City of Keene
*New Hampshire*

**PLANNING, LICENSES AND DEVELOPMENT COMMITTEE AGENDA**
**Council Chambers A**
**January 13, 2021**
**7:00 PM**

Kate M. Bosley, Chair
Mitchell H. Greenwald, Vice Chair
Philip M. Jones
Gladys Johnsen
Catherine Workman

1. Keene Sustainable Energy Program – Energy and Climate Committee

2. Councilor Clark - Relating to Small Wireless Facility Deployments in Public Rights-of-Way

3. Lori Schreier - Relating to Small Cell Wireless Facility Deployments in Public Rights-of-Way

4. Herman Kelting - Relating to Small Wireless Facility Deployments in Public Rights-of-Way

## MORE TIME ITEMS:

A. The Downtown Re-Opening Committee and Keene Young Professionals Network - Keene Food Festival

B. Relating to Social Service and Congregate Care Uses and License

C. City of Keene Land Development Code and Downtown Zoning Update

Non Public Session
Adjournment

Due to the COVID-2019 State of Emergency, the Planning, Licenses and Development Committee will be holding its meeting remotely using the web-based program, Zoom. Members of the public will be able to access this public meeting through a variety of options, described below. If you encounter any issues accessing this meeting, please call 603-757-0622 during the meeting. To access the meeting online navigate to Zoom.us and enter the Webinar ID # 895 8612 3552. To listen via telephone call 877-853-5257 and enter the Meeting ID: 895 8612 3552. When the meeting is open for public comment, callers may press *9 if interested in commenting or asking questions.

# Keene, NH Sustainable Energy Plan

December 2020

# ACKNOWLEDGEMENTS

The City of Keene gratefully acknowledges the participation and efforts of the following people and groups in the creation of this plan. Keene is indebted to your continued commitment to creating a sustainable, resilient, and thriving community powered by renewable energy.

## Mayor & City Council

Mayor George S. Hansel
Janis O. Manwaring
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Terry M. Clark
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Catherine Workman
Philip M. Jones
Thomas F. Powers
Randy L. Filiault
Bettina A. Chadbourne
Kate M. Bosley
Michael J. Remy
Stephen L . Hooper

## Energy & Climate Committee

Dr. Ann Shedd, Chair
Peter Hansel, Vice Chair
Rodney Bouchard
Councilor Terry Clark
Andrew Dey
Kenneth Dooley
Dr. Cary Gaunt
Zach Luse
Jake Pipp
Paul Roth
Anna Schierioth

## Special Thanks

Clean Energy Team
Charlie Pratt, Transportation Manager, City Express Bus
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Morgan Urquia — Planning Intern
Northeast Energy Efficiency Partnerships (NEEP)
Shaylin Salas — Communications & Outreach Intern
Southwest Region Planning Commission
The Cadmus Group

In addition to those mentioned above, the City of Keene thanks the focus group participants, interviewees, and community members who shared their feedback, ideas, and expertise with the City. Your participation was invaluable to the creation of this plan.

Cover photo credit: ReVision Energy

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# CHAPTER 1 | INTRODUCTION

## Keene's Sustainable Energy Goals

On January 17, 2019 the Keene City Council passed Resolution R-2018-36, which set a goal to transition Keene to a 100% renewable energy future by 2050, with an interim goal to reach 100% renewable energy for all electricity by 2030. This Sustainable Energy resolution highlights the City's long-standing commitment to climate action, and calls on the City to develop a strategic plan to achieve its renewable energy goals by December 2020. The full text of this resolution is included in Appendix A of this plan.

> "It is the goal of the City of Keene that all electricity consumed in the City will come from renewable energy sources by the year 2030 and that 100% of all thermal energy and energy used for transportation come from renewable energy sources by the year 2050. This goal will apply to the entire Keene community, not just municipal government operations."
> - Resolution R-2018-36, "Sustainable Energy Goals"

## A History of Climate Action

Keene's commitment to pursuing these sustainable energy goals is consistent with the City's long history as a climate leader. The City made its first formal commitment to climate action in 2000, when it joined the Cities for Climate Protection campaign and formed the "Cities for Climate Protection Committee", later named the "Energy and Climate Committee." This Committee, which is comprised of residents and business leaders in Keene, has worked on a number of initiatives over the past two decades. In 2001, the City's first greenhouse gas (GHG) emissions inventory was completed for baseline year 1995, and in 2004, the City adopted a climate action plan which set 20-year GHG reduction targets for both the community (10% reduction below 1995 levels by 2015) and local government (20% reduction below 1995 levels by 2015). In 2007, the City of Keene was one of the first communities in the nation to develop a Climate Adaptation Plan, and in 2010, many of the City's climate mitigation, adaptation, and sustainability goals were incorporated into the Comprehensive Master Plan.

Leading up to and following the adoption of the 2004 Climate Action Plan and the City's GHG reduction targets, the City took a variety of steps to reduce carbon emissions. Major accomplishments include the following:

- In 1994, the City installed a partial methane recovery system at the municipal landfill, and expanded the system when the landfill was capped in 1999. This methane-to-energy system powered the landfill for over 25 years, until the supply of methane from the capped landfill began to run out. In 2018, the City received an EPA Climate Showcase Community Grant to replace the methane-to-energy system with a generator that runs on biofuel made from 100% post-consumer vegetable oil.
- Since 2002, the City has been using a biodiesel blend to fuel its vehicle fleet to reduce emissions and fumes. In 2005, the City added hybrid vehicles to the fleet to further reduce emissions.
- In 2003, the City installed a geothermal HVAC system at the Public Works facility on Marlboro Street in Keene, and in 2018, the City installed the largest solar PV array in Keene at the time (643.2-kilowatts) on the roof of this same facility.[1]
- Between 2000-2017, all traffic signals, airport beacons, parking facility lights, and street lights in Keene were converted to LEDs.
- The City entered into an energy services contract from 2011-2020 to make various building envelope and lighting upgrades to City facilities and replace outdated systems, such as the chiller at City Hall.
- In 2015, the City made a commitment to the concept of "Complete Streets," formalizing its long-held approach to designing City streets to enable access and mobility for everyone, including pedestrians, bicyclists, children, older adults, and people with disabilities.[2]
- Over the past three decades, the City has prioritized infrastructure improvements that support reducing emissions, reducing traffic congestion, and increasing safety for walkers and bicyclists. Some of these infrastructure improvements include replacing five signalized intersections with roundabouts, improving rail trails and pedestrian infrastructure in the downtown and near schools, and installing pedestrian bridges over busy state routes to connect the Cheshire Rail Trail and Ashuelot Rail Trail to downtown Keene.
- Since 2007, the City has offered a property tax exemption for renewable energy systems, including solar energy systems (total assessed value), woodheating energy systems (up to $10,000), and wind powered energy systems (total assessed value). [3]
- In 2019, the City entered a two-year contract with Constellation Energy to procure Green-e® Certified Renewable Energy Certificates equivalent to 100% of municipal electricity use beginning in 2020.

## Spotlight: Clean Energy Team

The Clean Energy Team (CET) is a grassroots group of Keene residents, businesses, and leaders from education, faith, nonprofit and other sectors that works to make energy efficiency and renewable energy options accessible for residents and businesses in the Monadnock region. In 2018, the CET heard about the Sierra Club "Ready for 100" campaign, a national movement to transition communities in the United States to 100% clean and renewable energy. The CET knew they wanted to pursue this in Keene.

At the start of this effort, CET members made it a priority to listen. They interviewed City Council members, the Mayor, city and regional planners, and business owners to hear their concerns and ideas. Then, they led a public outreach campaign to share their vision with the public through tabling at events, participating in a local climate march, and getting signatures for a petition to City Council.

After extensive outreach and building public support for 100% renewable and clean energy goals, CET wrote a letter to the City Council asking them to adopt a 100% Renewable Energy Resolution, and delivered this letter along with a petition with signatures from Keene residents and businesses. The Mayor assigned it to the Municipal Services, Facilities, and Infrastructure Committee. On the night of the Committee's hearing, the room was filled with supporters of the resolution, all wearing green; over 20 members of the public spoke at the hearing to ask the City to pass the resolution. The Committee ultimately voted for the Resolution to be considered by the full City Council. On January 17, 2019 the City Council voted to adopt the Sustainable Energy Resolution.

*Above: Clean Energy Team (CET) memers and supporters attended a City Council committee meeting on November 19, 2018 to express support for the then-proposed renewable energy goals. Photo credit: CET.*

## Planning & Public Engagement Process

Following the passage of the Sustainable Energy Resolution, City staff began working with the Keene Energy and Climate Committee (ECC) and other community partners to obtain input on the energy plan vision, strategies, and objectives. During the spring of 2019, staff interviewed 18 key stakeholders in the community and worked with the ECC to develop a community engagement plan. This plan called for a series of three focus groups with the following stakeholders: 1) residential landlords, 2) businesses, and 3) large energy users (e.g. Cheshire Medical Center, Keene State College, and Hillside Village). The first focus group was held in August 2019, and the second and third focus groups were both held in February 2020. During this same timeframe, the City hired an energy planning consultant, The Cadmus Group ("Cadmus"), to conduct a baseline analysis of electricity consumption in Keene and help the City identify strategies to achieve 100% renewable electricity by 2030.

Outreach to the public kicked off in October 2019 with an in-person workshop held at Keene State College. Throughout the Fall 2019 and Winter 2020, the City worked with community volunteers to hold a series of 14 volunteer-led group discussions at various locations in the community to gather input from residents of Keene and surrounding towns. In addition, City staff presented at various local schools and civic organizations, including but not limited to MC2 Charter School, Surry Village Charter School (in Keene), the Rotary Club of Keene, and the Elm City Rotary Club. The summary notes and feedback from these discussions were shared with City staff and Cadmus to help inform the strategy prioritization process for the energy plan. Based on the priorities expressed by Keene residents at these meetings, Cadmus developed a preliminary list of criteria to evaluate and rank sustainable energy strategies. These criteria were refined by the ECC, then used to rank and prioritize strategies and actions to achieve the City's energy goals.

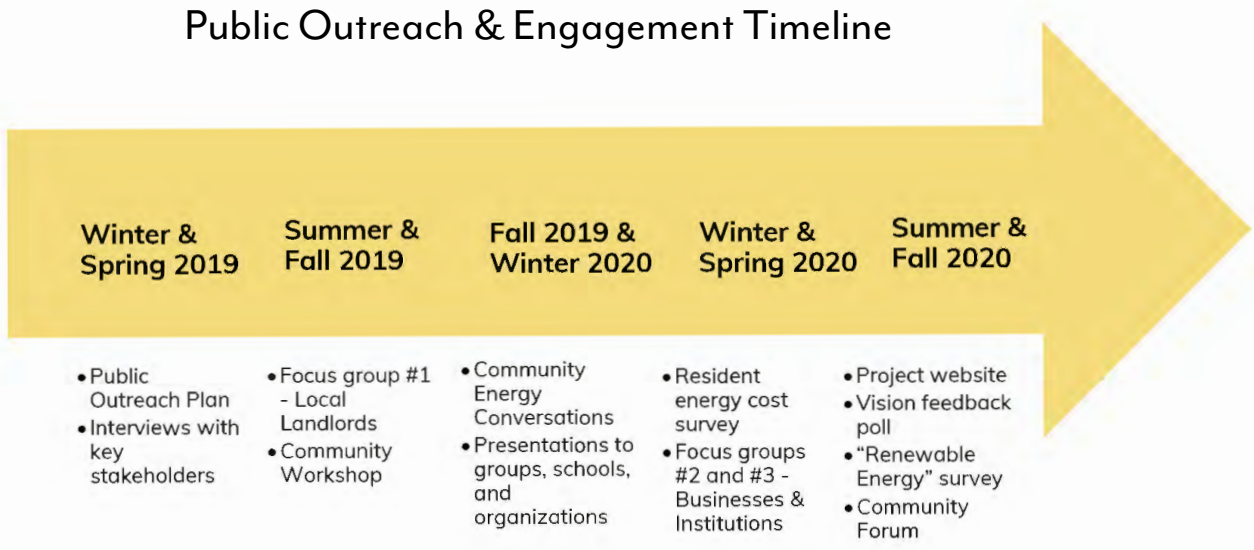



*Figure 1.1. Summary of the public outreach and engagement timeline for the Sustainable Energy Plan project.*

In April 2020, The Cadmus Group gave a public presentation summarizing their final report, "City of Keene Renewable Energy Transition Analysis." This 1.5-hour virtual community meeting gave an overview of the Keene's electricity context, summarized the findings of the electricity baseline analysis for the City, and gave a brief overview of six renewable energy strategies for the City to consider. A shorter presentation covering these same topics was provided at the City Council meeting later that same day. The full report prepared by Cadmus is attached to this plan in Appendix B.

Throughout the winter of 2020, staff worked with a group of students from Keene State College to conduct a Resident Energy Use Survey to better understand how energy costs for electricity, heating, and transportation affect residents in Keene. The results of this online survey, which garnered 75 responses, were shared with the ECC and presented at a KSC student research symposium. The summary of responses to this survey is included in Appendix C. In addition, staff collected data for the thermal and transportation energy baseline analysis and compiled baselines for thermal and transportation energy use. These baseline chapters were shared with the ECC at their regular meetings, and are summarized in Chapter 3 of this plan.

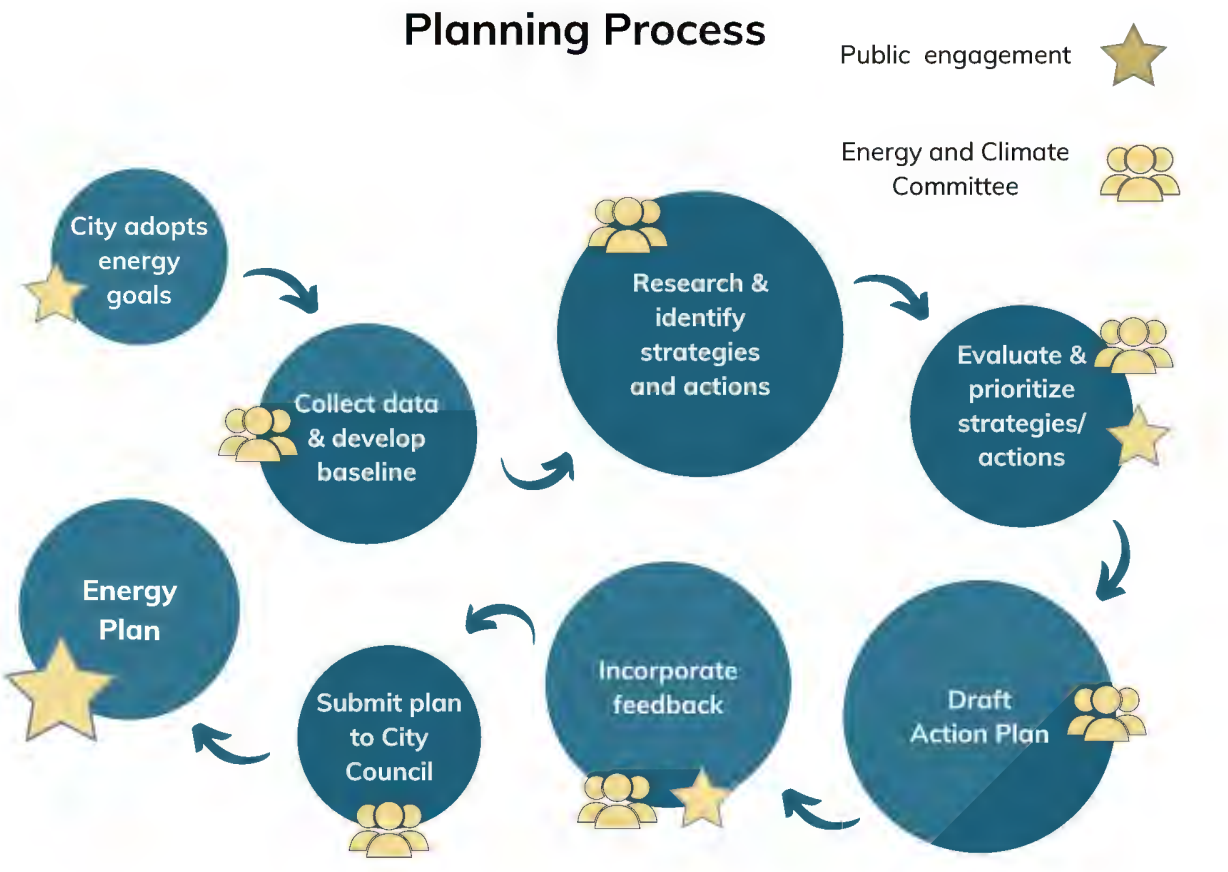



*Figure 1.2. A graphic that provides an overview of the planning process that City staff and the Energy & Climate Committee (ECC) followed in developing the Sustainable Energy Plan.*

In the summer of 2020, the City worked with a Sustainability Fellow from the University of New Hampshire Sustainability Institute to launch a project website (KeeneEnergyPlan.com) to gather public feedback through online polls and surveys, share educational information and resources, and highlight local success stories. This website also features podcast-style episodes to help explain key programs and actions proposed within this energy plan.

## Energy Plan Guiding Principles

The public input that the City received helped the ECC to identify several key guiding principles for this sustainable energy plan:

I. **"Renewable Energy" should be defined as green power sources that have the most environmental benefits and the fewest adverse impacts.** The City should transition to sources of energy that are both renewable and clean, such as solar, biomass, geothermal, and low impact hydropower. This approach is aligned with the U.S. EPA's definition of green power sources.[4]

II. **Equity should be at the forefront of the City's efforts for a just transition to a sustainable energy future.** Economically disadvantaged residents, older people and children, people who are experiencing homelessness, people with disabilities or health conditions, and members of minority groups experience the impacts of climate change disproportionately. The City should prioritize strategies and actions that reduce existing inequities and advance a future that benefits everyone in Keene.

III. **Energy efficiency measures that drive down energy demand should be the first step in the path to a renewable energy future.** The most inexpensive source of energy with the least impact is the energy we do not use. By prioritizing and promoting energy efficiency, the City can help residents, businesses, and others save money and make the goal of sourcing all of our energy from renewable sources more attainable.

IV. **Keene should harness the economic opportunity of clean energy in order to create jobs and attract new talent.** Clean energy jobs are growing; the renewable energy sector employed approximately 786,000 Americans in 2018,[5] and the energy efficiency sector employed over two million in 2019.[6] As the City increases renewable energy and energy efficiency projects, the demand for talent will increase, too. Keene residents can fill this job demand, which keeps money in our community.

V. **Keene's movement towards 100 percent renewable energy use should support climate resilience and preparedness.** The City should anticipate and prepare for disruptions from a changing climate by embracing new technologies and building partnerships with community members, businesses, and institutions. In this way, Keene can better support and respond to residents' needs.

## Defining Renewable Energy

Renewable energy sources are those that restore themselves. The Energy and Climate Committee recommends refining this definition of "renewable energy" to include only those renewable energy sources that have the most environmental benefits and the fewest adverse impacts. This approach is aligned with the U.S. EPA's definition of "green power," which is described as a subset of renewable energy, as shown in Figure 1. Green power sources include, but are not limited to, solar, biomass, geothermal, wind, and low-impact hydropower.

While all green power is renewable energy, not all renewable energy is considered green power. Large scale hydropower, for example, has impacts on fisheries and land use. For this reason, large hydropower is considered to be renewable, but not "green."

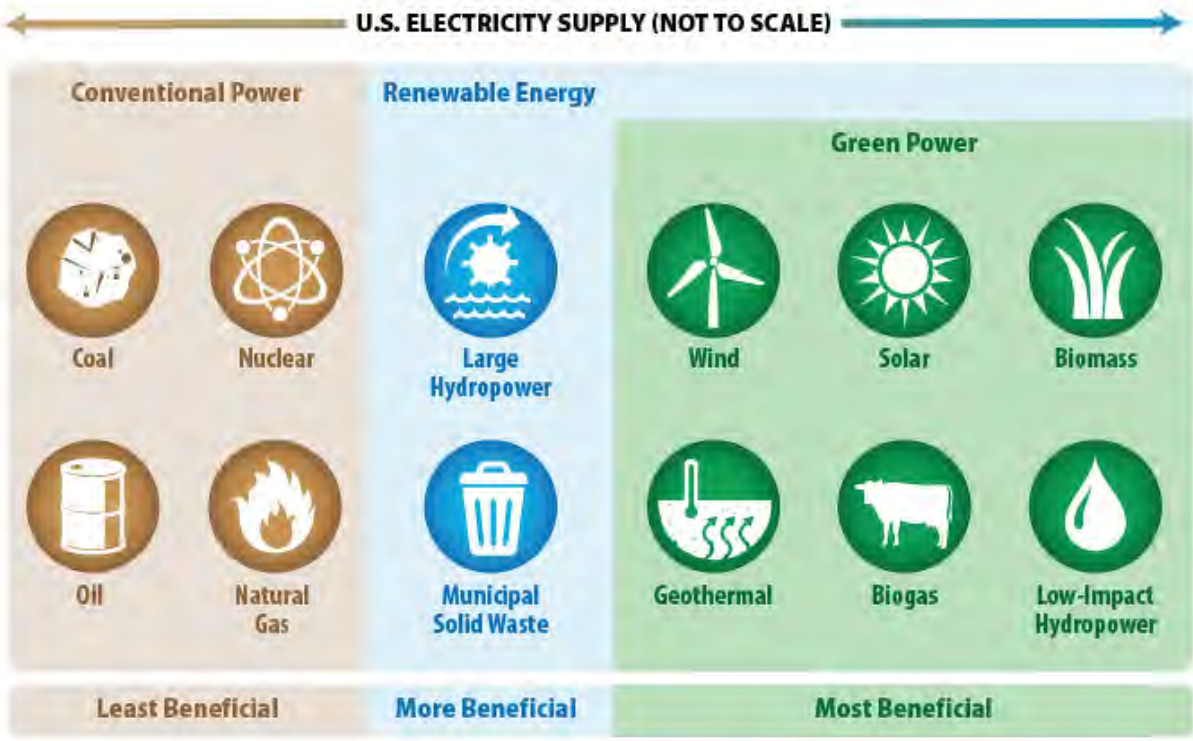



*Figure 1.3. A graphic that depicts how the United States Voluntary Market defines green power based on its relative environmental benefits. Source: U.S. EPA "What is Green Power" webpage.*

Keene residents were asked to weigh in on the ECC's proposed definition of renewable energy through an online poll. This poll included a brief description of renewable energy and green power, and asked residents whether Keene should include all renewable energy sources or just green power sources, or use a different definition. Twenty-one people responded to this poll, 15 of whom agreed with the ECC's proposal to use the definition of green power, 4 said the City should consider all renewable energy sources, and 2 responded "other" (see Figure 4). The full summary of responses to this survey, including written comments, is included in Appendix C.

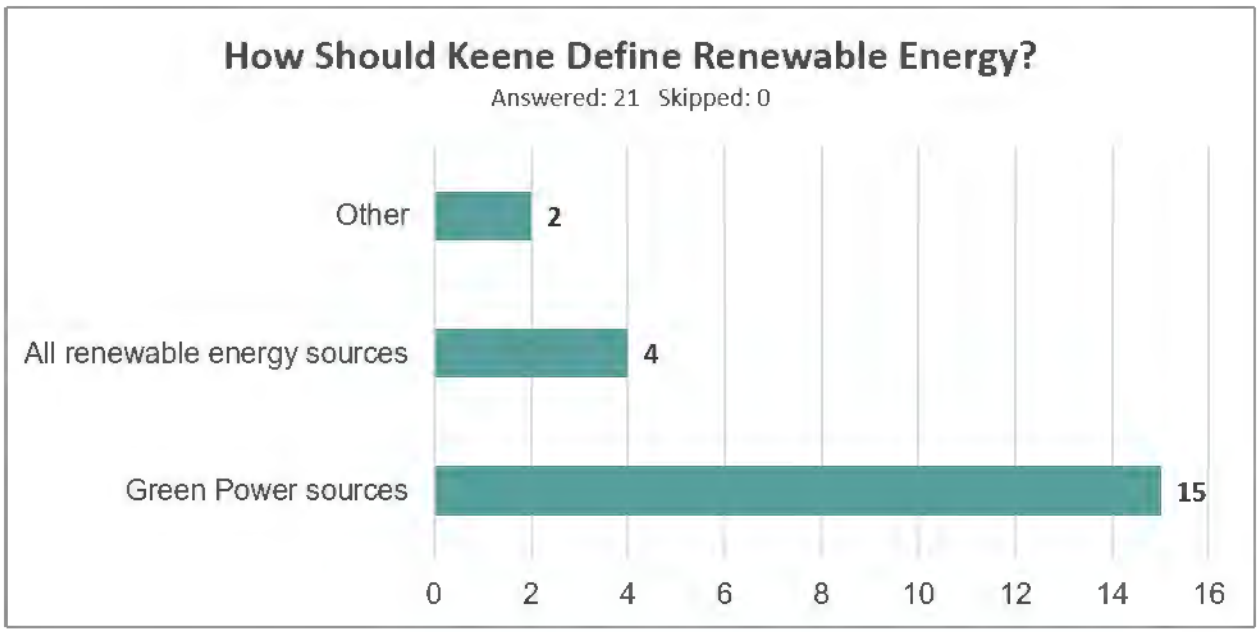



*Figure 1.4. Bar graph summarizing responses to the "Defining Renewable Energy" online survey that was posted throughout July and August 2020 on the www.KeeneEnergyPlan.com website.*

## Developing a Vision for Keene's Energy Future

At the beginning of the planning process, the Energy and Climate Committee held a 2-hour retreat to begin discussing their vision and guiding values for the sustainable energy plan. The vision and guiding values were refined as the committee received feedback and input from the public. Then, in July 2020, the ECC put forward a proposed vision statement and asked for input from Keene residents, businesses, and others with a strong connection to Keene. The goal of this vision statement is to provide a concise statement that answers the question: "Where do we want to go?" It describes Keene's values and aspirations as a community, and a shared image of what the community's energy future will become in the next 30 years.

**A Sustainable Energy Vision for Keene**

**In 2050, Keene will be a thriving and resilient community powered by affordable, clean, and renewable energy. All electricity and energy used for heating, cooling, and transportation will come from renewable energy sources.**

The public was asked to weigh in on this proposed vision statement using an online poll, which asked residents to indicate the extent to which they agree with the vision statement using a sliding scale of 0 (strongly disagree) to 6 (strongly agree). The results of this poll indicate that, in general, respondents agree with this vision statement. Of the 28 people who responded, 19 said they strongly agreed, 5 said they agreed, 2 were neutral, 1 disagreed, and 1 strongly disagreed. The average value of all responses was 5.1. The full summary of responses to this survey, including written comments, is included in Appendix C.

## Endnotes


1 City of Keene. “Solar panels installed on the roof of the Police/KeeneIce/Public Works buildings.” https://ci.keene.nh.us/our-city/news/solar-panels-installed-roof-police-keene-ice-public-works-buildings

2 City of Keene Community Development Department. “Complete Streets.” https://ci.keene.nh.us/community-development/projects/complete-streets

3 City of Keene Assessing Department. “Solar/Wind/Wood Energy System Property Tax Exemptions.” https://ci.keene.nh.us/assessing/solar-wind-wood-energy-system-property-tax-exemptions

City of Keene 2015 Greenhouse Gas Emissions Inventory (2018). https://ci.keene.nh.us/sites/default/files/Keene%20GHG%20Report%20FINAL_no%20draft%20mark.pdf

4 U.S. Environmental Protection Agency. “What is Green Power?” (Accessed 2020). https://www.epa.gov/greenpower/what-green-power

5 International Renewable Energy Agency. “Renewable Energy and Jobs--Annual Review 2018.” May 2018. https://www.irena.org/publications/2018/May/Renewable-Energy-and-Jobs-Annual-Review-2018

6 USEnergyjobs.org. “The 2020 U.S. Energy & Employment Report.” 2020. https://www.usenergyjobs.org/

# CHAPTER 2 | ROADMAP TO 2050

## Overview

Achieving the City's vision of becoming a thriving and resilient community powered by affordable, clean, and renewable energy will require collaboration between the City and community partners as well as coordination and support across all levels of government. There is no "silver bullet" strategy to reach this vision; rather, the City will need to enact a diverse array of policies, programs, and incentives with buy-in and support from the community. To reach the City's goals, it will be essential to reduce total energy use through energy efficiency and conservation, while simultaneously switching to renewable electricity and renewable fuels for heating, cooling, and transportation.

To guide these efforts, the Energy and Climate Committee identified four key pathways, or approaches, to achieving the City's energy goals: reduce energy use, generate and store renewable energy locally, and meet remaining energy demand through renewable energy procurement or fuel switching. Throughout this process, the City will need to advocate to remove barriers to renewable energy at the state and federal level, and inform the public of renewable energy options and resources.

## Pathways to 100% Renewable Energy:

**Pathway 1. Reduce energy use.**

By reducing community-wide energy use, Keene will reduce the amount of both nonrenewable and renewable resources consumed in the City.

**Pathway 2. Generate and store renewable energy locally.**

Generating renewable resources (like solar) in Keene can create jobs locally and keep money circulating in the community.

**Pathway 3. Switch remaining energy purchases to renewable sources.**

The City can meet its remaining energy demand by switching to renewable energy sources from outside Keene and the region.

**Pathway 4. Conduct ongoing advocacy and information sharing.**

Throughout this process, ongoing advocacy and information sharing will be critical in order to reduce barriers at the state and federal levels and increase community buy-in.

This chapter is organized into three sectors, which correspond to the City's sustainable energy goals: Electricity, Thermal (Heating and Cooling), and Transportation. Within each sector, a set of strategies and actions were identified as priorities for near-term implementation. These 17 priority actions are listed here and further described in Chapter 5 – Action Plan.

## Sectors in this Plan

### Electricity

This sector includes all electricity consumed within the City, including electricity consumed by residential, commercial, manufacturing/industrial, and municipal electricity accounts.

### Thermal

The thermal sector includes all energy used to heat and cool buildings located in Keene. Electrical energy used to heat and cool is counted under the electricity sector.

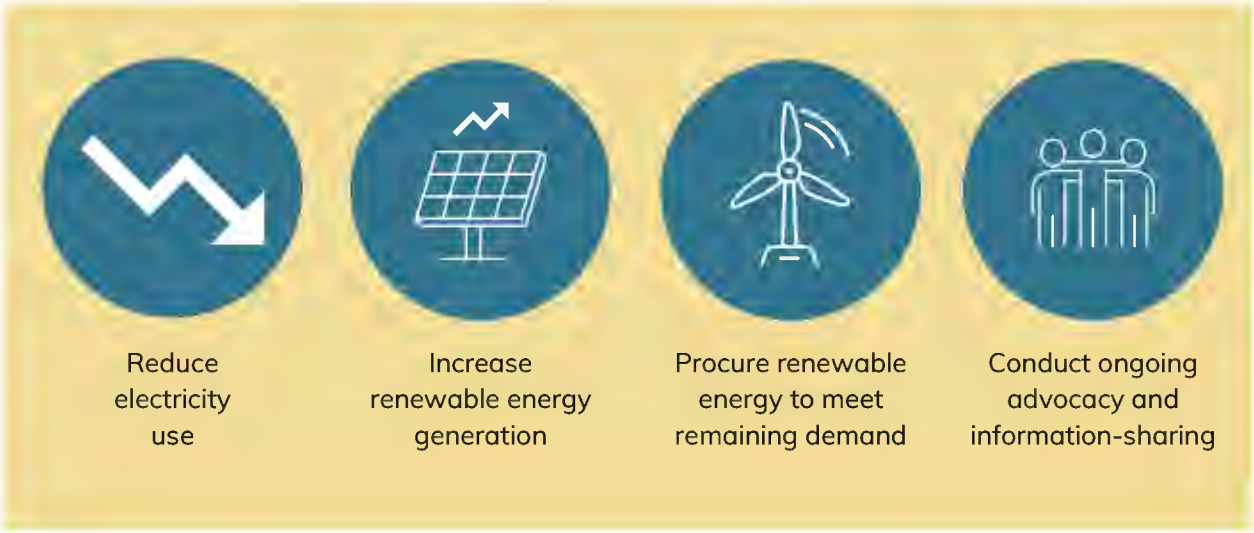
### Transportation

Transportation - In the context of this plan, the transportation sector is defined as the energy consumed by Keene residents to travel from place to place. This sector includes ground transportation only.

# ELECTRICITY SECTOR

Transitioning to a 100 percent renewable electricity supply by 2030 is a critical first step to achieving the City's goal to have all energy consumed come from renewable sources by 2050, as the electrification of thermal and transportation energy consumption will only be beneficial if the electricity source itself is clean and renewable. The main electric utility in Keene is Eversource, an investor-owned utility that delivers electricity and natural gas service to customers in New Hampshire, Connecticut, and Massachusetts. Eversource customers receive electricity from the New England power grid. In 2019, the NEPOOL system mix was approximately 20.1% renewable and 79.9% non-renewable. The 20.1% of renewable energy was comprised of hydropower (8.9%), refuse/other (3.5%), wind (3.4%), wood (2.4%), and solar (1.8%).

Because New Hampshire has a deregulated electricity market, investor-owned utilities, including Eversource, are not permitted to own and operate power plants that generate electricity. Retail customers are free to purchase energy from a competitive supplier, while the utility continues to provide transmission and distribution services. In 2019, there were approximately 15 residential[1] and 25 commercial/industrial[2] energy suppliers active in Eversource's territory. Eversource reported that approximately 22% of its residential customers and 58% of total customer load in New Hampshire had migrated to the competitive supply market by the end of the third quarter in 2019.[3]




## Pathway 1: Reduce electricity use for all buildings in Keene

Reducing electricity use in all buildings will help control costs by reducing total energy demand and limiting or deferring the need to upgrade the electricity grid. Examples of electric efficiency measures for buildings include weatherization, thermal envelope retrofits, plug load management, LED lighting, and using intelligent sensors and controls to optimize system performance in commercial buildings.

Priority implementation steps that fall within this pathway are listed below. These actions also fall within the Thermal Sector, as they impact both electrical and thermal energy consumption.

**I.** Adopt a "Home Energy Labeling" program for residences: Require energy efficiency disclosure for existing and new residential properties at the time a property is listed for sale or rent.

**II.** Adopt a Benchmarking Ordinance: Require building owners of certain sizes or in certain districts to report energy use data to the City. This program should start out as a voluntary policy, in order to encourage participation from building owners in a benchmarking effort to collect building energy use data.

**III.** Partner with existing weatherization programs to enhance public outreach and education, amplify impact, and increase capacity.

## Pathway 2: Increase renewable energy generation & storage

Generating renewable energy locally will maximize benefits to the local community by creating and supporting local jobs and businesses, reducing reliance on imported fuels, diversifying the electricity supply, and increasing the reliability and resilience of the grid to severe weather events and other potential system disruptions. Energy storage offers further opportunities for enabling increased use of renewable electricity generation, creating a more efficient grid that is resistant to disruptions, and creating jobs in supporting sectors such as manufacturing, engineering, construction, transportation, and finance.[4]

Priority implementation steps that fall within this pathway include the following:

**I.** Adopt solar photovoltaic (PV) and electric vehicle (EV) ready guidelines to encourage or require new developments to be built in a manner that accommodates future solar and EV charging station installations.

**II.** Partner with a local financial institution to create a loan product to finance renewable energy installations targeted at businesses or residents.

**III.** Work with the utility to develop a pilot battery storage program for residents and/or businesses in Keene.

## Electricity Pathway 3: Procure renewable energy to meet remaining electricity demand

The City recognizes that it will not be possible for all of the City's electricity demand to be met by generating renewable energy locally by 2030. For a variety of reasons, not all residents, businesses, and organizations in Keene will be able to install renewable energy systems. In some instances, up-front costs and financing can be a barrier, and in other situations, the physical limitations of a site (e.g. lack of solar exposure) may limit opportunities for on-site renewable generation. However, there are a variety of options the

City can pursue to provide the benefits of renewable energy to all residents, businesses, and other organizations in Keene, regardless of their ability to install renewable energy systems on their own property.

Priority implementation steps that fall within this pathway include the following:

**I.** Establish a Community Power Program – Aggregate community load and purchase electricity from an alternate electricity supplier, while still receiving transmission and distribution service from Eversource.

**II.** Virtual Power Purchase Agreements (VPPAs) by City- Enter into a long-term, fixed price contract for renewable energy from a specific project (i.e. agree to a contract for differences, or CfD). The renewable energy system developer sells the energy generated into the normal power market and uses the CfD as a hedge on the variable price of power.

## Electricity Pathway 4: Conduct ongoing advocacy and information sharing

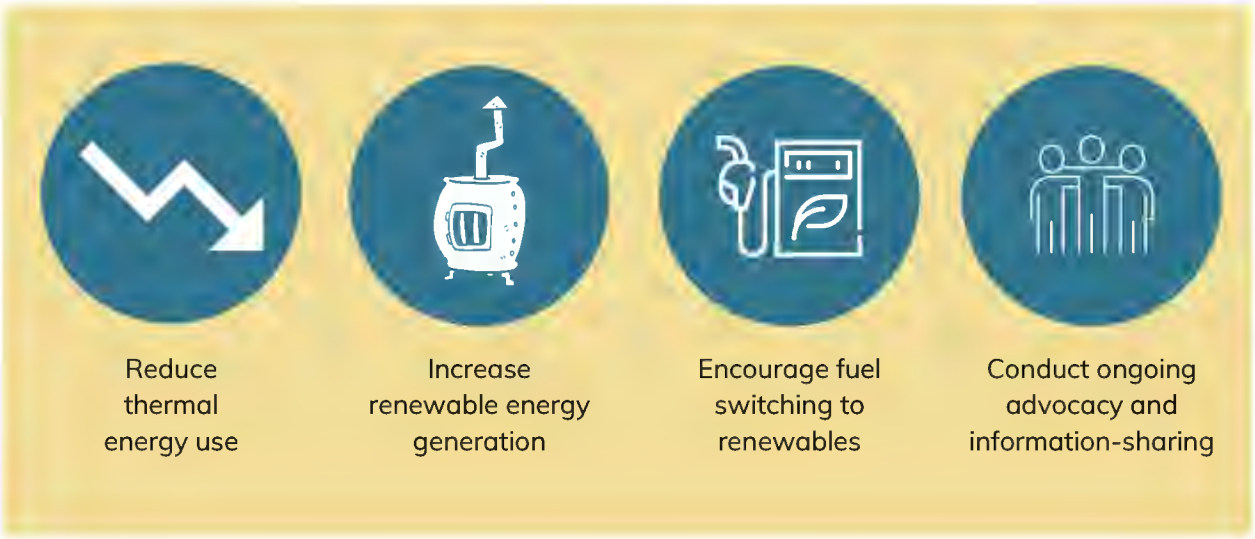
Renewable energy technologies, programs, and incentives are constantly changing and evolving over time. For residents and small businesses in particular, it can be challenging to parse out what opportunities exist at any given time, and which are most advantageous to pursue. The City should take an active role in providing resources and sharing information that is most relevant and useful for Keene residents and businesses. One way to do this would be to post information and resources in a central location, such as on a website that is periodically updated and maintained. Other opportunities include hosting workshops for residents, businesses, and other stakeholder groups (e.g. NHSaves "Button Up" weatherization workshops), partnering with local volunteers and organizations to run programs with a large educational component, such as "solarize" campaigns, and collaborating with local educational institutions and job training programs.

Achieving 100 percent clean and renewable energy will require action across all levels of government. In addition to education and resource sharing, the City should advocate for state and federal policies and programs that support energy efficiency and renewable energy in New Hampshire. The City has done this in past by expressing support for legislation that would benefit the City's residents and businesses. For example, the City has expressed support for continuing New Hampshire's participation in the Regional Greenhouse Gas Initiative (RGGI), and on a couple of occasions the City has submitted a letter of support for legislation that would have raised the individual project net metering cap in New Hampshire from one megawatt to 5 megawatts, which would have benefitted larger energy users in Keene. Additional opportunities in New Hampshire include strengthening the Renewable Portfolio Standard, allocating a greater share of RGGI funds to energy efficiency, and at the federal level, extending the investment tax credit (also known as the federal solar tax credit).

# THERMAL SECTOR

Achieving 100 percent renewable energy for all heating and cooling will require aggressive energy efficiency and weatherization paired with "beneficial electrification" – i.e. replacing fossil fuel-powered heating and cooling systems with more efficient electrical systems and other fossil fuel-free alternatives. Although 2050 is 30 years away, the average lifespan of a heating system (15-20 years) means that, in order to source 100 percent of all thermal energy from renewable sources by 2050, any new heating systems installed in 2040 or later should be electricity-based or run on renewable fuels. As fossil fuel heating systems come to the end of their useful life, it will be important to provide residents, businesses, and nonprofits with options and incentives to replace them with electric or renewable alternatives.

The two most consumed heating fuels in Keene are No. 2 heating oil and propane. Other heating fuels include electricity, wood (wood/pellet stoves & commercial-scale biomass), compressed natural gas (CNG), biofuel, and solar. There is also a geothermal heating system at the City's public works complex located at 350 Marlboro Street.




## Pathway 1: Reduce thermal energy use for buildings in all sectors

Energy efficiency within the thermal sector can mainly be accomplished by weatherizing existing buildings, ensuring that new buildings are constructed with proper insulation, sealing, and ventilation, and by upgrading, replacing, or better controlling HVAC and hot water heating equipment so that they use less energy.

Priority implementation steps that fall within this pathway are listed below. These actions also fall within the Electricity Sector as they impact both thermal and electrical energy consumption.

I. Adopt a "Home Energy Labeling" program for residences: Require energy efficiency disclosure for existing and new residential properties at the time a property is listed for sale or rent.

II. Adopt a Benchmarking Ordinance: Require building owners of certain sizes or in certain districts to report energy use data to the City. Optional: require a reduction in energy use over time. This could start out as a voluntary policy, in order to encourage participation from building owners in a benchmarking effort to collect building energy use data.

III. Partner with existing weatherization programs to enhance public outreach and education, amplify impact, and increase capacity.

## Pathway 2: Increase local renewable energy generation and storage

There are already several examples of renewable thermal systems in Keene that use locally generated sources of renewable energy, such as solar thermal and geothermal systems. In addition, there are a number of wood stove and pellet stove systems as well as commercial-scale wood chip plants which may use wood-based biomass fuel sourced within New Hampshire or the New England region. For example, in 2017 Filtrine Manufacturing, a Keene-based manufacturer of water chilling and filtering systems, installed a 1 million BTU wood chip boiler. The company reports that this renewable thermal system reduced Filtrine's reliance on heating oil by 90%.[5]

Priority implementation steps that fall within this pathway include the following:

I. Commission a study to assess the potential for a renewable district heating system in Keene to understand what areas of the city would have the appropriate demand characteristics to justify a district energy system, as well as what local renewable sources are available and at what potential and likely cost.

   A. Explore options for a renewable district heating and/or combined heat and power pilot project, including possible public-private partnerships, grants, and other funding opportunities.

## Pathway 3: Encourage fuel switching to renewable fuel sources

Fuel switching, such as replacing furnace and boiler heating systems with air source heat pumps (ductless and/or ducted), will be necessary in order to move away from Keene's dependency on fossil fuels. Currently, heating oil and propane are the two most widely used heating fuels in Keene. However, some organizations in Keene have already switched to renewable fuel sources. For example, Keene State College switched its heating plant from heavy No. 6 oil to a biofuel made from recycled vegetable oil over a two-year period starting in 2016, and is now one of the New Hampshire's largest generators of Thermal Renewable Energy Credits (T-RECs), using over 8,000,000 gallons of the biofuel each school year.

Priority implementation steps that fall within this pathway include the following:

**I.** Host a renewable heating and cooling (RH&C) campaign (e.g. “Heatsmart” campaign). RH&C campaigns are a type of bulk purchasing program aimed at homeowners and small businesses. These campaigns encourage the installation of renewable thermal technologies for space heating and cooling or for hot water heating through targeted local out-reach efforts and, often, with bulk discount prices.

## Pathway 4: Conduct ongoing advocacy and education

As discussed under the Electricity Sector section, the renewable energy landscape is changeable and constantly evolving. The City should partner with local businesses, contractors, and installers to offer workshops and trainings on energy efficiency and renewable thermal technologies for residents and businesses. In the spirit of collaboration, the City should promote existing programs, such as New Hampshire Saves, and share information and resources related to energy efficiency and renewable thermal technologies in one central location. In addition, the City should track state and federal legislation and weigh in when opportunities arise to support renewable energy and energy efficiency programs, policies, regulations, and incentives.

