB 1317 and HB 1496. Unfortunately, these were not enacted into law. Preventing the diversion or “rebate” of RGGI efficiency funds should be included in any action plan to move NH forward with respect to energy policy.

Another initiative, known as the “Carbon Cash-back” program should also be considered as part of our renewable energy strategy. This program would add a “pollution fee” to every fossil fuel based on the tons of CO_2 pollution it adds to the atmosphere. All of this revenue (except ~1% administration and postage) would be rebated to NH residents equally. Such a “revenue neutral” program repairs a market failure that allows “zero-cost pollution” for dirty fuels. The program would make fossil carbon fuel pay for the health and environmental damage it causes, while at the same time making clean energy more attractive to consumers. Most of NH would come out ahead, with more dollars in their cash-back check than the additional amount they paid for fossil fuels. By choosing subsequent energy purchases that have a lower “pollution fee” cost, they will reduce the carbon footprint of their energy purchases and retain even more of their cash-back checks.

SYNERGIES

In order to continue to reduce greenhouse gasses, it is necessary to provide a more diverse, flexible and resilient electricity grid. Such a grid would promote clean, renewable energy for traditional electricity uses, but would also support future demand for heating and transportation improvements. These improvements reflect emerging demand for air-source heat pumps (“mini-splits”) and electric vehicles, which are explored elsewhere in this report. Net-metering and Distributed Energy will play key roles in such grid improvements.

Currently, our state is overly dependent on out-of-state natural gas supplies for electricity and heating needs, and for petroleum to support transportation. Net-metering, distributed energy and energy storage are crucial tools for fostering NH’s in-state energy production. As an important bonus, NH-sourced energy would come predominantly from clean sources, because no fossil fuel is extracted in our state!

Net-metering is the simple concept of allowing NH residents, municipalities and businesses to generate their own renewable energy, *and* reduce what they pay for energy by receiving a credit on their electricity bill for the electricity that they send back into our shared electricity grid. (For systems over 100 kW, the value of that credit is currently the “default rate”, which varies from 4 and 13 cents kWh, depending on the utility, type of customer, and time of year.) Our state must also scale up NH’s net-metering cap from 1 to 5 MW, to greatly enable municipalities and businesses alike to build energy-producing facilities at an economically practical scale.

Distributed Energy generation, which depends on local decentralized small and medium energy resources, such as rooftop solar or local hydro, must be a part of this plan. Together, net-metering and distributed generation increase the resiliency of the grid, increase distribution efficiency and provide a greater degree of energy self-sufficiency to our state. Distributed energy resources should also include microgrid systems and energy storage facilities, which would help build reliability and level out the intermittency of some renewable energy sources (such as wind, solar and hydro). It is encouraging that the governor signed HB715 into law, opening the door to energy storage in NH.

In light of the fact that the cost of Energy Storage is declining while the technology is becoming more efficient, the legislature and the PUC should create an RPS that sets energy storage targets as a separate, fifth Class. New Hampshire’s RPS provides us with directives to meet future goals, encouraging businesses to provide the needed investment, products and services with stable, long-range milestones.

Energy Storage resources are one of the important elements of a smarter and more flexible electricity grid. Energy Storage provides a way to address a weakness of intermittent renewable energy resources like solar and wind. Intermittent resources do not provide continuous energy, but may only operate 20% to 75% of the time. Not only does energy storage allow surplus energy to be stored, but it allows cheaply generated energy to be dispatched when demand is highest, and energy is usually most expensive. These resources have the capability to provide other “ancillary services”, such as smoothing surges and load balancing, that make the grid more stable and efficient. They have the potential to reduce both the transmission and distribution portions of our electric bills, for which they cannot not currently be compensated under existing law.

Without storage, the current grid must stand ready to add in generators in real time to match sudden increases in demand, for example as dinner is being prepared simultaneously in every NH household. One of the most important benefits that energy storage could provide is to displace older, and dirtier, fossil fuel “peaker plants”, which are only operated infrequently (perhaps just a few hours a year on the hottest days) when the electricity demand is extraordinarily high. If sufficient energy storage existed, those peaker plants would not need to be paid all year to “standby”, producing nothing.