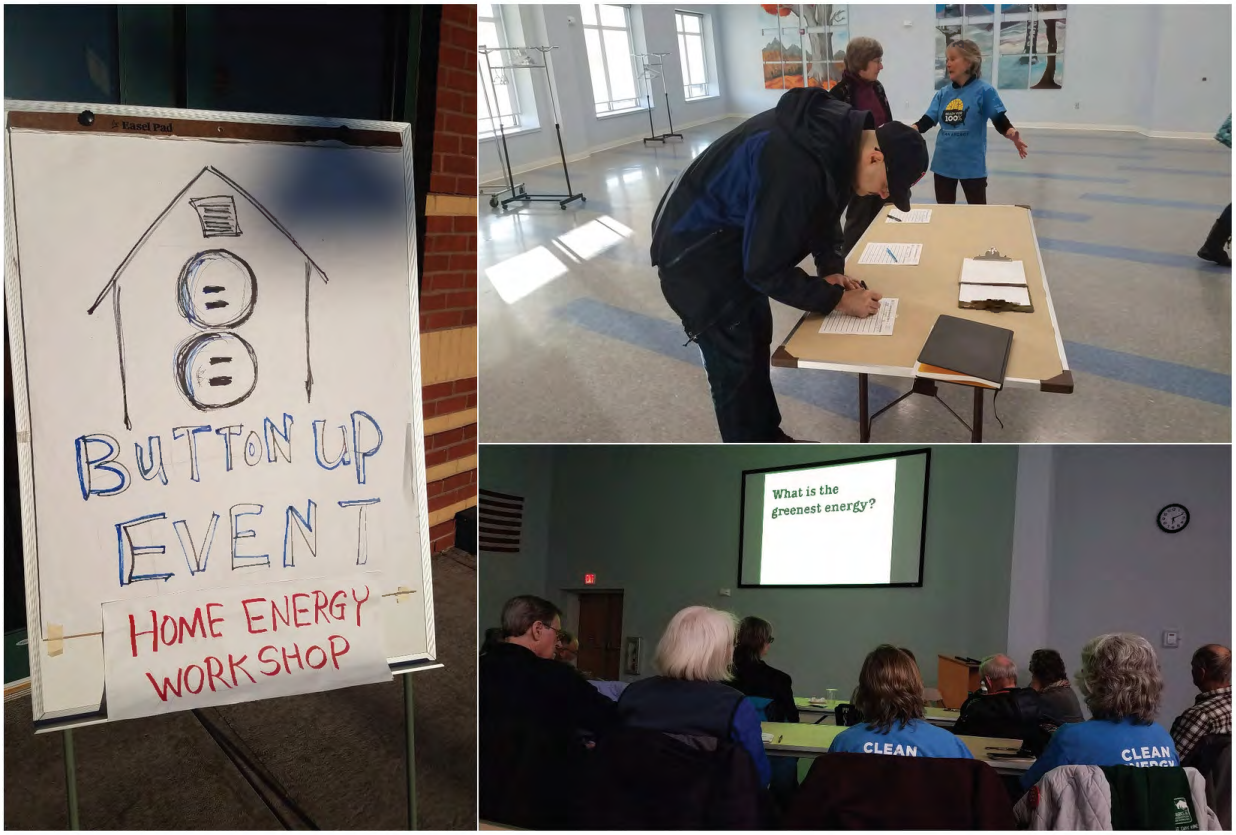
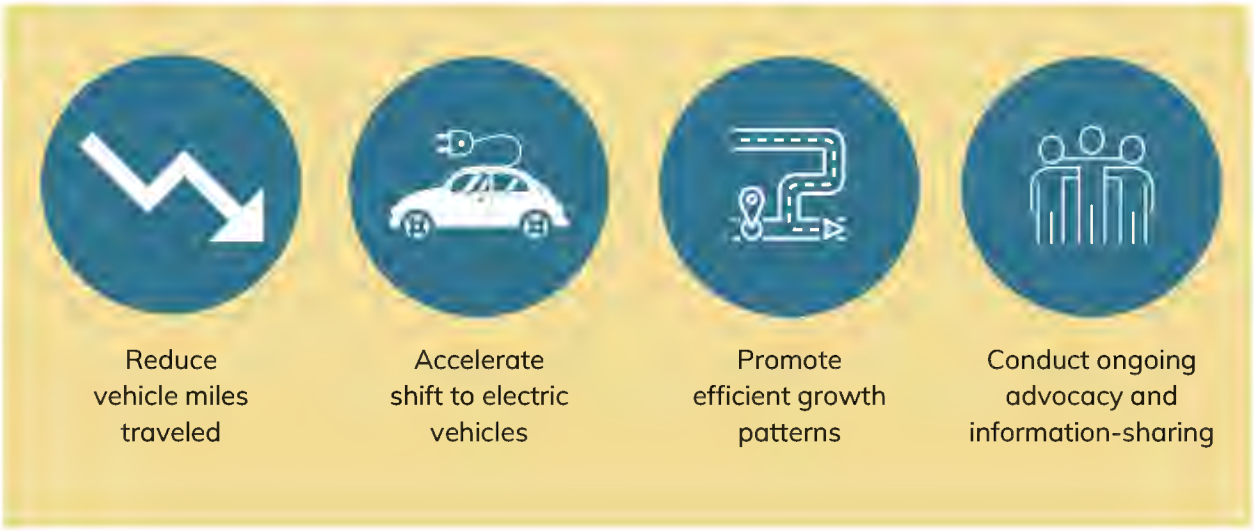



*Figure 2.1. In 2019, the City's Energy & Climate Committee and the Clean Energy Team hosted a NHSaves "Button Up Workshop" to provide residents with home energy weatherization resources. Over 50 people attended this free workshop.*

# TRANSPORTATION

The Transportation Sector currently relies heavily on fossil fuels. In 2015, ground transportation in Keene accounted for almost half (46%) of all greenhouse gas emissions. The majority of these emissions were generated by on-road gasoline use (84%) followed by on-road diesel use (16%). Only a small fraction, about 0.1%, were attributable to the City Express bus service and the Friendly Bus Service operated by Home, Healthcare, Hospice and Community Services (HCS).[6]

Vehicle emissions are generally a function of three variables: fuel carbon content, vehicle efficiency, and how much people drive (i.e. vehicle miles traveled, or VMT). At the national scale, gains in vehicle efficiency have been more than offset by increases in VMT. From 1990-2020, the US population grew by 32%, whereas VMT grew 51%.[7] According to the U.S. Environmental Protection Agency (EPA), over that same time period, transportation emissions increased about 23% despite overall increases in vehicle efficiency.[8] This trend suggests that the City should focus on reducing overall VMT and switching to carbon-free fuels in order to reach the City's goal to source 100% of all transportation energy consumption from renewable sources by 2050.



## Pathway 1: Reduce vehicle miles traveled

Enabling people to get around without a car can significantly reduce fossil fuel consumption while providing many co-benefits, such as reducing transportation costs, increasing physical activity, improving air quality, and providing access to jobs and other necessities for people who either cannot afford or choose not to own a car. Increasing transportation choices to encourage more walking, bicycling, and public transit use within City limits is a well-established goal in Keene. The 2010 Comprehensive Master Plan refers to this concept as a "park and walk community."

> **"Other alternatives should be explored to reduce fuel use by reducing vehicle miles traveled, such as rideshare programs, car-share programs, and the exploration of an official community Zip Car or Segway Safe program. All of these have potential to assist in moving people in a more economical, environmentally friendly way, which will assist in creating a sustainable community as well as highlighting Keene's creative problem-solving mentality."**
>
> **–Keene Comprehensive Master Plan (2010)**

Examples of strategies and actions that can help reduce VMT include improving public transportation access and service, improving walkability, and improving bikeability. These strategies encourage people to choose alternate modes of travel. In addition, land use strategies such as increasing density, promoting mixed uses, and increasing local and regional access to jobs can help reduce VMT by reducing trip distances and promoting carpooling and non-car travel modes. Land use strategies are discussed further under Pathway #3, "Promote Efficient Growth Patterns."

Priority implementation strategies and actions that fall within this pathway include the following:

**I.** Promote active transportation (walking, bicycling, and other "human-powered" transportation modes.

- **A.** Incorporate the adopted City of Keene Complete Streets Design Guidelines (2015) into the City's street standards for new streets, and develop Complete Streets standards for re-construction of existing streets.

**II.** Promote intracity and intercity transit options.

- **A.** Increase financial support for the City Express and Friendly Bus programs, and encourage HCS to expand services/routes.
- **B.** Work with Southwest Region Planning Commission and other community partners to explore options for a multi-modal transportation center in Keene and promote intercity transit options.

## Pathway 2: Accelerate the shift to EVs and other alternative fuel vehicles

Electric Vehicles (EVs) are becoming more widely available and affordable, and as a result, EV market adoption is expected to increase. The Bloomberg NEF "Electric Vehicle Outlook 2020" report predicts that 500 EV models will be available globally by 2022, and by 2040, over half of all passenger vehicles sold will be electric.[9] However, the long average lifetime of vehicles, which in 2019 was 11.8 years in the U.S., can lead to a significant lag between increases in EV sales and increases in the total number of EVs on the road.[10] For this reason, it is important to begin increasing the adoption of EVs now to ensure that a majority of passenger vehicles on the road in 2050 are EVs or other alternative vehicles that use renewable energy sources.

Priority implementation strategies and actions that fall within this pathway include the following:

**I.** Install EV charging stations (level 2 and fast-charge) in on-street parking areas and in public parking lots or structures.

**II.** Adopt solar PV and electric vehicle (EV) ready guidelines to encourage or require new developments to be built in a manner that accommodates future solar and EV charging station installations.

**III.** Work with the Keene School District and local school bus company to encourage the switch to electric school buses. Explore "battery to grid" programs to increase financial viability of electric buses and improve the resilience of the electricity grid.


*Figure 2.2. An EV was on display in Keene in August 2019 as part of the NH Department of Environmental Services Air Quality Day, an education event where residents got an opportunity to try out battery-powered lawn equipment and view an EV up close.*

## Transportation Pathway 3: Promote efficient grown patterns

As discussed above under Pathway 1: Reduce Vehicle Miles Traveled, reducing driving could generate many public benefits in addition to reducing fossil fuel consumption, such as improving public health through improved air quality, better individual health due to increased exercise from walking and biking, increasing access and equity for low and moderate income people, and enhancing interactions within our communities. However, reducing VMT will require coordinated land use and transportation planning. Local land use policies have the potential to shape and rearrange the origins and destinations of travel and can either support or hinder accessibility and mobility. For example, allowing a mix of land uses, providing thoughtful parking requirements, and permitting an increase in land use densities can decrease distances between different destinations, leading to shorter trip distances, a blend of jobs and housing within a community, and an increase in alternative modes of transportation. On the flip side, local policies that separate out land uses, provide inflexible or high minimum parking requirements, and/or reduce density have the opposite effect and lead to car-dependent communities.

The City of Keene has already taken steps to promote a mixed-use, walkable environment in the downtown and surrounding neighborhoods. For example, there are no minimum parking requirements in the core of the downtown, and as part of the Land Development Code project, the City is considering expanding the area where there are no parking minimums, allowing for shared parking and offsite parking arrangements, and offering parking reductions on a case-by-case basis. The City is also in the process of exploring form-based zoning in Downtown Keene in order to ensure that future development is compatible with historic development patterns and continues to foster a pedestrian-friendly environment, and for many years, the City has promoted a context-sensitive approach to street design through the implementation of a complete streets program. The City should continue to coordinate land use and transportation planning, and prioritize local policies that promote efficient growth patterns.

## Pathway 4: Conduct ongoing advocacy and information-sharing

Although there are many actions the City can take to work towards increasing the share of renewable energy within the transportation sector, the City cannot get there on its own without state and federal action to support EVs, public transportation, and other alternative transportation modes. In addition, the City will need to prioritize education and sharing information and resources in order to help residents and fleet managers make informed choices about transportation mode choices and alternative vehicle adoption.

Priority implementation strategies and actions that fall within this pathway include the following:

**I.** Advocate for more funding at the state and federal levels for transportation, including funding for transit and "alternative" transportation options (in addition to funding to maintain / repair bridges, roads, and other infrastructure development and maintenance).

**II.** Advocate for state allocation of funding through the federal Transportation Alternatives Program for "non-infrastructure" Safe Routes to School projects (Education, Encouragement, and Evaluation programs).

**III.** Advocate for state-level policies, programs, and incentives for electric vehicles and other alternative vehicle technologies.

**IV.** Inform community members about the environmental, public health, and social benefits of public transportation and active transportation.

**V.** Promote EVs through education and marketing campaigns. For example, "drive electric" events can be leveraged as opportunities to educate Keene residents about the benefits of EVs as well as existing rebate programs and incentives to reduce costs of buying EVs.

## Endnotes


1 New Hampshire Public Utilities Commission. Residential (Accessed 2020). https://www.puc.nh.gov/consumer/Residential%20Suppliers.html

2 New Hampshire Public Utilities Commission. Commercial (Accessed 2020). https://www.puc.nh.gov/consumer/Commercial%20and%20CI.html

3 Eversource. Interconnected PV in Keene, New Hampshire. (Accessed April 24, 2020).

4 U.S. Department of Energy, February 2012. Energy Storage: The Key to a Reliable, Clean Electricity Supply. (Accessed 2020). https://www.energy.gov/articles/energy-storage-key-reliable-clean-electricity-supply

5 Filtrine Manufacturing Company website. Filtrine Reduces Its Use of Fossil Fuel by 90% with a New Wood Chip Boiler (Accessed 2020). https://www.filtrine.com/company-news/filtrine-reduces-its-use-of-fossil-fuel-by-90-with-a-new-wood-chip-boiler/

6 City of Keene 1995-2015 Greenhouse Gas Emissions Inventory. 2018.

7 U.S. Department of Transportation, Federal Highway Administration (2020). Highway Statistics 2018 (Accessed 2020). https://www.fhwa.dot.gov/policyinformation/statistics/2018/

8 U.S. Environmental Protection Agency (2020). Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2018.

9 Bloomberg NEF. Electric Vehicle Outlook 2020 (Accessed 2020). https://about.bnef.com/electric-vehicle-outlook

10 U.S. Department of Transportation Bureau of Transportation Statistics. Average Age of Automobiles and Trucks in Operation in the United States (Accessed 2020). https://www.bts.gov/content/average-age-automobiles-and-trucks-operation-united-states

# CHAPTER 3 | ENERGY SNAPSHOT

## Overview

This chapter provides a snapshot of energy use and trends in Keene for calendar year 2019.

The electricity baseline, which was prepared by the Cadmus Group, provides an estimate of total electricity consumption for all electricity accounts across the City using Keene-specific data provided by the local utility. In addition, the Cadmus Team developed a business as usual estimate of the projected 2030 electricity supply mix, assuming no further action from the City is taken between now and 2030.

The thermal sector baseline relies heavily on City Assessing data and average energy consumption data from the US Energy Information Administration scaled down to the local level. This baseline involves a number of assumptions in order to provide an estimate of energy consumption for the two most commonly used heating fuels in Keene, No. 2 heating oil and propane. It also provides information about the primary fuel types used for space heating and cooling in Keene by total building area (in square feet).

The transportation sector baseline does not attempt to estimate the amount of energy consumed or the percent energy that comes from renewable sources; however, it does provide information about indirect indicators that can be used to track progress towards the transportation energy goal, such as the number of EVs registered in Keene and transportation mode share.

It will be important for the City to continue to improve these estimates and seek and collect more accurate and reliable sources of data over time in order to accurately track its progress toward its energy goals, particularly for the thermal and transportation sectors.

# 2019 ELECTRICITY BASELINE

## Introduction

The electricity sector includes all electricity consumed in Keene, including electricity consumed by residential, commercial, municipal, and industrial/manufacturing accounts. The electricity baseline was prepared by the City's consultant, The Cadmus Group, in order to understand the starting point of electricity consumption within the City and the mix of generation resources producing the consumed electricity. The baseline draws from a combination of available state-level data, Keene-specific utility data provided by Eversource, and insights provided by the current regulatory landscape to estimate an electricity baseline for the City. As part of the baseline analysis, the Cadmus Team also developed a business as usual estimate of the projected 2030 electricity supply mix, assuming no further action from the City is taken between now and 2030. This analysis allows Keene to better understand the gap between the business as usual projection and the City's target of 100% renewable electricity by 2030.

## Electricity Consumption in Keene

In 2019, electricity accounts across the City of Keene consumed over 222 gigawatt-hours of electricity. On average, in 2019, a residential account used 4,089 kWh of electricity, a commercial account used 69,478 kWh, and a manufacturing/industrial facility used 28,930 kWh of electricity. It is important to note that industrial accounts are those that manufacturing/industrial accounts by the Eversource definition are those accounts whose demand exceeds 1,000 kW.  All other manufacturing/industrial accounts are combined with commercial accounts.

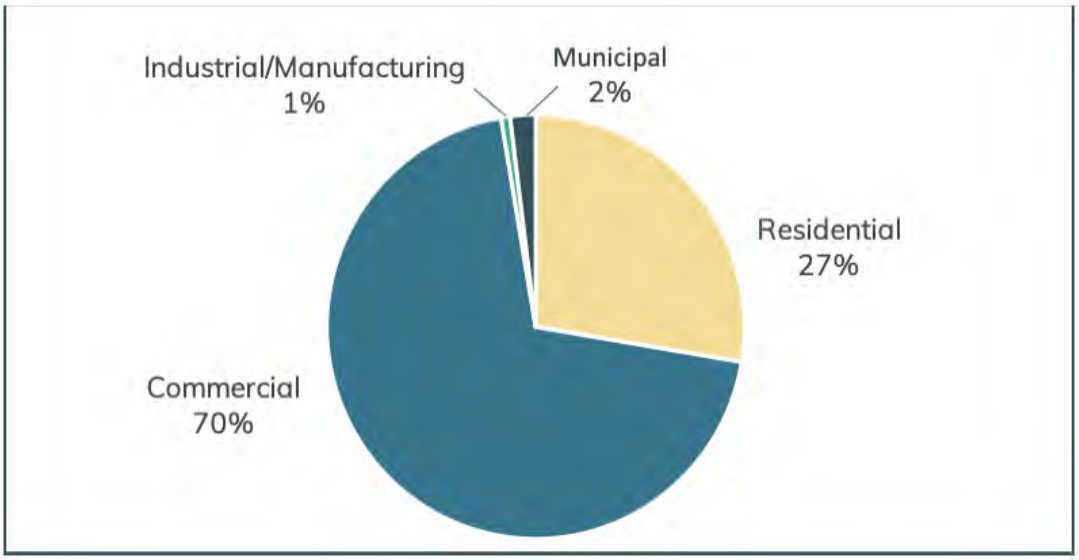



*Figure 3.1. Electricity Consumption by Sector 2019*

The commercial sector was the largest consumer of electricity, accounting for 70% of total community usage. Residential accounts made up 27% of usage in 2019, while municipal and industrial/manufacturing accounts made up the remaining 3% of electricity consumption in Keene (see Figure 3.1).[1]

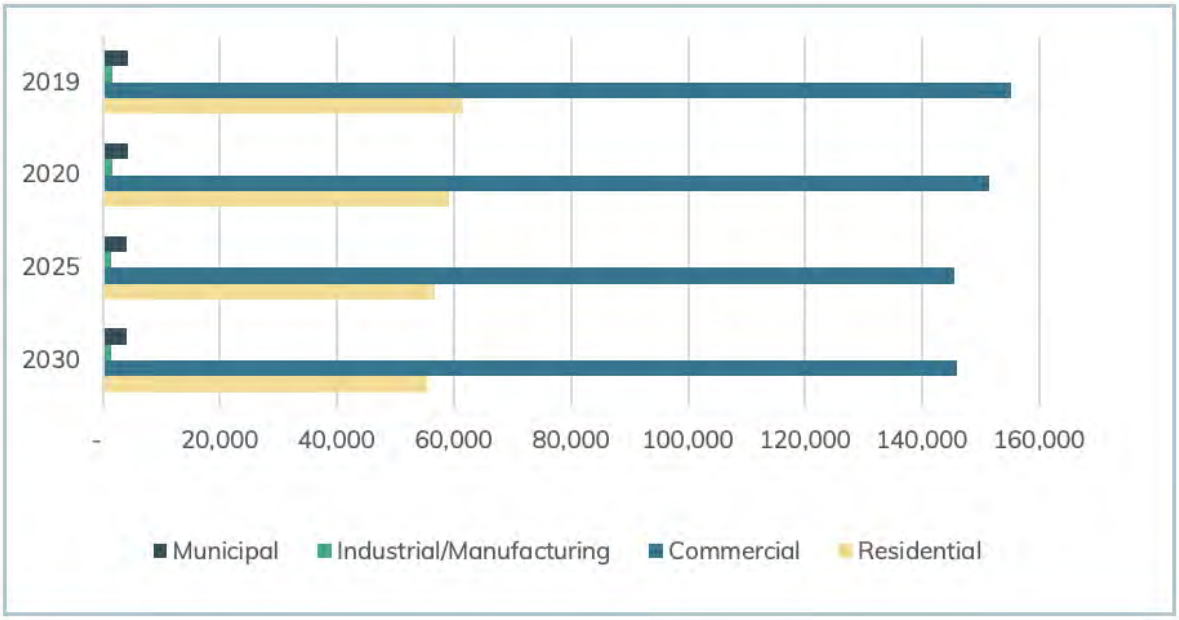



*Figure 3.2. Estimated Changes to Electricity Consumption in Keene (MWh)*

Over time, consumption is expected to shift due to the impacts of population growth and the increasing effectiveness of energy efficiency. In 2030, 78,315 people are expected to live in Cheshire County, representing an overall growth of 1.25% from 2015.[2] Factoring in both energy efficiency[3] and population growth, it is estimated that overall electricity consumption will decrease by approximately 7% by 2030. However, this analysis does not consider new potential sources of load growth through building electrification, electric vehicle infrastructure, or new capital assets that could drive demand.

## Renewable Energy in Keene

Currently, there are a number of systems in Keene that generate renewable electricity. Keene is home to a micro-hydropower system of 90 kW and over 3,300 kW of installed solar photovoltaic (PV) capacity across local homes and businesses.

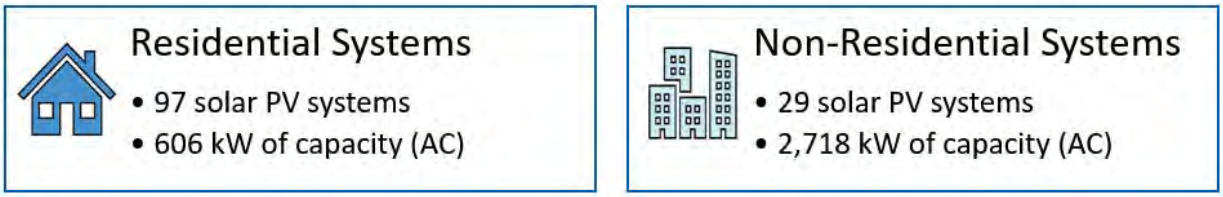



*Figure 3.3. Interconnected Solar PV in Keene[4]*

Figure 3.3 only includes interconnected systems and does not include off-grid systems within Keene. While distributed generation penetration is expected to grow over time, the 2030 forecast conservatively assumes the number of local renewable energy installations will stay constant over time.

## New Hampshire Energy Supply Mix

The local utility, Eversource, has divested its generation assets and relies on the New England Power Pool (NEPOOL[5]) and local energy generation to meet its customer demand for electricity and RPS requirements. The RPS ratchets up the renewable energy requirements every year. By 2025, in order to comply with the RPS, 25.2% of all electricity provided by Eversource will need to be generated using renewable sources. Currently, the RPS is projected to stay constant at 25.2% in 2025 and thereafter. The 2030 forecast conservatively assumes that the percentage of renewable generation mandated by the RPS will not increase after 2025.

Conservatively, the default electricity supply provided by Eversource will need to comply with the RPS. In actuality, the electricity supply that Eversource purchases may exceed this requirement. Eversource interacts heavily with the New England Power Pool (NEPOOL) to source electricity supply. In 2019, the New England-based generation that feeds into the NEPOOL to serve the electricity load was 20.12% renewable, up from 18.3% renewable in 2018.[6] While the regional 2019 level of 20.12% renewable supply exceeded the New Hampshire 2019 RPS requirement of 19.70%, the conservative RPS projections were the foundation of the Keene electricity baseline analysis. As Eversource's default supply changes periodically, the RPS provides a conservative baseline for understanding renewable and non-renewable supply over time, assuming the electric utility is compliant.

| Generation Type | Natural Gas | Nuclear | Coal | Oil | Hydro | Refuse/ Other | Wind | Wood | Solar | All Renewables |
|---|---|---|---|---|---|---|---|---|---|---|
| Capacity (MW) | 16,563 | 4,025 | 917 | 7,139 | 3,393 | 462 | 415 | 503 | 440 | 5,213 |
| Net Energy for Load (GWh) | 39725 | 25,182 | 369 | 117 | 7,305 | 2,895 | 2,794 | 2,004 | 1,474 | 16,472 |
| % of Total Gneration | 48.5% | 30.8% | 0.45% | 0.14% | 8.9% | 3.5% | 3.4% | 2.4% | 1.8% | 20.1% |

*Table 3.1. NEPOOL Generation Sector 2019[7]*

As of 2019, the regional grid relies heavily on natural gas (48.5% of total generation) and nuclear (30.8%), despite the recent closures of nuclear plants across the region, including the 2014 closure of Vermont Yankee Nuclear Power Plant in Vermont and the 2019 closure of the Pilgrim Nuclear Power Plant in Massachusetts. Renewable energy resources, including hydropower, refuse, wind, wood, solar, and other renewables sources made up a combined 20.1% of total regional generation.

**A Note on Competitive Suppliers**

In New Hampshire, customers have the option between default electricity supply from the utility and choosing supply from a competitive supplier. In both scenarios, electricity is still delivered to customers through the electric utility's transmission and distribution grid. In 2018, Eversource noted that 42% of customer load in New Hampshire was served through default service, while 58% of customer load had migrated to competitive energy suppliers. Competitive suppliers are still subject to the state's RPS, but may offer products to customers that exceed this requirement by offering contracts with higher renewable energy mixes than the default service from the utility. Competitive supplier contracts are typically short-term (12-36 months) and can offer fixed or variable pricing to customers for their electricity.[8] In 2020, the City of Keene entered into two competitive supply agreements for 100% renewable electricity for all but one of its municipal facilities. One contract is subject to a one-year term, and the other is two years. The New Hampshire Public Utilities Commission does not regulate the prices offered by competitive suppliers. However, it does provide questions that consumers should ask competitive suppliers while assessing options.[9]

## What this means for 2030

Overall, the business as usual case conservatively estimates that electricity consumption in the City of Keene will be 27% renewable by 2030. The baseline points to a steady increase in renewable electricity supply, largely driven by RPS compliance. Despite population growth, electricity consumption is anticipated to decrease slightly, driven primarily by expected energy efficiency improvements.

| Sector | Energy Type | Consumption 2019* (MWh) | Consumption 2030 (MWh) |
|---|---|---|---|
| Residential | Renewable | 12,137 | 13,945 |
| | Non-Renewable | 49,471 | 41,393 |
| Commercial | Renewable | 30,563 | 36,781 |
| | Non-Renewable | 124,580 | 109,176 |
| Industrial / Manufacturing | Renewable | 308 | 370 |
| | Non-Renewable | 1,254 | 1,099 |
| Municipal | Renewable | 860 | 4,109 |
| | Non-Renewable | 3,507 | 0 |

*Table 3.2: Electricity Consumption by Sector. *Note: The 2019 consumption figures for renewable energy are based on the 2019 NH RPS requirement of 19.70%, to be consistent with the 2030 forecast. The actual renewable energy content in 2019 was 20.1%.*

This baseline assumes that the City continues sourcing 100% renewable electricity for its municipal accounts through 2030 from competitive supply agreements. If the municipality chooses not to extend these agreements and default back to the utility supply, then the overall community renewable electricity mix is expected to decrease slightly.

In 2030, it is estimated that the commercial and residential sectors will be the largest consumers of electricity (71% and 27% of electricity consumption, respectively), but that a larger proportion will be sourced from renewable energy due to the RPS. Without further action, it is estimated that the City will achieve 26.7% of its 100% renewable electricity target by 2030.

# 2019 THERMAL BASELINE

## Overview

The Thermal Sector includes all energy except electrical energy used to heat and cool buildings located in Keene. Electrical energy used to heat and cool is already accounted for within the electricity baseline. Information about heating and cooling systems, as well as the area of buildings, was derived from data provided by the City Assessing Department, and thermal energy consumption was estimated using energy intensity figures and average consumption data for residential and commercial properties from the Energy Information Administration.

The Thermal Sector is divided into three types of buildings: Residential, Commercial, and Public / Non-profit.


## Data Limitations and Assumptions

The data obtained from the City Assessing Department provides information about the area (in square feet) of livable space by building type, as well as the type of heating or cooling system for each building and heat fuel type. There are several limitations to this data, including gaps in the data (fields not filled in), changes over time in how data is recorded by the Assessing Department, and the frequency with which the data about heating systems and heat fuel is updated. In addition, the data from the City Assessing Department only includes the primary heat source for each building, and does not include secondary heat sources such as wood stoves or pellet stoves. In the case where a home is heated primarily

by a wood stove or pellet stove and there is a back-up heating system for emergencies, the back-up system is typically recorded in the Assessing data and not the wood or pellet stove. Therefore, this baseline is likely to underestimate the amount of biomass consumed in Keene, while over-estimating the amount of heating fuel (heating oil and propane). In addition, in many instances the fuel type field is indicated as "typical," which means that the fuel type is unknown. This is especially true for commercial buildings and buildings in the "public/nonprofit" category.

## Fuels used for Space Heating and Cooling in Keene

There are a variety of fuels used for space heating in Keene. Figure 4 provides an overview of the total building area that is heated (in square feet), broken down by fuel type and by building category (residential, commercial, and public/nonprofit). Figure 5 shows the percent of total building area that is heated by fuel type. Number 2 heating oil is the most widely used heating fuel, followed by propane and piped propane (propane and air mix), electricity, wood, and solar. About 19% of all heated building space, corresponding to 102 buildings, is heated by an unknown fuel type.

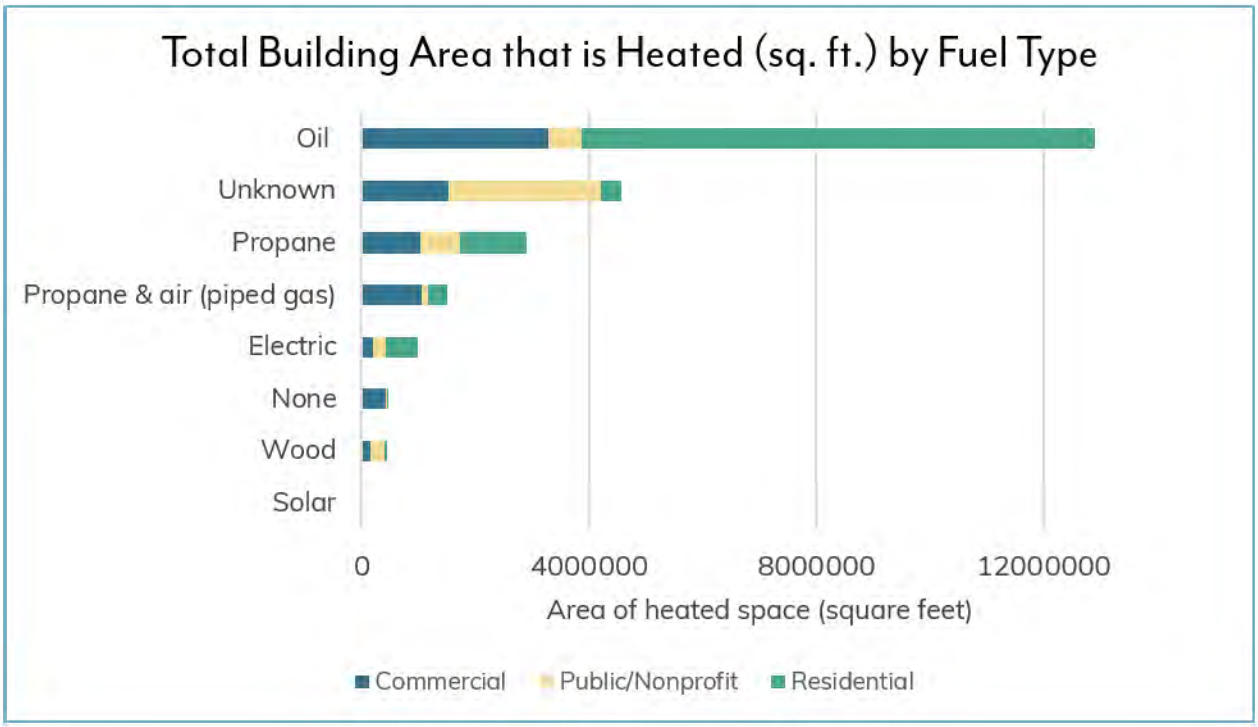



*Figure 3.4. Total building area that is heating, in square feet, by fuel type and by building category (residential use, commercial use, or public/nonprofit use).*

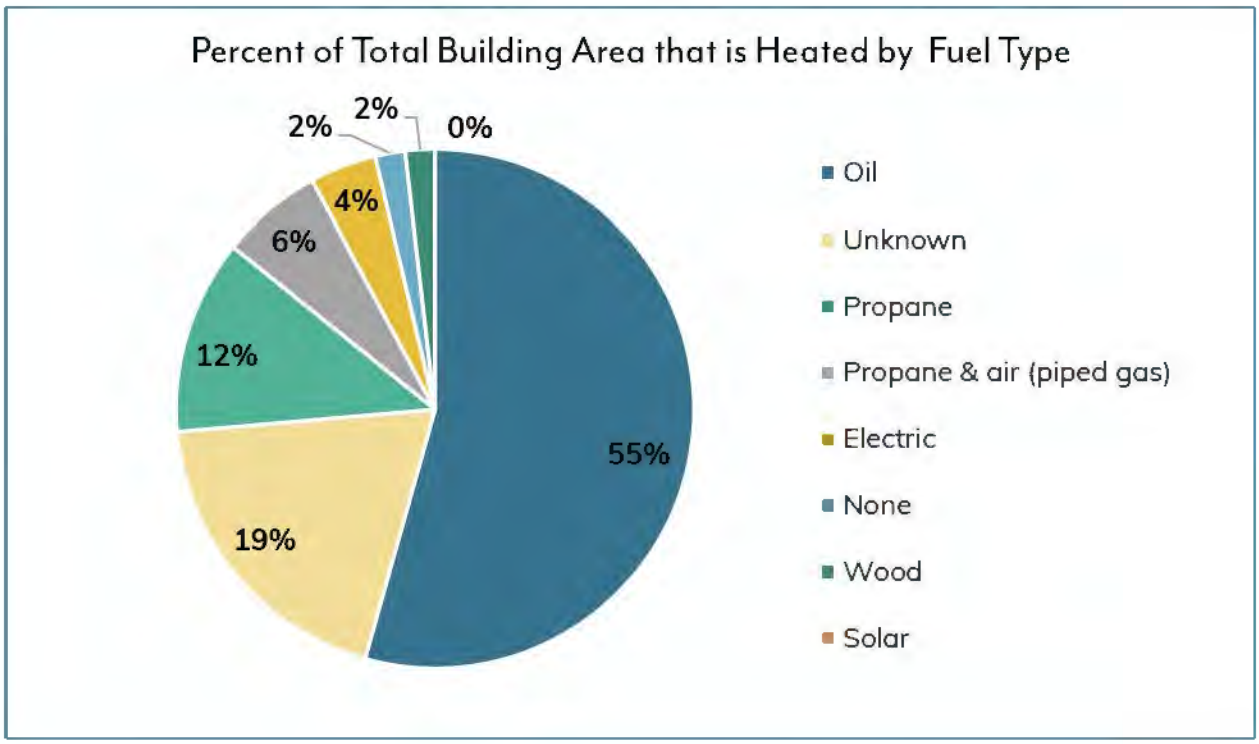



*Figure 3.5. Percent of total building area in Keene that is heated, by fuel type.*

There are examples of renewable thermal systems in Keene, including (but not limited to) a geothermal heating system at the City of Keene Public Works building, a biofuel plant that uses recycled vegetable oil to heat the Keene State College campus, a wood chip heating plant at the Keene Middle School, and wood chip boiler at Filtrine Manufacturing. Natural gas is not widely available in Keene; however, there are a limited number of buildings located in the Monadnock Marketplace development (about 5% of commercial space) that are heated by compressed natural gas (CNG).

## Fuel Costs and Vulnerability

In general, while the weekly residential heat oil and propane prices in New Hampshire have not increased significantly in the last 15 years, the price of propane and oil have been unpredictable and subject to spikes in the winter months when demand and need are highest (Figure 3.6). In addition, while costs have not increased significantly, average fuel costs in New Hampshire are consistently higher when compared to the rest of the country (Figure 3.7). High average fuel costs, in combination with price variability of the two most consumed fuels in the city, puts many Keene residents in a vulnerable place to meet their winter heating needs, cooking needs, and other critical building costs during high-demand months.

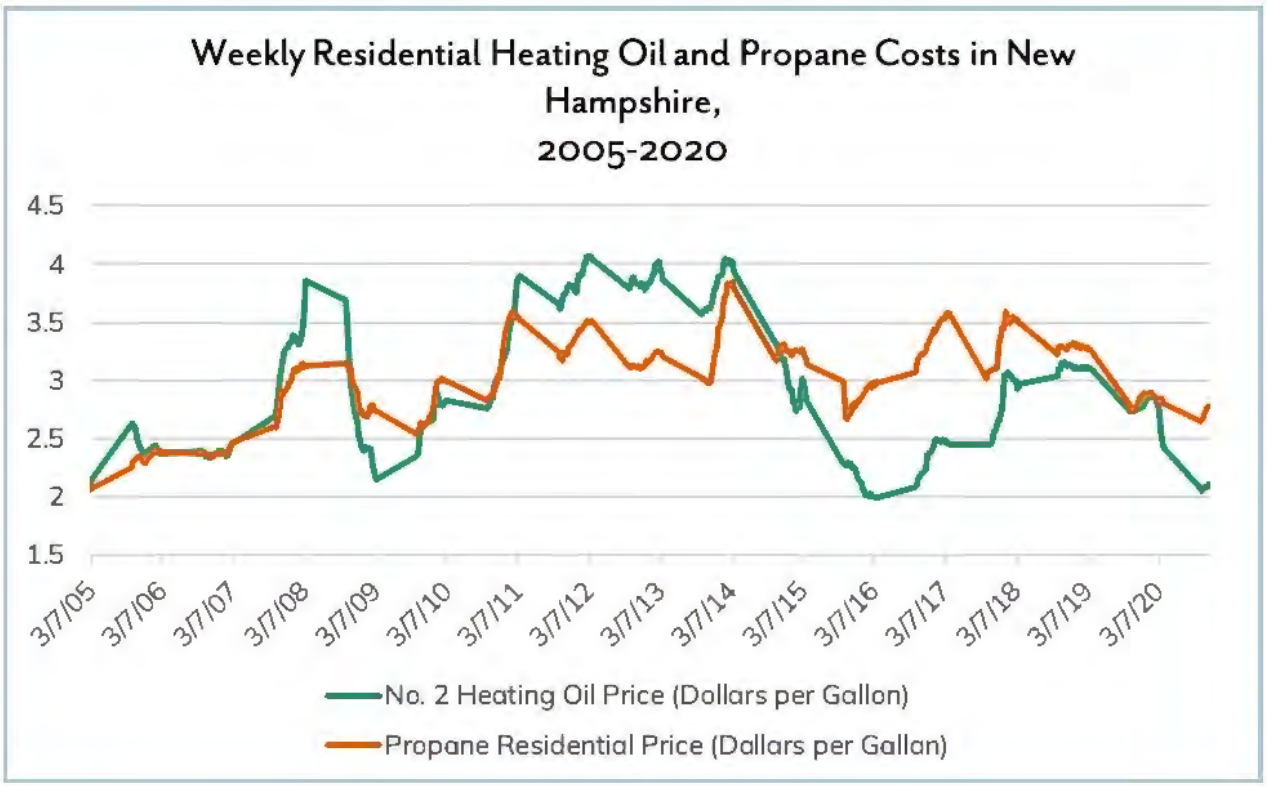



*Figure 3.6. Weekly Residential Heating oil and Propane costs for October-March, 2005-2020*[10]

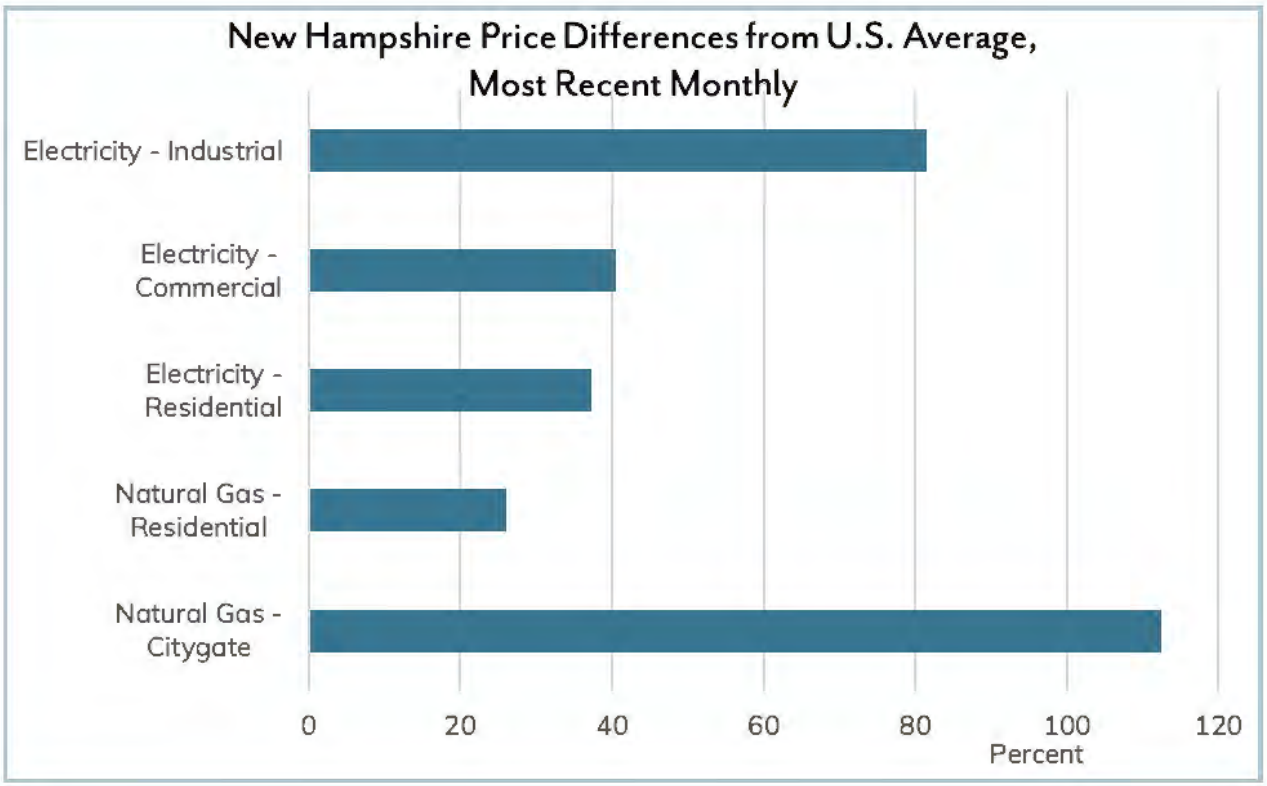



*Figure 3.7. Percent above US-average that NH Hampshire residents pay for building costs in January 2020.*[11]

# Estimated Fuel Consumption in Keene

While the City's Assessing data provides some information about the type of heating system and primary fuel type by building, it does not provide information about the amount of fuel used to heat and cool buildings in Keene. In order to estimate the amount of fuel consumed for space heating, average New England and Cold Climate consumption figures were used from the US Energy Information Administration (US EIA) and scaled to best match Keene building data.[12] Because electricity consumed for space and water heating and electricity for plug load cannot be separated, this analysis considers only the two most used heat fuels in Keene: No. 2 heating oil and propane. Electricity energy consumption for space heating and cooling is captured within the 2019 electricity baseline data.

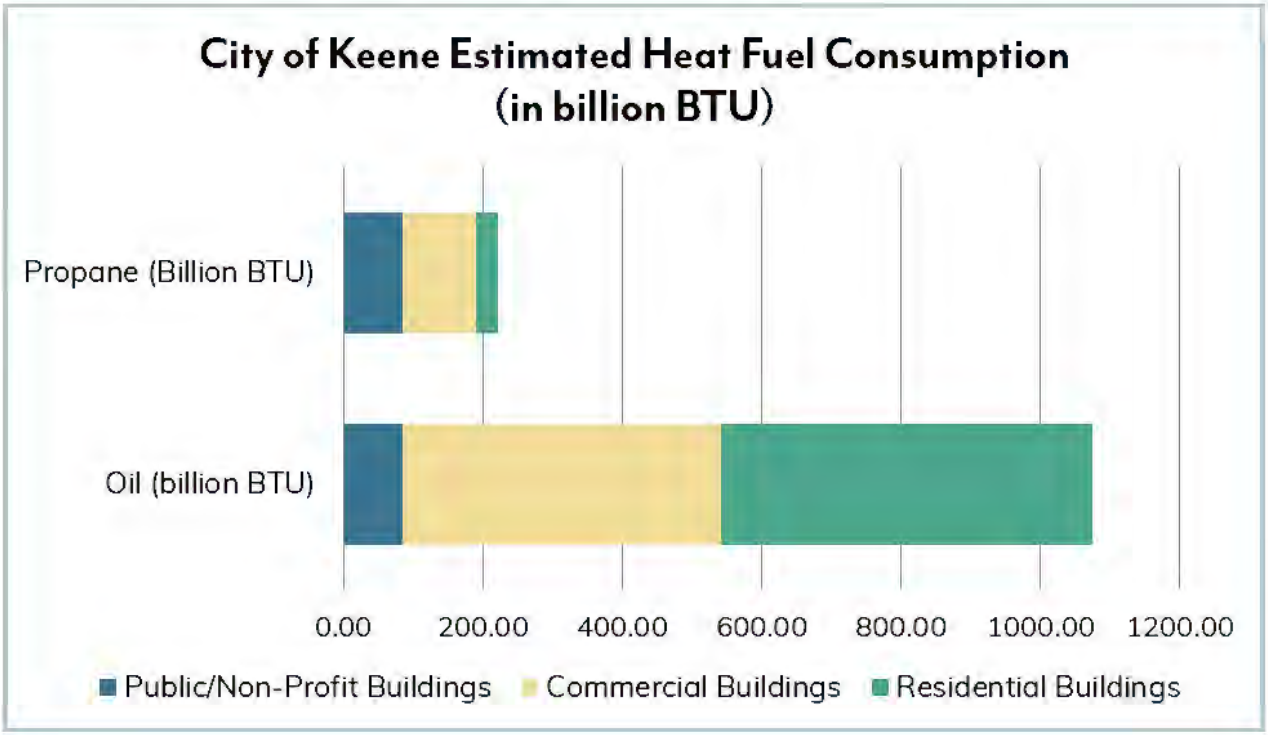



*Figure 3.8. Estimated heat fuel consumption (billion BTU) for propane and number 2 heating oil in Keene.*

| Heating Fuel Consumption Estimates | Oil (billion BTU) | Propane (Billion BTU) |
|---|---|---|
| Public/Non-Profit Buildings | 85.24 | 84.95 |
| Commercial Buildings | 455.62 | 105.31 |
| Residential Buildings | 534.85 | 30.44 |
| Total | 1075.71 | 220.69 |

*Table 3.3. Annual heating fuel consumption estimates for buildings in Keene, in billion BTU.*

Two methods were used to estimate Keene's heat fuel consumption for propane and oil. For residential buildings, US EIA data for Average Site Energy Consumption in the Northeast US, recorded in million BTU per household by fuel type, was applied to local figures for Keene. For each fuel – propane and oil in this case – the US EIA provides an average consumption

figure for the following sub-units: single family home attached, single family home detached, multi-family home 2-4 units, multi-family home 5+ units, and manufactured (mobile) homes. Using the assessing data from the City of Keene, the number of households in a given sub-sector were multiplied by the average site consumption per household figure. This includes each residential unit, for example 2-units in a 2 family home, 9 units in a 9-occupancy apartment building, and so on. Each sub-sector total was then combined to approximate total residential energy consumption: 534.85 billion BTU for Oil and 30.44 billion BTU for Propane.

For Commercial and Public/Non-Profit buildings, heat fuel consumption was estimated based on US EIA energy intensity figures (thousand BTU/square foot) for New England (very cold/cold climate designation). The US EIA estimates that the energy intensity for the sum of major fossil fuels in a commercial building is 86.1 thousand BTU/square foot. The EIA also provides specific energy intensity figures for propane (88 thousand BTU/square foot) and fuel oil (115 thousand BTU/square foot). These figures were multiplied by the total area of heated space for each fuel type to estimate fuel consumption in buildings used for a commercial or public/nonprofit purpose.

These energy consumption estimates can be better understood when they are converted from billion BTUs to "native" energy units. Based on average consumption, Keene buildings consume an estimated 221 billion BTUs of propane and 1,076 billion BTUs of Oil per year. Using the US EIA conversion table[13] that equates to:

| | BTU consumption | Conversion ratio (US EIA) | Total consumption/year |
|---|---|---|---|
| **Propane** | 221 billion BTUs | 1 gallon of propane = 91,333 Btu | 2.4 million gallons of propane |
| **Oil** | 1,076 billion BTUs | 1 gallon of heating oil = 138,500 Btu | 7.8 million gallons of heating oil |

*Table 3.4. Estimated annual heat fuel consumption in Keene for propane and number 2 heating oil.*

# 2019 TRANSPORTATION BASELINE

## Introduction

The Transportation Sector includes the movement of people and goods within, into, and out of Keene. For the purposes of measuring and tracking progress towards the 2050 Transportation Sector goal, the scope of the baseline metrics is limited to ground transportation of Keene residents. However, the City recognizes that non-residents visiting or working in Keene likely account for a large proportion of the travel that occurs within the City limits. As such, the transportation strategies in this plan are intended to have a broader impact.

The transportation baseline considers how residents choose to get around (transportation mode choice), the types of vehicles residents choose to buy or lease, and the infrastructure and systems in place to support different transportation modes (cars, buses, bicycles, walking, etc.). How people choose to travel directly translates into fossil fuels consumed (or not consumed) and the host of local and global environmental impacts that result from our reliance on combustion fuels.

## Vehicles Registered in Keene

According to data from the New Hampshire Department of Environmental Services, there were 19,911 registered vehicles in Keene as of December 2019, or about 2.1 vehicles for every household and approximately 1 vehicle for every adult age 16 or older. Of these, 92% were light-duty conventional vehicles with internal combustion engines (ICE), 6% were heavy-duty conventional vehicles, 1% (222) vehicles were registered as hybrid electric vehicles (HEVs), 1% were registered as plug-in hybrid electric vehicles (PHEVs), and less than 1% (15 vehicles) were registered as all-electric vehicles (AEVs).

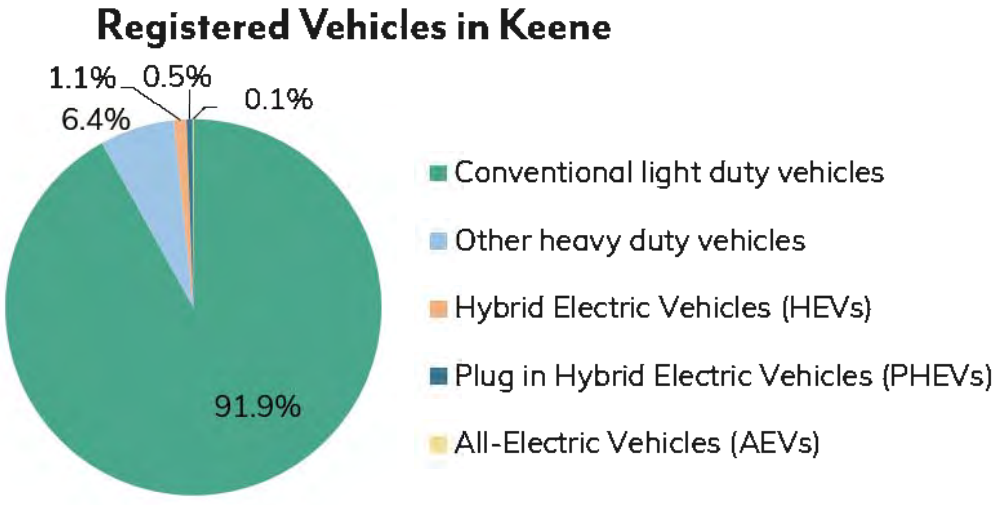



*Figure 3.9. Percent total registered vehicles in Keene by vehicle type as of December 2019.*

| Conventional and Electric Vehicle Designation: An Overview | | | |
|---|---|---|---|
| Conventional Passenger Car | Hybrid Electric Vehicle (HEV) | Plug-in Hybrid Electric Vehicle (PHEV) | All Electric Vehicle (AEV) |
| Conventional passenger cars are motor vehicles with internal combustion engines. This includes gasoline, diesel, and flex (ethanol capable) vehicles. | Hybrid electric vehicles (HEVs) are powered by an internal combustion engine and an electric motor. Batteries can be charged by the internal combustion engine or through regenerative braking, but not by an outside electric power source. | Plug-in hybrid electric vehicles (PHEVs) use batteries to power an electric motor and use another fuel, such as gasoline or diesel, to power an internal combustion engine or other propulsion source. Batteries can be charged by an outside electric power source, by the internal combustion engine, or through regenerative braking. | All-electric vehicles (AEVs) operate on electricity alone using batteries charged by an outside electric power source. They include battery electric vehicles (BEVs) and fuel cell electric vehicles (FCEVs). |

## How Residents Choose to Travel

Information about how people commute, or transportation mode share (TMS), indicates that the majority of Keene residents prefer using a personal motor vehicle to get to and from work or school. According to Transportation Mode Share data from the American Community Survey in 2017, 73 percent of survey respondents drove alone for their commute, 8 percent carpooled, 0.2% used public transit, 7% walked, 9% worked from home, and 4% selected "other" (see Figure 10).[14] This data does not include how people choose to travel for other types of trips, such as shopping or recreational trips. However, it is reasonable to assume that the majority of trips made by residents in Keene are made using a personal motor vehicle due to several factors, including long distances that people may need to travel to get to their destination, the lack of alternative transportation options outside of Keene, the convenience of personal vehicles as compared to other options, and climate/weather conditions.

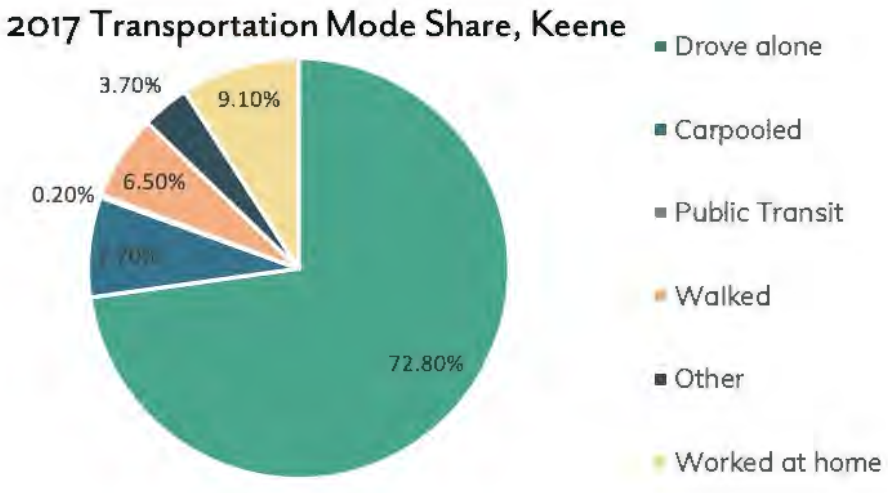



*Figure 3.10. Transportation Mode Share among workers age 16+ (data source: American Community Survey, 2017)*

# Public Transportation Options

Keene is currently home to one fixed-route bus system, the City Express Bus, as well as a demand-response bus designated to meet the needs of people aged 60 or older, the Friendly Bus. During the academic school year, the Keene State Campus Community Shuttle bus is also available for Keene resident use. The City Express Bus, campus shuttle, and the Friendly Bus are operated by Home, Healthcare, Hospice and Community Services of Southwestern New Hampshire (HCS). The City Express service has two operating bus lines which run outside of typical work hours. Both lines operate Monday through Friday, starting at 8:00 am and finishing at either 4:09 pm or 5:04 pm. Both routes originate and terminate at the Keene Transportation Center, and a bus runs once every hour for each line. While there are 39 set bus stops along the two lines, the bus can be hailed or stopped at the rider's request as long as it is on the bus path.[15] Given these factors, ridership is estimated by the 2018 American Community Survey as 27 (+/-32) people per day,[16] and HCS reports an average of 72 riders per day, with some fluctuation due to whether or not Keene State College is in session.

Two Greyhound Bus routes provide service in Keene, heading either north to beyond White River Junction or south to Springfield, MA. According to Southwest Region Planning Commission (SWRPC), the average ridership for both of those lines is about 5 riders getting on and 5 riders getting off the bus each day.

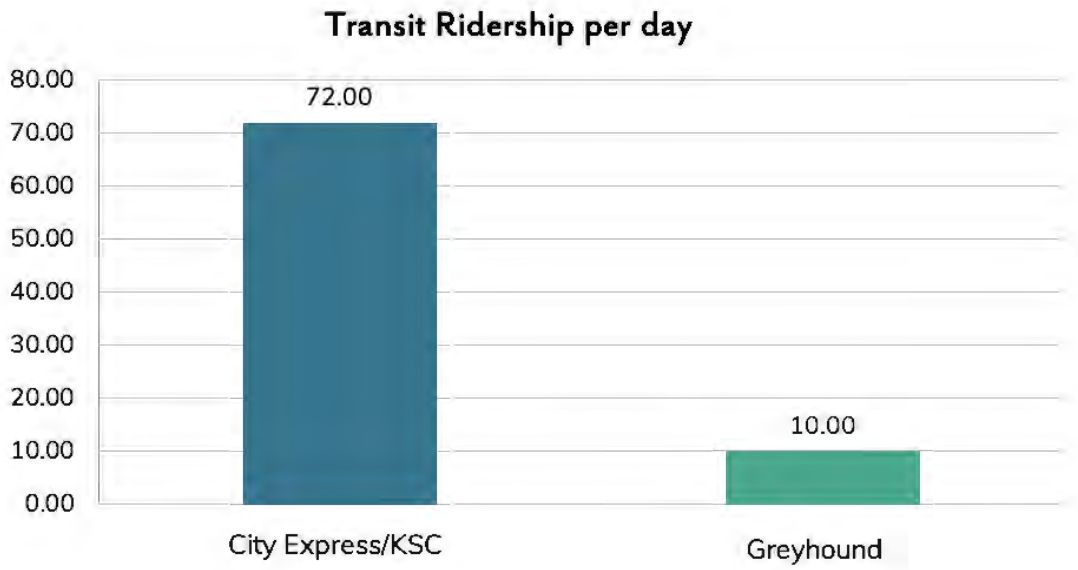



*Figure 3.11. Average transit ridership per day in Keene, NH*

# Transportation Infrastructure

## Roundabouts

As a way to reduce vehicle delay time and improve the flow and safety of traffic, the City of Keene and NH Department of Transportation have installed six roundabouts throughout the city at busy intersections where traffic delay, congestion, and/or safety issues were identified. Roundabouts are circular intersections where entering traffic yields to traffic

in the circle. Design features, such as a smaller diameter and splitter islands, slow traffic speeds. Because they reduce idle time and improve traffic flow, the replacement of a failing signalized intersection with a roundabout has been shown to reduce fuel consumption and emissions.[17] As of October 2020, Keene had 6 roundabouts and 20 signalized intersections, with an additional two roundabouts planned for construction on Winchester Street in 2021.

## Pedestrian, Bike and Transit Miles

Infrastructure such as sidewalks, marked crosswalks, bicycle lanes, bicycle boxes, and other supportive infrastructure for pedestrians and bicyclists improves safety and helps promote "human-powered" transportation modes that do not rely on fossil fuels. As of October 2020, the City maintains over 54 miles of pedestrian sidewalks year-round, 3.75 miles of bicycle lanes, and 2.92 miles of shared bicycle lanes. In addition, there are over 13 miles of multi-use trails within the City limits, and over 41 miles of fixed bus routes.

*Figure 3.12. Image of a painted "bicycle box" on Central Square in Keene.*

The City has installed 15 enhanced pedestrian crossings in locations where traffic speed, traffic volume, or proximity to a grade school or other destination for pedestrians warrants increased safety measures. An example is the two crosswalks on Winchester Street near its eastern terminus, where high volumes of student foot traffic led to the installation of raised crosswalks with automated flashing lights to increase the visibility of pedestrians and slow motorized traffic. In 2017, the City installed "Bicycle Boxes," or painted areas where bicyclists can queue at an intersection, in order to increase the visibility and safety of people riding bicycles as they enter the busy Central Square intersection (see Figure 3.12).

Figure 3.13 on the next page depicts a map of bicycle infrastructure in downtown Keene, which includes in-street shared lane markings (sharrows) and bicycle lanes, as well as off-street multiuse rail trails. Table 3.5, below, includes counts for the number of bicycle boxes, enhanced pedestrian crossings, road/trail crossings, and bus stops in Keene as of October 2020.

| Type of Infrastructure | Count |
|---|---|
| Bicycle Boxes | 2 |
| Enhanced pedestrian crossings | 15 |
| Road crossings for multiuse trails/paths | 32 |
| Bus stops | 39 |

*Table 3.5. Selected bicycle, pedestrian, and transit infrastructure counts in Keene*


*Figure 3.13. A map of bicycle infrastructure in Downtown Keene.*

## EV Charging Infrastructure

There are 3 charging locations within the City of Keene, including two "Level 2" charging ports in the Commercial Street parking lot (available for a parking fee of $1.49/hour), two "Level 2" charging ports at the Fairfield Kia Dealership, and one "Level 2" charging port at the Antioch University New England campus. There are no DC fast charge stations ("Level 3" charging stations) in Keene. However, within 20-30 miles of Keene, there are a number of charging stations and charging ports, most of which are along the Route 91 corridor between Brattleboro and Putney across the Connecticut River in Vermont, including 4 public DC fast charging locations. There are 13 "Level 2" charging locations within 20 miles, and 16 additional "Level 2" charging locations within 30 miles of the City (Figure 3.14).

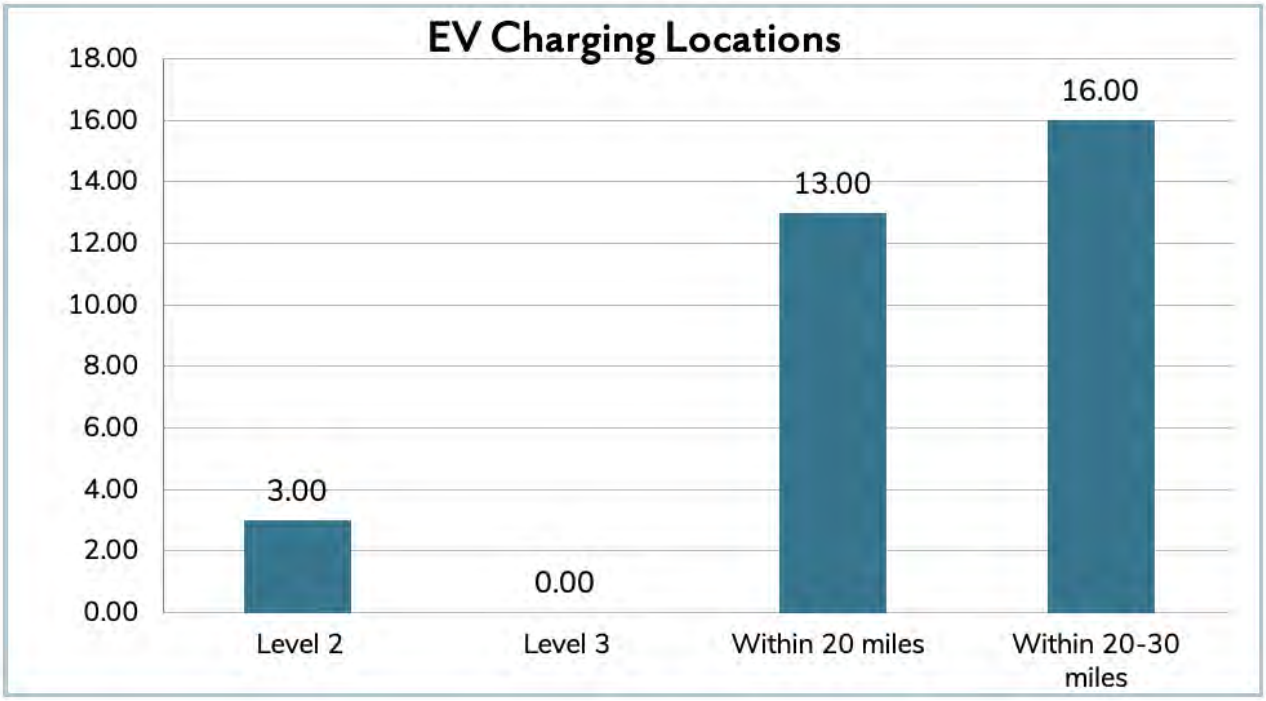



*Figure 3.14: Number of EV charging location at varying distances from Keene, NH.*

# Transportation and Land Use

Coordinated transportation and land use planning can help reduce energy use within the transportation sector over the long term by shortening trip distances, reducing the need for parking, and supporting sustainable travel modes such as public transit, walking, and bicycling. There are several land use factors that impact how much people drive (vehicle miles traveled) and the number of single occupancy vehicle trips, which is among the most inefficient and energy intensive ways to travel. These factors include the density and mix of land uses, access to transit, interconnected and well-designed streets, and walkable neighborhoods.

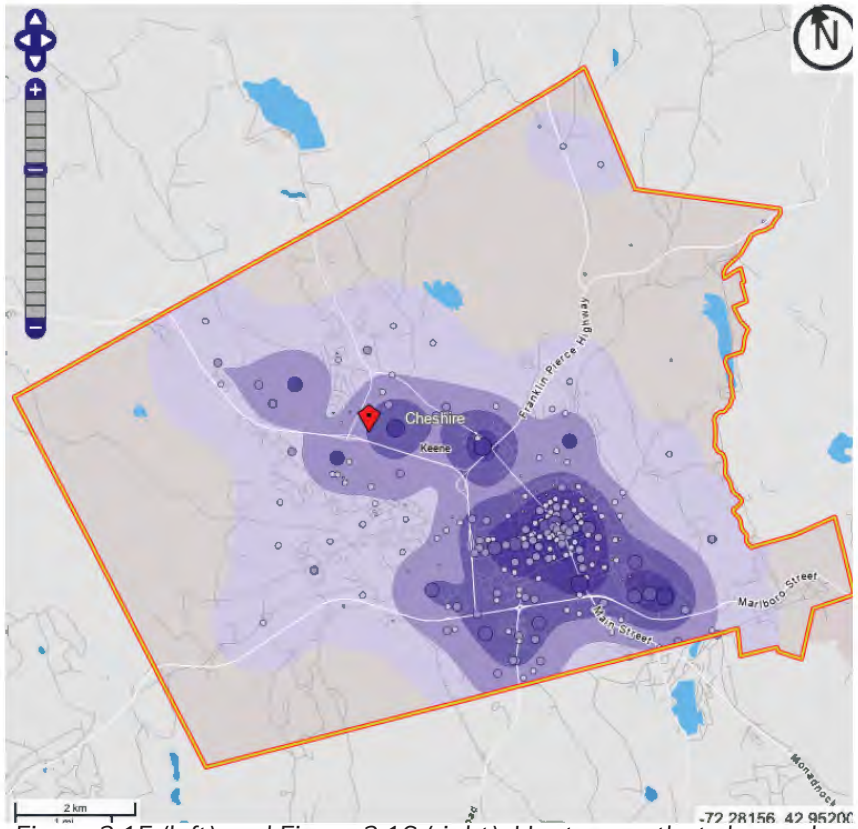
## Housing in Mixed Use Areas

According to a housing inventory analysis presented to the Keene City Council in February 2020, 26 percent (2,628 units) of all residential dwelling units in the City are located in the Central Business (7 percent or 725 units), Central Business Limited (1 percent or 111 units), or High Density (17.4 percent or 1,792 units) Zoning Districts. These districts are located in either the downtown or areas directly surrounding the downtown and provide easy access to a multitude of services and resources, including convenient access to public transportation. Most of the City's dense residential developments are located in these areas with 54 percent of all residential buildings with over 8 Units, and 54 percent of all residential buildings with 4-8 units being located in these districts. Figures 3.15 and 3.16 on the next page show a side-by-side comparison of where people work in Keene (Figure 3.15, on the left) and where people live in Keene (Figure 3.16, right) using the US Census "On the Map" tool. This data shows that job centers and population centers within Keene are well-aligned, which can help support more energy-efficient transportation modes such as walking, bicycling, and public transit.

## Complete Streets

In 2015, the City of Keene adopted a Complete Streets policy (in the form of a resolution) which made a commitment to designing, constructing, operating, and maintaining all City-owned transportation facilities to support the needs of all users of the roadway, including bicyclists, pedestrians, transit riders, and motorists. To support this policy, the City also adopted a set of Complete Streets Design Guidelines that establishes a Complete Street Typology system and map (see Figure 3.17). This typology system classifies the streets in Keene based on each roadway's function and surrounding land use context, including right of way width, building types, predominant travel modes, and surrounding land uses. For each street type, the guidelines includes a list of features that should be considered in the form of a checklist. Examples of complete streets features includes pedestrian crossings, medians, pedestrian islands, street furniture, pedestrian-scale lighting, bicycle lanes, sidewalks, and on-street parking in appropriate areas.

In 2018/2019, a group of Keene State College students in the Geography Department prepared a report that addresses the City's progress on its Complete Streets commitment. This analysis was limited to a review of "Slow," "Bicycle," and "Gateway" street types. The students evaluated a random sample of streets throughout Keene within each of these three street types, and assigned letter grades to each street segment based on how well the street matched the list of suggested Complete Streets treatments listed in the City's Design Guidelines (see Figure 3.18). The student report concludes that, of the 24 street segments that were assessed, many do not meet the City's Complete Streets design guidelines, with only one street segment receiving a letter grade of "A" – the segment of Main Street between Central Square and the Winchester Street/Marlboro Street/Main Street intersection.



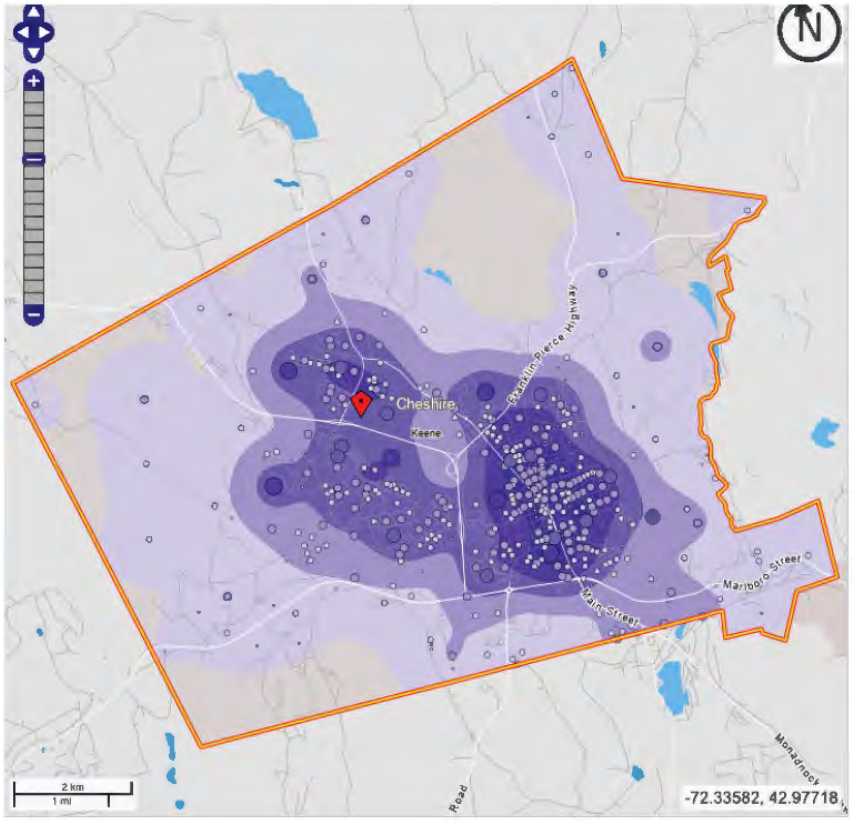




*Figure 3.15 (left) and Figure 3.16 (right). Heat maps that show where people work (left) and where people live (right) in Keene, generated by the US Census "On the Map" tool. The darker colors represent higher density areas.*[18]

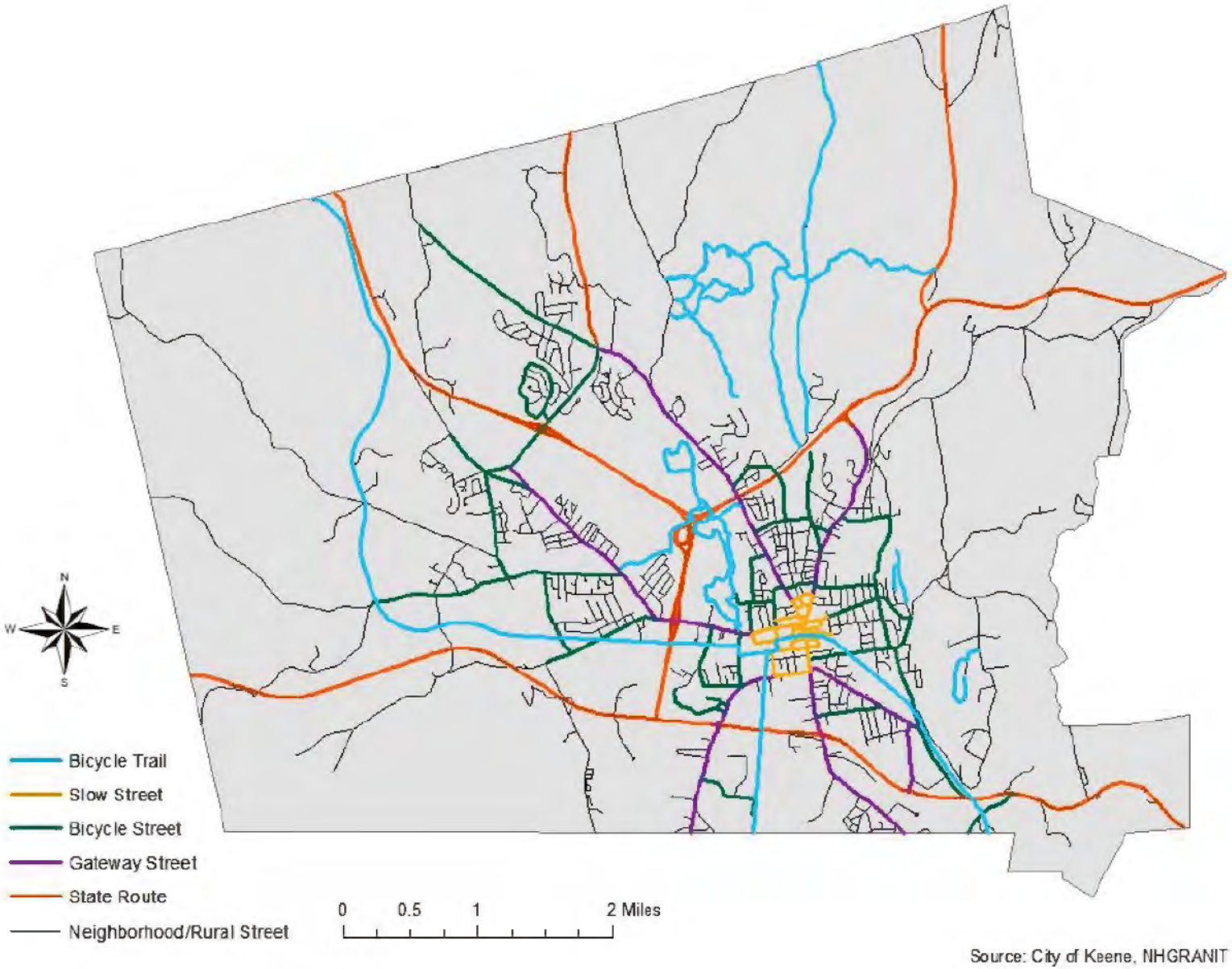



*Figure 3.17. City of Keene Complete Streets typology.*

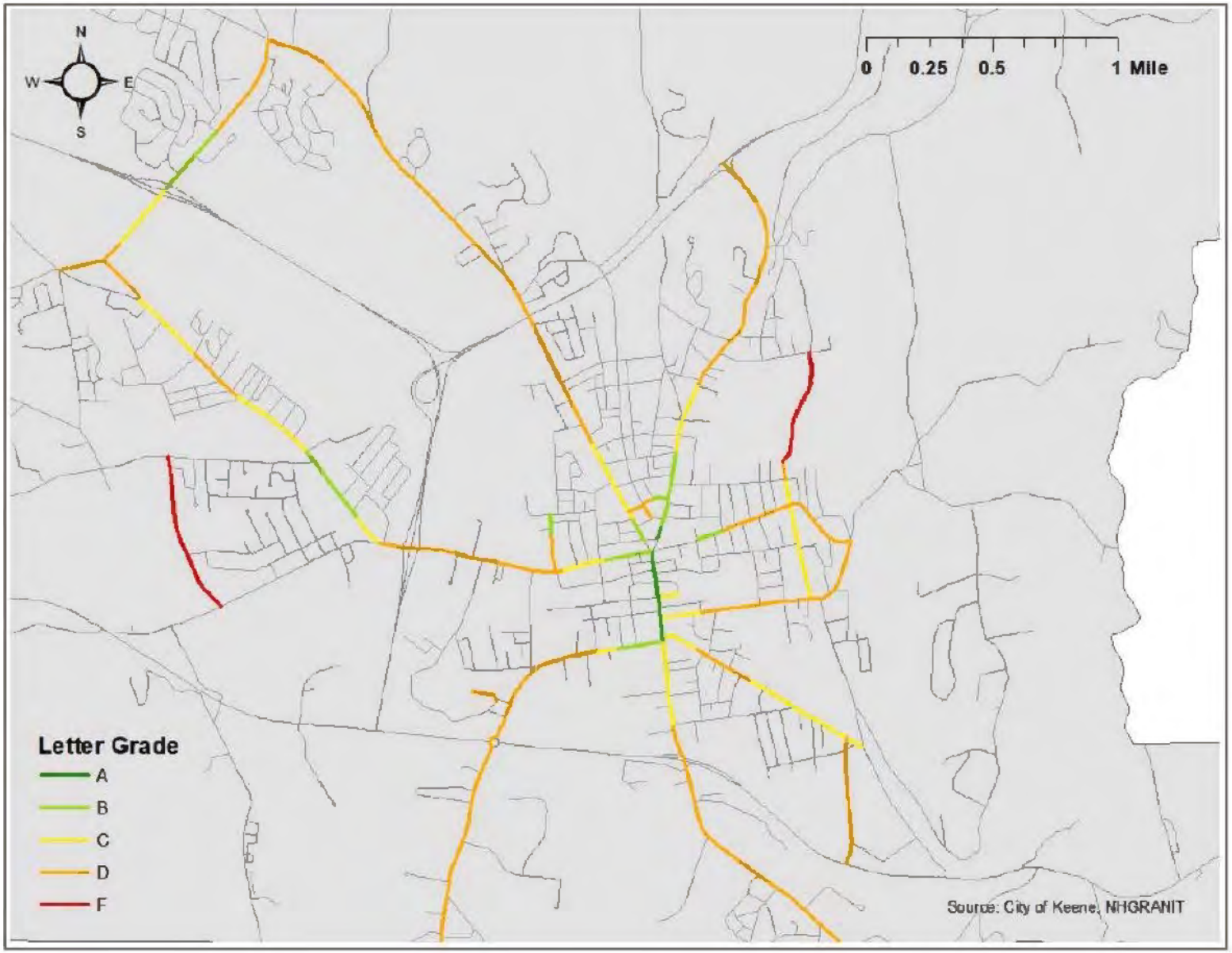



*Figure 3.18. City of Keene street grade by segment.*

## Endnotes

1 Data provided by Eversource. Industrial accounts are those that have peak electricity demand greater than 1,000 kW.

2 The New Hampshire Office of Energy and Planning. *State of New Hampshire Regional Planning Commissions: County Population Projections* (2016). https://www.nh.gov/osi/data-center/documents/2016-state-county-projections-final-report.pdf

3 Energy efficiency is based on delivered energy from the EIA Annual Energy Outlook (Publication 2019). https://www.eia.gov/outlooks/aeo/data/browser/#/?id=2-AEO2019&region=1-1&cases=ref2019

4 Distributed generation information was provided by Eversource.

5 New England Power Pool (Accessed 2020). http://nepool.com/

6 New England Power Pool. *Working Together to Shape Tomorrow: Annual Report* 2019 (2020). http://nepool.com/uploads/Annual_Report_2019.pdf

7 ibid

8 Information was not available about the current competitive supply agreements or environmental disclosures of those agreements within Keene. Therefore, this analysis assumes that all electricity mix throughout Keene met the RPS requirements and did not exceed the renewable energy carve outs.

9 New Hampshire PUC. *Choosing an Energy Supplier: Suppliers and Aggregators* (Accessed 2020). https://www.puc.nh.gov/consumer/energysuppliers.htm

10 US Energy Administration. Weekly Heating Oil and Propane Prices (October-March). https://www.eia.gov/dnav/pet/PET_PRI_WFR_DCUS_SNH_W.htm

11 US Energy Information Administration. NH Price Differences from U.S. Average, Most Recent Monthly. https://www.eia.gov/state/?sid=NH#tabs-5

12 US Energy Information Administration. Commercial Buildings Energy Consumption Survey (CBECS). https://www.eia.gov/consumption/commercial/data/2012/c&e/cfm/c10.php and US Energy Information Administration. 2009 RECS Survey Data. https://www.eia.gov/consumption/residential/data/2009/#structural

13 US Energy Information Administration. Units and calculators explained. https://www.eia.gov/energyexplained/units-and-calculators/

14 https://data.census.gov/cedsci/table?q=Keene,%20NH&g=1600000US3339300&tid=ACSST5Y2017.S0801&layer=VT_2018_160_00_PY_D1&vintage=2017

15 https://www.hcsservices.org/services/transportation/city-express/

16 https://data.census.gov/cedsci/table?q=Keene,%20NH&g=1600000US3339300&tid=ACSST5Y2017.S0801&layer=VT_2018_160_00_PY_D1&vintage=2017

17 U.S. Federal Highway Administration Publication No. FHWA-SA-15-071. *Accelerating Roundabout Implementation in the United States - Volume III of VII: Assessment of the Environmental Characteristics of Roundabouts*. September 2015.

18 https://onthemap.ces.census.gov/

# CHAPTER 4 | MEASURING OUR PROGRESS


## Why Track Progress?

As the City and community partners work to achieve the sustainable energy goals for electricity by 2030 and for thermal and transportation by 2050, it will be important to track and report our progress towards these goals. Measuring progress will enable improved and informed management of projects and programs, helping to drive continuous improvement. Effectively communicating progress will help generate and maintain interest among residents and stakeholders, increase transparency and trust, and provide quantitative support for existing strategies or, if necessary, for changing course.

## Performance Metrics

A performance metric, sometimes referred to as an "indicator," is a measurement for understanding the impacts of actions and progress toward goals. For example, a good performance metric for a program that aims to increase the number of EV charging stations would be the number of new EV charging stations installed over a given time period.

Metrics can be used to measure the overall impact of a combination of strategies ("system-level metric"), for example, total residential energy use in MMBtu per year. They can also be used to measure the impact of a specific activity or program ("program-level metric" – see EV example above) or to illustrate whether or not a specific action has been taken ("milestone metric"). An effective metric should be aligned with a specific goal or outcome, be relatively easy to understand, rely on trustworthy data (be accurate), and be timely (can be updated frequently enough to be useful).

# 2030 ELECTRICITY GOAL

Due to the shorter timeframe to achieve the electricity goal and the availability of locally specific data through the utility, this plan recommends tracking progress towards the 2030 electricity goal on an annual basis using the metrics listed below. As the City pursues specific programs and actions, additional metrics should be identified and tracked to evaluate the effectiveness of these initiatives.

## Electricity Sector Performance Metrics

| Performace Metric | Data Source | Responsibility | Requency |
|---|---|---|---|
| Annual electricity consumption by sector (residential, commercial, industrial/manufacturing, municipal). | Eversource or Community Power program | City staff | Annual |
| Electricity supply mix (renewable v. non-renewable) by sector (e.g. ISO New England Resource Mix). | Eversource or Community Power program | City staff | Annual |
| Percent of households/customer load on competitive energy supply (or participating in Community Power program) | Eversource or Community Power program | City staff | Annual |
| Number of solar installations by sector (residential, commercial, etc.) | Eversource; City Assessing Department | City staff | Annual |
| Installed solar capacity by sector (residential, commercial, etc.) | Eversource; City Assessing Department | City staff | Annual |
| Number/percent of eligible homeowners and businesses that take advantage of the renewable energy property tax exemption. | City Assessing Department | City staff | Annual |

# 2050 THERMAL GOAL

In contrast to the electricity sector, the thermal sector does not have a readily available, locally-specific source of data to measure the amount of energy consumed for heating and cooling within the City. The metrics listed below are indirect indicators to help the City and public understand trends in weatherization, building energy efficiency, and uptake of renewable thermal technologies. These metrics rely on several data sources with varying degrees of accuracy and timeliness. For example, City Assessing data on the type of heating system and type of heating fuel is not regularly updated, and is unlikely to show any measurable change year to year. Therefore, the recommended frequency for updating these metrics varies depending on the data source(s), the accuracy of the data, and the level of effort it will take to collect the necessary data.

As programs such as benchmarking, home energy labeling, and Community Power are adopted and implemented, accurate and reliable data at the local level will become more available to track progress towards the thermal goal on a more frequent basis.

## Thermal Sector Performance Metrics

| Performance Metric | Data Source | Responsibility | Frequency |
|---|---|---|---|
| Number of households and businesses that participate in weatherization programs per year (e.g. NHSaves, local weatherization campaign) | NH Saves program; local weatherization programs | City staff, NHSaves, SCS | Annual |
| Number of high performance buildings in Keene (e.g. NE-CHPS, LEED, etc.) | Local survey; Organization contacts | City staff & Energy and Climate Committee | 2-3 years |
| total building area/ percent of building area using renewable thermal (e.g. biomass, solar thermal, geothermal, etc.) for space and hot water heating, by sector | City Assessing Data; Local surveys or organization contacts | City staff & Energy and Climate Committee | 2-3 years |
| Estimated energy consumption for space heating (per household / per square foot commercial floor space) | Assessing Data (sq. ft of building space); Energy Information Administration (energy intensity figures; average consumption per sq. ft. commercial space, average consumption per household) | City staff | 3-5 years |

# 2050 TRANSPORTATION GOAL

As with the Thermal Sector, the Transportation Sector lacks a locally-specific source of data to measure the amount of energy consumed for ground transportation directly. However, locally-specific data is available for the number and types of vehicles registered in Keene, allowing the City to track adoption of electric vehicles and other alternative fuel vehicles. In addition, the City has access to data on transportation infrastructure, public transportation ridership, and Census data such as transportation mode share. As with the Thermal Sector, these metrics rely on various different data sources and are associated with varying degrees of accuracy and level of effort for data collection.

## Transportation Sector Performance Metrics

| Performance Metric | Data Source | Responsibility | Frequency |
|---|---|---|---|
| Total number of vehicles registered in Keene / Number vehicles per household and per capita | NH Department of Environmental Services (NHDES); US Census | City staff | Annual |
| Percent of new light-duty vehicle registrations and total light-duty vehicle registrations that are electric vehicles or hybrid vehicles | NHDES | City staff | Annual |
| Transportation Mode Share (Percent who drive, walk, bike, take transit) for work / school | U.S. Census / American Community Survey (ACS) | City staff | Every 5 years |
| Transit ridership (City Express Bus) | Home, Healthcare, Hospice and Community Services (HCS) | City staff | Annual |
| Number of bus stops / Miles of bus routes | City GIS data / City Engineering Office | City staff | Every 2-3 years |
| Miles of bike/ pedestrian pathways and sidewalks maintained year-round | City GIS data / City Engineering Office | City staff | Annual |
| Number/distribution of EV charging stations by type (level 2/level 3) | PlugShare.com | City staff | Annual |
| Proportion of residents living in locations with mixed land uses | City Assessing Department | City staff | Every 5 years |
| Number of roundabouts compared to signalized intersections | City GIS data / City Engineering Office | City staff | Annual |

# CHAPTER 5 | ACTION PLAN

## Implementation

The City recognizes that in order to meet its ambitious energy goals, the City and its community partners need to act now using the tools that are available today. Future technologies, policies, and incentives will – and should – influence the specific actions and strategies that the City and others deploy to reach the energy goals by the 2030 and 2050 target dates. However, given the urgency of climate change and the short time frame for achieving the community's energy goals, implementation must start now. To that end, the City should allocate appropriate staffing and other resources to achieve the priority action strategies outlined in this plan.