A step in the right direction was the governor’s signing of HB 715 which directs the PUC to develop ways to properly compensate energy storage resources including so-called BYOD (Bring Your Own Device) which would allow an energy customer to provide their own energy storage devices that could be linked to the grid and receive compensation for the service provided.

Microgrids are another new concept allied with Distributed Energy resources. Microgrids routinely function as an integrated portion of the larger utility grid, but can become an autonomous “energy island” that meets local energy needs if the larger grid fails for any reason. Microgrids provide both flexibility and local control because they function “behind the meter” that connects them to the regional transmission grid. Within the microgrid any combination of conventional fossil fuel resources and renewable energy resources can be connected and managed as one system. They have their own control systems and can adjust their resources according to their customers’ needs or preferences (say, for a municipal 100% renewable goal) without involvement of the primary grid. A microgrid provides both resiliency and reliability for its customers, by being able to continue operations even when the primary grid suffers a power outage due to a weather disaster or cyberattack. In fact, microgrids can act as emergency islands for adjacent municipalities, when needed. As a small or community-scale energy resource, the microgrid’s managers can modernize their own local equipment and reduce redundancy of individually-operated backup power systems.

While facilities like the Portsmouth Naval Shipyard and Concord Hospital already are microgrids, the University of New Hampshire is working with TRC Portsmouth and its utility partners to create a microgrid for the University’s Durham campus.

New Hampshire should encourage the possibilities for microgrids to be sited at other locations in our state. Even though HB 1301 did not get a final vote during the past session, it should be resubmitted, because it creates a study committee to identify areas and applications within our state that would benefit from microgrids.

HEATING

If our state plans to shift to a renewable energy economy in the future we need to decarbonize our “Heating Energy”. Currently NH uses approximately 324 Trillion BTUs of energy annually, with 33% dedicated to heating. If we wish to reduce our GHG emissions, there are three primary steps we could consider:

- Switching from oil and coal heating, to natural gas
- Heating homes exclusively with electricity (preferably from clean energy sources)
- Replacing fossil fuels with low- or zero-emission fuels including future hydrogen (H2) and renewable natural gas (RNG) suppliers

Natural gas is seen by many as a “bridge fuel” as part of the transition from dirty fossil fuels like coal and oil, to a zero-emission renewable energy future. But in pursuit of our goal of clean energy by 2050, the co-editors strongly believe it is not a good strategy to expand fossil natural gas capacity and plants in NH during the remaining 30 years until that goal is achieved. Natural gas is a reduced-carbon fuel, but is not carbon emission free. Expansion of clean energy production is required, not further fossil fuel expansion.

If a NH customer today wishes to electrify their heating, an air source heat pump (ASHP) would be the most promising technology, because it moves more than three times as much heat energy into a home as it consumes in electricity, even at cold temperatures. Additionally, the ASHP can be used both as a space-heater (in the winter) and an air conditioner (in the summer). Unfortunately, up-front costs today still make it too expensive for most NH residents. However, prices are declining and if the State would offer more inducements such as financing or energy efficiency grants, there would be more such installations.

In the near future, a greater supply of renewable natural gas (RNG), recovered from landfills and waste-water treatment facilities could be made available, reducing somewhat the need to import out-of-state natural gas. Moreover, capture of landfill methane (itself a powerful GHG) would prevent its leakage into the atmosphere. An intriguing future fuel option could be the use of hydrogen (H2) for home heating use, in combination with H2 fuel-cell technology.

With the exception of a small number of electric vehicles, New Hampshire is almost entirely dependent on out-of-state petroleum resources for our Transportation needs, using gasoline or diesel fuel. We must begin to decarbonize our transportation fuels which contribute the largest portion to our total GHG emissions. While many of our neighboring states have begun tackling this challenge, in NH efforts to move forward have been stymied by partisan politics, without alternatives suggested. Even a bill recommending that our state begin procuring low- or zero-emission vehicles for our state government fleet, where appropriate, has met with strong opposition by the governor.