The Energy & Climate Committee (ECC) recommends that the City consider the following to ensure implementation happens in a coordinated and effective fashion:

**I.** In the near-term (6 months - 1 year), the City should identify a team of existing staff to lead implementation efforts within the City. The membership of this "implementation team" may vary over time depending on the current focus of the group (e.g. Community Power, Benchmarking policy, EV charging infrastructure, etc.). The team would work together in coordination with the ECC and City Council to implement policies and actions to achieve the City's Sustainable Energy Goals. This internal City staff team could be an informal group appointed by the City Manager, or it could be more formally created through a City Council resolution.

**II.** Explore options for hiring a shared Sustainability Coordinator position with other local governments or institutions. While hiring a full-time sustainability coordinaor may not be feasible at this time, there are existing models for shared sustainability positions that the City could look into. For example, Clean Energy NH has created a "North Country Circuit Rider" position. This person acts as an additional staff person for communities in Coös County, helping them implement energy projects. Just over the border in Maine, the Southern Maine Planning & Development Commission has created a Sustainability Coordinator position that is shared among six towns. This person works with each of the six communities to research effective actions and assist with implementation of programs to help each community reach its local energy and resilience goals.

# Priority Action Strategies

In order to identify priority strategies for implementation, the ECC worked with staff to identify, evaluate and rank a set of policies, programs, incentives, and other actions that the City can pursue in the near-term to make progress towards achieving its energy goals. These action strategies were ranked using the following evaluation criteria:

I. **Scale of Impact:** Extent to which the action has the potential to increase the level of renewable energy in the electricity mix, thermal energy mix, or transportation energy mix.

II. **Local Impacts:** Extent to which a strategy will increase renewable energy development or generation within the region and increase resiliency to shocks to the energy system.

III. **Environmental & Social Goals:** Extend to which a strategy is expected to contribute to local job growth and impact greenhouse gas emissions.

IV. **Inclusion & Equity:** Extent to which a strategy is expected to be affordable and cost-effective for residents and businesses of all income levels within Keene, and extent to which the benefits associated with the strategy are expected to be distributed equitably.

V. **Feasibility:** Extent to which the City will incur costs to implement the strategy, and extent to which the strategy is technically possible. This rating criteria also includes the availability of existing funding sources and incentives.

The evaluation criteria above were developed based on feedback gathered from a series of outreach events conducted in the fall of 2019 and early winter of 2020. Using these evaluation criteria, the ECC identified 17 priority action strategies, which generally fall into three broad categories:

**Energy Efficiency:** Many of the priority strategies focus on reducing energy use as a first and critical step in reducing the total supply of renewables needed to meet energy demand and control costs. This is especially true with the electricity sector, as the electrification of thermal and transportation energy consumption will lead to a substantial increase in total electricity consumption.

**Renewable Energy – Generation & Procurement:** In order to reach the 100% renewable energy goals, the City, businesses, and residents will need to both procure electricity from renewable sources and substantially increase local renewable energy generation.

**Fuel Switching:** The long lifespan of heating and cooling systems, vehicles, and new construction means that the City should start encouraging and supporting the replacement of fossil fuel systems with electric or renewable systems as soon as possible. Each fossil fuel-based vehicle and/or heating & cooling system purchased today will be around for years to come, and represents a lost opportunity for transitioning away from fossil fuels.

Table 5.1 on the next two pages summarizes the 17 priority implementation tools & strategies by category (energy efficiency, renewable energy, and fuel switching) and sector (electricity, thermal, or transportation). It also includes information about the potential lead organization for each strategy, potential partners, and implementation timeframe (1-2 years, 3-5 years, or 5-10 years).

| | Tool / Strategy | Description | Sector(s) | Lead | Partners | Timeframe |
|---|---|---|---|---|---|---|
| Energy Efficiency | Benchmarking Ordinance | Require building owners of certain sizes or in certain districts to report energy use data to the City. | Electricity, Thermal | City of Keene | Business community, large energy users | 1-2 years |
| | Home Energy Labeling Program | Require energy efficiency disclosure for existing and new residential properties at the time a property is listed for rent or sale. | Electricity, Thermal | City of Keene | Association of Realtors, NEEP | 1-2 years |
| | Weatherization Program | Partner with existing weatherization programs to enhance public outreach and education, amplify impact, and increase capacity. | Electricity, Thermal | ECC/ City of Keene | SCS, Eversource, Keene Housing | 1-2 years |
| | Complete Streets Program | Incorporate the adopted City of Keene Complete Streets Design Guidelines (2015) into the City's street standards for new streets, and develop Complete Streets standards for re-construction of existing streets. | Transportation | City of Keene | SWRPC, MAST, BPPAC | 3-5 years |
| | City Express Bus | Increase financial support for the City Express and Friendly Bus programs, and encourage HCS to expand services/routes. | Transportation | HCS | City of Keene, SWRPC | 3-5 years |
| | Multi-Modal Transportation Center | Work with community partners to construct a multi-modal transportation center in Keene and promote inter-city transit options. | Transportation | City of Keene | SWRPC, Greyhound, HCS | 5-10 years |
| | Advocacy for Public Transportation & Active Transportation | Advocate at the federal and state level for more funding to support public transportation and active transportation. | Transportation | ECC/City of Keene | MAST, MRCC | 1-2 years |
| Renewable Energy | Community Power Program | Establish a Community Power Program to aggregate community load and purchase electricity from an alternate electricity supplier. | Electricity | City of Keene | Cheshire County, Other towns | 1-2 years |
| | Virtual Power Purchase Agreement | Enter into a long-term, fixed price contract for renewable energy from a specific project (i.e. agree to a contract for differences, or CfD). | Electricity | City of Keene | | 3-5 years |
| | Pilot Battery Storage Program | Collaborate with Eversource to provide a pilot batter storage program for residents and businesses to reduce demand on the grid during peak times. | Electricity | Eversource | City of Keene | 3-5 years |
| | Renewable Energy Loans | Partner with a local financial institution to create a loan product to finance renewable energy installations targeted at businesses or residents. | Electricity, Thermal | Financial Institution(s) | City of Keene | 3-5 years |
| | Solar & EV Ready Guidelines | Adopt Solar & EV Ready Guidelines to encourage new buildings to be built in a way that accommodates future solar installations. | Electricity, Thermal, & Transportation | City of Keene | | 1-2 years |

| | Tool / Strategy | Description | Sector(s) | Lead | Partners | Timeframe |
|---|---|---|---|---|---|---|
| Fuel Switching | Heatsmart Campaign | Host a "Heatsmart" campaign to encourage the installation of renewable thermal technologies for space heating and cooling or for hot water heating through targeted local out-reach efforts and bulk discount prices. | Thermal | ECC / Community Volunteers | City of Keene, Local contractors | 1-2 years |
| | Public EV Charging Stations | Install public EV charging stations (level 2 and fast-charge) in on-street parking areas and in public parking lots or structures. | Transportation | City of Keene | Eversource | 1-2 years |
| | Electric Buses | Work with the Keene School District/local school bus company and HCS (City Express and Friendly Bus) to encourage switch to electric buses. | Transportation | First Student / HCS | SAU 29 | 5-10 years |
| | Advocacy for EVs and Alternative Fuel Vehicles | Advocate at the federal and state level for more funding to support EVs and other alternative fuel technologies. | Transportation | ECC/City of Keene | MAST | 1-2 years |
| | Renewable District Heating system | Commission a study to assess the potential for a renewable district heating system in Keene to understand what areas of the city would have the appropriate demand characteristics to justify a district energy system, as well as what local renewable sources are available and at what potential and likely cost. | Electricity (co-generation), Thermal | City of Keene | | 3-5 years |

*Table 5.1 Priority implementation strategies and actions for the Keene Sustainable Energy Plan.*

# BENCHMARKING ORDINANCE

## Overview

A municipal and commercial building benchmarking ordinance is an effective strategy that enables building owners to measure the energy efficiency of their building against comparable buildings from across the country and identify buildings that could benefit most from energy efficiency improvements. The vast majority of building benchmarking ordinances rely on the use of the Environmental Protection Agency's (EPA's) ENERGY STAR Portfolio Manager, a free online benchmarking tool that helps building managers track data and measure progress. Portfolio Manager allows building managers to compare their building to similar buildings using the 1-100 ENERGY STAR score. Achieving a score of 50 would be considered the median, while a score of 75 would indicate that the building is performing better than 75% of its peers and may be eligible for ENERGY STAR certification.

Through the identification of inefficient buildings, a benchmarking ordinance can be effective in driving increased participation in already existing energy audit and energy efficiency programs, such as those offered through Eversource. These programs can accelerate the path towards decreased energy consumption, energy cost, and GHG emissions. Many benchmarking programs feature a public disclosure component, which can have beneficial impacts such as empowering prospective tenants to make informed decisions before entering into a lease agreement. Benchmarking programs can be voluntary or mandatory, include energy and/or water consumption, and can be customized by square footage and building type. For example, many benchmarking ordinances have stricter reporting requirements for larger commercial buildings that exceed a certain square footage threshold. Some benchmarking ordinances also link the program to mandatory energy audits or energy efficiency improvements for inefficient buildings. Since over 70% of total electricity consumption in Keene is associated with commercial and municipal buildings, a benchmarking ordinance has significant potential to reduce electricity consumption in Keene's existing building stock.

## Keys Benefits and Challenges

Key benefits and challenges associated with implementing a building benchmarking ordinance are summarized in the table below:

| Key Benefits | Key Challenges |
|---|---|
| Identifies commercial and municipal buildings in Keene that could benefit most from energy efficiency improvements | Potential pushback from affected property owners associated with passing a mandatory ordinance through City Council |
| Drives participation in existing energy audit and energy efficiency programs offered through Eversource | Mandatory benchmarking does not guarantee energy-efficiency upgrades and improvements |
| Availability of a free online benchmarking tool, EPA's ENERGY STAR Portfolio Manager (other tools are available, but usually have an associated cost). | Potential issues with data access, quality, and accuracy |

| Key Benefits | Key Challenges |
|---|---|
| Opportunity for Keene to lead by example by benchmarking municipal buildings | Compliance with, and enforcement of, mandatory ordinance |
| Potential to link financial incentives to energy-efficient upgrades (see South Portland example below) | Administrative burden associated with ongoing support and management of the program |

## Implementation Steps

Initial implementation steps for developing a building benchmarking ordinance are listed below:

| Implementation Steps | |
|---|---|
| ✓ | Review EPA's list of Benchmarking Programs and Policies Leveraging ENERGY STAR[1] to evaluate options for program design, requirements, and incentives being utilized by other localities. |
| ✓ | Consider a voluntary program to precede a mandatory ordinance. |
| ✓ | Consider thresholds for program participation (e.g. by building size, by building type, etc.) |
| ✓ | Draft ordinance language for review by City Council. |
| ✓ | Lead by example by publicly sharing energy use data for City buildings and facilities. |
| ✓ | Develop or enhance a webpage to host relevant resources and materials. |
| ✓ | Determine which metrics will be disclosed publicly. |

## Examples from Other Communities

This section includes communities that have implemented best practices related to implementation of municipal and commercial building benchmarking ordinances in the US. Each example includes a few key points and differentiating factors as well as a hyperlink to each ordinance. For additional examples, the EPA's ENERGY STAR program developed an interactive map[2] to track benchmarking programs in the US that are utilizing Portfolio Manager in their ordinance. All of the ordinances listed below involve mandatory reporting requirements and utilize Portfolio Manager as the primary benchmarking platform.

### Energy & Water Benchmarking Ordinance: South Portland, Maine

Adopted in 2017, the Energy & Water Benchmarking Ordinance in South Portland, Maine requires all municipal, school, and commercial buildings larger than 5,000 square feet to benchmark and disclose their annual energy and water consumption to the city each year.[3] The ordinance also applies to residential multifamily buildings with more than 10 units. In order to encourage increases in energy efficiency, the ordinance mandates that each covered property subject to reporting requirements must complete a building energy audit once every five years. However, while disclosure of the building energy use and periodic audits are required, the policy does not mandate buildings to meet certain levels of energy efficiency, reach energy reduction targets, or make energy-related improvements. Typically, it's uncommon for mandatory benchmarking ordinances to offer incentives, but in the case

of South Portland, they offer a $5,000 compliance incentive that can be used as a credit for future expenses stemming from city application, review, or inspection fees associated with construction or redevelopment projects at the property.

## Building Energy Saving Ordinance: Berkeley, California

Adopted in 2015, the Building Energy Saving Ordinance (BESO) in Berkeley, California requires that all covered buildings report their annual energy consumption.[4] The BESO phases in reporting requirements by building size so that larger buildings over 50,000 square feet must report first in 2018 while smaller buildings, such as those below 5,000 square feet, are not required to report until 2022. Similarly, covered buildings over 25,000 square feet must conduct an energy assessment every five years while covered buildings below that threshold must only conduct an energy assessment every ten years. Berkeley also operates an Energy Efficiency Incentive Program that complements the BESO and encourages building upgrades and improvements.

## Building Energy Use Disclosure Ordinance: Cambridge, Massachusetts

Adopted in 2014, the Building Energy Use Disclosure Ordinance (BEUDO) in Cambridge, Massachusetts is a time-tested ordinance that provides a wealth of resources and data that can be leveraged by those looking to create ordinances in other jurisdictions. Covered buildings include all buildings over 25,000 square feet, residential buildings with over 50 units, and municipal buildings over 10,000 square feet. Each of these building subsets is required to report energy and water usage to the city on an annual basis. The results of the reporting are publicly disclosed on a building-level basis on the Cambridge Open Data Portal. Cambridge also publishes annual reports, summary statistics, and compliance maps.[5]

# HOME ENERGY LABELING PROGRAM

## Overview

A Home Energy Labeling program provides an assessment of a home's energy performance, typically in MMBtu/year, and compares it to that of other similar homes. It uses the same approach as other labeling programs, such as miles-per-gallon ratings on cars, nutrition labels on food, and Energy Guide labels on appliances, to compare two "products." Homebuyers, homeowners, and renters can use this information not only to estimate energy use, but also to estimate energy costs and potential energy efficiency upgrades to make a home more comfortable and less expensive to run. When properly designed, home energy labels allow the consumer to make an informed decision about home purchases, rentals, or upgrades they can make.

A key benefit of Home Energy Labeling is its ability to help overcome the "split incentive," an often-cited barrier to energy efficiency for homes and rental properties. For new homes, the split incentive arises when builders have little or no incentive to build to higher efficiency standards, which is largely invisible to homebuyers and increases the build cost. A home energy label addresses this by adding visibility to the energy costs of operating a home, which in turn increases the marketability of homes that are more efficient and helps builders sell more quickly and for a better price.[6] With rental properties, the split incentive arises when the building owner, who is responsible for maintenance and major appliances, does not pay for the energy that the building uses. In this case, a home energy label allows renters to understand how much they can expect to pay for utilities and more accurately compare the options available to them.

**Common Components of a Home Energy Label:**

- Home profile (year built, area, # of bedrooms).
- Details about home's current structure and systems.
- Home Energy Score, Energy Star score, or similar rating.
- Annual energy use and cost based on energy modeling.
- Home's carbon footprint.
- Custom energy improvement recommendations.

Local governments can adopt a Home Energy Labeling Policy to encourage or require a home energy label in real estate listings, at time of sale, point of lease/rental, at time of building renovation, and/or when major systems are replaced. Mandatory programs have higher rates of participation; however, they are often preceded by a voluntary program to help demonstrate benefits and provide proof of concept.

A variety of rating systems can be used for the scorecard, including DOE Home Energy Score (HES), RESNET Home Energy Rating System (HERS) rating, ENERGY STAR Certified Homes (HPwES), and state-created stand-alone scorecards (which are often tied to the modeling engines of other labels like HERS or HES). The scorecard should be designed to include metrics that are clear and easy to understand, are aligned with local and state policy goals, and allow for tracking progress on those goals. An example scorecard from Efficiency Vermont is shown on the next page.

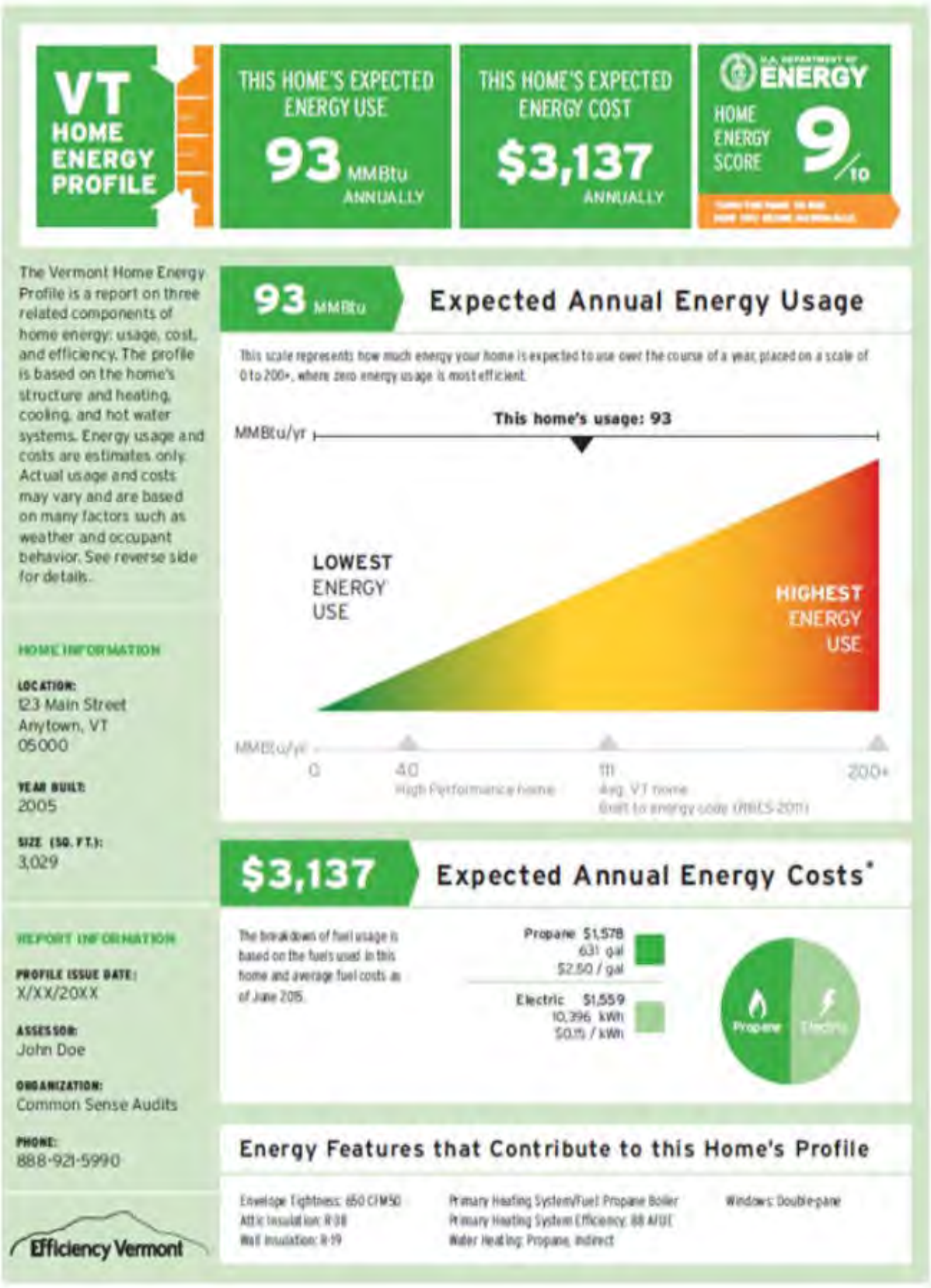



*Figure 5.1. An example of the front page of the Efficiency Vermont Home Energy Profile.*

## Key Benefits and Challenges

| Key Benefits | Key Challenges |
|---|---|
| Identifies rental properties and homes in Keene that could benefit most from energy efficiency improvements. | Potential pushback from affected property owners associated with passing a mandatory ordinance. |
| Applies to both existing housing stock and new homes. | Mandatory energy labeling does not guarantee energy-efficiency upgrades and improvements. |
| Provides consumers with greater transparency and a measure of protection when making large financial investment in a home or rental. | Compliance with, and enforcement of, mandatory ordinance. |
| Helps to overcome the "split incentive" for rental properties and construction of new homes. | Administrative burden associated with ongoing support and management of the program |
| Potential to link financial incentives to energy-efficient upgrades | Requires buy-in and support from stakeholders groups including builders, real estate professionals, and contractors / appraisers. |

## Implementation Steps

| Implementation Steps | |
|---|---|
| ✓ | Review policies and ordinances from other communities to evaluate options for program design, requirements, and incentives being utilized by other localities. |
| ✓ | Consider a voluntary and/or pilot program to precede a mandatory ordinance. |
| ✓ | Draft ordinance language and pass through City Council. |
| ✓ | Develop or enhance a webpage to host relevant resources and materials. |
| ✓ | Determine which metrics will be disclosed publicly. |

## Examples from Other Communities

This section includes communities that have implemented Home Energy Labeling programs in the US. Each example includes a few key points and differentiating factors as well as a hyperlink to each program page. All of the ordinances listed below involve mandatory reporting requirements and utilize a variety of tools for reporting. For a state-by-state list of home energy labeling programs in the Northeast and Mid-Atlantic, see the Northeast Energy Efficiency Partnerships Residential Labeling Dashboard.[7]

### Home Energy Score Ordinance: Portland, Oregon

The City of Portland adopted the Home Energy Score Ordinance in December 2016, which went into effect just over a year later in January 2018. The ordinance requires sellers to obtain a home energy performance report prior to listing their properties.[8] The report must contain the DOE Home Energy Score and must be provided to prospective buyers and included in the real estate listing. Home Energy Score data is entered into a local Green Building Registry, which then auto-populates Portland's local multiple listing service, which in turn, populates several consumer-facing real estate portals, such as Zillow and Trulia. Sellers who fail to comply with the ordinance receive a warning notice, and if the seller does

not take corrective action within 90 days, they must pay a fine of $500. The City of Portland maintains a dedicated webpage with information, tools, and resources to help support homeowners with compliance - www.pdxhes.com.

## Rental Housing Time of Sale Energy Efficiency Ordinance: Burlington, Vermont

In order to strengthen the City's response to the "split incentive paradigm" and increase energy efficiency in rental housing, the City of Burlington, VT adopted a "Time of Sale Energy Efficiency Ordinance" which mandates that cost-effective energy efficiency standards be met when buildings are sold and inspected every 1 to 5 years.[9] This ordinance only applies to rental properties where tenants pay directly for heating costs. In addition, the program has a built-in cap on costs in order to mitigate pass-through of costs to tenants.

## Building Energy Saving Ordinance: Berkeley, California

Berkeley's Building Energy Saving Ordinance (BESO)[10] applies to 1-4 unit homes in addition to buildings of a certain size or greater. Homeowners are required to get a Home Energy Score prior to sale. However, this requirement may be deferred to the buyer for up to 12 months at time of sale. Data from the first year of the ordinance shows that the majority of homes scored lacked proper insulation and had single paned windows. The three most common recommendations included in Berkeley Home Energy Score reports to date have been floor insulation, attic insulation and air sealing, and installing a central gas furnace. In a recent report that evaluates the BESO program, recommendations for improving the program for 1-4 unit homes include requiring the Home Energy Score at time of listing rather than at time of sale, among other recommendations.[11]

# SUPPORT & ENHANCE EXISTING WEATHERIZATION PROGRAMS

## Overview

This strategy leverages existing programs and seeks to extend the reach and/or enhance the impact through local volunteer support for outreach, education, and marketing. In addition, it is possible that additional financial support could extend the eligibility of these programs to currently ineligible households.

There are a couple well-established, existing weatherization programs available to homeowners, renters, and businesses in Keene, as well as new program that is in the works:

- NHSaves is a collaboration of New Hampshire's electric utilities working with the New Hampshire Public Utilities Commission and other interested parties. The program provides links and information on how customers can qualify for rebates and other incentives, including commercial and industrial energy efficiency options.12 According to Frank Melanson, Supervisor in Energy Efficiency with Eversource, the High Performance with Energy Star (HPwES) program, which assists homes with high heat fuel usages to transition to energy efficient appliances, has reached 17 households in Keene in the past 5 years, nearly doubling their 2018 totals in 2019 due to the success of the program. The Home Energy Assistance Program (HEA) has worked closely with Keene Housing and saw a dramatic increase in income eligible homes who are served by this program in recent years. In total, HEA has reached 124 homes in Keene in the past three years, 116 of which were in 2019. NH Saves Energy Efficiency Department predicts HEA will reach over 200 homes in 2020.
- Southwestern Community Services (SCS) Weatherization Assistance Program is designed to help reduce heating and other energy costs for income eligible households by improving living conditions and providing warmer, safer, and more comfortable homes. It also aims to lower energy costs by 19 to 22 percent. Priority is given to the elderly, the disabled, and households with small children. Eligibility for the program is determined by gross household income and vulnerability to heating and electricity costs.13 In addition, the SCS Heating Repair and Replacement Program (HRRP) can help clients repair or replace their heating systems. Recipients must be income-eligible and receiving fuel assistance in order to qualify for HRRP. Assistance for heating replacement is based on availability of funds.
- The City of Keene, SCS, and other potential partners are in the process of creating a program to update and weatherize homes in Keene's "middle" neighborhoods. Middle neighborhoods are places where home prices and rentals are generally affordable, but are often on the edge between growth and decline. These neighborhoods are not thriving enough to attract sustained private investment, yet are not troubled enough to warrant government intervention. They are in desirable locations near the downtown and employment. This concept, called "21 in 21," is intended to help coordinate repairs to buildings in order to abate housing/safety/zoning issues, enhance safety, increase

energy efficiency (defined as a Home Energy Score of 7 or better), improve curb appeal, and increase home ownership opportunities, which is positively associated with social capital.

By hosting local Button-Up Workshops, organizing weatherization campaigns run by a group of volunteers, or even cost sharing to hire a local or regional NHSaves representative, the reach and efficacy of these programs could be increased by building off of their existing successes.

## Keys Benefits and Challenges

| Key Benefits | Key Challenges |
|---|---|
| Leverages existing program structure and design + builds on pre-existing success. | Would require an engaged group of volunteers with a high time commitment. |
| Takes advantage of utility/state funding, technical expertise, and preexisting infrastructure and programs. | City not in direct control of program development and implementation + success is largely dependent on Eversource / SCS being active + willing participants. |
| Helps lower energy costs for residents and businesses. | Need to identify the right points of contact at all participating organizations. Partnership may require connection at the upper management/admin level. |
| Potential to expand the reach of existing programs to residents and businesses who do not currently qualify. | Due to the high percentage of rentals in Keene, overcoming the split incentive for rental properties could be a major challenge. |
| Opportunity to support local economy by engaging with local contractors. | |

## Implementation Steps

| Implementation Steps | |
|---|---|
| ✓ | Reach out to Eversource and/or SCS to discuss potential opportunities to collaborate on an existing weatherization program. |
| ✓ | Reach out to local energy groups / advocates to assess level of interest in volunteering or otherwise supporting a local weatherization program. |
| ✓ | Assign resources (volunteers, City staff time, and financial commitments). |
| ✓ | Develop or enhance a webpage to host relevant resources and materials. |
| ✓ | Measure and track metrics to evaluate program impact. |

## Examples from Other Communities

This section includes examples of how communities have partnered with existing programs and utilities to enhance weatherization efforts.

### Weatherize Upper Valley: Weatherize Campaigns

Coordinated by the nonprofit organization Vital Communities, Weatherize Upper Valley enlisted community volunteers to join local outreach teams responsible for increasing participation in existing energy efficiency programs in New Hampshire (NHSaves) and Vermont (Efficiency Vermont).[14] Energy consultants offered free or discounted home energy consultations, and the volunteer teams helped generate leads for the contractors, helping justify the discounted services. This approach created economies of scale in small communities and made the vendor selection process easier for participants. According to the Island Institute 2018 report, "Bridging the Rural Efficiency Gap," Pilot Weatherize campaigns in 14 Vermont towns resulted in 100 weatherization projects in just six months, an increase of 40% above their typical annual average. During the program's second round, six New Hampshire towns with virtually no history of weatherization projects helped weatherize over 90 homes with help from seven New Hampshire contractors.

### Rural Alaska Community Action Program: Energy Wise Outreach Program

The Rural Alaska Community Action Program (RurAL CAP), formed in 1965, piloted their "Energy Wise" program in 2009 to help Alaskans reduce energy consumption, create local jobs and training opportunities, and save on electric bills and home heating costs.[15] However, in an assessment conducted in 2011, insufficient public awareness was identified as a major barrier to program success. In order to address this barrier and improve public education and outreach, RurAL CAP developed a Community Energy Education Kit that utilized the existing infrastructure of the Energy Wise Program to pilot a public education delivery system. This system included the creation of nine different "Booth in a Bucket" hand-on science kits, which were featured at energy fairs in 13 Alaskan communities. RurAL CAP also created a "how-to" guide to replicate the bucket booth and energy fair model in other communities.

# EXPAND COMPLETE STREETS PROGRAM

## Overview

The City of Keene formally adopted a Complete Streets policy and a set of Complete Streets guidelines in 2015. The policy directs the City to consider and incorporate all modes of transportation and the safety needs of all users, including motorists, transit, pedestrians, bicyclists, seniors, youth, and persons with disabilities, when making improvements to existing infrastructure or building new projects.[16] The Complete Streets Guidelines establish a street typology system, shown in Figures 5.2 and 5.3. The guidelines provide a checklist of recommended Complete Streets treatments, such as sidewalks, pedestrian crossings, green buffers, lighting, etc. that are appropriate for each street type.[17]

**What is a Street Typology?**

Typology classifies streets by roadway function and surrounding context, including right of way width, building types, predominant travel modes, and land uses. The designation of Keene's roadways as different street types serves as a methodology to ensure that the design and use of a street complements the surrounding area and vice versa.


*Figure 5.2. City of Keene Complete Street Types.*

Since its adoption, the City has used the Complete Streets policy and guidelines to help guide decisions related to infrastructure improvement projects. The City has actively pursued grants to help offset the increased cost associated with these projects, including the NH DOT Transportation Alternatives Program (TAP) grant, the Monadnock Alliance for Sustainable Transportation (MAST) Complete Streets grant, and the US Department of Transportation Better Utilizing Investments to Leverage Development (BUILD) grant.

Providing funding for up-front capital costs as well as for ongoing maintenance of Complete Streets infrastructure is critical the success of the Complete Streets program. Often, the rationale for including or not including Complete Streets elements in a given infrastructure project is driven by the project budget. In addition, as the City has added new bicycle and pedestrian infrastructure over the past few years, the operational budget for maintaining this infrastructure has not increased. This puts a greater burden on existing resources and can cause delays in maintenance and upkeep of infrastructure, such as re-striping bicycle lanes, crosswalks, and repair of pedestrian crosswalk beacons.

As a next step, the City should incorporate the adopted City of Keene Complete Streets Design Guidelines into the City's street standards for new streets, and develop Complete Streets standards for re-construction of existing streets. As part of this effort, the

maintenance budget should be re-evaluated and adjusted to account for increased costs associated with Complete Streets infrastructure. In addition, the City should continue to pursue grant funding to install new infrastructure to support Complete Streets.

## Key Benefits and Challenges

| Key Benefits | Key Challenges |
|---|---|
| Increased safety for all users of the roadway. | Constrained right-of-way widths of exi[18]sting streets. |
| Increase in foot traffic and economic vitality of downtown centers and neighborhoods. | Balancing competing interests of diffe[19]rent users within the roadway. |
| Improved public health due to features that promote regular walking, cycling and transit use. , | Increased cost of already expensive [20]in[21]frastructure projects. |
| Reduced barriers for seniors, young children, people with disabilities, and individuals & families who do not own a motor vehicle. , , | Ensuring adequate funding for main[22]te[23]na[24]nce, repair, and operation of infrastructure. |
| Potential to increase property values, support existing businesses, and attract new businesses., | Building and maintaining public supp[25]or[26]t for projects with a lengthy delay between planning/public outreach and construction. |
| Encourages people to take more trips by foot, bicycle and transit, with associated reduction in GHG emissions. , , , | Administrative burden associated[27] w[28]it[29]h [30]developing and writing standards for existing streets, and revising standards for new streets. |

## Implementation Steps

| Implementation Steps | |
|---|---|
| ✓ | Reach out to community groups and advocates to build public support. The City of Keene has a long history of citizen support for Complete Streets dating back to the 1980s. Past initiatives include the 1987 Downtown Revitalization Project, which transformed Main Street from a wide, car-centric thoroughfare to a pedestrian-friendly downtown street, a 1999 Council policy to evaluate the installation of bike lanes during road construction projects, the incorporation of Complete Streets into the City's 2010 Comprehensive Master Plan, a 2011 City Council resolution to adopt a Complete Streets policy, and the 2015 Complete Streets policy and design guidelines. This existing momentum should be leveraged to demonstrate strong community support. |
| ✓ | Submit proposal to City Council for review and approval. |
| ✓ | Assign resources (City staff time and financial commitments). |
| ✓ | Develop Complete Street standards for existing streets, and incorporate Complete Street standards for new streets into City Code. |
| ✓ | Submit the draft Complete Street standards to City Council for adoption. |
| ✓ | Advocate for funding in the Capital Improvement Program and the annual City budget. |
| ✓ | Measure and track metrics to evaluate program impact. |

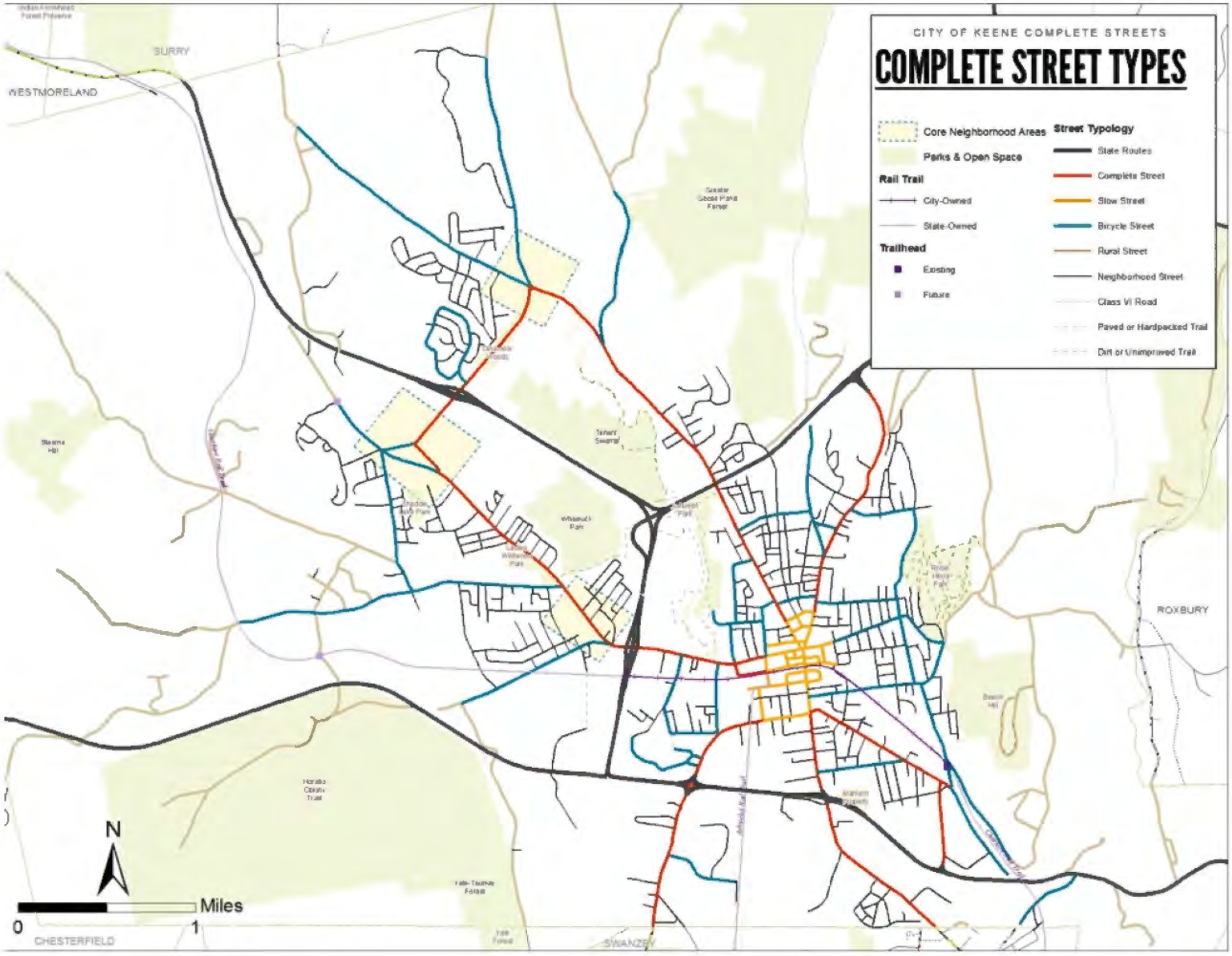



*Figure 5.3. City of Keene Complete Street Types.*

# EXPAND AND ENHANCE CITY EXPRESS BUS SERVICES

## Overview

The City Express Bus, operated by Home, Healthcare, Hospice and Community Services of Southwestern New Hampshire (HCS), is currently the only fixed-route transit system in Keene serving an average of 72 riders per day and over 30,000 rides annually.[31] There are two year-round bus lines that operate from 8:00 a.m. to 5:00 p.m. on weekdays, and a campus shuttle that operates during the Keene State College school year from 7:30 am to 7:00 pm, as shown on the bus route map in Figure 5.5. The program operates on an annual budget of about $410,000.[32]


*Figure 5.4. Image of a City Express Bus. Source: www.hcsservices.org/transportation*

It is possible that increasing hours of service and the frequency of bus stops would better serve a greater number of residents and increase ridership. However, doing so would require a significant investment of resources, and would not be possible without additional funding for the program and the full support of HCS and the New Hampshire Department of Transportation (NH DOT). Charlie Pratt, the Transportation Manager for the City Express Bus, estimates that adding an additional bus route would add approximately $125,000 to the annual operating budget. [33] HCS already has a spare bus; however, there are significant costs associated with maintaining and operating the bus, as well as hiring a bus driver. Mr. Pratt notes that the City Express program is always thinking about ways to increase ridership and better serve its riders, and would like to expand services if the resources are available.

Operating costs for the City Express are based on a number of variables, including the number of bus routes offered, the level of service on each route, the span of service (start and end time for each route), and the number of days that the service is operated. Before making a decision to expand service, careful study is required in order to determine when and how to make investments to expand or improve services. Conducting a study and comparing various route alternatives can also help to build the case for additional funding from major funders, including the Federal Transit Administration (through the NH DOT) and local match providers (City of Keene and HCS).

The most recent planning study for the City Express Bus was done in 1999 by Southwest Region Planning Commission (SWRPC) in order to support the design of a proposed service expansion for the City Express Bus in 2000.[34] At the time, the City Express operated a single

fixed-route bus with limited hours, serving primarily area elders for daytime trips between housing, services, and shopping. The NH DOT, HCS, and City of Keene identified a need and opportunity for expansion of public transportation services in Keene in order to better serve residents without reliable access to personal transportation. Ultimately, many of the findings and recommendations from the study were implemented, including the addition of a second bus route; however, some of the recommendations have not been implemented. A new study could help provide insights into current conditions and opportunities for expanding and/or increasing transit service in Keene.

## Keys Benefits and Challenges

| Key Benefits | Key Challenges |
|---|---|
| Enhanced mobility and transportation choice for people without reliable access to a personal vehicle. | Requires up-front capital investment in buses and supporting infrastructure. |
| Equitable and affordable transportation option. | Securing funding for high ongoing maintenance and operational costs. |
| Moves people more efficiently and produces less air pollution per passenger mile than a single occupancy vehicle. | Lack of public awareness and understanding of benefits of public transit as well as needs and funding sources. |
| Potential to reduce traffic & parking congestion. | Effectively advertising and marketing to potential riders to increase ridership. |
| Potential to support economic development by shifting consumer expenditures, creating local jobs, improving access to education, job training, and employment, and increased property values. | Less convenient than a door-to-doo[35]r service or personal vehicles. |

## Implementation Steps

| Implementation Steps | |
|---|---|
| ✓ | Conduct a study to assess opportunities for expanding and/or increasing City Express Bus Services. The most recent study for the City Express Bus was completed in 1999; however, local markets and conditions have shifted since that time. A new study could help identify potential new routes or expansion to existing routes, and/or improvements in service, that would be most effective at increasing ridership. |
| ✓ | Provide ongoing education to local employers and public regarding the benefits of the City Express Bus to both riders and non-riders, as well as the needs and funding requirements for the bus service. |
| ✓ | Advocate for more federal and state funding for public transportation. Work with local community partners, such as the Monadnock Region Coordinating Council for Community Transportation (MRCC) and SWRPC to educate decision-makers about the need for additional public transportation funding. |
| ✓ | Pursue new funding sources to supplement existing sources, such as grants, matches from local institutions that benefit from the bus service, and support from not-for-profit organizations and charitable foundations. |

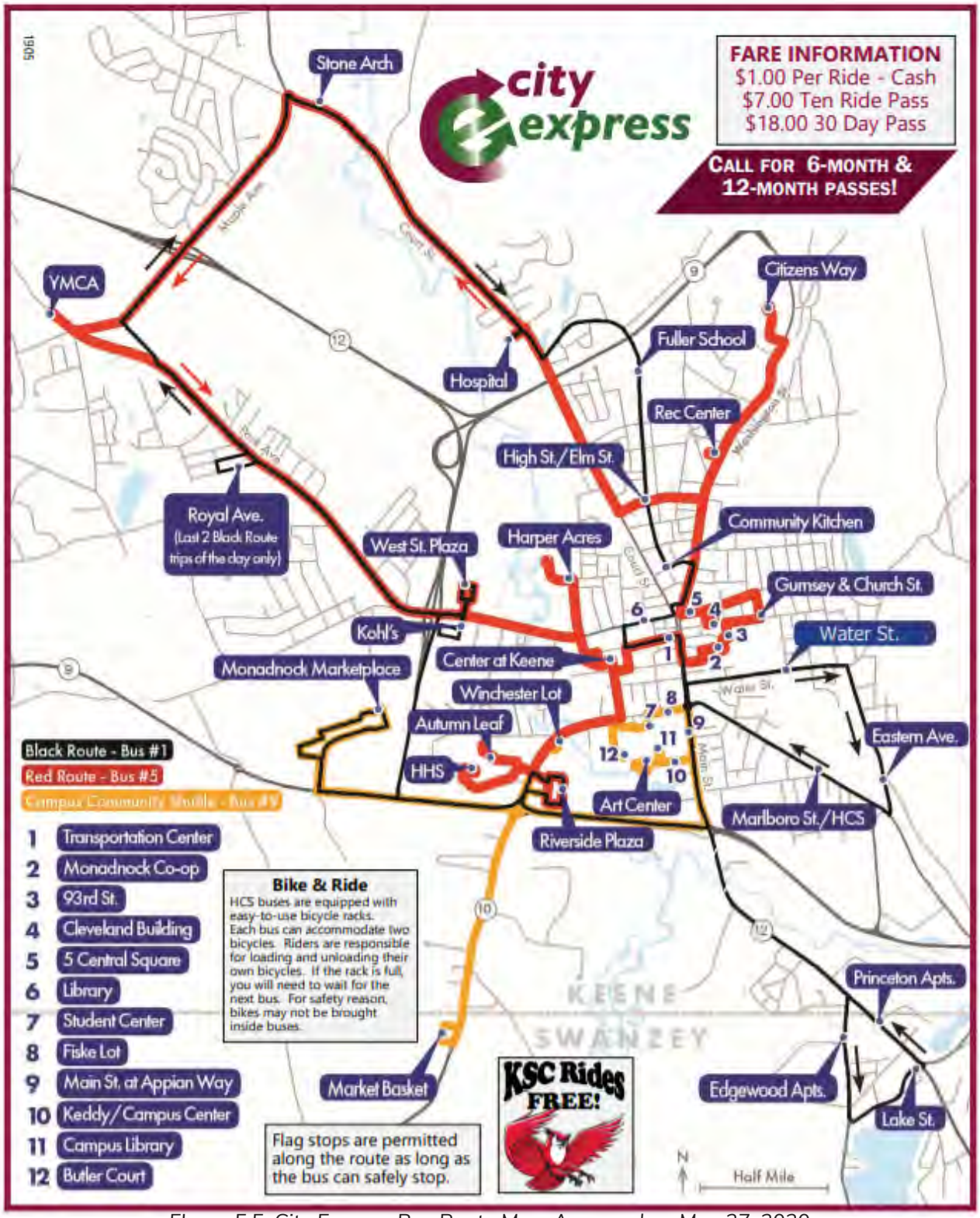



*FIgure 5.5. City Express Bus Route Map. Accessed on May 27, 2020.*

# MULTI-MODAL TRANSPORTATION CENTER

## Overview

A multi-modal transportation center is a facility that ties together several modes of transportation, such as driving, fixed-route bus transit, intercity bus transit, bicycling, walking, car-sharing, and more. It provides a convenient location for travelers to transfer among multiple types of transportation in a comfortable and attractive environment. Potential features include short-term and long-term parking, bicycle parking & storage, passenger waiting areas, carsharing services, EV charging stations, and dining facilities and/or vending machines. Southwest Region Planning Commission (SWRPC) is currently in the midst of a study to better understand what services would be most appropriate and beneficial to include in a multi-modal transportation center for Keene and the surrounding region.[36] This study will also evaluate potential sites where a transportation center could be located. Following the conclusion of this study, the City should review the recommendations included within the report and determine whether to pursue construction of a multi-modal transportation center.