However, progress is being made regarding electric vehicles (EVs). SB 275 requires the PUC to issue standards for electric charging stations. In addition, an Electric Vehicle Charging Station Commission will be issuing its recommendations to disburse the VW Dieselgate Settlement monies by the end of 2020.

In the meantime, thirteen Northeastern jurisdictions have agreed to work on a Transportation and Climate Initiative (TCI) to develop clean transportation options. (The TCI has some resemblance to RGGI.) Currently, our governor is opposing this initiative, and the legislature must take action to join the TCI group.

However, other initiatives such as the purchase of electric vehicles for school buses and municipal use could go forward locally. In addition, we must build more support for commuter rail, and inter- and intra-state bus service.

Nuclear power provides a continuous "base-load" supply of electrical power to the grid at a reasonable price, without emitting GHG. It would be difficult to quickly replace the amount of electricity provided by Seabrook for use in NH with a sufficient quantity of renewable energy. To date, no advanced type of nuclear plant has been developed and approved for commissioning in the United States.

However, a number of crucial questions surrounding nuclear power still have not been resolved. The consensus of most energy experts is that smaller, diverse, distributed energy resources (including wind, solar, hydro, and biomass microgrids) are safer, more resilient and more reliable than large expensive centralized energy generation (nuclear, coal or natural gas plants). Nuclear is not a renewable energy source. Unresolved issues also include: weapons proliferation, national security issues, plant security, and the environmental fate of nuclear fuel and mining waste.

At this point in time, biomass energy provides a base-load transitional, renewable energy source that will have difficulties in the future competing with other renewable energy resources. However, the electricity generated is a mere byproduct of the forestry industry and provides other benefits to our state. These include jobs and a healthy environment for tourism and public health, as the result of the intelligent forest management. To maintain healthy forests that are significant contributors to capturing CO_2 emissions both on public and private lands, there needs to be active management. Our state has always supported our forest management businesses, and it is extremely important that we continue to help them to properly maintain our wooded areas by thinning forests and removing dead trees and wood waste. Local industries and local families can prosper from maintaining these wooded areas, by way of thinning the forests and removing low-value trees, sawlogs and wood waste, as well as selling and servicing the specialized equipment required. A new concept called "reforestation" claims to be able to increase the carbon capture and storage capabilities of forested

areas, increasing healthy sustainable growth by more intense forest management. According to a professional forester, passed on by Jasen Stock of the New Hampshire Timberland Owners Association: “a no-cut/old forest/wilderness area makes a good carbon sink, but it represents carbon sequestered in the past. What we need to fight climate change is maximum sequestration today and in the future - that does not happen in wilderness areas/older forests. Young to middle-aged forests (pole to small sawtimber forests) are the best ones to sequester the most carbon today and in the future“. (See publication: UMass/UVM -Forest Carbon
- https://masswoods.org/sites/masswoods.org/files/Forest-Carbon-web_1.pdf)

All of these forestry efforts cannot succeed unless there is a market for these services and products, otherwise that industry and its positive economic impact will disappear.

The economic value from forestry for our state was recently documented by a Plymouth State University study (July 2020). It found that the biomass and forestry industry accounts for a grand total of 932 jobs and a payroll contribution of $50.9 million/yr. That industry also contributes $7.3 million/yr. in tax revenues to the state and local municipalities. Finally, while more difficult to quantify, it also contributes to New Hampshire’s tourism industry, which represents $3.1 million/yr. in economic activity. (See also: “Facts about New Hampshire” https://nhtoa.org/general/61-facts-about-new-hampshire-s-forest-and-forest-economy.html)

Supplying fuel for 6.7% of NH households today, producing fuel wood has been an integral part of good forest management for many years. The ongoing transition from old-fashioned, draft-limited wood-burning stoves to newer modern cleaner burning stoves, including those that use wood pellets has already provided significant environmental benefits in our state and throughout the country. Other new developments in the biomass industry include portable biomass electric generation units, and a new technology being championed in Canadian British Columbia for processing waste wood into renewable natural gas, not originating from fossil fuels.