## Keys Benefits and Challenges

| Key Benefits | Key Challenges |
|---|---|
| Enhances the image and effectiveness of public transportation and other transportation options. | Providing sustainable funding of operation and management through revenue from meters, permits, and fines. |
| Increases mobility and transportation choice for people without reliable access to a personal vehicle. | Managing impacts to parking, traffic, and existing transportation system during construction. |
| Improves connections within Keene and the region, and between the Monadnock Region and other regional centers. | Securing grants, private investments, and other funding sources to cover the up-front cost without increasing the tax burden. |
| Potential to support existing and future intercity transit, including possible connections to Brattleboro, Concord, and Boston. | Political challenges with funding and supporting a high-cost, long-term capital project. |

## Implementation Steps

| Implementation Steps | |
|---|---|
| ✓ | Review the results and recommendations of the Greater Keene Intermodal Transportation Center Feasibility Study. |
| ✓ | Build a coalition of advocates and community supporters to demonstrate public support for a multi-modal transportation center. |
| ✓ | Provide education and outreach to increase understanding among the public, large employers, and decision-makers of the potential benefits of a multi-modal transportation center in the Keene area. |
| ✓ | Work with decision-makers to select a location for the transportation center. |
| ✓ | Pursue funding sources to cover project costs, including land acquisition (if necessary), project design, and construction. |

# ADVOCACY FOR PUBLIC TRANSPORTATION & ACTIVE TRANSPORTATION

## Overview

In New Hampshire, the vast majority of funding for public transportation and active transportation such as walking and bicycling comes from the federal or local level, with very little financial support from the state. New Hampshire ranks 44th in the nation in state spending per capita on public transit,[37] and the League of American Bicyclists ranks New Hampshire 47th in the nation for state funding for bicycle infrastructure.[38] A lack of funding from the state places a higher burden on local communities to provide matches for federal grants and programs. For example, Home Healthcare, Hospice and Community Services (HCS), which runs the City Express Bus (fixed route) and Friendly Bus (demand response), relies on municipal and charitable contributions to provide matches to federal grants and keep its transportation services in operation.[39]

The City should be an active participant in regional and statewide transportation planning processes, and should consider advocating for more state and federal funding for infrastructure and programs to support public transportation and active forms of transportation. These efforts should focus not only on the environmental benefits of public transportation and active transportation, but also co-benefits such as reduced congestion, improved air quality, increased mobility, reduced household expenditure on transportation, energy efficiency, and improved health outcomes through increased social inclusion and physical activity. Key partners for this strategy include local transportation providers such as HCS and the Community Volunteer Transportation Company (CVTC), the Monadnock Region Coordinating Council for Community Transportation (MRCC), Southwest Region Planning Commission (SWRPC), Monadnock Alliance for Sustainable Transportation (MAST), the National Complete Streets Coalition, the League of American Bicyclists, and other local, state, and national organizations with a focus on transportation planning and/or advocacy.

# COMMUNITY POWER PROGRAM

## Overview

A community power program (CPP), also known as community choice aggregation (CCA), enables a local government (or multiple local governments) to pool the electricity load of residents and small businesses and procure electricity on their behalf, while the utility continues to be responsible for electricity delivery, transmission, and distribution and maintenance of poles and wires. Community power programs (CPP) are "opt-out", meaning that residents and businesses would participate in the program by default, but would have the option to "opt-out" if they preferred to receive basic service from Eversource or purchase electricity from a competitive supplier. This is an impactful strategy because it provides New Hampshire communities with greater control over their energy mix and the opportunity to increase the percentage of renewables within the mix at potentially lower energy prices.

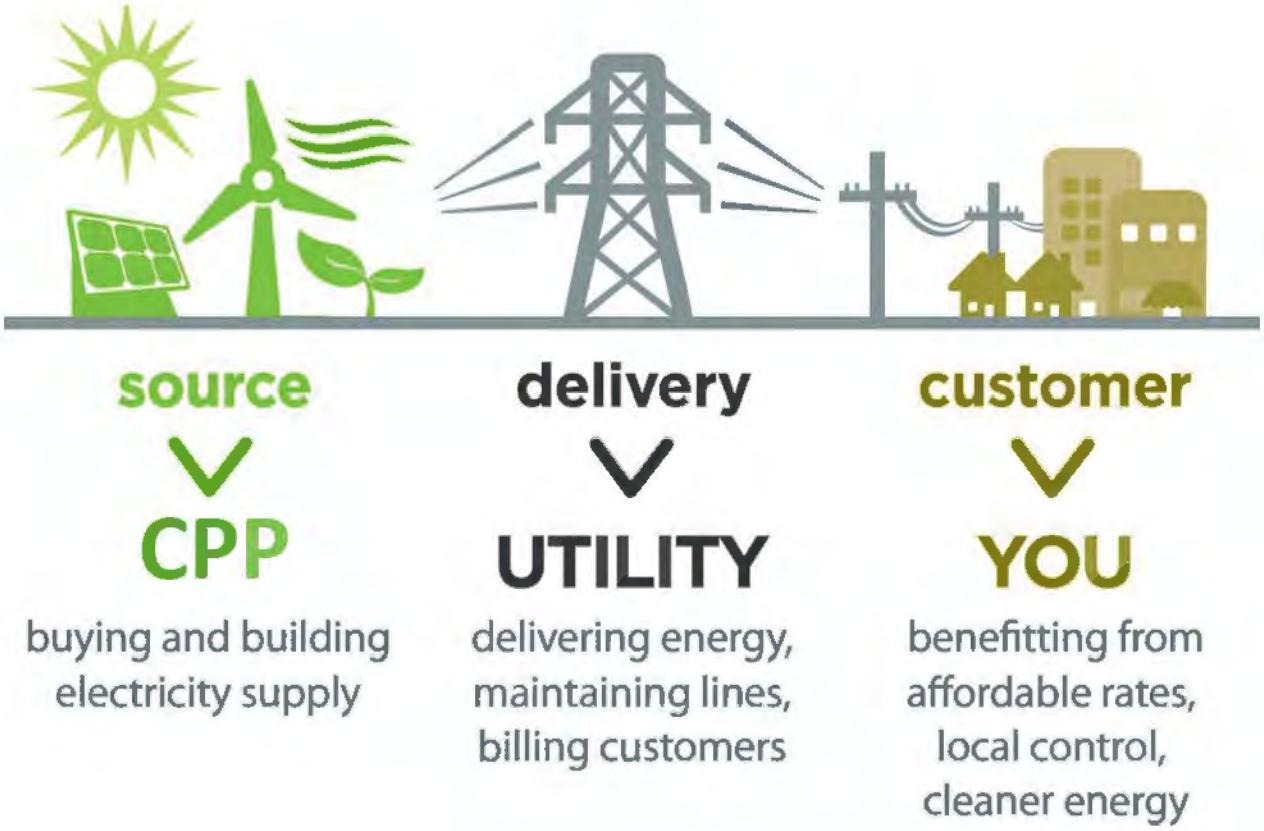



*Figure 5.6. How Community Power Programs (CPP) Work*[40]

## Key benefits and challenges

Key benefits and challenges associated with establishing a community power program are summarized below:

| Key Benefits | Key Challenges |
|---|---|
| Increases local control over the energy supply mix | Political and regulatory uncertainty in New Hampshire |
| Provides the ability to increase the percentage of electricity from renewables through RECs | Limited ability to achieved "additionality" due to reliance on RECs (see description below) |
| Potential cost savings to the community | Some administrative burden on city staff to set up program and identify a broker |
| Potential expansion in the future to drive local renewables, energy efficiency, and other innovative offerings | Political coordination required with neighboring communities if Keene wants to enhance economies of scale |

When implementing this strategy, it will be important to have a strong understanding of renewable energy credits, or RECs. RECs are tradeable, market-based instruments that represent the legal rights to one megawatt-hour (MWh) of renewable electricity generation. There are two main types of RECs:

**Unbundled RECs:** Unbundled RECs are those that are sold, delivered, or purchased separately from physical electricity. Many CPPs rely on unbundled RECs as the primary means of increasing the renewable percentage of the electricity product delivered to customers. The key advantage of unbundled RECs is they can be sourced from renewable energy projects across the country, are relatively low cost and simple to procure. However, Unbundled RECs are often criticized for capitalizing on the presence of existing renewable energy projects and not driving the development of new renewable energy projects that would not have otherwise been built. Thus, unbundled RECs are generated by renewable energy projects that are referred to as "non-additional".

**Bundled RECs:** In contrast to unbundled RECs, bundled RECs are sold together with the physical electricity generated by a specific renewable energy project. Bundled RECs, and their associated clean electricity, are typically procured by CPPs through PPAs or VPPAs. Advantages of bundled RECs are that they drive the development of new (or "additional") renewable energy projects that would not have otherwise been built (i.e. achieving additionality). However, identifying and contracting electricity that is bundled with RECs can often be more administratively burdensome, and sometimes more expensive, for CPPs.

CPPs, especially in early stages, often rely on unbundled RECs to increase the renewable percentage of the electricity product delivered to customers; however, it is possible to shift towards bundled RECs over time as the CPP generates revenue and potentially partners with neighboring communities to increase scale.

## Implementation Steps

Initial implementation steps for establishing a Community Power program are listed below:

| Implementation Steps | |
|---|---|
| ✓ | Conduct research on community power and its potential role in achieving local RE goals. |
| ✓ | Form an electric aggregation committee or designate an existing committee to develop a Community Power Plan. |
| ✓ | Gain local approval for the finalized Community Power Plan from the local legislative body (e.g. City Council). |
| ✓ | Select a supplier and enter into a short-term (1-3 year) contract to supply residents and businesses with a greater amount of renewable electricity. |
| ✓ | Notify residents & businesses about newly formed program and ability to opt-out prior to service beginning. |

## Key Examples from Other Communities

A number of communities are establishing community power programs across the country and within the region. As of 2017, there were approximately 750 operational CPPs procuring electricity on behalf of about 500 million customers.[41] While these programs operate differently across states due to state-level regulation, CPPs in Massachusetts operate similarly to how they would operate in New Hampshire. Although there are no New Hampshire towns or cities that have actually launched a CPP, state legislation does allow this method of energy procurement and there is growing interest across several communities, with some in the advanced stages of the planning process. New Hampshire communities have the ability to pursue a CPP through the standard single procurer model, and there is some interest in a regional approach that would involve multiple communities combining their energy purchasing power to achieve economies of scale. This latter type of CPP is referred to as the alternate or "joint-office" model.

### Cambridge Community Electricity: Cambridge, Massachusetts

One example is the Cambridge Community Electricity (CCE) program, a city-run aggregation program established in 2017.[42] CCE selected Direct Energy as the program's electricity provider from January 2019-2021 and will offer fixed electricity prices throughout this contract duration. This type of CPP, where city staff interact with a single electricity broker, is the most simplified and the least administratively burdensome. The program currently offers Cambridge residents and businesses two electricity products, including Standard Green and 100% Green Plus. The Standard Green option provides an electricity product that is similar in renewable energy content to the regional grid, about 20%, while the 100% Green Plus option offers a 100% renewable electricity product. As with most CPPs, customers "opting up" to the 100% renewable electricity product pay a slight price premium per kWh compared to the standard electricity product offering. Additionally, as of April 2020, both electricity products offered through Cambridge's CCE have lower rates for residential and small business customers than the standard Eversource offering.[43] However, these savings are subject to change as Eversource rates change every six months

for residents and small businesses. One unique aspect of the Cambridge's CCE is that both rate options include a small fee, knows as an "operational adder", that will go towards the development of new solar projects within the City of Cambridge.

## Community Power New Hampshire

Community Power New Hampshire (CPNH)[44] is a municipal and county-led initiative working with Clean Energy New Hampshire and local governments throughout the state to offer an alternative to the standard CPP model, which typically involves a single community contracting with an energy broker to procure renewable energy through the purchase of RECs. Under this alternative model, also known as the joint-office CPP model, cities can form their own community power program and then join the centralized CPNH network.[45] The intention of a combined-joint office is to expand the communities' technical capacity, reduce and centralize administrative costs, leverage pooled revenue to develop and administer innovative energy efficiency, demand response, and renewable energy programs, and bolster the group's purchasing power. CPNH is still in the planning phase of development, but many New Hampshire communities are hopeful it will enable accelerated grid modernization and renewable energy adoption in the near future.

# VIRTUAL POWER PURCHASE AGREEMENT

## Overview

Cities and community power programs can support the creation of additional renewable energy by entering into long-term contracts with renewable energy generators in the form of a power purchase agreement (PPA) or virtual power purchase agreement (VPPA).

A **PPA** is a contract between a buyer and renewable energy generator where the buyer takes ownership of the electrons and RECs produced by the renewable energy project.

A **VPPA** is a financial transaction where the buyer does not own the electrons produced by the renewable energy project, but receives titles to the RECs.

Both contracting instruments, but especially VPPAs, allow both the buyer and the generator to hedge against electricity market price volatility and allow the buyer to benefit from long-term price stability.

A key advantage of VPPAs over traditional PPAs is their geographic flexibility. With PPAs, the renewable energy generator and the consumer must be physically connected to the same regional grid. Because a VPPA is a solely financial (i.e. "virtual") contract, the energy buyer does not receive physical possession of electricity. Instead, the buyer continues to receive energy from its current supplier while simultaneously receiving Renewable Energy Credits, or RECs. Every megawatt hour of electricity generated from a renewable source

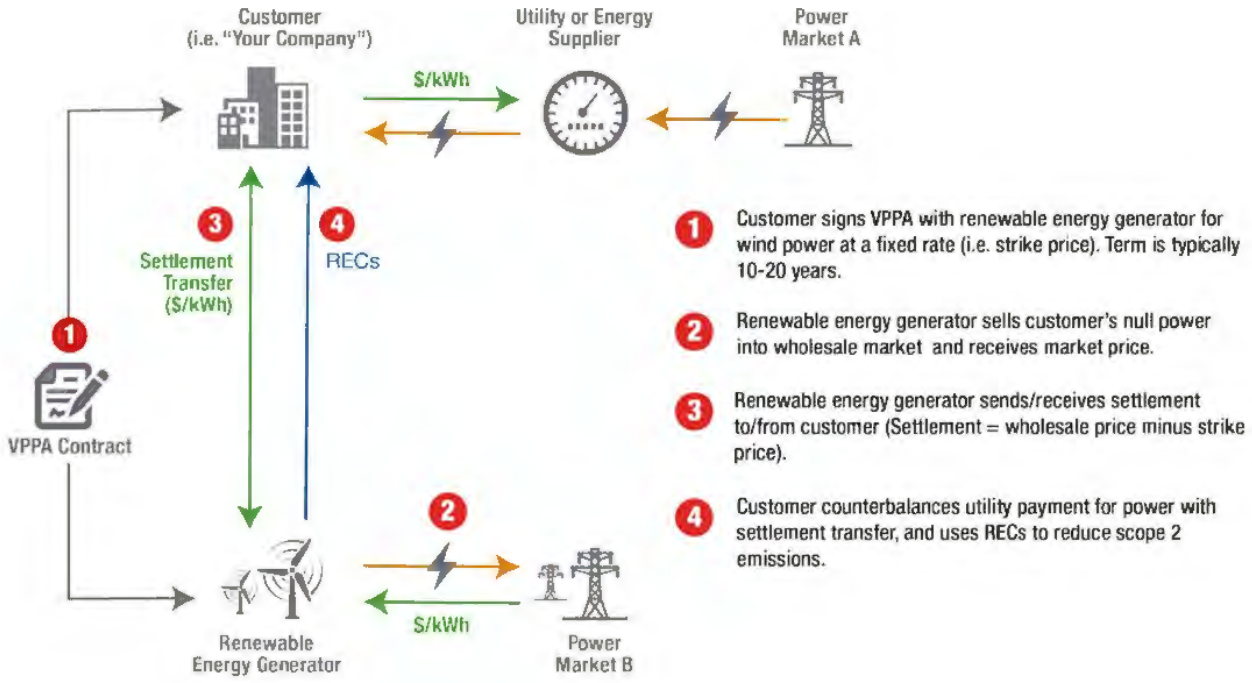



*Figure 5.7 How a Virtual Power Purchase Agreement (VPPA) Works*

counts as one REC. The owner of a REC has exclusive claim to the energy associated with it, meaning a REC can't be doubled counted. A REC is what substantiates that electricity can be considered renewable.

If Keene were to launch a CPP, there are strong potential synergies between a CPP and VPPAs. Leveraging VPPAs, the City could transition their CPP away from unbundled RECs and towards bundled RECs over time, driving the development of renewable energy projects that would not have otherwise been constructed.

Figure 5.7 demonstrates the step-by-step process for how a VPPA works.[46] There are a few notable takeaways from the above graphic. First, the power market that the renewable energy generator is selling electricity into ("Power Market B") does not have to be the same as the power market that the customer (e.g., Keene CPP) is physically connected to ("Power Market A"). In practical terms, this means that the Keene CPP could sign a VPPA with, for example, a wind farm project in Iowa that may have more favorable financial terms than a similar renewable energy project in New England.

Secondly, step 3 in the above figure demonstrates the price hedge value of a VPPA. By entering into a VPPA, the customer (e.g., Keene CPP) locks in a fixed price, or strike price, for Bundled RECs from the renewable energy generator. If the wholesale price of electricity rises, the customer will be insulated from these price increases because of the long-term nature of the VPPA. Conversely, if the VPPA strike price is greater than the wholesale market price, the customer would pay the net difference to the renewable energy generator. In this way, the VPPA acts as a price hedge against potentially volatile future energy costs.

Keene could consider entering into a VPPA with a renewable energy generator within the New England Power Pool (NEPOOL) to support the development of local/regional renewables and resilience. However, it is possible that the financial terms will not be as favorable as they could be in another power market.

## Keys Benefits and Challenges

Key benefits and challenges associated with engaging in virtual power purchase agreements are summarized below:

| Key Benefits | Key Challenges |
|---|---|
| Supports the development of new, additional renewable energy projects with no upfront cost | The commitment of a small CPP program to purchase the energy may not be sufficient to cover the financing of a project |
| Provides the opportunity to increase the community's % of electricity from renewables without unbundled RECs | Contracts can be complex and may be challenging to navigate without additional legal support |
| Enables the community power program to purchase large volumes of electricity in a single transaction from generators located across the country | By committing revenue to a long-term project, the CPP is limiting its ability to implement other initiatives in that timeframe |
| Hedge against electricity market price volatility, long-term price stability, and potential cost savings to the community | By locking into a long-term contract, risk that basic supply rate will dip below CPP rate |

## Implementation Steps

Initial implementation steps for engaging in virtual power purchase agreements are listed below:

| Implementation Steps | |
|---|---|
| ✓ | Customer signs a VPPA with a renewable energy generator for wind power at a fixed rate (i.e. strike price). Term is typically 10-20 years. |
| ✓ | Renewable energy generator sells customer's null power into wholesale market and receives strike price. |
| ✓ | Renewable energy generator sends/receives settlement to/from customer (settlement = wholesale price – strike price). |
| ✓ | Customer counterbalances utility payment for power with settlement transfer and uses RECs to reduce scope 2 emissions .[47] |

## Examples from Other Communities

This section includes an example of how one Virginia community is utilizing a VPPA to reach its renewable energy goals.

### Amazon Arlington Solar Farm: Arlington County, VA

Arlington County, in partnership with Dominion Energy and Amazon, recently agreed to purchase 31.7% of the energy generated by a Dominion owned solar farm in Pittsylvania County, VA. The solar farm is projected to cover 1,500 acres of agricultural land and produce 250 million kWh annually upon completion in 2022.[48] Procuring 31.7% of the electricity produced by the solar farm equates to more than 79 million kWh and will offset 83% of the electricity currently used by the county government to operate its buildings, streetlights, water pumping station, and wastewater treatment facility. For reference, annual electricity consumption across all of Keene is equivalent to approximately 222 million kWh. This VPPA agreement is key to Arlington County reaching the targets outlined in their Community Energy Plan, including a goal to use 100% renewable energy for government functions by 2025.

# PILOT BATTERY STORAGE PROGRAM

## Overview

This strategy involves the City of Keene establishing a close working partnership with their local utility, Eversource, to develop a pilot battery storage program. This could include efforts to collaboratively develop ideas with the utility that support battery storage initiatives and build on preexisting Eversource programs. Existing battery storage programs in other regions or operated by other utilities have utilized rebates, demand response incentives, or a combination of the two to increase proliferation of battery storage systems.

Battery storage is a rapidly developing technology that can be coupled with solar and other renewable energy resources. This strategy has the potential to significantly benefit residents, businesses, the City, and the utility by reducing demand on the grid during peak times. Through the strategic deployment of electricity stored in batteries during peak times, local businesses can significantly reduce their demand charges. Demand charges for commercial customers are based on the highest level of electricity supplied by the grid at one time during the billing period and can make up a large portion of total electricity expenses for some businesses. From an environmental perspective, the ability of batteries to reduce peak demand on the grid also reduces the reliance on natural gas "peaker" power plants, which generate a large amount of greenhouse gasses, to meet this peak demand. As battery costs continue to decrease over time, implementing a pilot battery storage program will position Keene well to take advantage of the environmental, cost, and resiliency benefits of modernizing the grid, which will be key in the City's efforts to achieve 100% renewable electricity by 2030.

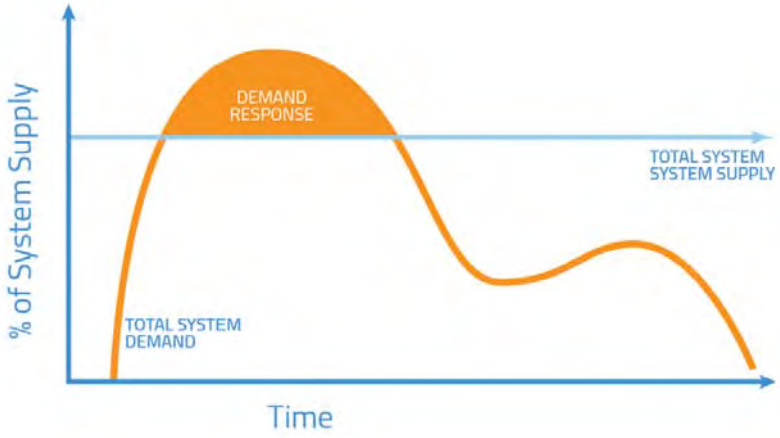



*Figure 5.8. How Battery Storage Helps Reduce Demand Charge Peaks*[49]

The above figure highlights the costs saving and environmental potential of battery storage systems paired with solar PV. When total electricity demand on the grid (orange line) exceeds the total electricity being supplied by power plants currently on line (the horizontal blue line), electricity stored in batteries can be deployed (orange shaded region) to reduce electricity demand charges for local businesses and reduce the need for polluting natural gas power plants to come online to meet peak demand.

## Keys Benefits and Challenges

Key benefits and challenges associated with this strategy are summarized below:

| Key Benefits | Key Challenges |
|---|---|
| Takes advantage of utility funding, technical expertise, and preexisting infrastructure and programs | City not in direct control of program development and implementation + success is largely dependent on Eversource being an active + willing participant. |
| Reduces electricity costs for consumers and the utility by minimizing peak demand | Need to identify the right points of contact at both organizations. Partnership may require connection at the upper management/admin level. |
| Modernizes the grid, boosts resilience, and reduces the need for gas "peaker" plants | Utility priorities can shift during a project |
| Pilot program is a low-cost strategy for the City to pursue | Third-party complexity is introduced, as battery vendors (i.e. Tesla, LG, Generac) often play a role in demand response |
| Potential to expand the pilot program by partnering with other local governments, nonprofits, and businesses in the future | Keene is at the forefront of exploring battery storage pilot program models in New Hampshire, with minimal in-state precedent to leverage |
| Provides a cleaner and cheaper alternative for back-up power, which can be deployed to support essential infrastructure | |

## Implementation Steps

Initial implementation steps for collaborating with the utility to develop a pilot battery storage program are listed below:

| Implementation Steps | |
|---|---|
| ✓ | Discuss potential opportunities to partner with Eversource on a pilot battery storage program. Given the preexisting demand response thermostat program Eversource has already made available in New Hampshire and the demand response battery storage program deployed by the utility in Massachusetts, there is already proven interest and precedent that the City of Keene can build from. |
| ✓ | Invest in battery storage at municipal facilities through Eversource's pilot program, potentially providing City co-funding. The City can serve as an example, showing the benefits of utilizing battery storage while reducing electricity costs and minimizing the environmental footprint of municipal operations. Installing battery storage as an alternative to diesel generators for essential infrastructure could be explored. |
| ✓ | Seek opportunities to expand and publicize the pilot battery storage program to local businesses and residents, leveraging strong interest in the strategy expressed during both the community presentation and Environment and Climate Committee meetings. |

## Examples from Other Communities

This section includes examples of how communities and their local utility have implemented best practices related to the implementation of battery storage technology. Utility administered battery storage incentives typically compensate utility customers in one of two ways. Demand response programs pay customers for the energy their battery contributes to the grid during periods of high demand, while other programs simply provide a rebate to customers for installing battery storage at their home or business. Examples of demand response, rebate, and a hybrid program options are explained in more detail below.

## ConnectedSolutions Demand Response Program: Eversource, Massachusetts

The ConnectedSolutions Demand Response Program is a program run by Eversource in Massachusetts that enables participating residents to be compensated for allowing the utility to use the energy stored in their batteries during periods of high demand on the grid.[50] Residents with battery storage can also choose not to be enrolled in the program, saving the electricity stored in their battery as a personal back-up generator instead.

## Bring Your Own Device Program: Green Mountain Power, Vermont

Developed in partnership with Renewable Energy Vermont, the Bring Your Own Device Program enables participating utility customers with onsite battery storage to choose between an upfront payment from the utility or a compensation rate for demand response use. The level of compensation is determined by the size of the customer's battery storage system.[51]

## Home Battery Storage Pilot: Liberty Utilities, New Hampshire

The Home Battery Storage Pilot was recently approved by the New Hampshire PUC. This program will allow residents to sign up for a home battery installation in partnership with the utility and qualify them for varying time-of-use rates.[52]

# RENEWABLE ENERGY LOANS

## Overview

Renewable energy loans, particularly for distributed solar PV systems, can help make the installation of renewable energy projects more affordable for Keene residents and businesses by minimizing the up-front capital costs required to complete an installation and offering low-interest, fixed rates with flexible terms. With limited renewable energy financing options currently available for residents and businesses, the City of Keene could potentially partner with a local financial institution to offer competitive financing for renewable energy projects. By financing projects with more capital from local banks or credit unions, Keene can maximize the number of renewable energy installations within the City, as well as the economic and environmental benefits associated with deployment of these technologies.

## Keys Benefits and Challenges

Key benefits and challenges associated with this strategy are summarized below:

| Key Benefits | Key Challenges |
|---|---|
| Increased financing access for local residents and businesses to overcome financial barriers to renewable energy adoption | City not in direct control of program development and implementation. Success is largely dependent on local banks and co-ops being an active and willing participant |
| Opportunity to support local economy by engaging with local banks credit unions | Keene is at the forefront of exploring partnering with local financial institutions to finance solar in the state of New Hampshire, with minimal in-state precedent to leverage |
| Equitable solution that increases ability of low-income residents to install solar | Potentially high administrative burden on City staff engage with local banks and co-ops to establish program |
| Established best practices to draw on for engaging with local banks and co-ops to develop similar programs | |

## Implementation Steps

Initial implementation steps for partnering with a local financial institution to offer a renewable energy loan are listed below:

| Implementation Steps | |
|---|---|
| ✓ | Conduct a review of local financial institutions that may serve as a potential partner based on current or past offerings. |
| ✓ | Conduct outreach to local institutions and provide educational materials on the benefits of offering loans for renewable energy. Keene could further support private sector lending by offering to provide a loan loss reserve or credit enhancement program. |
| ✓ | In parallel, considering advocating for the expansion of existing state or regional loan offerings, such as NH Saves, to include renewable energy or energy storage offerings. |

## Examples from Other Communities

This section includes examples of other communities and organizations that have implemented innovative financing solutions to accelerate clean energy adoption.

### Milwaukee Shines: Milwaukee, Wisconsin

The City of Milwaukee, Wisconsin partnered with Summit Credit Union to create "Milwaukee Shines," a special loan program for city residents. With a $2 million budget, the program offers eligible customers up to $20,000 at a low-interest, fixed-rate with flexible terms.[53] Financing can be applied to solar electric systems up to 6 kW and solar hot water systems of 1-8 panels in size. Eligible expenses include all equipment, labor, permits, and interconnection fees, as well as structural re-enforcement and re-roofing expenses, if needed.

### Admirals Bank & Solarize: Multiple Locations

Admirals Bank, a Boston-based bank active in lending for residential solar projects, has partnered with local governments and non-profits administering Solarize programs in Connecticut, Massachusetts, and North Carolina to provide financing options for participants.[54] For example, during the Solarize Connecticut Durham Pilot Project, the selected installer referred customers to Admirals Bank, which worked with homeowners to put together a loan package that allowed customers to participate in the program and purchase the system. Admirals Bank Relationship Managers and Solar Financing Experts have also attended town information sessions to educate homeowners on available lending products for other campaigns they have participated in.

### New Hampshire Examples

Several New Hampshire banks and credit unions offer energy efficiency loans and could potentially expand to provide renewable energy loans as well.

- BCCU[55] is a credit union with locations in Manchester, Nashua, and Bedford offering energy efficiency loans.
- NHSaves[56] is a utility-run program that has partnered with local savings banks/credit unions to offer energy efficiency loans.

# SOLAR & EV READY GUIDELINES

## Overview

The City of Keene can adopt solar PV and electric vehicle (EV) ready guidelines that encourage or require new developments to be built in a manner that accommodates future solar and EV charging station installations. Designing new buildings with future installations of these technologies in mind, as opposed to installing them at existing buildings not designed to accommodate the required infrastructure, can significantly reduce total costs associated with the installation. For example, one study found that installing an EV charging space at an existing commercial building is 2.8 to 4.0 times more costly than installing the same EV charging space at a new commercial building.[57] Preemptively reducing cost barriers to entry for these key technologies can accelerate community-wide adoption of solar and EV charging in commercial developments. Access to EV charging, especially at the workplace, is key to the widespread adoption of EVs. This policy could also serve as a foundation for more far-reaching guidelines in the future that could, for example, require new residential buildings to also be built solar and EV ready.


EV charging stations, like the ones pictured above at the Commercial Street parking lot in Keene,[58] will be more cost effective to install if new construction is designed to accommodate future installation by taking steps such as installing all necessary electrical infrastructure, pulling conduit and wire to the appropriate locations, and ensuring concrete work accommodates mounting of charging stations.

## Keys Benefits and Challenges

Key benefits and challenges associated with adopting solar and EV ready guidelines are summarized in the following table:

| Key Benefits | Key Challenges |
|---|---|
| Reduces technical and financial barriers to solar and EV infrastructure implementation over the medium/long-term | Limited direct energy impacts expected as the strategy does not directly generate clean energy and is limited to the new construction market |
| Facilitates community adoption of EVs by increasing access to publicly available charging infrastructure | Limited precedent, with few examples of extensive solar and EV ready guidelines currently implemented in New England |
| Low-cost step for building owners, positioning them to take advantage of lower infrastructure costs in the future | Additional upfront construction costs to ensure solar and EV readiness may need to be reconciled |
| Establishes a foundation for future action in the residential market and surrounding communities | Administrative burden associated with development of guidelines or ordinance. |

## Implementation Steps

Initial implementation steps for establishing a Community Power program are listed below:

| Implementation Steps |
|---|
| ✓ Leverage the City's ability to adopt more stringent building regulations or (stretch codes). Local governments in New Hampshire have the ability to adopt stretch codes, which can be used to implement stricter guidelines than those explicitly outlined by the New Hampshire State Building Code. Stretch codes are a tool Keene can use to require higher building standards that coincide with solar and EV readiness guidelines. |
| ✓ Evaluate if solar and EV ready guidelines will be a recommendation or requirement for new construction. For example, some communities opt to make solar and EV readiness a recommendation at first, then transition to a requirement later. |
| ✓ Consider if Keene's solar and EV ready guideline requirements will vary based on size, function, and financial ability of the building owner. For example, communities may require larger commercial buildings to follow building guidelines and relax the guidelines for smaller entities. |

## Examples from Other Communities

This section includes examples from communities that have implemented best practices related to the implementation of solar and electric vehicle readiness guidelines in the United States. Each example includes a few key points and differentiating factors.

### Commercial Buildings Solar Requirement: Watertown, Massachusetts

In 2018, Watertown's Planning Board amended their zoning language, requiring all developments greater than or equal to ten thousand (10,000) gross square feet or containing ten (10) or more residential units to include a solar energy system that is equivalent to a minimum of 50% of the roof area of all buildings.[59] In cases where a site includes an uncovered parking structure, the structure will also be required to have a solar energy system installed.

## Solar Friendly Best Planning Practices: Southern New Hampshire

The Southern New Hampshire Planning Commission (SNHPC) created this resource to assist New Hampshire communities interested in facilitating solar PV adoption.[60] This includes guidance on how to develop solar friendly land use and zoning regulations and the policies and planning practices that remove barriers to development and reduce burdensome soft costs.

## Solar and EV Readiness Reach Codes: San Mateo, CA

The City of San Mateo has effectively leveraged their ability to implement reach codes to facilitate solar and EV infrastructure adoption in their community.[61] The City requires all new construction to install a minimum size solar PV or solar thermal system in addition to requiring a minimum number of EV capable spaces or charging stations at qualifying sites. San Mateo has found that establishing minimum requirements often results in owners and developers far exceeding what is required in order to maximize cost-effectiveness.

# HEATSMART CAMPAIGN

## Overview

Heatsmart campaigns (also called "thermalize") are a community-based outreach and education tool that aims to increase adoption of renewable thermal technologies such as air source heat pumps, solar thermal, wood pellets, and ground source heat pumps. In addition, some campaigns have encouraged homeowners to consider energy efficiency improvements and home weatherization upgrades. Heatsmart leverages partnerships with installers, group purchasing power, and volunteer energy to provide focused community outreach and education around renewable thermal technologies, reduce logistical and financial barriers to participation, and reduce heating and cooling costs for residents and small businesses.

Renewable thermal technologies are relatively unknown by most customers, and as a result, the "soft costs" of educating consumers can be a barrier for contractors making sales. Heatsmart campaigns use the same model as "solarize" to promote public awareness of renewable thermal technologies, increase consumer confidence, and help reduce customer acquisition costs for installers. A successful campaign should include the following[62]:

- **Outreach to local contractors** in advance of program launch to ensure they understand the goals of the program, how to position themselves to participate, and how to successfully leverage the program to generate leads. Due to the nature of the HVAC contractor industry, which is typically composed of smaller, more localized firms, it may be worth exploring a contractor arrangement that utilizes multiple installers in a campaign in order to address concerns such as perceived favoritism, challenges in meeting a sudden surge in demand, and sensitivity of smaller firms to competition from larger external firms.
- **A dedicated campaign leader and a team of community volunteers** are critical to the success of a program. The leader and volunteers manage the program, plan and coordinate events, serve as a point of contact, and provide the "boots on the ground" for one-on-one outreach.
- **Support or sponsorship from a trusted organization** helps to build trust and increase consumer confidence in the program. Often, local governments will play a role in organizing or supporting a program, especially if it is aligned with local policy goals.
- **An easy sign-up process** is essential to make it as easy as possible for people to participate in the program.
- **Consistent messaging and coordinated outreach** are necessary to drive participation in the program and overcome barriers such as lack of awareness / familiarity with renewable thermal technologies and available financial incentives and programs.

- **A limited sign-up period with deadlines for customer enrollment.** This helps to create a sense of urgency and drive higher participation rates; however, the program length should be longer than a typical solarize campaign to build in extra time for education, outreach, and messaging to overcome lack of consumer awareness / familiarity with renewable technologies.

## Keys Benefits and Challenges

| Key Benefits | Key Challenges |
|---|---|
| Reduces technical and financial barriers to renewable thermal adoption over the short-term. | If offering a diversity of renewable thermal technologies, the potential to achieve economy of scale is diluted and may affect ability to offer discounts. |
| Helps to build a local installer base and support existing contractors. | Potential for unforeseen installation costs and heating system upgrades (i.e., upgrading electrical system to accommodate an air source heat pump), which can add to overall costs |
| Existing federal and state rebates and loans are already available to reduce up-front costs of installation and improve rate of return on investment. | Explaining the complexity of the various renewable thermal technologies and how they integrate with existing heating systems presents a challenge for outreach and education. |
| Effective strategy for raising consumer awareness and increasing confidence in renewable thermal technologies. | Barriers to participation from low and moderate income households without additional funding to provide affordable access. |
| Opportunity to pair program with energy efficiency and weatherization programs and/or financial incentives, such as local or utility rebates. | Overcoming the split incentive for rental properties where the building owner does not pay for energy use. |

## Implementation Steps

| Implementation Steps | |
|---|---|
| ✓ | Identify a local champion to serve as a team lead. A successful program hinges on having a local champion or group of champions to run and manage the program and coordinate volunteers. |
| ✓ | Reach out to local installers during program design phase. Local HVAC contractors should be engaged early on so that their perspectives and concerns can be addressed through the local program design. |
| ✓ | Review examples from other communities and identify structure/design of a Keene-specific program. Heatsmart campaigns are less established than solarize campaigns, and there are various different models that Keene can learn from. The design of a local program should be informed by best practices and lessons learned from other communities, as well as the unique characteristics of Keene. |
| ✓ | Identify community partners to help amplify messaging and outreach. For example, Northampton, MA's initial Heatsmart campaign was a collaboration between the City of Northampton Energy and Sustainability Department, Mothers Out Front, and Climate Action Now – Western Massachusetts. |

## Examples from Other Communities

This section includes examples from communities that have implemented a Heatsmart campaign. Information in this section was taken from the Clean Energy States Alliance June 2019 report, "Community Campaigns for Renewable Heating and Cooling Technologies: Four Case Studies." [63]

## Northampton, MA: 2017 / 2018 HeatSmart Campaign

The first iteration of this program, which ran from August 2017 through February 2018, focused on cold climate air source heat pumps and owners of one- to four-unit residential buildings. The project lead was the City's Energy and Sustainability Officer; however, the program relied heavily on volunteers to provide outreach. Goals of the program included increased awareness of air source heat pumps and their benefits, increased adoption of air source heat pumps, reduced costs associated with air source heat pump installations, and reduced greenhouse gas emissions. Program outreach included "Meet the Installer" workshops, open houses at the homes of residents with air source heat pumps, social media and other online outreach, media placements in newspapers, TV, and radio, signage, direct mailings, and tabling at farmer's markets and other local community events. The program resulted in 162 people who expressed interest, 130 installer site visits, and 106 price quotes, and 54 installed air source heat pump systems. Of the systems installed, there were 19 single-zone, 34 multi-zone, and one heat pump water heater.

## Boulder, CO: Comfort365 Program

Launched in April 2018, the Boulder Comfort365 program provides information and resources related to air source heat pumps and helps to connect interested consumers with EnergySmart-registered contractors, evaluate contractor bids, and access rebates and incentives at no charge. The first iteration of this campaign, which ran throughout the spring and summer, focused on the cooling aspect of heat pumps, and the second on the heating aspect. The City of Boulder and Boulder County spearheaded the program, providing free one-on-one time with personal energy advisors, access to a broad array of incentives and rebates, and assistance evaluating bids from prequalified, vetted contractors. Through a collaboration with Mitsubishi, the outreach efforts of the City and County were complemented by a regional marketing campaign that included paid advertisements, Google ads, and television marketing. Comfort365 estimates that the program resulted in the installation of 66 air source heat pumps in 2018, and set a goal of 120 installations for 2019.

# EV CHARGING STATIONS

## Overview

Electric vehicle charging stations, also referred to as "Electric Vehicle Supply Equipment" (EVSE), are necessary to support the shift from internal combustion engine (ICE) vehicles to electric vehicles (EVs). EVs are more efficient than ICE vehicles; according to a 2012 study by the Union of Concerned Scientists, emissions from an EV are less than those of an average conventional vehicle regardless of the mix of fuels used to generate the electricity.[64] A review of research related to life-cycle emissions of electric cars as compared to conventional vehicles, conducted by the International Council on Clean Transportation, found that EVs are much cleaner than ICE vehicles over their lifetime. In markets with low-carbon electricity, EVs produce less than a third of the life-cycle emissions of an average ICE vehicle.[65] However, in order for widespread EV adoption to occur, it will be important to provide convenient and publicly accessible EV charging stations for visitors, employees, and residents to use.

**What is an electric vehicle (EV)?**

Electric vehicles (EVs) derive all or part of their power from electricity. There are several categories of EVs:

- All-electric vehicles (AEVs) operate on electricity alone using batteries charged by an outside electric power source.
- Plug-in hybrid electric vehicles (PHEVs) use batteries to power an electric motor and use another fuel, such as gasoline or diesel, to power an internal combustion engine or other propulsion source.
- Hybrid electric vehicles (HEVs) are powered by an internal combustion engine and an electric motor.

There are three levels or categories of EV charging stations, summarized in Figure 5.9.

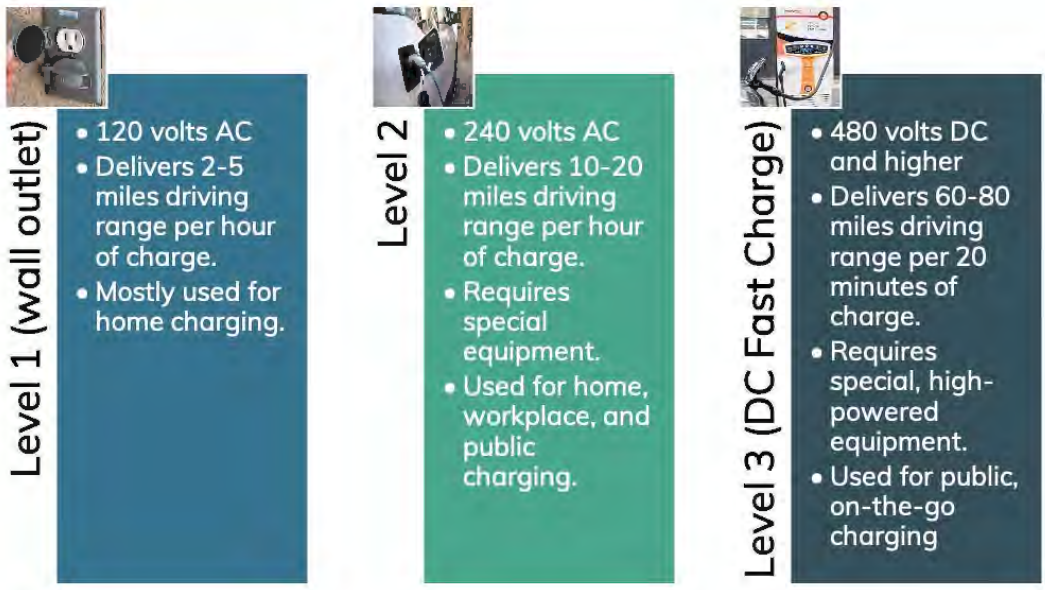



*Figure 5.9. Summary of EV charging infrastructure categories, including Level 1, Level 2, and Level 3 (i.e. "DC Fast Charge").*

In order to accelerate EV adoption, charging stations should be installed in key areas, such as multi-family apartment buildings and condominiums (Level 1 or 2), workplaces (Level 2), hotels, bed & breakfasts, inns, and motels (Level 2), highway corridors (Level 3), and downtown centers (Level 3). Level 3 charging stations are the most costly to install, ranging anywhere from $20,000 for a lower-end, 50 kW charging station to $150,000 for a 350 kW charging station.[66]

New Hampshire currently has funding for EV charging stations through the Volkswagen Environmental Mitigation Trust, which allows beneficiaries to use up to fifteen percent of their allocation for projects involving acquisition, installation, operation, and maintenance of new light-duty EVSE such as EV charging stations. New Hampshire has committed to using the full fifteen percent (approximately $4.6 million) available for this purpose, and has identified "Electric Vehicle Fast Charging Corridors" within the state where Level 3 charging stations will be prioritized. The Monadnock Region has one EV Fast Charging Corridor, NH Route 101 from Keene to I-93.[67]

The City of Keene should develop a plan to deploy Level 3 public EV charging infrastructure using grant funding and/or public-private partnerships. By providing DC Fast Charge stations in or near Downtown Keene, the City will help accelerate the shift to EVs and ensure the City does not discourage business from tourists and other visitors who drive EVs.