While fossil fuels require millions of years to transform into a fuel (which is why they are not a renewable energy source) biomass is considered worldwide a renewable energy source. Its renewable cycle can be as short as 1 year for some crops (such as *Brassicas napas*, aka “canola oil”) or as long as 90 years for mature hardwood trees.

New Hampshire should continue to support our biomass industry to ensure secure and useful jobs for NH residents, e.g. by encouraging the use of modern wood stoves, the use of clean pellet fuels and for the generation of biomass electricity within the requirements that are needed to earn Renewable Energy Credits (RECs).

Among the most promising opportunities for NH to increase in-state renewable energy production is offered by solar energy. Currently solar energy only represents 0.7% of our electricity production. Total NH solar resources currently supply only 0.29% of NH’s total energy budget. In comparison, Massachusetts and Vermont get 15% and 14% of their electricity from solar today. We need a much bigger portion of our energy budget to come from solar, perhaps 20% by 2035, especially as EVs are adopted. We are missing out on good jobs and lucrative in-state economic development opportunities because of our low RPS goal for solar energy. It is important to remember that we are competing with other New England states for both jobs and economic activity in an emerging market for renewable energy generation. If we do little, we continue to fall behind them and permanently lose our claim on a share of the market.

Because of our low solar RPS goal, NH utilities whose energy mix barely meets the too-modest goal of containing 0.7% renewable energy content, are excused from buying Renewable Energy Certificates from renewable energy suppliers. Because they don't buy enough RECs , demand and prices for solar energy are further depressed, shrinking the market incentive to build more solar energy resources in our state. Our RPS goals need to be raised to send a signal to the market that NH values renewable energy, and desires rapid private investment in distributed solar energy.

Increasing the net-metering cap from 1 to 5 MW would also be a big step in the right direction. NH's Renewable Energy Fund (REF) needs to be replenished so that incentives are available to assist NH citizens to overcome the high start-up cost to harvesting free energy, whether these are residential or commercial installations. We should not lose sight of the fact that installing in-state energy resources will benefit our business community, our residents, our environmental (leaf-peeping) tourism industry and positively impact climate change issues. By pushing down demand for imported energy, in-state energy resources help keep capital in NH and also reduce NH's regional (interstate) transmission costs, which benefits all NH electricity consumers.

We have already started losing solar energy jobs to other states. Clean energy jobs peaked in 2017 at 1200, but by 2019 were down to 800 jobs. Opportunities to boost these job numbers include promoting more virtual net-metered community solar projects and allowing municipalities to fully exhaust all the solar energy potential available in their respective towns.

State policies should be geared to encouraging a "smart grid" that will easily accommodate new distributed energy resources, such as rooftop solar. Barriers to community solar development should be removed and the state should implement standardization and compatibility guidelines for solar installations, so costs to customers for new installations are reduced. Finally, revenues need to be found so that the state credits for solar installations are available all year long, instead of shutting down on July 1 because all funds have been exhausted before demand has been met.

By far, the greatest potential for a new energy resource is offered from the installation of offshore wind energy generation. Even though the proposed timeline for the Gulf of Maine projects that it could be roughly 10 years until the first turbine is installed, NH's offshore wind energy potential is enormous. It is claimed that the Gulf of Maine (centrally served by New Hampshire's deepwater port, Portsmouth) is the best location for wind energy generation in the United States, and among the best locations in the world.