## Keys Benefits and Challenges

| Key Benefits | Key Challenges |
|---|---|
| Facilitates community adoption of EVs by increasing access to publicly available charging infrastructure and leading by example. | Strategy does not directly generate clean energy; greenhouse gas benefits depend on the electricity mix used to power the charging station. |
| Funding is available through the Volkswagen Environmental Mitigation Trust. | Due to the high load that EVs draw from the grid, they can lead to large and variable demand charges, especially if charge management is not implemented. |
| Reduced tailpipe emissions resulting in reduced air pollution and improved public health outcomes. | Upfront capital costs may be required, depending on how the EVSE is funded and whether the funding source requires a local match. |
| Opportunity to support local economy by removing barriers to visitors who own EVs and market Keene as a leader in sustainability and alternative transportation. | Some EV charging equipment, such as DC fast chargers, may require ongoing maintenance and software upkeep. |
| Can be paired with solar to further increase greenhouse gas benefits. | Need to define how restrictions and time limits will be enforced, and who is responsible for enforcement. |
| Charge management can be used to reduce peak demand and/or peak period electricity consumption. | |

## Implementation Steps

| Implementation Steps | |
|---|---|
| ✓ | Identify priority locations for public EV charging stations. Assess EV ownership trends and regional/local travel data to identify areas where there will likely be demand for EV charging infrastructure. |
| ✓ | Choose a specific location and type of charging equipment. The specific location and type of charging equipment will impact utilization and installation costs. The selected location should be convenient to drivers, in close proximity to an existing electrical panel that has the capacity to handle the additional load required for EV charging, have network access (if "smart" chargers are planned), and should meet lighting and accessibility requirements. The selected EV charging equipment (e.g. Level 2, DC fast charge, etc.) should be chosen to best meet the needs of the intended users. |
| ✓ | Determine the project budget. There are two components to EV charging station costs: the capital costs of installing the equipment, and ongoing operations and maintenance costs. Capital costs are comprised of hardware, permitting, and installation and will vary depending on the charging level, site characteristics, and equipment features. Operation and maintenance costs include electricity costs, maintenance and repair of the EV charging equipment, and network and charging session fees (i.e. cost of cellular/Wi-Fi network and back office support). |
| ✓ | Secure funding. Identify potential partners and grant or other funding (e.g. Volkswagen Environmental Mitigation Trust funds) to reduce the cost burden on the City and local taxpayers. |

## Examples from Other Communities

### Salt Lake City, Utah: Public Level 2 EV charging stations

Through a grant from the Utah Division of Air Quality, Salt Lake City has installed 36 new Level 2 charging stations throughout the city since 2017. These charging stations are free for the public to use, and they have supported over 25,000 separate charges since their installation. Salt Lake City's installation of EV charging stations is part of its "Climate Positive" vision to reduce greenhouse gas emissions by 80 percent by 2040 and to transition to 100 percent renewable energy use for the city's electricity supply.

### Fargo, North Dakota: Public Level 3 EV charging stations

In September 2020, the Cass County Electric Cooperative installed three new public Level 3 EV fast charging stations in Fargo and West Fargo, adding to the Cooperative's existing charging network of 35 Level 2 charging stations. The new Level 3 chargers are located at a shopping mall, a shopping center, and a visitors' bureau in the Fargo area. The Cass County Electric Cooperative funded this project through North Dakota's share of the Volkswagen settlement. [68]

# ELECTRIC BUSES

## Overview

Battery electric buses offer a number of benefits over conventional diesel buses, including reduced particulate pollution leading to improved air quality and avoided healthcare costs, lower greenhouse gas (GHG) emissions, and long-term cost savings due to lower lifecycle costs.

**Improved Air Quality:** Electric buses can reduce emissions of diesel exhaust, particulate pollution and pollutants that contribute to the formation of ground-level ozone. Diesel exhaust, which contains more than 40 toxic chemicals, is linked to a number of health impacts such as lung cancer, bladder cancer, asthma, and autism. It is especially harmful to children, who have developing respiratory systems and inhale more air per pound of body weight than adults. In fact, there is no established safe level of exposure to diesel exhaust for children. Despite this, 95% of all school buses are powered by diesel, and every day about half of all school children ride a bus to get to school.

**Healthcare Cost Savings:** By switching to electric buses, communities can realize significant healthcare cost savings. For example, a study conducted by Columbia University for New York City's Metropolitan Transportation Authority (MTA) calculated that electric buses reduced particulate matter emissions by 97.5 percent compared with diesel buses, producing a healthcare cost savings of approximately $150,000 per bus per year. The Chicago Transit Authority estimates that a single electric bus saves the city nearly $55,000 every year in avoided healthcare expenses resulting from cleaner air.

**Reduced Greenhouse Gas Emissions:** A 2018 study by the Union of Concerned Scientists found that electric buses produce significantly lower greenhouse gas emissions than diesel, diesel hybrid and natural gas-powered buses over their entire life cycle, including the process of generating the electricity that powers them. The study found that over its entire life cycle, an electric bus charged with the national electricity mix produces less than half of the carbon dioxide-equivalent (CO2e) emissions per mile as are produced by natural gas or diesel-hybrid buses. The GHG emissions benefits increase if the electricity mix includes a high percentage of renewables.

**Long-Term Cost Savings:** Although electric buses generally cost more up-front, they cost less to maintain and operate than diesel buses because they have significantly fewer parts, no exhaust systems, their braking systems last longer, and they do not require oil changes or fossil fuels. In addition, recent advances in electric bus technology and a rapid decline in battery costs over recent years have made electric buses an increasingly viable option. Some reports indicate that electric buses could achieve unsubsidized price parity with the upfront cost of diesel buses by 2030.

**Revenue Generation:** Electric buses also have the opportunity to generate revenue when not in use if they are equipped with vehicle-to-grid (V2G) capabilities. Vehicle-to-grid (V2G) is an innovative concept that enables energy stored in electric vehicle batteries to be sold back into the electricity grid, providing a range of services such as demand response, standby capacity, mobile emergency power, and grid stabilization.

## Keys Benefits and Challenges

| Key Benefits | Key Challenges |
|---|---|
| Improved air quality due to a reduction in diesel emissions and emissions from other fossil fuels. | Higher upfront costs. Currently, a diesel-powered school bus costs about $110,000-$180,000, whereas an electric school bus costs between $230,000-$440,000. |
| Avoided healthcare costs due to a reduction in particulate matter emissions. | Lack of charging station infrastructure to support electric buses. |
| Lower lifecycle costs than diesel buses due to lower operational and maintenance costs. | Overcoming range anxiety related to shorter ranges of electric buses compared to diesel-powered buses. |
| Opportunity to generate revenue and provide a mobile power source to the grid through vehicle-to-grid programs. | Need to retrain drivers to drive electric buses, including learning how to maximize power usage. |

## Implementation Steps

| Implementation Steps | |
|---|---|
| ✓ | Identify a local bus operator (for the Keene School district or for Keene's CityExpress) to participate in a pilot program for electric buses. |
| ✓ | Determine the project budget. The budget must include the capital costs of the buses, charging equipment, and facility work for the bus operators. Operation and maintenance costs include electricity costs, maintenance and repair of the EV buses and charging equipment, and network and charging session fees (i.e. cost of cellular/Wi-Fi network and back office support). |
| ✓ | Secure funding. Identify potential partners and grant or other funding (e.g. Volkswagen Environmental Mitigation Trust funds) to reduce the cost burden on the City and local taxpayers. |

## Examples from Other Communities

### White Plains, New York: ConEdison Electric Bus Vehicle-to-Grid Pilot Project

Con Edison and the White Plains school district launched a pilot project in 2018 to add five electric school buses to its bus fleet. These electric buses have technology that allows them to store energy and feed it back to the electrical grid in summer months when the buses aren't transporting students. These electric school buses can send about 75 kilowatts of power to the grid when demand is high.[69]

### Burlington, Vermont: Electric Buses for Commuter Public Transit

Vermont's first ever electric buses unveiled in Burlington in January 2020. The two new buses operate on the busiest route in the Green Mountain Transit system, which serves both the University of Vermont and Burlington High School areas. Funding for the project came from the Burlington Electric Department, Green Mountain Transit, VLITE (a trust that funds projects and initiatives that serve low income Vermonters), and a federal grant.[70]

# ADVOCACY FOR EVS AND ALTERNATIVE FUEL VEHICLES

## Overview

Of the 30.9 million dollars that New Hampshire received through the Volkswagen Environmental Mitigation Trust, New Hampshire can use 15 percent towards acquiring, installing, and operating electric vehicle charging equipment. There are currently no Level 3 fast charging stations in Keene or in Cheshire County, making Keene part of an "EV Desert."

Keene should advocate at the federal and state levels for more funding to support EVs, EV charging equipment, and other alternative fuel technologies. If Keene both increases its renewable portfolio and supports a shift to electric vehicles, then the City can move towards a transportation sector powered by renewable energy.

At the state level, the City should be an active proponent of using Volkswagen funds for the installation of a Level 3 fast charger in Keene. If the New Hampshire Department of Environmental Services releases a new RFP for fast charging infrastructure, the City should submit a proposal or assist community partners in their applications. In addition, the City should encourage the State to formally join the Transportation and Climate Initiative, a regional collaboration of 12 Northeast and Mid-Atlantic States and the District of Columbia that seeks to improve transportation, develop the clean energy economy and reduce carbon emissions from the transportation sector. In addition, the City should advocate for the state to join the Zero Emissions Vehicle (ZEV) program, which requires increasing sales of ZEVs over a 10-year period. ZEVs include AEVs, hydrogen fuel cell vehicles, and PHEVs.

At the federal level, the City should advocate for an expansion of the federal tax credit for plug-in electric vehicles. Under the current federal tax credit, automakers have a cap of 200,000 sales that are eligible for up to a $7,500 tax credit. If the automaker hits that cap, then the amount of the tax credit goes down.[71] Increasing the cap beyond 200,000 will allow more prospective buyers to receive the full $7,500 credit, which could incentivize EV adoption.[72]

# RENEWABLE DISTRICT HEATING & COOLING SYSTEM

## Overview

District Heating and/or Cooling Systems transfer thermal energy from a central source using a system of insulated pipes to residential, commercial, and industrial consumers for use in space heating (or cooling), water heating, and process heating.[73] District energy systems are best suited to areas with a higher density of buildings/population and relatively cold climate zones. Historically, many district heating and cooling systems have relied on fossil fuels as either a primary or backup energy source. However, the central thermal energy source could come from a number of different options, such as boiler units (which could use a variety of different fuels), geothermal, biomass, solar energy, waste-to-energy, and combined heat and power (CHP), which can result in GHG emission reductions unachievable on a building-by-building basis.[74]

By connecting multiple buildings to a district system and providing thermal energy in a usable form, district heating and cooling systems help to improve efficiency, enable fuel flexibility, simplify building operations and maintenance, eliminate the need for installing boilers in individual buildings, and reduce or avoid costs for operation, maintenance, repair, and replacement of individual building energy systems. However, building a district energy system is a major engineering project that would require buy-in from a wide array of stakeholders. It requires a local champion to build support for the concept, availability of local renewable sources of energy, a potential customer base, and turnover in existing equipment in a districts building stock. Understanding these conditions and building a business case can be a hurdle for project developers to overcome. As a first step, the City could consider commissioning a study that analyzes the local market and conditions for a renewable district heating system to set the stage for future developers.

## Keys Benefits and Challenges

| Key Benefits | Key Challenges |
|---|---|
| Stable thermal energy services and costs could help retain and attract industry by providing reliable thermal energy, both in terms of supply and cost. | Requires collaboration and cooperation from utility and other partners, which can add time and complexity to the process. |
| Creation of short-term and long-term employment opportunities, resulting from both construction and ongoing maintenance and operation of the system. | Feasibility studies are generally expensive and time-consuming. A long-term champion is required to keep momentum and interest in the project going. |
| Adaptable to a wide variety of fuel types. | High capital costs to design and construct a system. |
| Improves local air quality by replacing small, uncontrolled sources of air pollution with a more efficient, centralized source. This benefit is enhanced if a non-polluting source of energy is used. | High perceived risk to investors due to long lead time before district energy system is operational and generating revenues. |

| Key Benefits | Key Challenges |
|---|---|
| Requires and encourages collaboration among public and private sector, building relationships that could be applied to other projects / endeavors. | Requires strong and ongoing political support at local, state, and federal level to eliminate regulatory, policy, and institutional barriers. |

## Implementation Steps

| | Implementation Steps |
|---|---|
| ✓ | Assess level of interest among key stakeholders and identify a local champion. District energy requires careful study, and the process from planning to construction can take years. Before committing resources, key stakeholders such as the City of Keene, Keene State College, and large commercial and industrial energy users who may benefit from a district energy system should be engaged to determine whether there is enough interest to warrant further exploration. Due to the long timeframe for implementation, a local champion or champions will be needed to maintain interest and momentum for the project. |
| ✓ | Commission a preliminary feasibility study to determine whether a renewable district heating system is technically and economically feasible in Keene, including cost estimates. |
| ✓ | If the study shows that a system is feasible, seek funds to commission an engineering study to examine system feasibility for a specific location in detail. The study should include a preliminary / conceptual design and improved cost estimates. |
| ✓ | If renewable district energy appears feasible and beneficial for Keene, an advisory committee should be formed (or an existing committee should be tasked) to conduct education / outreach and verify whether the concept is acceptable to the public. In addition, it is critical to engage potential users to determine whether they support further study and the commitment of resources for a local system. |
| ✓ | Secure funding and identify regulatory requirements. This may require exploring ways to reduce financial barriers, such as offering tax-exempt financing, identifying sources of grant funding, and working with regulators at the state and federal level to understand permitting requirements. |
| ✓ | Hire a firm to prepare engineering drawings and detailed cost estimates. |
| ✓ | Finalize institutional and financing arrangements for the district energy system. This step is critical, and should be done prior to finalizing construction drawings (an expensive and time-consuming task) or beginning construction. |
| ✓ | Finalize construction drawings and begin construction. |

## Examples from Other Communities

This section includes examples from communities and organizations that have installed a renewable district heating or combined heat and power (CHP) system.

### Shands Cancer Center in Gainesville, FL: Providing Energy Security with CHP

When Shands HealthCare decided to build a new cancer hospital in Gainesville, FL, the company conducted a competitive solicitation process to find an efficient and reliable energy source to keep the hospital operational in the event of a prolonged power disruption. This process resulted in a unique public/private partnership between Shands HealthCare and Gainesville Regional Utilities (GRU) to build a state-of-the-art combined heat and power (CHP) plant that can generate all of the power needed for the hospital and use the waste heat from the generator to produce all required chilled water for cooling and steam for heating.[75] The GRU South Energy Center includes a 4.3 MW natural gas-fired recuperated combustion turbine housed in a structure designed to withstand Category 4 hurricane-force

winds. The facility went into operation in 2009 and has achieved annual energy savings equal to the power needed to run more than 3,000 homes. The Shands Cancer Hospital was awarded LEED Gold certification in 2010, due in part to its onsite district energy and CHP facility.

## District Energy St. Paul: Renewable District Heating and CHP

District Energy St. Paul is one of the most advanced and integrated district energy systems in North America, incorporating CHP, biomass, solar thermal, community solar partnerships, and thermal storage to provide space heating/cooling and hot water to its customers. As of April 2019, the nonprofit served about 500 commercial and residential customers in and around downtown Saint Paul, MN and employed 45 people.[76] It began in 1979 as a public-private partnership to develop the first hot water district energy system in North America. In 2003, a biomass-powered CHP plant was constructed, and in 2011, the system was advanced further with the addition of a 1.2 MW solar thermal system. As a result of energy efficiency upgrades and fuel switching to biomass, solar, and natural gas, in March 2019 the company retired coal from its heating portfolio, two years earlier than planned. The company is currently exploring low temperature loops and geo-exchange projects to reduce emissions even further.

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# CITY OF KEENE R-2018-36

In the Year of Our Lord Two Thousand and Eighteen

A RESOLUTION RELATING TO SUSTAINABLE ENERGY GOALS

***Resolved by the City Council of the City of Keene, as follows:***

WHEREAS, The City of Keene has formally recognized the challenges of Climate Change since the year 2000 when it became a participant in the Cities for Climate Protection Program; and

WHEREAS, The City of Keene then developed and implemented a Climate Action Plan in 2004 and a Climate Adaptation Plan in 2007 and incorporated these plans into its 2010 Comprehensive Master Plan after extensive community stakeholder engagement; and

WHEREAS, The State of New Hampshire 2009 Climate Action Plan set a goal of reducing Greenhouse Gas Emissions by 80% from 1990 to 2050; and

WHEREAS, the challenges presented by Climate Change have become increasingly apparent in the intervening years, as reported in the Congressionally-mandated National Climate Assessments; and

WHEREAS, the United States Energy Information Administration reports that the combustion of fossil fuels accounts for as much as 76% of US Greenhouse Gas Emissions; and

WHEREAS, energy efficiency measures that drive down energy demand are the most cost-effective means to reduce fossil fuel consumption, and clean energy sources such as solar, wind, and small hydro may now be cost-competitive with fossil fuel sources; and

WHEREAS, local, distributed generation of energy can provide resilience to weather-related interruptions of energy supply and economic disruptions of energy pricing while reducing air pollution and associated public health risks; and

WHEREAS, clean, renewable energy is one of the nation's fastest-growing employment sectors and represents an enormous economic opportunity for Keene to create jobs and attract talent, thereby contributing to the vision of a vibrant economy outlined in the Comprehensive Master Plan and the Economic Development Action Plan; and

PASSED

WHEREAS, economically disadvantaged residents, older people and children, people who are homeless, people with disabilities or health conditions, and

members of other underrepresented minorities experience the impacts of climate change disproportionately; and

WHEREAS, cities across the nation have made commitments to transition to 100 percent clean energy and Keene strives to remain a leader among its peer cities.

NOW, THEREFORE, BE IT RESOLVED by the Council of the City of Keene that:

A. It is the goal of the City of Keene that all electricity consumed in the City will come from renewable energy sources by the year 2030 and that 100% of all thermal energy and energy used for transportation come from renewable energy sources by the year 2050. This goal will apply to the entire Keene community, not just municipal government operations.

B. The City of Keene develop a strategic plan by December, 2020 to meet these renewable energy goals through a transparent and inclusive stakeholder process.

Kendall W. Lane, Mayor

In City Council December 20, 2018.
Referred to the Municipal Services, Facilities, Infrastructure Committee.

City Clerk

PASSED January 17, 2019

A true copy;
Attest:
City Clerk

CADMUS

# City of Keene Renewable Energy Transition Analysis

April 2020

**Prepared for:**

The City of Keene

**Prepared by The Cadmus Group:**
Ben Butterworth
Megan Lynch
Anthony Albano
Zack Wyman

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# Introduction and Background

## Keene Renewable Energy Goals

In January 2019, the Keene City Council adopted a goal to achieve:

- 100% of all electricity consumed in the City will come from renewable sources by 2030
- 100% of all thermal energy and energy used for transportation will come from renewable sources by 2050

The resolution further calls for the City to develop a strategic plan by December 2020 to meet these renewable energy goals through a transparent and inclusive stakeholder process. As such, the City of Keene hired The Cadmus Group to identify and evaluate renewable energy strategies to achieve the City's 2030 renewable electricity goal.

## Objective and Approach

Local governments across the United States are employing a wide range of strategies to achieve their renewable energy goals. However, the viability and impact of a given strategy across communities depending on contextual factors, such as state-level regulation, utility type, and local factors. The purpose of this report is to provide the City of Keene with actionable strategies given their specific policy and regulatory context to achieve their renewable electricity goals along with targeted implementation guidance for pursuing the selected strategies. The Cadmus Team's process for identifying these strategies is summarized in Figure 1 below:

**Figure 1: Summary of Cadmus Process**

1. **Electricity Context Review**. At the outset of the project, the Cadmus Team conducted a review of Keene's electricity context, including state, utility, and local electricity market context, as well as key renewable energy policies, to provide a foundational understanding of Keene's local barriers and opportunities related to increased renewable energy deployment. The findings of this review supported the development of the electricity baseline scenario and the identification of strategy options Keene could leverage to achieve 100% renewable electricity. For more information, see the Electricity Context section.
2. **Electricity Baseline Analysis**. Next, the Cadmus Team analyzed current electricity consumption in Keene and developed a baseline, or business as usual, scenario forecast of likely changes in the electric power mix during the planning period (present-2030) without any further action from the City. This analysis helps the City to better understand the magnitude of change that will be necessary to meet its 2030 goals. For more information, see the Electricity Baseline section.
3. **Renewable Energy Strategy Analysis**. Lastly, the Cadmus Team identified a list of 16 strategies that are actionable and appropriate in the City of Keene and analyzed them against key criteria identified through conversations with City staff. With insights from this prioritization exercise, the Keene Energy and Climate Committee selected six strategies for the Cadmus Team to explore in more detail. For each strategy, the Cadmus Team developed a description, key benefits and challenges, implementation steps, and relevant examples. For more information, see the Strategy Analysis and Findings section.

# Electricity Context

At the outset of the project, the Cadmus Team reviewed Keene's state, utility, and local electricity market context, as well as key policies, to provide a foundational understanding of Keene's local barriers and opportunities related to increasing renewable energy deployment. This section outlines key findings from this review.

## State Regulatory Context

New Hampshire is one of 17 states in the United States with a deregulated electricity market. In deregulated electricity markets, investor-owned utilities, including Eversource, are not permitted to own and operate power plants that generate electricity. Retail customers are free to purchase energy from a competitive supplier, while the utility continues to provide transmission and distribution services.

There are currently four electric distribution investor-owned utility companies in the State of New Hampshire,[1] with Eversource serving as the main electric utility in Keene. Additionally, there are a number of competitive energy suppliers active in New Hampshire, offering customers a range of electricity sourcing options and prices. There are approximately 15 residential[2] and 25 commercial/industrial[3] energy suppliers currently active in Eversource's territory. Eversource reported that approximately 22% of its residential customers and 58% of total customer load in New Hampshire had migrated to the competitive supply market by the end of the third quarter in 2019.[4] Having the ability to select a competitive supplier provides residents, businesses, and local governments with greater control over their energy mix and the opportunity to increase renewable energy supply.

Governor Hassan signed House Bill 614[5] in 2015, which aims to modernize the grid and draws from the goals outlined in the 2014 NH Energy Strategy.[6] The New Hampshire Public Utilities Commission worked alongside industry experts to develop a report titled *Grid Modernization in New Hampshire.*[7] The report detailed a number of energy initiatives and an updated 2018 State Energy Strategy,[8] which focused on building a more flexible and efficient grid capable of supporting the State's evolving energy goals more effectively than currently possible given the failing and outdated grid infrastructure in place today. Grid modernization is essential to support the growth of New Hampshire's economy and must rely on the effective integration of distributed energy resources, such as solar photovoltaic (PV) systems, which bolster resilience to grid disruptions and power outages, reduce costs, and encourage further development of clean renewable resources. The Public Utilities Commission (PUC) has continued their efforts to encourage all stakeholders to actively contribute to grid modernization,[9] with recent efforts focused on increasing the availability of consumer's utility data to make the State's energy system more responsive, dynamic, and consumer focused.[10]

Some state-level policies and programs in New Hampshire support renewable energy development, while others could benefit significantly from drawing on precedent provided by other New England states. For example, New Hampshire can increase the requirements currently outlined under the Renewable Portfolio Standard (RPS) by ratcheting up the requirements for the percent of total electricity supplied by renewable sources and ratcheting up "carve outs" that mandate what portion of the RPS must be met by

specific technologies, such as solar PV. Similar measures have already been incorporated into the Vermont Renewable Energy Standard,[11] Massachusetts' RPS,[12] and New York RPS.[13] For example, the New Hampshire RPS requires 25.2% of electricity to come from renewables by 2025, and mandates that only 0.7% of that electricity generation come from new solar by 2020. Conversely, the Vermont RPS requires 75% of electricity to come from renewables by 2032[14] and Massachusetts obtained over 13% of all electricity generated from solar in 2019[15] and is continuing to aggressively incentivize further solar expansion through the Solar Massachusetts Renewable Target (SMART) Program.[16] Beyond Massachusetts, other northeastern states have developed their own solar incentive programs to facilitate new PV development, including Rhode Island's Renewable Energy Growth Program[17] and New York's NY-Sun Solar Initiative.[18] These programs are implemented by the state to help alleviate the cost of solar for consumers and promote the adoption of renewable energy resources in accordance with aggressive state targets.

Examples of key state-level policies in New Hampshire include:

- **The New Hampshire GHG Targets and Climate Plan**: In 2009, New Hampshire established statewide carbon reduction and renewable energy goals within its Climate Action Plan (CAP). These goals include an 80% reduction in greenhouse gas emissions by 2050 below base year 1990 levels and 25% of statewide energy to be sourced from renewables by 2025. Additionally, the GHG Targets and Climate Plan called for investment in and incentivization of renewable energy via the state renewable portfolio standard (RPS) and participation in the Regional Greenhouse Gas Initiative (RGGI).[19] As of 2017, based on power plants physically located in the State, New Hampshire reported a 61% reduction in GHG levels from the electricity sector below 1990 levels, with renewables comprising 19.7% of the State's energy portfolio. This is largely a result of New Hampshire's transition away from a reliance on coal and petroleum for electricity production and the adoption of more natural gas and renewable energy resources in their place. Natural gas, despite being a fossil fuel, produces significantly less GHG emissions per unit of electricity generated in comparison to coal and petroleum. In 1990, coal and petroleum made up roughly 43% of the State's electricity generation supply mix and accounted for 98% of electricity generation GHG emissions, while in 2017 coal and petroleum comprised approximately 2.3% of the supply mix and accounted for 23% of electricity generation emissions. In 1990, no natural gas power plants were operational in New Hampshire, but, as of 2017, natural gas plants account for 73% of in-state electricity generation emissions.[20]
- **State Renewable Portfolio Standard (RPS):** New Hampshire's RPS requires private electricity providers to utilize renewable energy according to a compliance schedule with a goal of 25.2% of all electricity provided to be renewable by 2025.[21] As of 2019, the RPS mandated that 19.7% of energy consumed in New Hampshire be sourced from renewable energy.[22] Eversource currently fulfills their obligations under the State's RPS primarily through the issuance of periodic RFP's for the purchase of Class I Renewable Energy Certificates (RECs)[23] from Burgess BioPower and Lempster Wind.[24]
- **Net Metering**: Utility customers that generate electricity on-site are eligible for net metering credits when they produce more electricity than they consume in a given month. Within

Eversource territory, "each kilowatt-hour of Net Sales will earn a monetary bill credit equal to the sum of the Default Energy Service charge, the Transmission Charge, plus 25 percent of the Distribution Charge. Customers who take energy supply service from a competitive retail supplier are not eligible for the Default Energy Service portion of this credit".[25] The PUC distinguishes between small customer-generators (up to 100 kilowatts) and large customer-generators (greater than 100 kW and up to 1 MW), with slightly varied rules for each. The aggregate statewide capacity limit for all net metered systems is 100 MW, with 50% specifically held for the state's investor-owned utilities as upheld by HB 1116.[26] There have been recent motions to amend net metering, such as SB 365 (2019),[27] which would have expanded the net metering size limit for eligible customer-generators from 1 MW to 5 MWs,[28] but was vetoed. A similar bill, SB 159,[29] was passed by the legislature, but was vetoed by the governor. The state Senate overrode the veto in March 2020, but it is unclear if the House will override the veto as well.[30] Currently in New Hampshire, all municipal and residential solar PV systems wishing to net meter are guaranteed interconnection, without requirement of additional payments in the form of fees, tests, or insurance. However, some efficiency and safety requirements must be met during the interconnection process, which is upheld by New Hampshire Statutes § 362-A:9.[31]

- **Group Net Metering:** Group net metering is permissible per SB 98,[32] which allows a customer-generator (e.g. solar PV array owner) to act as a group host for non-generator customers and distribute the kWh credits generated by the host system among the group. The group host would then receive compensation from the utility, and pay members based upon their contractual agreement for their portion of the array. The challenge is that group net metering places an administrative burden on the group host and creates taxable income for members. SB 165,[33] which recently became law in NH, will allow for more traditional community solar through on-bill credits.

- **Third-Party Ownership:** The state permits third-party ownership in the form of power purchase agreements (PPAs), pending independent approval. Limitations for approval are listed in New Hampshire Statute Ann. §362-A:4-c.[34] A PPA allows for the procurement of electricity through a private third-party contractor. In this scenario, the private third-party pays for the cost of the system and bears the burden of operation and management. The consumer then purchases the energy produced by the system directly from the third-party, usually at a discounted rate compared to the default utility. There are several potential benefits to utilizing a PPA. For example, if a public or non-profit entity wishes to realize some of the Federal Investment Tax Credit (ITC) for solar installations, they can partner with a private third-party that qualifies for such lucrative incentives.

- **Community Power Program (CPP):** Also known as a community choice aggregation (CCA), this option allows New Hampshire communities to pool their electricity load and encourages the purchase of clean and renewable energy on behalf of participating customers. Communities may also implement cost-saving measures and reallocate funds towards other renewable energy-based projects as well. With the passing of New Hampshire *Senate Bill 286-FN-Local* in June 2019, New Hampshire municipalities and counties are permitted to develop plans for electric aggregation

programs for the first time.[35] In addition, the bill also allows cities and towns to implement community power on an opt-out basis, meaning customers are automatically enrolled, giving local governments far more bargaining power.[36] Development of CPPs enables communities to pursue more aggressive renewable energy goals than otherwise possible through default utility providers.

- **Financing Mechanisms and Incentives**: The state of New Hampshire offers a number of financial incentives for residents, businesses, and commercial customers interested in installing a renewable energy system. More details on these tax incentives, rebates, loan programs, and other financing mechanisms can be found in **Appendix A**.

## Utilities in Keene

There are currently four electric distribution companies operating in New Hampshire, with each serving a mutually exclusive franchise territory. Eversource is the primary distributor, serving about 70% of retail customers, Unitil and New Hampshire Electric Cooperative (NHEC) serve roughly 11% each, and Liberty Utilities serves about 6% of customers.[37]

The City of Keene is located within Eversource's territory for electricity service. Eversource is an investor-owned utility that provides electricity and natural gas service to customers in New Hampshire, as well as Connecticut and Massachusetts. Eversource provides a few programs to help promote renewable energy resources in New Hampshire and comply with the state RPS requirements, such as net metering and the provision of educational materials. Additionally, Eversource owns a number of renewable generation sources across its service territory, including a 51-kW solar array in Manchester.[38] Eversource also offers a range of energy efficiency-focused programs, including their Residential Energy Efficiency Rebate Program,[39] New Equipment & Construction Schools Standard,[40] and their Commercial New Construction Energy Efficiency Rebate Program.[41] The New Hampshire PUC regulates investor-owned utilities within New Hampshire, including Eversource, and is responsible for ensuring reliable service at reasonable rates.

Eversource customers receive electricity from the New England power grid. In 2019, the NEPOOL system mix was approximately 20.1% renewable and 79.9% non-renewable. The 20.1% of renewable energy was comprised of hydropower (8.9%), refuse/other (3.5%), wind (3.4%), wood (2.4%), and solar (1.8%).

## Local Policies and Initiatives

In addition to state-level policies, the City of Keene has taken steps locally to support the deployment of renewable energy. In 2018, Keene passed a resolution setting aggressive community-wide energy goals, including (1) 100% of all electricity consumed in the City from renewable sources by 2030, and (2) 100% of all thermal energy and energy used for transportation from renewable sources by 2050.[42] The City of Keene has also developed several planning documents to guide renewable energy and sustainability efforts, including:

- **Adapting to Climate Change: Planning a Resilient Community (2007)[43]:** This climate resilience action plan outlines the expected impacts of climate change in the Northeast and New Hampshire,

identifies Keene's vulnerabilities to these impacts, and lays out key goals and targets for increasing resilience along with implementation steps.

- **Local Action Plan (2004)[44]:** This climate action plan provides an overview of climate change and its impacts, and outlines key municipal, residential, and commercial/industrial opportunities for reducing greenhouse gas emissions to support efforts to mitigate the impacts of climate change.
- **Greenhouse Gas Emissions Inventory Report (2015)[45]:** This report provides an inventory of 2015 community-wide and 2015 municipal GHG emissions to help the City track progress against its emissions reduction goals and inform climate action planning.

Furthermore, the City has completed a number of projects to support renewable energy and the reduction of greenhouse gas emissions. Some key highlights include the installation of a solar PV system and geothermal HVAC system at the Public Works Department, the installation of hydropower at the water treatment facility, replacing the methane-to-gas system at the transfer station with a biodiesel generator, the installation of a solar PV system on City Hall, the conversion of all City lights to LEDs, and providing tax incentives for residential wood, wind, and solar installations.[46] Additionally, the City has entered a two-year contract with Constellation Energy to procure Green-e® Certified Renewable Energy Certificates equivalent to 100% of municipal electricity use beginning in 2020. For more information on the City's renewable energy accomplishments, please see the Energy and Climate Program Brochure.

## Innovative Action in New Hampshire

A number of communities in New Hampshire have taken innovative action to support renewable energy deployment. A few key highlights are summarized below:

- The **City of Lebanon** is currently planning a CPP pilot program in hopes of realizing some of the benefits a program of this type can have for a community. This originally was an opt-in pilot program; however, the model may change with the passage of SB 286.
- Several New Hampshire communities have already leveraged their group purchasing power by participating in a Solarize campaign. During a Solarize campaign, a community partners with one or several developers, who can offer residents and small businesses competitive pricing due to anticipation of a large number of installations in one area over a condensed period of time. Communities participating in Solarize campaigns to expedite the adoption of solar include **Nashua, the Monadnock Region, and New Hampshire's Upper Valley**.
- **The City of Concord** has also taken action recently, pledging its own commitment to pursuing 100% renewable electricity by 2030 and 100% renewable energy for the thermal and transportation sectors by 2050. In July of 2019, Concord released a strategic plan outlining strategies and action steps to achieve their goals.[47]
- **Energize 360[48]** was a one-year, community-led effort in New Hampshire that took advantage of similar bulk discount incentives as leveraged through Solarize. Energize 360 allowed citizens in participating communities to request a free site visit to their home or business, providing them useful information about their energy consumption and opportunities to weatherize their property, install solar or other technologies, and implement energy efficiency measures, among other

strategies. Communities that participated in the Energize 360 campaign included Dover, Durham, Exeter, Hampton, Kensington, Lee, Madbury, New Castle, Newmarket, Northwood, Portsmouth, Rye, Somersworth, Strafford, and Stratham. The six-month campaign resulted in 251 clean energy and energy efficiency projects, which will collectively result in a reduction 1,015,937 pounds of carbon per year for the lifetime of those projects.[49]

- **Vital Communities** is a nonprofit organization that offers a range of economic, environmental, and civic-oriented programs and resources to support in the Upper Valley region of New Hampshire and Vermont. Their energy programs include Weatherize and Solarize Upper Valley campaigns, as well as a Green Real Estate Network to educate home buyers and sellers on energy efficiency.[50]

# Electricity Baseline

## Context

The objective of an electricity baseline is to understand the starting point of electricity consumption within the City and the mix of generation resources producing the consumed electricity. The baseline draws from a combination of available state-level data, Keene-specific utility data provided by Eversource, and insights provided by the City and the current regulatory landscape to estimate an electricity baseline for the City. Given that City-specific information is limited, much of the assumptions made are based on State-level information and scaled down to apply to the City of Keene. As part of the baseline analysis, the Cadmus Team also developed a business as usual estimate of the projected 2030 electricity supply mix, assuming no further action from the City is taken between now and 2030. This analysis allows Keene to better understand the gap between the business as usual projection and the City's target of 100% renewable electricity by 2030. The electricity baseline will serve as a starting point for the City, giving decision-makers a better understanding of what their electricity supply mix will likely be if no action is taken between baseline year 2019 and 2030. The following section outlines current consumption, energy supply, and key assumptions within the electricity baseline.

## Electricity Consumption in Keene

In 2019, electricity accounts across the City of Keene consumed over 222 gigawatt-hours of electricity. On average, in 2019, a residential account used 4,089 kWh of electricity, a commercial account used 69,478 kWh, and a manufacturing/industrial facility used 28,930 kWh of electricity.

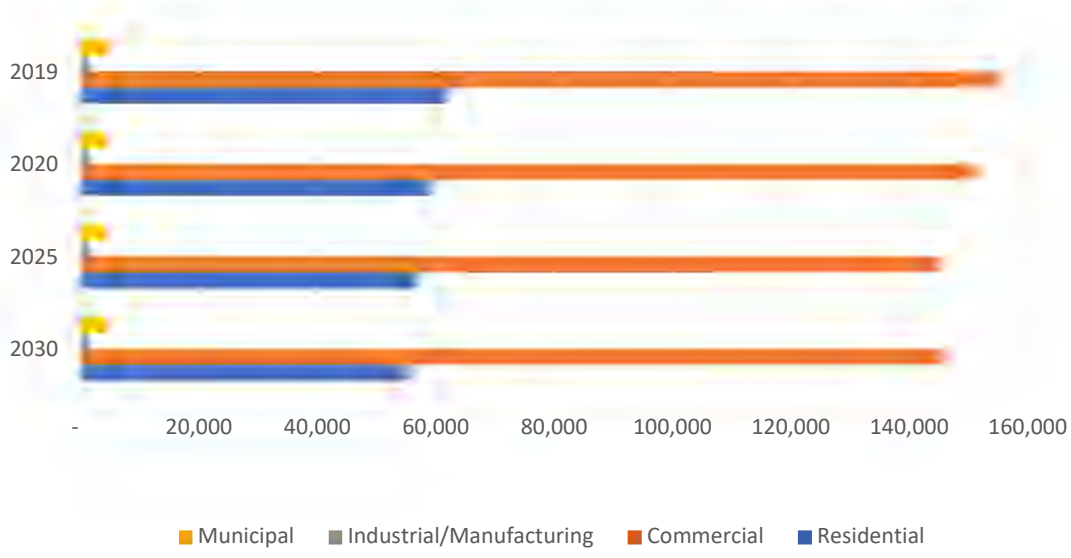
The commercial sector was the largest consumer of electricity, accounting for 70% of total community usage. Residential accounts made up 27% of usage in 2019, while municipal and industrial/manufacturing accounts made up the remaining 3% of electricity consumption in Keene (see Figure 2).[1]

[1] Data provided by Eversource. Industrial accounts are those that have peak electricity demand greater than 1,000 kW.

**Figure 2: Electricity Consumption by Sector 2019**


Over time, consumption is expected to shift due to the impacts of population growth and the increasing effectiveness of energy efficiency. In 2030, 78,315 people are expected to live in Cheshire County, representing an overall growth of 1.25% from 2015.[51] Factoring in both energy efficiency[52] and population growth, it is estimated that overall electricity consumption will decrease by approximately 7% by 2030. However, this analysis does not consider new potential sources of load growth through building electrification, electric vehicle infrastructure, or new capital assets that could drive demand.

**Figure 3: Estimated Changes to Electricity Consumption in Keene (MWh)**



## Renewable Energy in Keene

Currently, there are a number of systems in Keene that generate renewable electricity. Keene is home to a micro-hydropower system of 90 kW and over 3,300 kW of installed solar photovoltaic (PV) capacity across local homes and businesses.

**Figure 4: Interconnected Solar PV in Keene[2]**

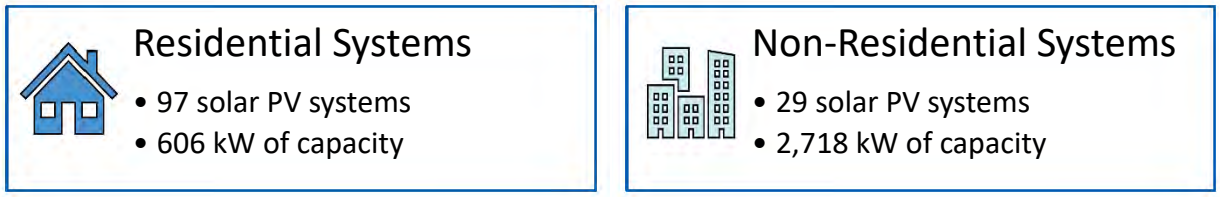



Figure 4 only includes interconnected systems and does not include off-grid systems within Keene. While distributed generation penetration is expected to grow over time, the 2030 forecast conservatively assumed the number of local renewable energy installations will stay constant over time.

## New Hampshire Energy Supply Mix

As mentioned above, Eversource has divested its generation assets and relies on the New England Power Pool (NEPOOL[53]) and local energy generation to meet its customer demand for electricity and RPS requirements. The RPS ratchets up the renewable energy requirements every year (see **Table 1: New Hampshire RPS**Table 1**Error! Reference source not found.**). By 2025, in order to comply with the RPS, 25.2% of all electricity provided by Eversource will need to be generated using renewable sources. Currently, the RPS is projected to stay constant at 25.2% in 2025 and thereafter. The 2030 forecast conservatively assumes that the percentage of renewable generation mandated by the RPS will not increase after 2025.

**Table 1: New Hampshire RPS[54]**

| Year | Annual Percent Increase | Renewable Energy Supply as Percent of Total Supply |
|---|---|---|
| **2019** | Baseline | 19.7% |
| **2020** | 1.0% | 20.7% |
| **2021** | 0.9% | 21.6% |
| **2022** | 0.9% | 22.5% |
| **2023** | 0.9% | 23.4% |
| **2024** | 0.9% | 24.3% |
| **2025 & thereafter** | 0.9% | 25.2% |

Conservatively, the default electricity supply provided by Eversource will need to comply with the RPS. In actuality, the electricity supply that Eversource purchases may exceed this requirement. Eversource interacts heavily with the New England Power Pool (NEPOOL) to source electricity supply. In 2019, the New England-based generation that feeds into the NEPOOL to serve the electricity load was 20.12%

[2] Distributed generation information was provided by Eversource.

renewable, up from 18.3% renewable in 2018.[55] While the regional 2019 level of 20.12% renewable supply exceeded the New Hampshire 2019 RPS requirement of 19.70%, the conservative RPS projections were the foundation of the Keene electricity baseline analysis. As Eversource's default supply changes periodically, the RPS provides a conservative baseline for understanding renewable and non-renewable supply over time, assuming the electric utility is compliant.

**Table 2. NEPOOL Generation Sector 2019[56]**

| Generation Type | Natural Gas | Nuclear | Coal | Oil | Hydro | Refuse /Other | Wind | Wood | Solar | All Renewables |
|---|---|---|---|---|---|---|---|---|---|---|
| Capacity (MW) | 16,563 | 4,025 | 917 | 7,139 | 3,393 | 462 | 415 | 503 | 440 | 5,213 |
| Net Energy for Load (GWh) | 39,725 | 25,182 | 369 | 117 | 7,305 | 2,895 | 2,794 | 2,004 | 1,474 | 16,472 |
| % of Total Generation | **48.5%** | **30.8%** | **0.45%** | **0.14%** | **8.9%** | **3.5%** | **3.4%** | **2.4%** | **1.8%** | **20.1%** |

As of 2019, the regional grid relies heavily on natural gas (48.5% of total generation) and nuclear (30.8%), despite the recent closures of nuclear plants across the region, including the 2014 closure of Vermont Yankee Nuclear Power Plant in Vermont and the 2019 closure of the Pilgrim Nuclear Power Plant in Massachusetts. Renewable energy resources, including hydropower, refuse, wind, wood, solar and other renewables sources made up a combined 20.1% of total regional generation.