If we can encourage the development of this new energy industry on our shores, it would have a huge positive impact on NH's economy, providing thousands of good-paying jobs for at least several decades. At this time, wind turbine manufacturing is primarily centered in Europe. It is reasonable to expect that, at least initially, large turbines would have to be shipped from Europe to New England for installation. However, it is inevitable that those European companies would quickly attempt to establish a presence on the Northern Atlantic coast for manufacturing and maintaining the wind turbines along the Gulf of Maine. This would bring a whole new large industry to New England including the skilled jobs that go along with that, as well as the marine services that would be needed to maintain, repair and ultimately upgrade wind turbine installations. New Hampshire should move aggressively to become a center for that activity.

In September 2020, Massachusetts Speaker Pro Tempe Patricia Haddad reported that Massachusetts had already started accepting bids on 1600 MW of offshore wind projects, and is considering legislation to authorize 3600 MW more. In contrast, Maine has only one small 12 MW pilot project and NH has none proposed at this time.

The Gulf of Maine has relatively deep waters so that floating turbines will be required, These have already been tested and are operating in European waters. Within the last 10 years the capacity of one offshore wind turbine has tripled to 12 MW, while construction and installation costs have been dropping. According to a 2010 US Department of Energy report, the Gulf of Maine has a power potential of 200 gigawatts, the equivalent of 70 Seabrook Nuclear Power plants), within 50 miles of the coastline. Even within limited NH waters, the DOE estimates 2 gigawatts of wind power capacity is economically accessible, which represents more power than is generated in NH by the Seabrook nuclear plant. Estimates say that wind energy alone could provide 100% of New Hampshire's energy needs by 2040, if we deployed turbines using existing technology.

New Hampshire appears to be moving ahead in the area of offshore wind. Last year Governor Sununu requested that BOEM (Bureau of Ocean Energy Management - the federal agency in charge of issuing licenses for offshore energy activities) allow our state to participate with Maine and Massachusetts on the BOEM-led intergovernmental offshore wind task force. In addition, the Governor also signed into law SB668-FN (sponsored by Senator Watters, and which was incorporated into omnibus bill HB 1245) to create a New Hampshire Offshore Wind Development Commission to coordinate state activities with the BOEM taskforce. One way that these efforts could be supported by our state in the future, is for New Hampshire to commit, as other states have done, to guarantee that a certain amount of wind energy will be procured for use by state utilities, community power programs and state agencies.

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- The Co-Editors

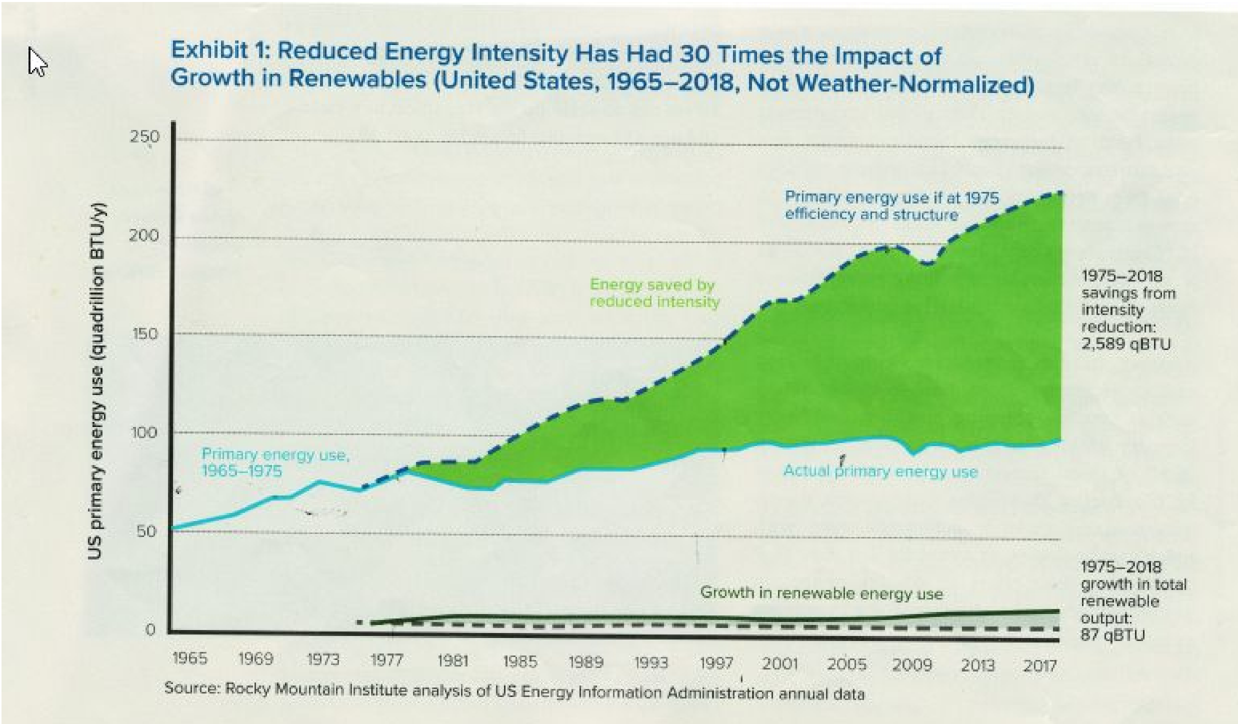
Contributors:

Peter Somssich (Co-Editor and State Representative-STE Committee, tel. 603-436-5221, staterep27nh@gmail.com), Ken Wells (Co-Editor and State Representative-STE Committee, tel. 603-735-5756, kenwells3@gmail.com), Robert Backus (State Representative-STE Committee, tel. 603-867-7277, robertbackus05@comcast.net), Chris Balch (State Representative-STE Committee, tel. 603-654-6433, chris1953balch@gmail.com), John Mann (State Representative-STE Committee, tel. 603-499-3088, john.mann67@comcast.net), Howard Moffett (State Representative-STE Committee, tel. 603-783-4993, howard.m.moffett@gmail.com), Lee Oxenham (State Representative-STE Committee, tel. 603-727-9368, leeoxenham@comcast.net), Tom Rooney (TRC Portsmouth, tel. 603-766-0781, trooney@trcsolutions.com), David Watters (State Senator-Senate Energy & Natural Resources Committee, tel. 603-969-9224, david.watters@leg.state.nh.us), Kat McGhee (State Representative-STE Committee, tel. 617-791-3166, kat.mcghee@leg.state.nh.us), George Saunderson (State Representative-STE Committee, tel. 603-783-4750, saunderson.george@gmail.com), Dan Weeks (Revision Energy, tel. 603-264-2877, dweeks@revisionenergy.com), Doug Bogen (Seacoast Anti-Pollution League-SAPL, tel. 603-664-2696, dbogen@metrocast.net),

Advice, Research and Copy-Editing:

Lee Oxenham, Kent Howard

Appendix 1: Historical Data for USA Energy Intensity 1965-2017 (Amory Lovins)



The Power of Energy Efficiency and Integrative Design:

The potential of energy efficiency combined with integrative energy design is demonstrated in the graph above. The graph depicts the US primary energy use from 1965 to 2017. The upper dashed line (approx. + 4.9% per year) shows the consensus energy use predicted in 1975 based on efficiency and structure in place at the time (1). The lower solid line (approx. + 0.9% per year) shows the actual energy use as it occurred from 1977 to 2017 (almost exactly as predicted by Dr. Lovins in 1975 (2)).

The difference between the two curves (area in green) is the total amount of energy that was saved through energy efficiency and integrative design. The graph shows there was an actual 43% energy savings since 1975 versus the 1975 consensus projection, an amount of energy savings that is 30 times the amount generated from renewable energy sources since 1975.

Source:

(1) Amory Lovins: Forbes/ Jan.21, 2019 https://www.forbes.com/sites/amorylovins/2019/01/21/the-invisible-energy-bonanza/
(2) Amory Lovins: Foreign Affairs, Oct. 1976, “Energy Strategy: the road not taken”.