**A Note on Competitive Suppliers**

In New Hampshire, customers have the option between default electricity supply from the utility and choosing supply from a competitive supplier. In both scenarios, electricity is still delivered to customers through the electric utility's transmission and distribution grid. In 2018, Eversource noted that 42% of customer load in New Hampshire was served through default service, while 58% of customer load had migrated to competitive energy suppliers. Competitive suppliers are still subject to the state's RPS, but may offer products to customers that exceed this requirement by offering contracts with higher renewable energy mixes than the default service from the utility. Competitive supplier contracts are typically short-term (12-36 months) and can offer fixed or variable pricing to customers for their electricity.[57] In 2020, the City of Keene entered into two competitive supply agreements for 100% renewable electricity for all but one of its municipal facilities. One contract is subject to a one-year term, and the other is two years. The New Hampshire Public Utilities Commission does not regulate the prices offered by competitive suppliers. However, it does provide questions that consumers should ask competitive suppliers while assessing options.[58]

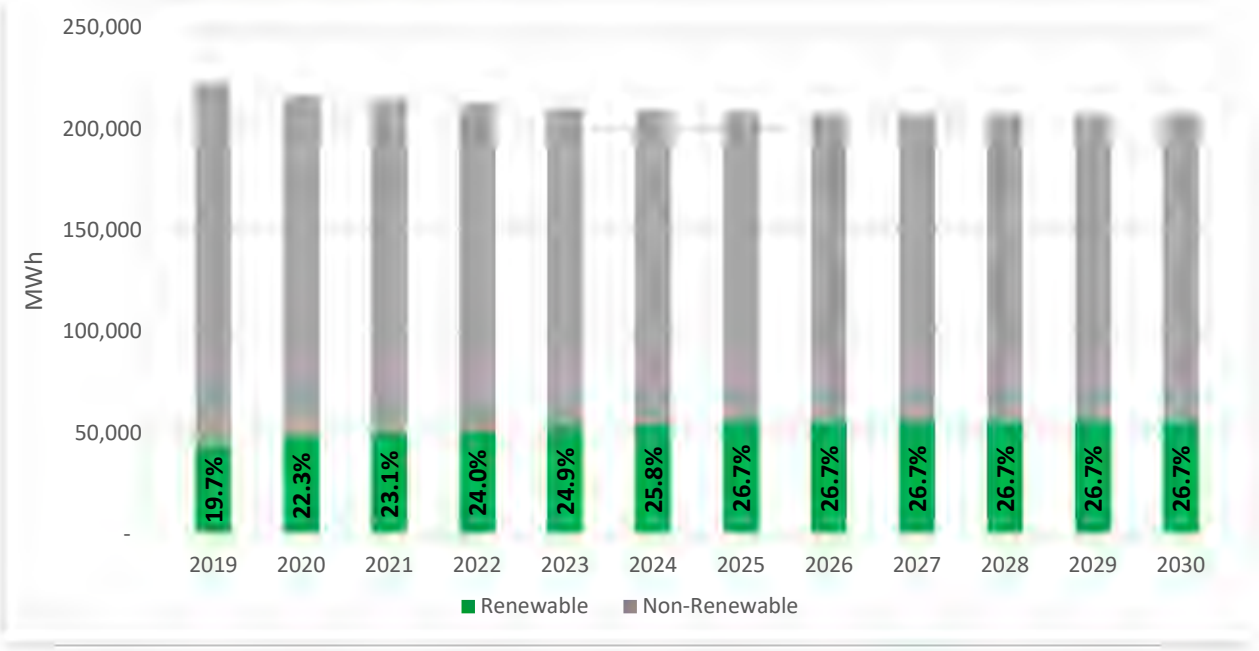
## What this means for 2030

Overall, the business as usual case conservatively estimates that electricity consumption in the City of Keene will be 27% renewable by 2030. The baseline points to a steady increase in renewable electricity supply, largely driven by RPS compliance. Despite population growth, electricity consumption is anticipated to decrease slightly, driven primarily by expected energy efficiency improvements (see Figure 5).

**Table 3: Electricity Consumption by Sector**

| Sector | Energy Type | Consumption 2019 (MWh) | Consumption 2030 (MWh) |
|---|---|---|---|
| **Residential** | Renewable | 12,137 | 13,945 |
| | Non-Renewable | 49,471 | 41,393 |
| **Commercial** | Renewable | 30,563 | 36,781 |
| | Non-Renewable | 124,580 | 109,176 |
| **Industrial/Manufacturing** | Renewable | 308 | 370 |
| | Non-Renewable | 1,254 | 1,099 |
| **Municipal** | Renewable | 860 | 4,109 |
| | Non-Renewable | 3,507 | 0[59] |

**Figure 5. Business as Usual Electricity Consumption and Supply in Keene**




This baseline assumes that the City continues sourcing 100% renewable electricity for its municipal accounts through 2030 from competitive supply agreements. If the municipality chooses not to extend these agreements and default back to the utility supply, then the overall community renewable electricity mix is expected to decrease slightly.

In 2030, it is estimated that the commercial and residential sectors will be the largest consumers of electricity (71% and 27% of electricity consumption, respectively), but that a larger proportion will be sourced from renewable energy due to the RPS. Without further action, it is estimated that the City will achieve 26.7% of its 100% renewable electricity target by 2030.

# Strategy Analysis and Findings

## Strategy Analysis Methodology

There are numerous strategies that the City of Keene could undertake in an effort to achieve its renewable electricity, workforce development and educational goals. To identify a subset of strategies that would be appropriate and impactful in the Keene context, the Cadmus Team first compiled an initial list of 16 strategy options based on conversations with City staff; the Cadmus Team's prior work with municipal governments nationwide; and desk research on Keene's state, utility, and local policy context, outlined in the Electricity Context section.

For each of the 16 strategies, the Cadmus Team then qualitatively assessed and ranked each strategy against key criteria, summarized below.

| Criteria | Description |
|---|---|
| Scale of Impact | Includes the extent to which a strategy will increase the level of renewable energy within the electricity mix. |
| Local Impact | Includes the extent to which a strategy promotes renewable energy generation locally and whether it supports resiliency. |
| Local Environmental and Social Goals | Includes the extent to which the strategy contributes to local job growth and works to reduce greenhouse gas emissions. |
| Inclusion and Social Equity | Includes the extent to which the strategy is expected to be affordable for all-income levels, alignment with other community initiatives, and extent to which the benefits of the strategy are equitable. |
| Feasibility | Includes timeframe for implementation, costs to the City for implementation and support, and technical feasibility for implementation. |

With the insights of this prioritization exercise, which can be found in **Appendix C**, the Keene Climate and Energy Committee selected six strategies for the Cadmus Team to explore in further depth, listed below:

1. Establish a community power program
2. Engage in virtual power purchase agreements
3. Collaborate with the utility to develop a pilot program related to energy storage
4. Partner with a local financial institution to offer a renewable energy loan product
5. Implement a building benchmarking ordinance
6. Adopt solar and EV ready guidelines

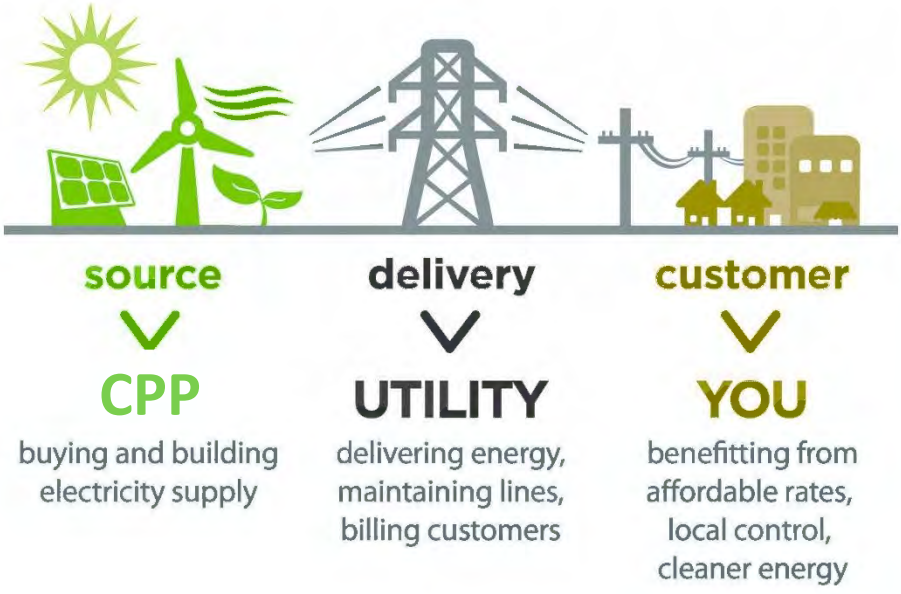
The following section summarizes key information related to each strategy, including a description, expected benefits and challenges, initial implementation steps, and examples of communities where the strategy has been implemented.

## Strategy 1: Establish a Community Power Program

### Overview

A community power program (CPP), also known as community choice aggregation (CCA), enables a local government (or multiple local governments) to **pool the electricity load of residents and small businesses and procure electricity on their behalf,** while the utility continues to be responsible for electricity delivery, transmission, and distribution and maintenance of poles and wires. Community power programs (CPP) are "opt-out", meaning that residents and businesses would participate in the program by default, but would have the option to "opt-out" if they preferred to receive basic service from Eversource or purchase electricity from a competitive supplier. This is an impactful strategy because it provides New Hampshire communities with **greater control over their energy mix and the opportunity to increase the percentage of renewables** within the mix at potentially lower energy prices.

**Figure 6: How Community Power Programs (CPP) Work[60]**




Source: Adapted from LEAN Energy

## Keys Benefits and Challenges

Key benefits and challenges associated with establishing a community power program are summarized below:

| Key Benefits | Key Challenges |
|---|---|
| **Increases local control** over the energy supply mix | **Political and regulatory uncertainty** in New Hampshire |
| Provides the ability **to increase the percentage of electricity from renewables** through RECs | **Limited ability to achieved "additionality"** due to reliance on RECs (see description below) |
| Potential **cost savings** to the community | Some **administrative burden** on city staff to set up program and identify a broker |
| Potential expansion in the future **to drive local renewables, energy efficiency, and other innovative offerings** | **Political coordination required** with neighboring communities if Keene wants to enhance economies of scale |

When implementing this strategy, it will be important to have a strong understanding of renewable energy credits, or RECs. RECs are tradeable, market-based instruments that represent the legal rights to one megawatt-hour (MWh) of renewable electricity generation. There are two main types of RECs:

**Unbundled RECs:** Unbundled RECs are those that are sold, delivered, or purchased separately from physical electricity. Many CPPs rely on unbundled RECs as the primary means of increasing the renewable percentage of the electricity product delivered to customers. The key advantage of unbundled RECs is they can be sourced from renewable energy projects across the country, are relatively low cost and simple to procure. However, Unbundled RECs are often criticized for capitalizing on the presence of existing renewable energy projects and not driving the development of new renewable energy projects that would not have otherwise been built. Thus, unbundled RECs are generated by renewable energy projects that are referred to as "**non-additional"**.

**Bundled RECs**: In contrast to unbundled RECs, bundled RECs are sold together with the physical electricity generated by a specific renewable energy project. Bundled RECs, and their associated clean electricity, are typically procured by CPPs through PPAs or VPPAs (see Strategy 2 below). Advantages of bundled RECs are that they drive the development of new (or "**additional**") renewable energy projects that would not have otherwise been built (i.e. **achieving additionality**). However, identifying and contracting electricity that is bundled with RECs can often be more administratively burdensome, and sometimes more expensive, for CPPs.

CPPs, especially in early stages, often rely on unbundled RECs to increase the renewable percentage of the electricity product delivered to customers; however, it is possible to shift towards bundled RECs over time as the CPP program generates revenue and potentially partners with neighboring communities to increase scale.

## Implementation Steps

Initial implementation steps for establishing a Community Power program are listed below:

| | Implementation Steps |
|---|---|
| ✓ | **Conduct research** on community power and its potential role in achieving local RE goals. |
| ✓ | **Form an electric aggregation committee** or designate an existing committee to develop a Community Power Plan. |
| ✓ | **Gain local approval** for the finalized Community Power Plan from the local legislative body (e.g. City Council). |
| ✓ | **Select a supplier** and enter into a short-term (1-3 year) contract to supply residents and businesses with a greater amount of renewable electricity. |
| ✓ | **Notify residents & businesses** about newly formed program and ability to opt-out prior to service beginning. |

## Key Examples from Other Communities

A number of communities are establishing community power programs across the country and within the region. As of 2017, there were approximately 750 operational CPPs procuring electricity on behalf of about 500 million customers.[61] While these programs operate differently across states due to state-level regulation, CPPs in Massachusetts operate similarly to how they would operate in New Hampshire. Although there are no New Hampshire towns or cities that have actually launched a CPP, state legislation does allow this method of energy procurement and there is growing interest across several communities, with some in the advanced stages of the planning process. New Hampshire communities have the ability to pursue a CPP through the standard single procurer model, and there is some interest in a regional approach that would involve multiple communities combining their energy purchasing power to achieve economies of scale. This latter type of CPP is referred to as the alternate or "joint-office" model.

**Cambridge Community Electricity: Cambridge, Massachusetts[62]**

One example is the Cambridge Community Electricity (CCE) program, a city-run aggregation program established in 2017. CCE selected Direct Energy as the program's electricity provider from January 2019-2021 and will offer fixed electricity prices throughout this contract duration. This type of CPP program, where city staff interact with a single electricity broker, is the most simplified and the least administratively burdensome. The program currently offers Cambridge residents and businesses two electricity products, including Standard Green and 100% Green Plus. The Standard Green option provides an electricity product that is similar in renewable energy content to the regional grid, about 20%, while the 100% Green Plus option offers a 100% renewable electricity product. As with most CPPs, customers "opting up" to the 100% renewable electricity product pay a slight price premium per kWh compared to the standard electricity product offering. Additionally, as of April 2020, both electricity products offered through Cambridge's CCE have lower rates for residential and small business customers than the standard Eversource offering.[63] However, these savings are subject to change as Eversource rates change every six months for residents and small businesses. One unique aspect of the Cambridge's CCE is that both rate

options include a small fee, knows as an "operational adder", that will go towards the development of new solar projects within the City of Cambridge.

**Community Power New Hampshire[64]**

Community Power New Hampshire[3] (CPNH) is a municipal and county-led initiative working with Clean Energy New Hampshire and local governments throughout the state to offer an alternative to the standard CPP model, which typically involves a single community contracting with an energy broker to procure renewable energy through the purchase of RECs. Under this alternative model, also known as the joint-office CPP model, cities can form their own community power program and then join the centralized CPNH network. The intention of a combined-joint office is to expand the communities' technical capacity, reduce and centralize administrative costs, leverage pooled revenue to develop and administer innovative energy efficiency, demand response, and renewable energy programs, and bolster the group's purchasing power. CPNH is still in the planning phase of development, but many New Hampshire communities are hopeful it will enable accelerated grid modernization and renewable energy adoption in the near future.

[3] For more information on the structure, goals, and services of CPNH, please visit: Community Power New Hampshire (CPNH).

## Strategy 2: Engage in Virtual Power Purchase Agreement (VPPAs)

### Overview

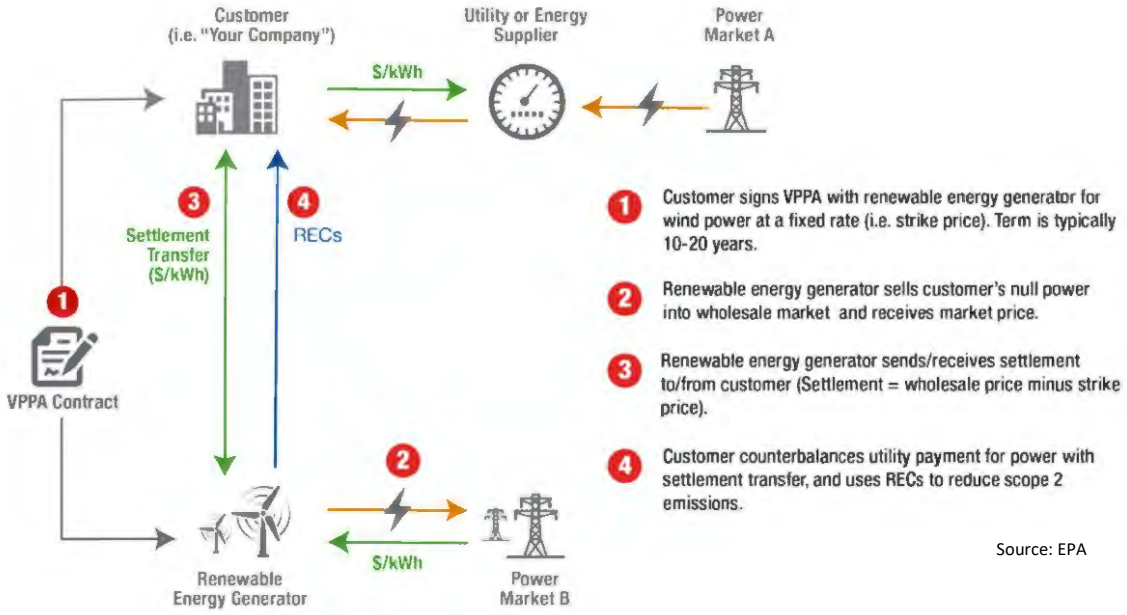
Cities and community power programs can **support the creation of additional renewable energy by entering into long-term contracts with renewable energy generators** in the form of a power purchase agreement (PPA) or virtual power purchase agreement (VPPA).

A **PPA** is a contract between a buyer and renewable energy generator where the buyer takes ownership of the electrons and RECs produced by the renewable energy project.

A **VPPA** is a financial transaction where the buyer does not own the electrons produced by the renewable energy project, but receives titles to the RECs.

Both contracting instruments, but especially VPPAs, allow both the buyer and the generator to hedge against electricity market price volatility and allow the buyer to benefit from long-term price stability. Another key advantage of VPPAs over traditional PPAs is their geographic flexibility. With PPAs, the renewable energy generator and the consumer must be physically connected to the same regional grid. However, with VPPAs, this is not the case, increasing the diversity of renewable energy generators a customer can contract with. If Keene were to launch a CPP, there are strong potential synergies between a CPP and VPPAs. Leveraging VPPAs, the City could transition their CPP away from unbundled RECs and towards bundled RECs over time, driving the development of renewable energy projects that would not have otherwise been constructed.

**Figure 7: How a Virtual Power Purchase Agreement (VPPA) Works[65]**



The above figure demonstrates the step-by-step process for how a VPPA works. There are a few notable takeaways from the above graphic. First, **the power market that the renewable energy generator is selling electricity into ("Power Market B") does not have to be the same as the power market that the customer (e.g., Keene CPP) is physically connected to ("Power Market A")**. In practical terms, this means that the Keene CPP could sign a VPPA with, for example, a wind farm project in Iowa that may have more favorable financial terms than a similar renewable energy project in New England. Secondly, step 3 in the above figure demonstrates the **price hedge value of a VPPA**. By entering into a VPPA, the customer (e.g., Keene CPP) locks in a fixed price, or strike price, for Bundled RECs from the renewable energy generator. If the wholesale price of electricity rises, the customer will be insulated from these price increases because of the long-term nature of the VPPA. Conversely, if the VPPA strike price is greater than the wholesale market price, the customer would pay the net difference to the renewable energy generator. In this way, the VPPA acts as a price hedge against potentially volatile future energy costs.

Keene could consider entering into a VPPA with a renewable energy generator within NEPOOL to support the development of local/regional renewables and resilience. However, it is possible that the financial terms will not be as favorable as they could be in another power market.

## Keys Benefits and Challenges

Key benefits and challenges associated with engaging in virtual power purchase agreements are summarized below:

| Key Benefits | Key Challenges |
|---|---|
| Supports the development of **new, additional renewable energy projects with no upfront cost**<br><br>Provides the opportunity to **increase the community's % of electricity from renewables** without unbundled RECs<br>Enables the community power program to **purchase large volumes of electricity** in a single transaction **from generators located across the country**<br>**Hedge** against electricity market price volatility, **long-term price stability**, and **potential cost savings** to the community | The commitment of a small CPP program to purchase the energy **may not be sufficient to cover the financing of a project**<br>**Contracts can be complex and may be challenging to navigate** without additional legal support<br><br>By committing revenue to a long-term project, the CPP is **limiting its ability to implement other initiatives** in that timeframe<br><br>By locking into a long-term contract, **risk that basic supply rate will dip** below CPP rate |

## Implementation Steps

Initial implementation steps for engaging in virtual power purchase agreements are listed below:

| | Implementation Steps |
|---|---|
| ✓ | Customer signs a VPPA with a renewable energy generator for wind power at a fixed rate (i.e. strike price). Term is typically 10-20 years. |
| ✓ | Renewable energy generator sells customer's null power into wholesale market and receives strike price. |
| ✓ | Renewable energy generator sends/receives settlement to/from customer (settlement = wholesale price – strike price). |
| ✓ | Customer counterbalances utility payment for power with settlement transfer and uses RECs to reduce scope 2 emissions[4]. |

## Key Examples from Other Communities

This section includes an example of how one Virginia community is utilizing a VPPA to reach their renewable energy goals.

**Amazon Arlington Solar Farm: Arlington County, VA[66]**

Arlington County, in partnership with Dominion Energy and Amazon, recently agreed to purchase 31.7% of the energy generated by a Dominion owned solar farm in Pittsylvania County, VA. The solar farm is projected to cover 1,500 acres of agricultural land and produce 250 million kWh annually upon completion in 2022. Procuring 31.7% of the electricity produced by the solar farm equates to more than 79 million kWh and will offset 83% of the electricity currently used by the county government to operate its buildings, streetlights, water pumping station, and wastewater treatment facility. For reference, annual electricity consumption across all of Keene is equivalent to approximately 222 million kWh. This VPPA agreement is key to Arlington County reaching the targets outlined in their Community Energy Plan, including a goal to use 100% renewable energy for government functions by 2025.

[4] Scope 2 emissions are indirect emissions from the generation of purchased energy. For most cities, the vast majority of scope 2 emissions come from electricity that is generated outside of the city boundary but consumed inside the city boundary.

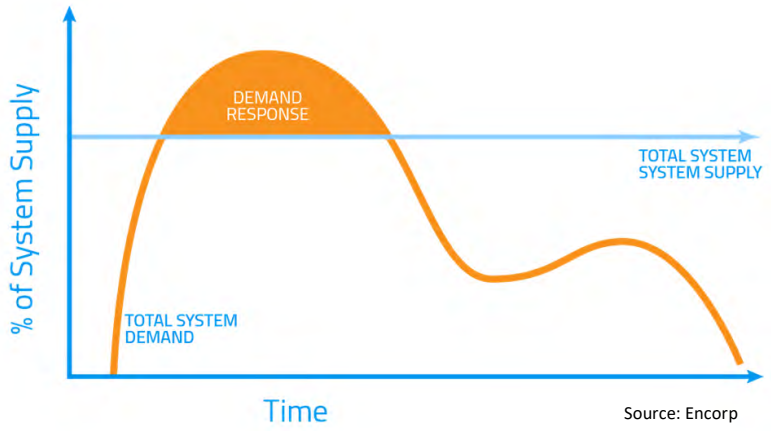
## Strategy 3: Collaborate with the Utility to Develop a Pilot Battery Storage Program

### Overview

This strategy involves the City of Keene establishing a close working partnership with their local utility, Eversource, to develop a pilot battery storage program. This could include efforts to collaboratively develop ideas with the utility that support battery storage initiatives and build on preexisting Eversource programs. Existing battery storage programs in other regions or operated by other utilities have utilized **rebates, demand response incentives, or a combination of the two to increase proliferation** of battery storage systems.

Battery storage is a rapidly developing technology that can be **coupled with solar and other renewable energy resources**. This strategy has the potential to significantly benefit residents, businesses, the City, and the utility by **reducing demand on the grid during peak times**. Through the strategic deployment of electricity stored in batteries during peak times, **local businesses can significantly reduce their demand charges**. Demand charges for commercial customers are based on the highest level of electricity supplied by the grid at one time during the billing period and can make up a large portion of total electricity expenses for some businesses. From an environmental perspective, the ability of batteries to reduce peak demand on the grid also **reduces the reliance on natural gas "peaker" power plants**, which generate a large amount of greenhouse gasses, to meet this peak demand. As battery costs continue to decrease over time, implementing a pilot battery storage program will position Keene well to take advantage of the environmental, cost, and resiliency benefits of modernizing the grid, which will be key in the City's efforts to achieve 100% renewable electricity by 2030.

**Figure 8: How Battery Storage Helps Reduce Demand Charge Peaks[67]**




The above figure highlights the costs saving and environmental potential of battery storage systems paired with solar PV. When total electricity demand on the grid (orange line) exceeds the total electricity being supplied by power plants currently on line (the horizontal blue line), electricity stored in batteries can be deployed (orange shaded region) to reduce electricity demand charges for local businesses and reduce the need for polluting natural gas power plants to come online to meet peak demand.

## Keys Benefits and Challenges

Key benefits and challenges associated with this strategy are summarized below:

| Key Benefits | Key Challenges |
|---|---|
| Takes advantage of **utility funding, technical expertise, and preexisting infrastructure and programs** | City not in direct control of program development and implementation + **success is largely dependent on Eversource being an active + willing participant.** |
| **Reduces electricity costs for consumers** and the utility by minimizing peak demand | Need to **identify the right points of contact** at both organizations. Partnership may require connection at the upper management/admin level. |
| **Modernizes the grid**, **boosts resilience**, and **reduces the need for gas "peaker" plants** | Utility **priorities can shift** during a project |
| Pilot program is a **low-cost strategy for the City** to pursue | Third-party complexity is introduced, as **battery vendors (i.e. Tesla, LG, Generac) often play a role in demand response** |
| **Potential to expand the pilot program** by partnering with other local governments, nonprofits, and businesses in the future | Keene is at the forefront of exploring battery storage pilot program models in New Hampshire, with **minimal in-state precedent to leverage** |
| Provides a **cleaner and cheaper alternative for back-up power**, which can be deployed to **support essential infrastructure** | |

## Implementation Steps

Initial implementation steps for collaborating with the utility to develop a pilot battery storage program are listed below:

| | Implementation Steps |
|---|---|
| ✓ | **Discuss potential opportunities to partner with Eversource on a pilot battery storage program.** Given the preexisting demand response thermostat program Eversource has already made available in New Hampshire and the demand response battery storage program deployed by the utility in Massachusetts, there is already proven interest and precedent that the City of Keene can build from. |
| ✓ | **Invest in battery storage at municipal facilities through Eversource's pilot program, potentially providing City co-funding.** The City can serve as an example, showing the benefits of utilizing battery storage while reducing electricity costs and minimizing the environmental footprint of municipal operations. Installing battery storage as an alternative to diesel generators for essential infrastructure could be explored. |
| ✓ | **Seek opportunities to expand and publicize the pilot battery storage program to local businesses and residents**, leveraging strong interest in the strategy expressed during both the community presentation and Environment and Climate Committee meetings. |

## Key Examples from Other Communities

This section includes examples of how communities and their local utility have implemented best practices related to the implementation of battery storage technology. Utility administered battery storage incentives typically compensate utility customers in one of two ways. Demand response programs pay customers for the energy their battery contributes to the grid during periods of high demand, while other programs simply provide a rebate to customers for installing battery storage at their home or business. Examples of demand response, rebate, and a hybrid program options are explained in more detail below.

**ConnectedSolutions Demand Response Program: Eversource, Massachusetts[68]**

The ConnectedSolutions Demand Response Program is a program run by Eversource in Massachusetts that enables participating residents to be compensated for allowing the utility to use the energy stored in their batteries during periods of high demand on the grid. Residents with battery storage can also choose not to be enrolled in the program, saving the electricity stored in their battery as a personal back-up generator instead.

**Bring Your Own Device Program: Green Mountain Power, Vermont[69]**

Developed in partnership with Renewable Energy Vermont, the Bring Your Own Device Program enables participating utility customers with onsite battery storage to choose between an upfront payment from the utility or a compensation rate for demand response use. The level of compensation is determined by the size of the customer's battery storage system.

**Home Battery Storage Pilot: Liberty Utilities, New Hampshire[70]**

The Home Battery Storage Pilot was recently approved by the New Hampshire PUC. This program will allow residents to sign up for a home battery installation in partnership with the utility and qualify them for varying time-of-use rates.

## Strategy 4: Partner with a Local Financial Institution

### Overview of the strategy

Renewable energy loans, particularly for distributed solar PV systems, can help make the installation of renewable energy projects more affordable for Keene residents and businesses by **minimizing the up-front capital costs** required to complete an installation and offering low-interest, fixed rates with flexible terms. With limited renewable energy financing options currently available for residents and businesses, the City of Keene could potentially partner with a local financial institution to offer **competitive financing for renewable energy projects**. By financing projects with more capital from local banks or credit unions, Keene can **maximize the number of renewable energy installations** within the City, as well as the economic and environmental benefits associated with deployment of these technologies.

### Keys Benefits and Challenges

Key benefits and challenges associated with this strategy are summarized below:

| Key Benefits | Key Challenges |
|---|---|
| **Increased financing access for local residents and businesses** to overcome financial barriers to renewable energy adoption | **City not in direct control of program development** and implementation. Success is largely dependent on local banks and co-ops being an active and willing participant |
| Opportunity to **support local economy** by engaging with local banks credit unions | Keene is at the forefront of exploring partnering with local financial institutions to finance solar in the state of New Hampshire, with **minimal in-state precedent to leverage** |
| Equitable solution that **increases ability of low-income residents to install solar** | Potentially **high administrative burden** on City staff engage with local banks and co-ops to establish program |
| **Established best practices to draw on** for engaging with local banks and co-ops to develop similar programs | |

## Implementation Steps

Initial implementation steps for partnering with a local financial institution to offer a renewable energy loan are listed below:

| | Implementation Steps |
|---|---|
| ✓ | Conduct a review of local financial institutions that may serve as a potential partner based on current or past offerings. |
| ✓ | Conduct outreach to local institutions and provide educational materials on the benefits of offering loans for renewable energy. Keene could further support private sector lending by offering to provide a loan loss reserve or credit enhancement program. |
| ✓ | In parallel, considering advocating for the expansion of existing state or regional loan offerings, such as NH Saves, to include renewable energy or energy storage offerings. |

## Key Examples from Other Communities

This section includes examples of other communities and organizations that have implemented innovative financing solutions to accelerate clean energy adoption.

**Milwaukee Shines: Milwaukee, Wisconsin[71]**

The City of Milwaukee, Wisconsin partnered with Summit Credit Union to create "Milwaukee Shines," a special loan program for city residents. With a $2 million budget, the program offers eligible customers up to $20,000 at a low-interest, fixed-rate with flexible terms. Financing can be applied to solar electric systems up to 6 kW and solar hot water systems of 1-8 panels in size. Eligible expenses include all equipment, labor, permits, and interconnection fees, as well as structural re-enforcement and re-roofing expenses, if needed.

**Admirals Bank & Solarize: Multiple Locations[72]**

Admirals Bank, a Boston-based bank active in lending for residential solar projects, has partnered with local governments and non-profits administering Solarize programs in Connecticut, Massachusetts, and North Carolina to provide financing options for participants. For example, during the Solarize Connecticut Durham Pilot Project, the selected installer referred customers to Admirals Bank, which worked with homeowners to put together a loan package that allowed customers to participate in the program and purchase the system. Admirals Bank Relationship Managers and Solar Financing Experts have also attended town information sessions to educate homeowners on available lending products for other campaigns they have participated in.

**New Hampshire Examples**

Several New Hampshire banks and credit unions offer energy efficiency loans and could potentially expand to provide renewable energy loans as well.

- BCCU[73] is a credit union with locations in Manchester, Nashua and Bedford offering energy efficiency loans.
- NHSaves[74] is a utility-run program that has partnered with local savings banks/credit unions to offer energy efficiency loans.

## Strategy 5: Implement a Building Benchmarking Ordinance

### Overview of the strategy

A municipal and commercial building benchmarking ordinance is an effective strategy that enables building owners to **measure the energy efficiency of their building** against comparable buildings from across the country and **identify buildings that could benefit most from energy efficiency improvements**. The vast majority of building benchmarking ordinances rely on the use of the Environmental Protection Agency's (EPA's) **ENERGY STAR Portfolio Manager**, **a free online benchmarking tool** that helps building managers track data and measure progress. Portfolio Manager allows building managers to compare their building to similar buildings using the 1-100 ENERGY STAR score. Achieving a score of 50 would be considered the median, while a score of 75 would indicate that the building is performing better than 75% of its peers and may be eligible for ENERGY STAR certification. Portfolio Manager allows building managers to compare their building to similar buildings across the country, using the 1-100 ENERGY STAR score. Achieving a score of 50 would be considered the median, while a score of 75 indicates that the building is performing better than 75% of its peers and is eligible for ENERGY STAR certification.

Through the identification of inefficient buildings, a benchmarking ordinance can be effective in **driving increased participation in already existing energy audit and energy efficiency programs**, such as those offered through Eversource. These programs can accelerate the path towards decreased energy consumption, energy cost, and GHG emissions. Many benchmarking programs feature a public disclosure component, which can have beneficial impacts such as empowering prospective tenants to make informed decisions before entering into a lease agreement. Benchmarking programs can be **voluntary or mandatory**, include energy and/or water consumption, and can be customized by square footage and building type. For example, many benchmarking ordinances have **stricter reporting requirements for larger commercial buildings** that exceed a certain square footage threshold. Some benchmarking ordinances also link the program to mandatory energy audits or energy efficiency improvements for inefficient buildings. Since over 70% of total electricity consumption in Keene is associated with commercial and municipal buildings, a benchmarking ordinance has significant potential to reduce electricity consumption in Keene's existing building stock.

**Figure 9: Example Dashboard Screenshot from ENERGY STAR Portfolio Manager[75]**


The above image displays a screenshot of the type of information building managers would see when logging into the ENERGY STAR Portfolio Manager platform, including the building's overall energy score and trends in the energy use intensity associated with their building.

## Keys Benefits and Challenges

Key benefits and challenges associated with implementing a building benchmarking ordinance are summarized below:

| Key Benefits | Key Challenges |
|---|---|
| Identifies commercial and municipal buildings in Keene that could benefit most from **energy efficiency improvements** | Potential **political hurdles** associated with passing a mandatory ordinance through City Council |
| **Drives participation** in existing energy audit and energy efficiency programs offered through Eversource | Mandatory benchmarking **does not guarantee energy-efficiency upgrades** and improvements |
| Encourages utilization of, and recognition from, EPA's ENERGY STAR Portfolio Manager, a **free online benchmarking tool** | Potential issues with **data access, quality, and accuracy** |
| Opportunity for Keene to **lead by example** by benchmarking municipal buildings | **Compliance** with, and **enforcement** of, mandatory ordinance |
| Potential to link **financial incentives** to energy-efficient upgrades (see South Portland example below) | **Administrative burden** associated with ongoing support and management of the program |

## Implementation Steps

Initial implementation steps for developing a building benchmarking ordinance are listed below:

| | Implementation Steps |
|---|---|
| ✓ | Review EPA's list of *Benchmarking Programs and Policies Leveraging ENERGY STAR*[76] to get a sense of program design, requirements, and incentives being utilized by other localities. |
| ✓ | Consider a voluntary program to precede a mandatory ordinance. |
| ✓ | Draft ordinance language and pass through City Council. |
| ✓ | Develop or enhance a webpage to host relevant resources and materials. |
| ✓ | Determine which metrics will be disclosed publicly. |

## Key Examples from Other Communities

This section includes communities that have implemented best practices related to implementation of municipal and commercial building benchmarking ordinances in the US. Each example includes a few key points and differentiating factors as well as a hyperlink to each ordinance. For additional examples, the EPA's ENERGY STAR program developed an interactive map[77] to track benchmarking programs in the US that are utilizing Portfolio Manager in their ordinance. All of the ordinances listed below involve mandatory reporting requirements and utilize Portfolio Manager as the primary benchmarking platform.

**Energy & Water Benchmarking Ordinance: South Portland, Maine[78]**

Adopted in 2017, the Energy & Water Benchmarking Ordinance in South Portland, Maine requires all municipal, school, and commercial buildings larger than 5,000 square feet to benchmark and disclose their annual energy and water consumption to the city each year. The ordinance also applies to residential multifamily buildings with more than 10 units. In order to encourage increases in energy efficiency, the ordinance mandates that each covered property subject to reporting requirements must complete a building energy audit once every five years. However, while disclosure of the building energy use and periodic audits are required, the policy does not mandate buildings to meet certain levels of energy efficiency, reach energy reduction targets, or make energy-related improvements. Typically, it's uncommon for mandatory benchmarking ordinances to offer incentives, but in the case of South Portland, they offer a $5,000 compliance incentive that can be used as a credit for future expenses stemming from city application, review, or inspection fees associated with construction or redevelopment projects at the property.

**Building Energy Saving Ordinance: Berkeley, California[79]**

Adopted in 2015, the Building Energy Saving Ordinance (BESO) in Berkeley, California requires that all covered buildings report their annual energy consumption. The BESO phases in reporting requirements by building size so that larger buildings over 50,000 square feet must report first in 2018 while smaller buildings, such as those below 5,000 square feet, are not required to report until 2022. Similarly, covered buildings over 25,000 square feet must conduct an energy assessment every five years while covered buildings below that threshold must only conduct an energy assessment every ten years. Berkeley also

operates an Energy Efficiency Inventive Program that complements the BESO and encourages building upgrades and improvements.

**Building Energy Use Disclosure Ordinance: Cambridge, Massachusetts[80]**

Adopted in 2014, the Building Energy Use Disclosure Ordinance (BEUDO) in Cambridge, Massachusetts is a time-tested ordinance that provides a wealth of resources and data that can be leveraged by those looking to create ordinances in other jurisdictions. Covered buildings include all buildings over 25,000 square feet, residential buildings with over 50 units, and municipal buildings over 10,000 square feet. Each of these building subsets are required to report energy and water usage to the city on an annual basis. The results of the reporting are publicly disclosed on a building-level basis on the Cambridge Open Data Portal. Cambridge also publishes annual reports, summary statistics, and compliance maps.

## Strategy 6: Adopt Solar and EV Ready Guidelines for All New Commercial Developments

### Overview of the strategy

The City of Keene can adopt solar PV and electric vehicle (EV) ready guidelines that encourage or require new developments to be built in a manner that accommodates future solar and EV charging station installations. Designing new buildings with future installations of these technologies in mind, opposed to installing them at existing buildings not designed to accommodate the required infrastructure, can significantly reduce total costs associated with the installation. For example, one study found that installing an EV charging space at an existing commercial building is 2.8 to 4.0 times more costly than installing the same EV charging space at a new commercial building.[81] Preemptively reducing cost barriers to entry for these key technologies can accelerate community-wide adoption of solar and EV charging in commercial developments. Access to EV charging, especially at the workplace, is key to the widespread adoption of EVs. This policy could also serve as a foundation for more far-reaching guidelines in the future that could, for example, require new residential buildings to also be built solar and EV ready.


Source: City of Keene

EV charging stations, like the ones pictured above at the Commercial Street parking lot in Keene,[82] will be more cost effective to install if new construction is designed to accommodate future installation by taking steps such as installing all necessary electrical infrastructure, pulling conduit and wire to the appropriate locations, and ensuring concrete work accommodates mounting of charging stations.

## Keys Benefits and Challenges

Key benefits and challenges associated with adopting solar and EV ready guidelines are summarized below:

| Key Benefits | Key Challenges |
|---|---|
| **Reduces technical and financial barriers to solar and EV** infrastructure implementation over the medium/long-term | Limited direct energy impacts expected as **the strategy does not directly generate clean energy** and is limited to the new construction market |
| **Facilitates community adoption of EVs** by increasing access to publicly available charging infrastructure | **Limited precedent**, with few examples of extensive solar and EV ready guidelines currently implemented in New England |
| **Low-cost step for building owners**, positioning them to take advantage of **lower infrastructure costs in the future** | **Additional upfront construction costs** to ensure solar and EV readiness may need to be reconciled |
| Several **resources outlining best practices** are already available via **SolSmart**[83] and other sources | **Administrative burden** associated with development of guidelines or ordinance. |
| **Establishes a foundation for future action** in the residential market and surrounding communities | |

## Implementation Steps

Initial implementation steps for establishing a Community Power program are listed below:

| | Implementation Steps |
|---|---|
| ✓ | **Leverage the City's ability to adopt more stringent building regulations or (stretch codes).** Local governments in New Hampshire have the ability to adopt stretch codes, which can be used to implement stricter guidelines than those explicitly outlined by the New Hampshire State Building Code. Stretch codes are a tool Keene can use to require higher building standards that coincide with solar and EV readiness guidelines. |
| ✓ | **Evaluate if solar and EV ready guidelines will be a recommendation or requirement for new construction.** For example, some communities opt to make solar and EV readiness a recommendation at first, then transition to a requirement later. |
| ✓ | **Consider if Keene's solar and EV ready guideline requirements will vary based on size, function, and financial ability of the building owner.** For example, communities may require larger commercial buildings to follow building guidelines and relax the guidelines for smaller entities. |

## Key Examples from Other Communities

This section includes examples from communities that have implemented best practices related to the implementation of solar and electric vehicle readiness guidelines in the United States. Each example includes a few key points and differentiating factors.

**Commercial Buildings Solar Requirement[84]: Watertown, Massachusetts**

In 2018, Watertown's Planning Board amended their zoning language, requiring all developments greater than or equal to ten thousand (10,000) gross square feet or containing ten (10) or more residential units to include a solar energy system that is equivalent to a minimum of 50% of the roof area of all buildings. In cases where a site includes an uncovered parking structure, the structure will also be required to have a solar energy system installed.

**Solar Friendly Best Planning Practices[85]: Southern New Hampshire**

The Southern New Hampshire Planning Commission (SNHPC) created this resource to assist New Hampshire communities interested in facilitating solar PV adoption. This includes guidance on how to develop solar friendly land use and zoning regulations and the policies and planning practices that remove barriers to development and reduce burdensome soft costs.

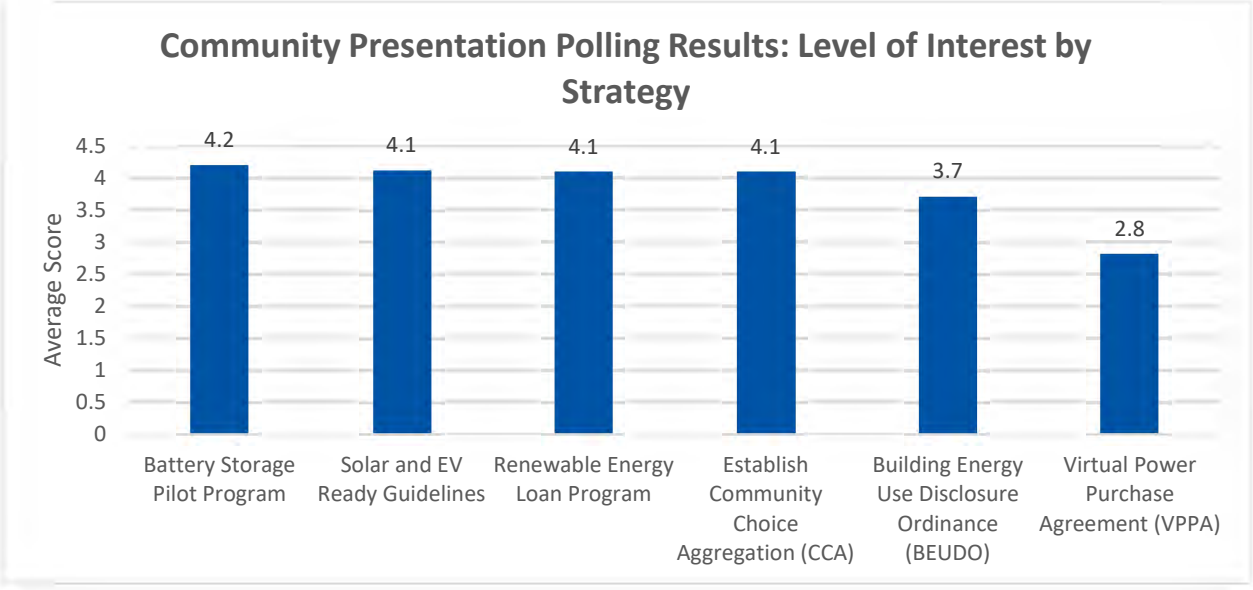
**Solar and EV Readiness Reach Codes[86]: San Mateo, CA**

The City of San Mateo has effectively leveraged their ability to implement reach codes to facilitate solar and EV infrastructure adoption in their community. The City requires all new construction to install a minimum size solar PV or solar thermal system in addition to requiring a minimum number of EV capable spaces or charging stations at qualifying sites. San Mateo has found that establishing minimum requirements often results in owners and developers far exceeding what is required in order to maximize cost-effectiveness.

## Community Feedback

The Cadmus Team hosted a webinar entitled *City of Keene Renewable Energy Transition Analysis* on the afternoon of April 2nd, 2020 and presented a similar, condensed presentation to City Council later that evening. The community webinar provided an overview of the analysis included in this report and was open to the public, with over 30 community members in attendance. Those who joined the webinar were encouraged to actively participate throughout the presentation, with the opportunity to submit questions throughout and answer poll questions gauging their general level of interest on each of the six strategies described.

**Community participants** were asked to express their level of interest in Keene pursuing each strategy on a scale of 1-5, with a **score of 1 equating to a "Low" level of interest and a score of 5 equating to a "High" level of interest**. The figure below summarizes the average score each strategy received from the public polling exercise, ordered from the highest to lowest priority.



# Conclusion

Keene has taken substantial action to date to support the development of renewable energy in the community and the recent adoption of the ambitious 100% community-wide renewable electricity by 2030 goal demonstrates the City's commitment to remaining a leader in climate mitigation efforts. The development of this Renewable Energy Transition Analysis lays a foundation for Keene to continue making strides towards the overarching 100% renewable electricity goal. As outlined above, Keene has multiple effective strategy options that could be leveraged to help meet this goal, while simultaneously achieving other community priorities including resilience, creating local jobs, reducing energy costs to local businesses and providing equitable access to clean electricity for all residents.

While all six strategies have the potential to drive increased reliance on renewable energy in Keene, the combination of Strategy 1 (Establish a Community Power Program) and Strategy 2 (Engage in a Virtual Power Purchase Agreement), in particular, have significant potential. The establishment of a CPP would enable Keene to offer electricity products that have a high renewable energy content to all residents and local businesses and a VPAA between the CPP and a renewable energy generator would reduce the CPP's reliance on unbundled RECs. The VPPA would ensure that the electricity products being offered to the Keene community through the CPP were driving 'additional' renewable energy products that would not have been built in the absence of the VPAA. While some residents and businesses would continue to procure their electricity from Eversource or other competitive suppliers, the City could still expect a high enrollment rate in the CPP due to competitive pricing and the "opt-out" nature of CPPs. Although still recommended for implementation, many of the other strategies detailed in this report are simply not as likely to achieve the same scale as the complimentary strategies of CPP formation coupled with a VPPA. For the four other strategies, limitations on achieving scale include reliance on partnerships and funding outside the direct control of the City (Strategy 3 and 4), programmatic focus on overall building energy goals without a direct path to increasing renewable energy supply (Strategy 5), and applicability being limited to new construction projects (Strategy 6).

Achieving a 100% renewable electricity supply is a critical step in the path towards achieving Keene's 2050 goal of having all thermal energy and energy used for transportation come from renewable sources by 2050. The two goals are directly linked – achieving 100% renewable electricity unlocks the potential for technologies including air source heat pumps and electric vehicles to be truly carbon neutral. The findings of this report provide the City with key information to support the implementation of six priority strategies, including key benefits and challenges, implementation steps, and examples from other leading communities. Next steps for Keene include reviewing and discussing the findings of this report with the Keene Climate and Energy Committee, along with other key stakeholders, to determine a course of action for implementation.

# Appendix A. State-Level Incentives

*Tax Incentives*

- **Local Property Tax Exemption**. Local property tax exemptions vary by city across New Hampshire. For example, the City of Keene set the solar exemption to "equal the total assessed value attributed to the solar energy system."[87] Similar local exemptions can also be applied to wood heating and wind systems as well.

*Rebate Programs*

- **Residential Small Renewable Energy Rebate Program**. Residential solar customers are eligible for the State rebate program on a first come, first serve basis. They may receive up to $2,500, granted they complete the pre-approval and final application. This is upheld by HB 1628.[88]
- **Residential Solar Water Heating Rebates**. Residential solar water heating customers are eligible for the State rebate program on a first come, first serve basis. They may receive up to $1,900, granted they complete the pre-approval and final application. This is upheld by New Hampshire Statutes, Chapter 362-F:10 and NH PUC Order No. 25,092.[89]

*Loan Programs*

- **Enterprise Energy Fund Loans**. Business and non-profit owners may apply for a loan through the New Hampshire Community Loan Fund and the New Hampshire Community Development Finance Authority. Loan amounts range from $50,000 to $500,000, with interest rates between 2% and 2.5% for non-profits, and 2.75% and 4% for for-profit businesses.[90]

# Appendix B. Renewable Electricity Baseline: Consumption and Percentages

| Renewable Energy Mix Percentage | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Total Renewable** | **19.7%** | **22.3%** | **23.1%** | **24.0%** | **24.9%** | **25.8%** | **26.7%** | **26.7%** | **26.7%** | **26.7%** | **26.7%** | **26.7%** |
| **Total Non-Renewable** | **80.3%** | **77.7%** | **76.9%** | **76.0%** | **75.1%** | **74.2%** | **73.3%** | **73.3%** | **73.3%** | **73.3%** | **73.3%** | **73.3%** |

| ***Renewable Energy Consumption (MWH)*** | **2019** | **2020** | **2021** | **2022** | **2023** | **2024** | **2025** | **2026** | **2027** | **2028** | **2029** | **2030** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Residential** | 12,137 | 12,241 | 12,680 | 13,111 | 13,511 | 13,902 | 14,307 | 14,195 | 14,133 | 14,070 | 14,008 | 13,945 |
| **Commercial** | 30,563 | 31,347 | 32,394 | 33,342 | 34,406 | 35,372 | 36,634 | 36,583 | 36,612 | 36,641 | 36,671 | 36,781 |
| **Industrial/Manufacturing** | 308 | 316 | 326 | 336 | 346 | 356 | 369 | 368 | 369 | 369 | 369 | 370 |
| **Municipal** | 860 | 4,263 | 4,221 | 4,171 | 4,139 | 4,097 | 4,092 | 4,086 | 4,090 | 4,093 | 4,096 | 4,109 |
| **Total RE Consumption (MWH)** | 43,868 | 48,166 | 49,621 | 50,959 | 52,403 | 53,727 | 55,402 | 55,233 | 55,203 | 55,174 | 55,144 | 55,205 |

# Appendix C. Renewable Energy Strategy Prioritization Exercise

In consultation with the City of Keene, Cadmus developed an initial list of potential strategies for the City to consider exploring in further depth. To help the City select up to six strategies to be included within the renewable energy plan, the Cadmus Team evaluated strategies against high-level criteria. Full details of this analysis are summarized in the table below:

| Strategy | Description | Targeted Impact | Scale of Impact Score | Local Impact Score | Local Environmental and Social | Inclusion and Social Equity Score | Feasibility Score | Timeline |
|---|---|---|---|---|---|---|---|---|
| **Establish a Community Choice Aggregation Program (municipal)** | Establish a community choice aggregation | Municipal, Residents, Businesses, Organizations within City of Keene | High | Low | Low | Medium | Medium | ~12 months to establish/start operating<br><br>Municipal participation will depend on when current contracts expire |
| **Establish a Community Choice Aggregation Program (Joint Office)** | Work with other entities to consolidate demand and establish a community choice aggregation | Municipal, Residents, Businesses, Organizations in Keene and in the region | High | Low | Low | Medium | Medium | ~12-18 months to establish/start operating<br><br>Municipal participation will depend on when current contracts expire |

| Strategy | Description | Targeted Impact | Scale of Impact Score | Local Impact Score | Local Environmental and Social | Inclusion and Social Equity Score | Feasibility Score | Timeline |
|---|---|---|---|---|---|---|---|---|
| **Virtual Power Purchase Agreements (VPPAs) by City** | Agree to a contract for differences (CfD) with a renewable energy developer at a given strike price to receive the RECs from a project. The renewable energy system developer sells the energy generated into the normal power market and uses the CfD as a hedge on the variable price of power. | Municipal, and potential partners (local businesses or organizations) | Medium | Low | Medium | Medium | High | ~3-6 months to identify a RE project and negotiate a contract<br>~10-20 year term |
| **Host a renewable energy bulk purchasing program (e.g. Solarize Campaign)** | Support solarize-style campaigns in the City to expand solar capacity | Residents, businesses, organizations in Keene or region | Low | Medium | Low | Medium | High | ~8 months to organize and run a bulk purchasing campaign |
| **Purchase Renewable Energy Credits or enter into competitive supply agreement for renewable energy** | Allows municipality to purchase renewable energy that matches consumption. RECs tend to be annual purchases and competitive supply agreements tend to be short-term. | Municipal | Low | Low | Low | Medium | Medium | ~2 months to identify/negotiate contract<br>~1-3 year contract term |

| Strategy | Description | Targeted Impact | Scale of Impact Score | Local Impact Score | Local Environmental and Social | Inclusion and Social Equity Score | Feasibility Score | Timeline |
|---|---|---|---|---|---|---|---|---|
| **Encourage residents and businesses to purchase RECs or enter into competitive supply agreements** | Encourage community members to purchase RECs or enter into competitive supply agreements. | Residents, businesses, organizations in Keene | Low | Low | Low | Low | High | If implemented - could include a marketing campaign, creation of resources (webpage, fliers, one pagers), workshops, with ongoing updates ~3 months-3 years |
| **On-Site Generation - Direct Ownership** | Install renewable energy projects on City facilities and City-owned lands; City would own the project(s) and the RECs. | Municipal | Low | Low | Medium | Medium | Low | ~12-18 months to install on-site system<br><br>Would be ongoing as opportunities arise for procurement. |
| **On-Site Generation – Third-Party Owned** | Generation is installed on City Property, but rather than owning the PV system, the City uses solar leasing or PPA to pay a fixed price for electricity generated by PV panels on city property | Municipal | Low | Low | Medium | Medium | Medium | ~12-18 months to install on-site system ~10-20 year contract term with potential opportunity to purchase the system |
| **Local Renewable Energy Requirements** | Require renewable energy installations in certain cases, such as new construction. | Businesses | Low | Medium | Low | Medium | Medium | ~3 months-1 year Largely dependent on political capital needed to pass mandate |

| Strategy | Description | Targeted Impact | Scale of Impact Score | Local Impact Score | Local Environmental and Social | Inclusion and Social Equity Score | Feasibility Score | Timeline |
|---|---|---|---|---|---|---|---|---|
| **Adopt Solar Ready Guidelines** | Encourage or require new buildings to be built in a way that accommodates future solar installations | Businesses | Low | Low | Low | Medium | High | ~2-3 months to develop and encourage solar ready guidelines<br><br>Adopting mandatory guidelines may take additional time |
| **Local Renewable Energy Non-Financial Incentive Programs** | The City establish programs to incentivize renewable energy for residents and businesses. Such programs could include creating local competitions where the primary incentive would be public recognition of achievement. | Residents, Businesses | Low | Low | Low | Medium | High | ~12-18 months to design and run an incentive program |

| Strategy | Description | Targeted Impact | Scale of Impact Score | Local Impact Score | Local Environmental and Social | Inclusion and Social Equity Score | Feasibility Score | Timeline |
|---|---|---|---|---|---|---|---|---|
| **Local Renewable Energy Financial Incentive Program(s)** | The City establishes programs to incentivize renewable energy for residents and businesses. Such programs could include local tax rebates for renewable energy installations, tax credits, exemptions from property taxes, and zero interest and forgivable loans. | Residents, Businesses | Low | Medium | Medium | Medium | Low | Largely dependent on available capital and political capital needed. Could be 1-3 years. |
| **Reduce permitting, zoning, and inspection barriers to Renewable Energy** | The City streamlines the permitting, zoning and inspection processes so that processing time and expenses are reduced. This may include streamlining permitting processes for specific technologies that meet certain standards, and eliminating redundancies from inspection protocols. | Residents, Businesses | Low | Medium | Medium | Medium | High | ~2-3 months to identify and reduce barriers through permitting, zoning, and planning improvements<br><br>Timeline may vary depending on community's process for changing zoning language. |

| Strategy | Description | Targeted Impact | Scale of Impact Score | Local Impact Score | Local Environmental and Social | Inclusion and Social Equity Score | Feasibility Score | Timeline |
|---|---|---|---|---|---|---|---|---|
| **Lease City property for renewable energy development** | Offer City property for lease to utilities or developers to host renewable energy projects. | Utility RE Supply | Low | Medium | Low | Medium | Medium | ~3-12 months to negotiate land leases and contracts. |
| **Community / Shared Solar Projects** | Organize community / shared solar projects in which multiple utility customers can subscribe to community solar and benefit from lower rates | Municipal, residents, businesses | Medium | Medium | Medium | Medium | Medium | ~6-24 months to identify a site, select a project developer, develop the solar array, and identify customers |
| **Revolving Investment Program** | City establishes a revolving fund where proceeds from existing RE projects are reinvested into new RE projects | Municipal (if internal), or residents/businesses if loan fund | Low | Low | Medium | High | Medium | ~18-24 months to establish a fund and generate sufficient revenue to invest in RE projects (assumes capital is available to start fund)<br><br>Ongoing support of RE projects |
| **Partner with a local bank to offer a solar loan program** | Create a partnership with a local financial institution to create a loan product to finance renewable energy | Residents, Businesses | Low | Medium | Low | Low | Medium | ~12-24 months to develop a partnership |

| Strategy | Description | Targeted Impact | Scale of Impact Score | Local Impact Score | Local Environmental and Social | Inclusion and Social Equity Score | Feasibility Score | Timeline |
|---|---|---|---|---|---|---|---|---|
| | installations targeted at businesses or residents | | | | | | | |
| **Work with the utility to develop a pilot incentive program for renewable energy or storage** | Engage electric utility on providing potential incentives for renewable energy installations or energy storage by residents or businesses in Keene | Residents, businesses | Low | Low | Low | Medium | Medium | ~6-12 months before a pilot program is implemented, ongoing KPI/metrics tracking |
| **Re-establish the Ecovation Hub** | Work with local colleges, vocational schools in the region to reestablish the Ecovation hub to create course content focused on renewable energy | Residents | Low | Low | Low | Medium | Medium | ~12-18 months to develop a workforce training program<br><br>Ongoing workforce training |

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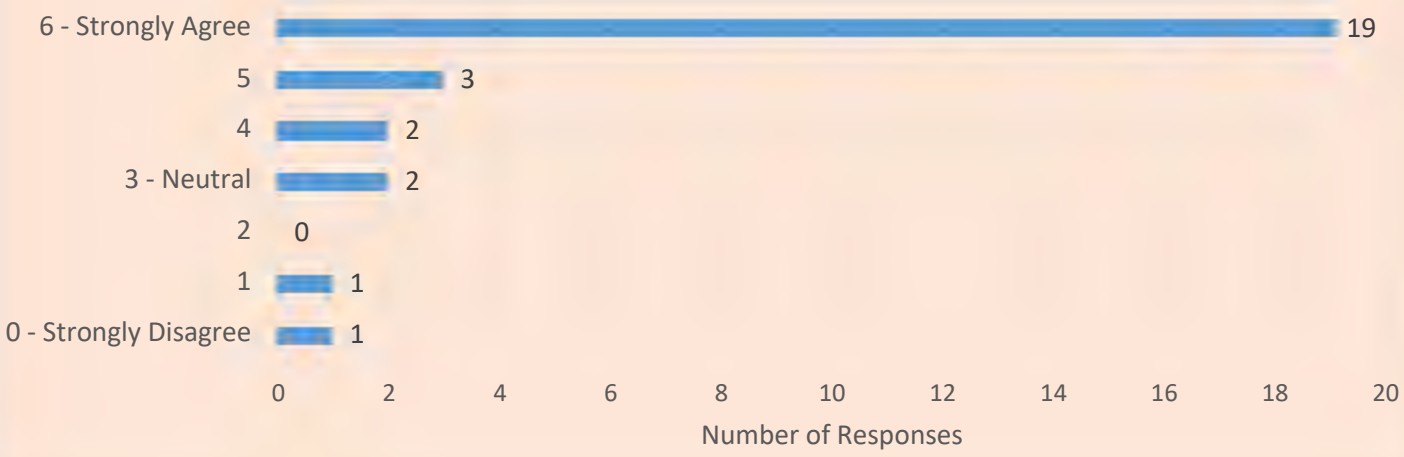
# Keene Energy Plan Draft Vision Statement

In 2050, the City of Keene will be a thriving and resilient community powered by affordable, clean, and renewable energy. All electricity and energy used for heating, cooling, and transportation will come from renewable energy sources.

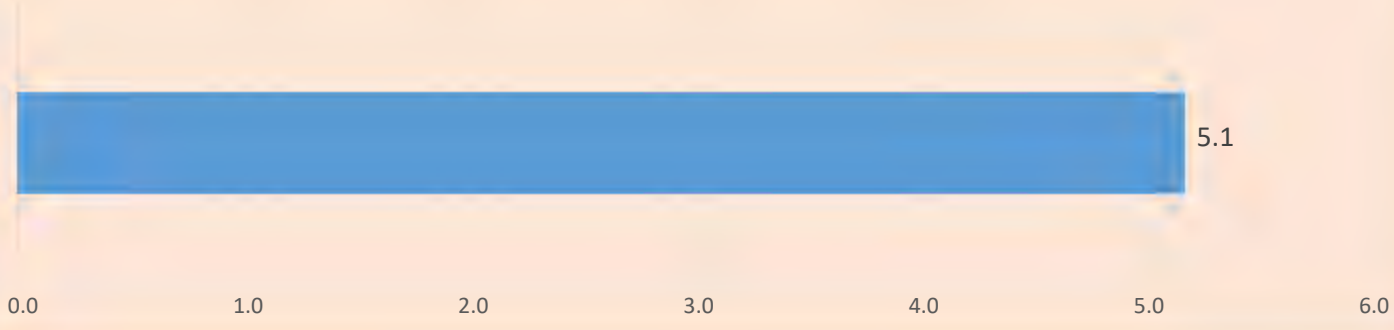
## Q1: To What Extent do you Agree with the Draft Vision Statement?

Answered: 28 Skipped: 2




## Q1: To what extent do you agree with the draft vision statement?

Answered: 28 Skipped: 2



# Q2: Please Tell Us Why

Answered: 21 Skipped: 9

Climate change is the biggest crisis facing the planet! Renewable energy sources can put a big dent in the greenhouse gas production of the US. Also, there are MANY other environmental and health problems caused by extracting, refining and burning fossil fuels. Nuclear energy isn't a long-term solution either. Ready for 100%!

We need to switch to more sustainable forms of energy to safeguard our future, and we need to make sure no one is left out.

The idea sounds great. But I am not sure what renewable energy sources you are referring to. Solar and wind? I do support small scale solar systems. It would be great residency houses and organizations can have their own solar panels. However, personally, I am really not a fan of windmills. Very expensive just to make a windmill. Let's not forget about transporting, mounting, installing those mills, and size of area needed etc. Windmills also generate rhythmic frequencies that could disturb wildlife which eventually could force animals to migrate from the area. Can it be really affordable?

We are on our way to 100%! I see the indications in legislation being passed in neighboring NE states and in the determination of Keene's dedicated volunteers to innovate and find solutions that are accessible to everyone (not just the rich!).

I believe this is an appropriate, achievable and beneficial vision and direction for Keene's energy future. We recognize the environmental and economic benefits of achieving these goals and have already as a community realized some of this potential and the opportunities seem to be growing. It is critical to end our reliance on fossil fuel. We need to make sure this is accessible for all.

Statement lacks clarity on economic impact to citizens, and equity for all. How will taxes be affected? They cannot go higher to achieve these goals.

It is vital that we protect our environment, both for human health purposes and to preserve the natural ecosystems that we have left. Keene is poised as a small city to lead as an example of sustainability and renewable energy in New England

I have a problem with the expectation that "all" electricity and energy will come from renewable energy sources. Property owners should decide for themselves what is most appropriate for their situation.

There are way too many reasons to mention- For future generations and as a person with asthma, this could mean cleaner air to breathe making me a healthier individual in my community.

Dealing with climate change actively and with citizen support is vital. As a city we should be striving aggressively toward this goal. My only wish would be that we do so more quickly, by say, 2030 or 2035. 2050 seems like it may be too late to make a difference given what we are already seeing in terms of climate change variations.

Don’t use the word “all”. It’s too ideological and leaves no room for practical solutions that don’t fit perfectly into this narrow framework.

I am all for this, hence strongly agree. However, 2050 is a few decades away. What are the milestone goals we need to meet each year or every five years that will add up to this broad vision?

## Q2: Please Tell Us Why

Answered: 21 Skipped: 9

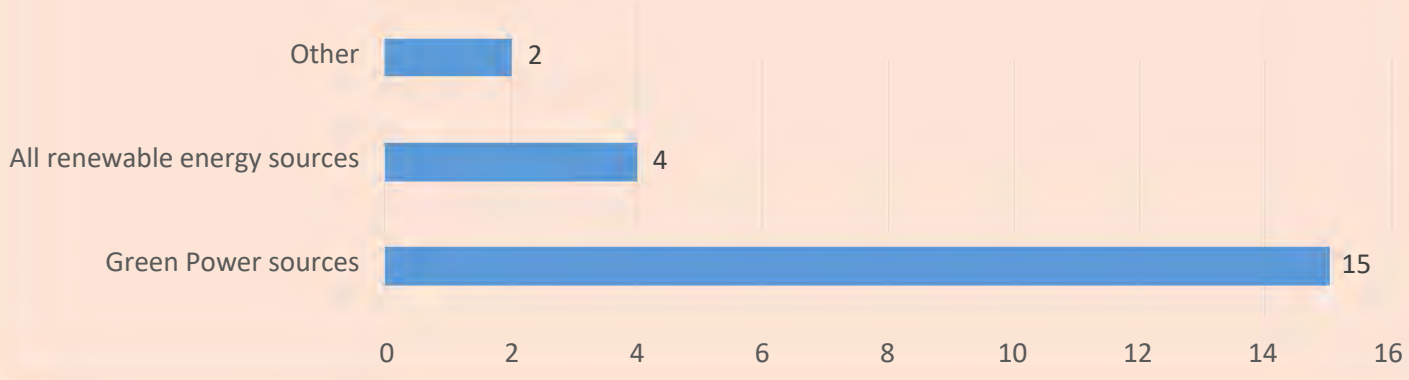
| |
|---|
| Fossil fuel will run out eventually anyway and it's polluting our world and creating havoc with our atmosphere! |
| Need something in there about energy efficiency and energy conservation. You probably think it's implicit, but people need to be constantly reminded of the importance of ee & ec first and foremost. |
| I like it, though I think the last sentence could be revised a bit, I might go with something along the lines of "All of our daily energy needs will be met by utilizing renewable, carbon-free sources." |
| Keene has always been on the forefront of change and this is another positive change for the City. |
| Excellent, succinct vision consistent with the 100% resolution. |
| The quicker we move, the better for all. |
| I don't think forcing private citizens to have to use renewable source for all heating / cooling will make Keene a destination for people to make "home". People like choices and less government telling them what they have to do. |
| Renewable energy is the only way! I also hope that it will happen before 2050. |
| Nuclear isn't "renewable", but it is clean. And efficient. I agree with the general premise. |

# How should Keene define Renewable Energy?

Keene's Energy and Climate Committee recommends defining "renewable" energy in the Energy Plan as green power sources. How do you think the Energy Plan should define "renewable"?

## Q1: How Should Keene Define Renewable Energy?

Answered: 21 Skipped: 0



# Q2: Please Tell Us Why

Answered: 12 Skipped: 9

I am choosing a compromise position because we need to get this done quickly. I would rather see only "green power" sources but I don't believe they will come on line in time to deal with the climate crisis. The others can be "bridge" fuels. And MSW isn't going anywhere, we may as well use it.

The intent is to lower environmental impact not shift it

The priority is to heal the damage we have done to our world's ecosystems and its inhabitants. Large hydropower and municipal solid waste have the capability to do more damage.

Large hydro produces a lot of electricity but has detrimental effects on the environment. Municipal solid waste is not clean energy. While we have to get rid of our waste, I don't think the energy should be considered "green" just because it is, in a sense, renewable.

There are methane releases associated with flooding large land areas for large hydro. Energy efficiency is not included in the choices, but it is the greenest of them all. Landfill gas is good in limited industrial application (like Keene did with the DPW), but should not be used to expand residential gas usage since the supply is very limited.

I'm fine with the 2nd choice - as long as we're not considering destroying the environment or putting up miles of line such as the Northern Pass project in order to access these other sources. If that's what you're meaning, then the first choice please. Local is best - we have more control and there is far less transmission. NO NUCLEAR!

Because I believe it is critical that we carefully consider the environmental impacts of our energy choices. While some renewable sources of energy may be accessible and perhaps more affordable, we need to be so mindful of the immediate and longterm environmental impact and costs. - therefore I favor the definition of "renewable energy from green power sources.

Need all angles to achieve the goal quickly and learn from new experiences

Support "right-sized" projects

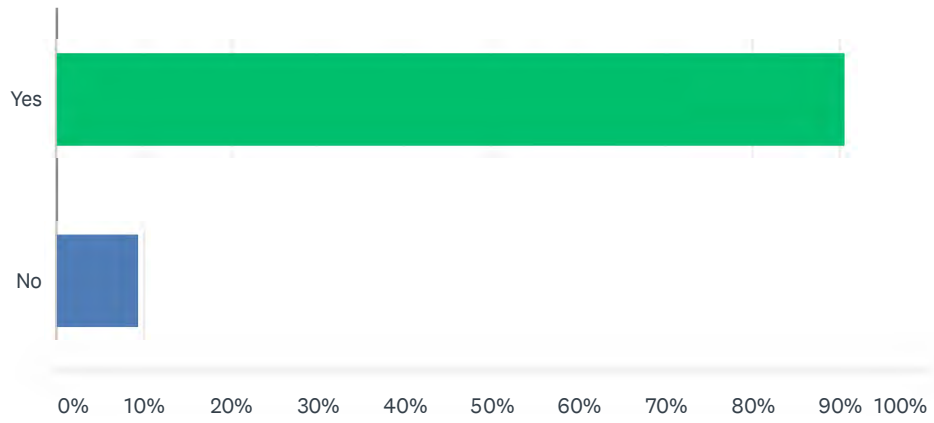
Why be so narrow minded and limited to energy sources that are far more expensive? Green energy is far from perfect. For example, wind energy impacts birds and solar is unreliable without battery technology. The batteries themselves are considered hazardous waste. Nuclear is considered clean and sustainable. https://www.energy.gov/ne/articles/3-reasons-why-nuclear-clean-and-sustainable#:~:text=Nuclear%20is%20a%20zero%2Demission,byproducts%20emitted%20by%20fossil%20fuels. Why is that completely disregarded?

Municipal solid waste implies a trash burning plant. No matter where situated nor how technologically advanced, such a facility will emit pollutants such as heavy metals, particulates and co2. I can't imagine that is what the people want or need in this day and age. Large hydro is also controversial. Studies show high level of mercury resulting from massive dam projects. Construction of these projects destroys large areas of natural environment. These projects are often imposed against the will of local, often native people. And construction still continues. Lets not contribute to more demand for new large hydro projects.

Landfill gas is still releasing methane and other gases into the atmosphere.

# Q1 Do you live in Keene?

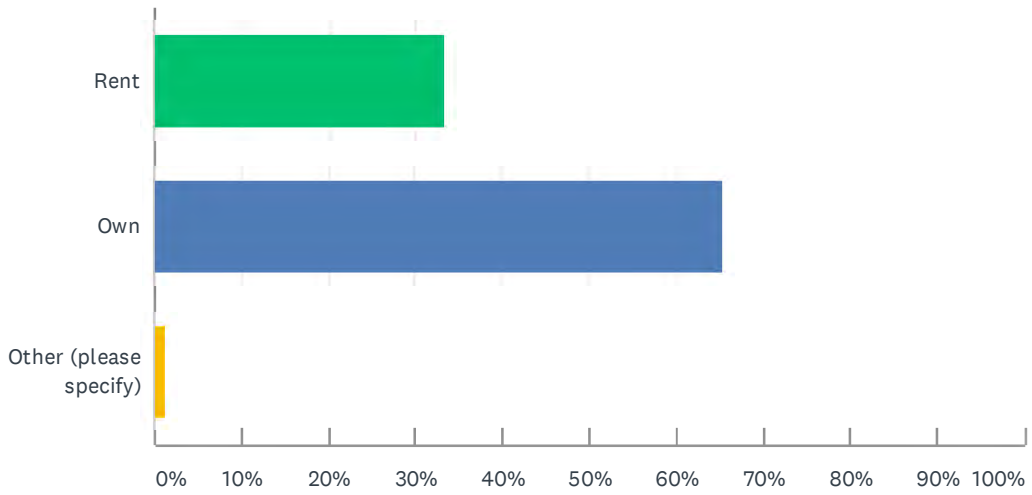
Answered: 75 Skipped: 0




| ANSWER CHOICES | RESPONSES | |
|---|---|---|
| Yes | 90.67% | 68 |
| No | 9.33% | 7 |
| TOTAL | | 75 |

# Q2 Do you rent or own your home?

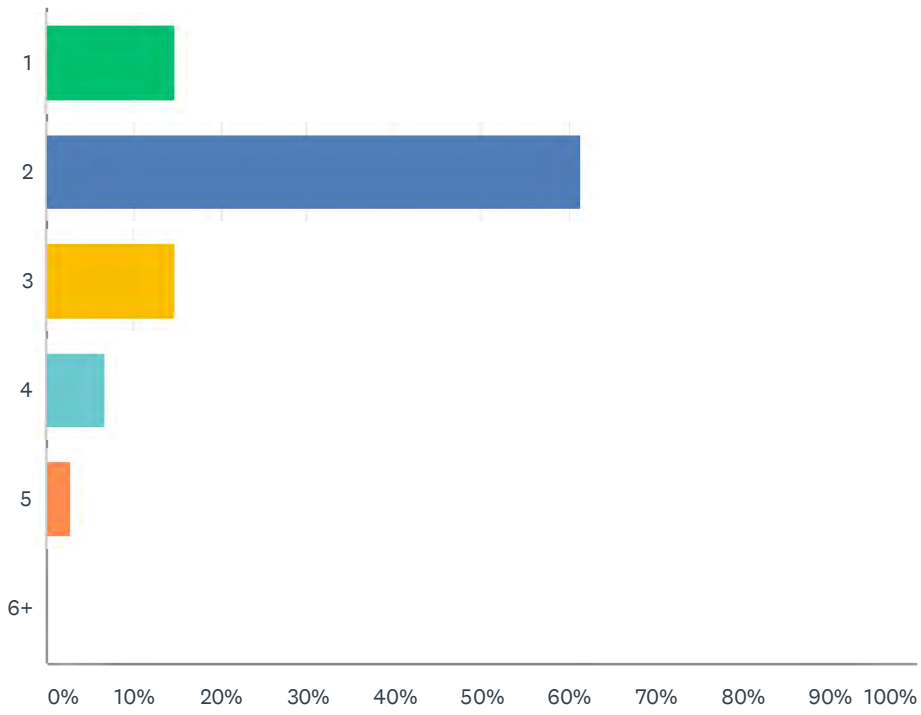
Answered: 75 Skipped: 0




| ANSWER CHOICES | RESPONSES | |
|---|---|---|
| Rent | 33.33% | 25 |
| Own | 65.33% | 49 |
| Other (please specify) | 1.33% | 1 |
| TOTAL | | 75 |

# Q3 How many adults live in your household?

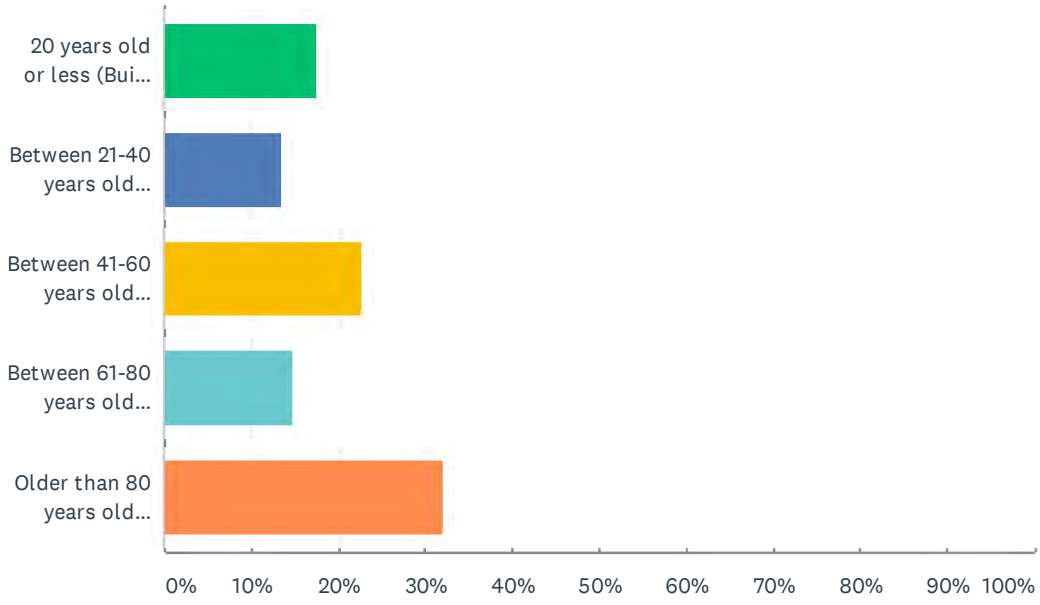
Answered: 75 Skipped: 0




| ANSWER CHOICES | RESPONSES | |
|---|---|---|
| 1 | 14.67% | 11 |
| 2 | 61.33% | 46 |
| 3 | 14.67% | 11 |
| 4 | 6.67% | 5 |
| 5 | 2.67% | 2 |
| 6+ | 0.00% | 0 |
| TOTAL | | 75 |

# Q4 To the best of your knowledge, how old is your home, condo, or apartment building?

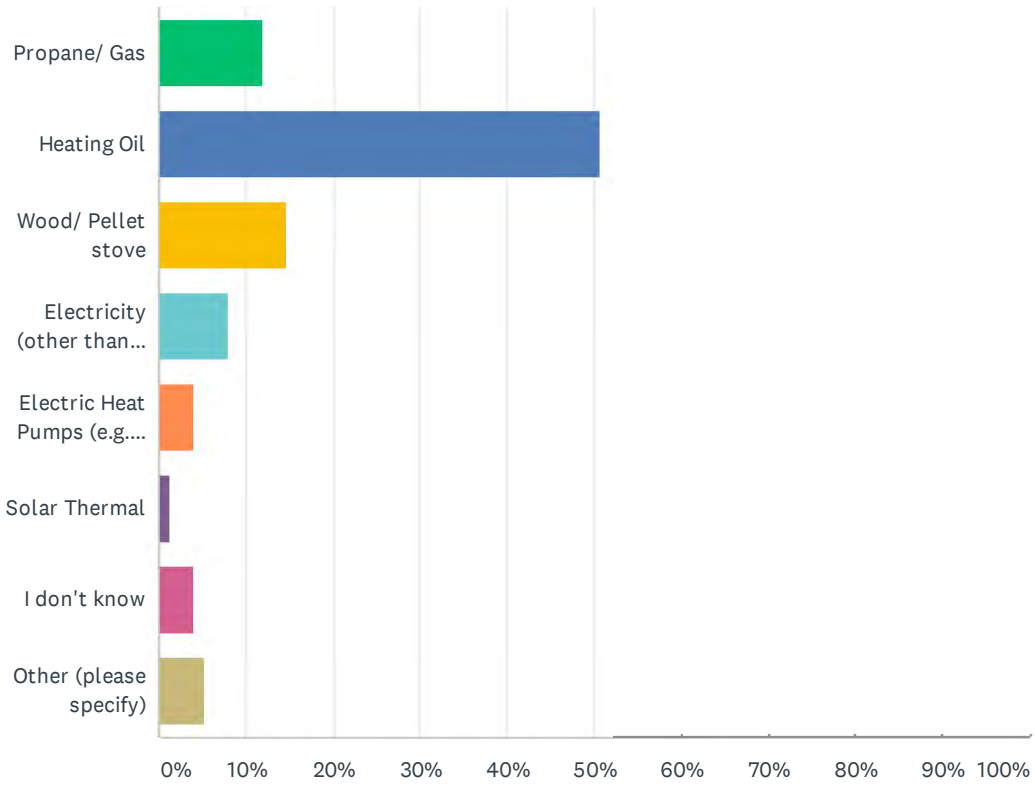
Answered: 75 Skipped: 0




| ANSWER CHOICES | RESPONSES | |
|---|---|---|
| 20 years old or less (Built 2000 or later) | 17.33% | 13 |
| Between 21-40 years old (Built 1980-1999) | 13.33% | 10 |
| Between 41-60 years old (Built 1960-1979) | 22.67% | 17 |
| Between 61-80 years old (Built 1940-1959) | 14.67% | 11 |
| Older than 80 years old (Built 1939 or earlier) | 32.00% | 24 |
| TOTAL | | 75 |

# Q5 What fuel or energy source do you primarily use to heat your home?

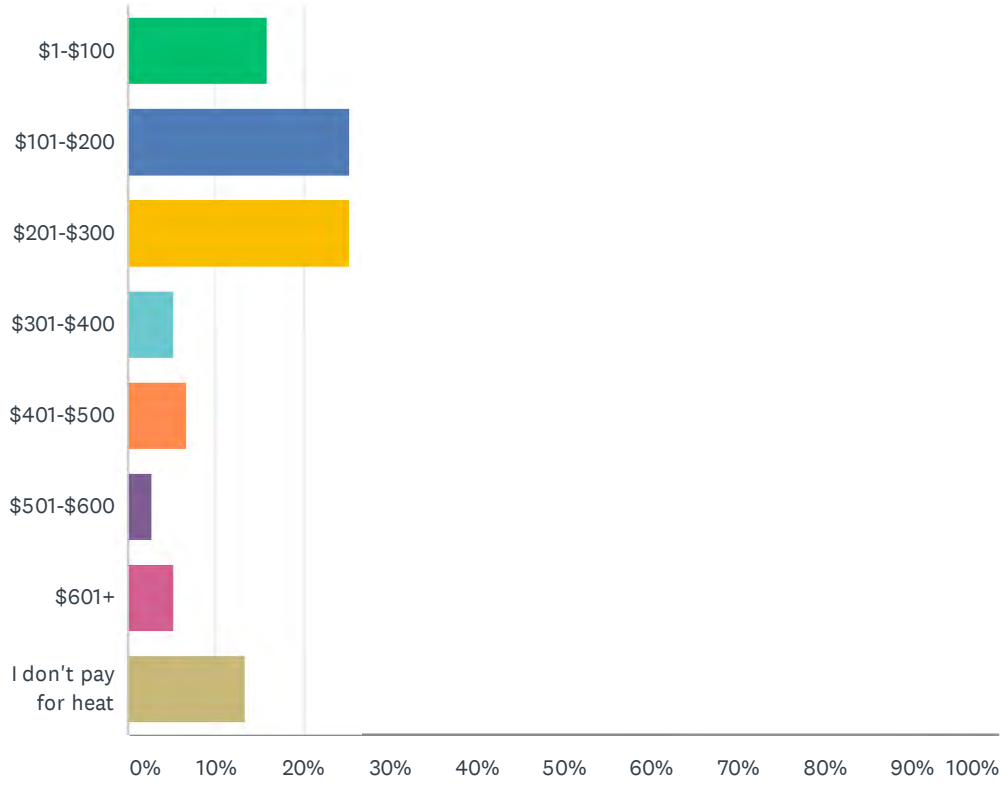
Answered: 75 Skipped: 0




| ANSWER CHOICES | RESPONSES | |
|---|---|---|
| Propane/ Gas | 12.00% | 9 |
| Heating Oil | 50.67% | 38 |
| Wood/ Pellet stove | 14.67% | 11 |
| Electricity (other than heat pumps) | 8.00% | 6 |
| Electric Heat Pumps (e.g. mini splits) | 4.00% | 3 |
| Solar Thermal | 1.33% | 1 |
| I don't know | 4.00% | 3 |
| Other (please specify) | 5.33% | 4 |
| TOTAL | | 75 |

# Q6 On average, about how much does your household spend per month to heat your home during the heating season?

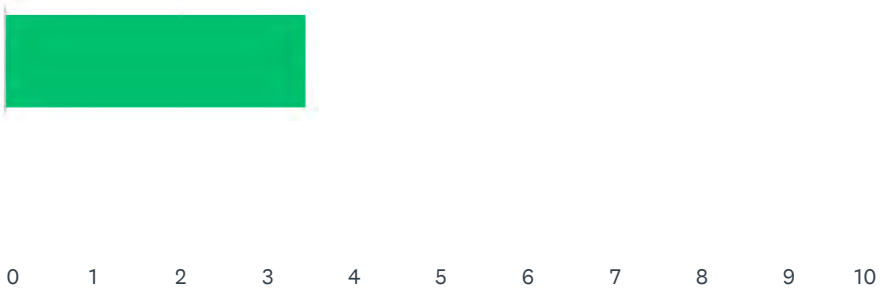
Answered: 75 Skipped: 0




| ANSWER CHOICES | RESPONSES | |
|---|---|---|
| $1-$100 | 16.00% | 12 |
| $101-$200 | 25.33% | 19 |
| $201-$300 | 25.33% | 19 |
| $301-$400 | 5.33% | 4 |
| $401-$500 | 6.67% | 5 |
| $501-$600 | 2.67% | 2 |
| $601+ | 5.33% | 4 |
| I don't pay for heat | 13.33% | 10 |
| TOTAL | | 75 |

# Q7 Using the slider below, please indicate how concerned you are about the cost of heating your home. If you do not pay for heating, please select "Not at all concerned."

Answered: 75 Skipped: 0

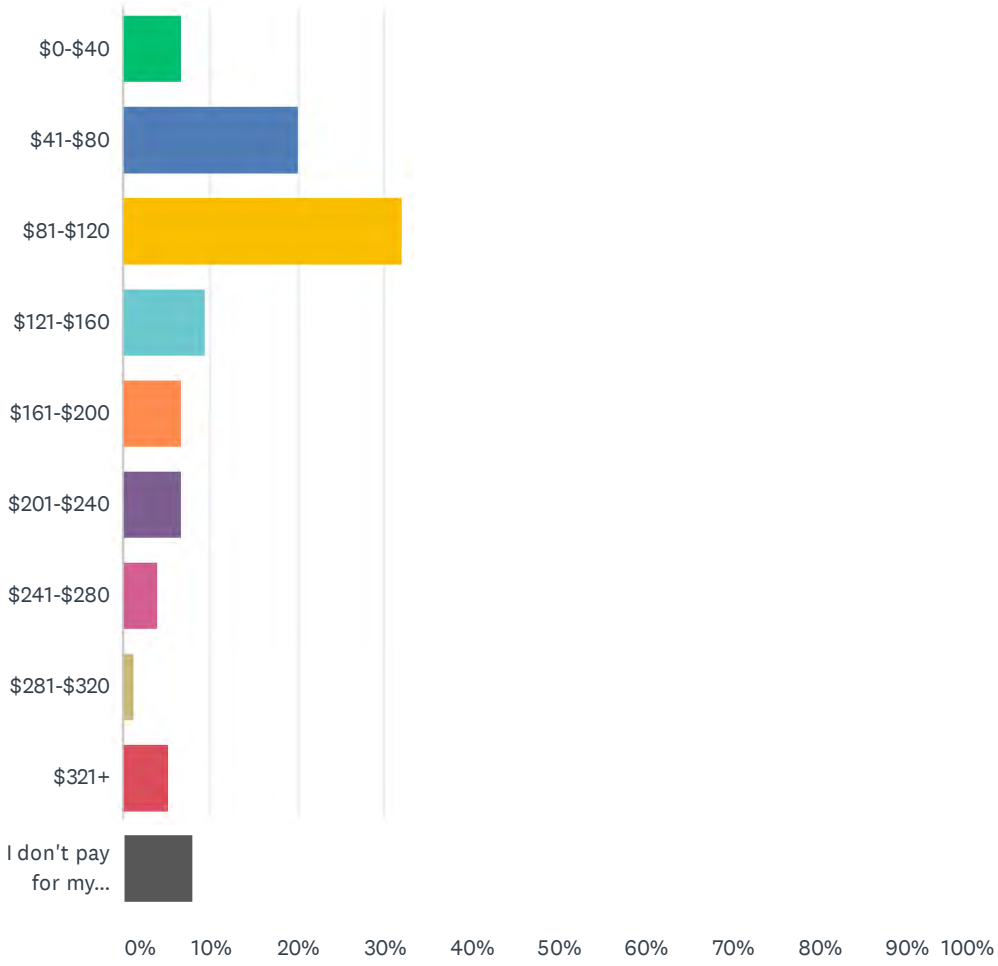



| ANSWER CHOICES | AVERAGE NUMBER | TOTAL NUMBER | RESPONSES |
|---|---|---|---|
| | 3 | 259 | 75 |

Total Respondents: 75

# Q8 On average, about how much does your household spend per month on your electricity bill?

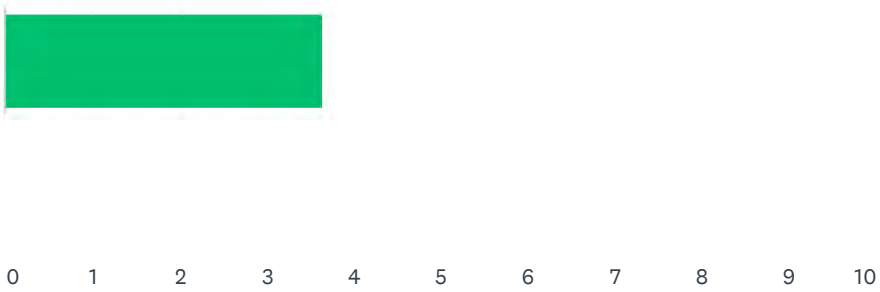
Answered: 75 Skipped: 0



| ANSWER CHOICES | RESPONSES | |
|---|---|---|
| $0-$40 | 6.67% | 5 |
| $41-$80 | 20.00% | 15 |
| $81-$120 | 32.00% | 24 |
| $121-$160 | 9.33% | 7 |
| $161-$200 | 6.67% | 5 |
| $201-$240 | 6.67% | 5 |
| $241-$280 | 4.00% | 3 |
| $281-$320 | 1.33% | 1 |
| $321+ | 5.33% | 4 |
| I don't pay for my electricity bill | 8.00% | 6 |
| TOTAL | | 75 |

# Q9 Please indicate how concerned you are about the cost of electricity. If you do not pay for electricity please select "Not at all concerned."

Answered: 75 Skipped: 0

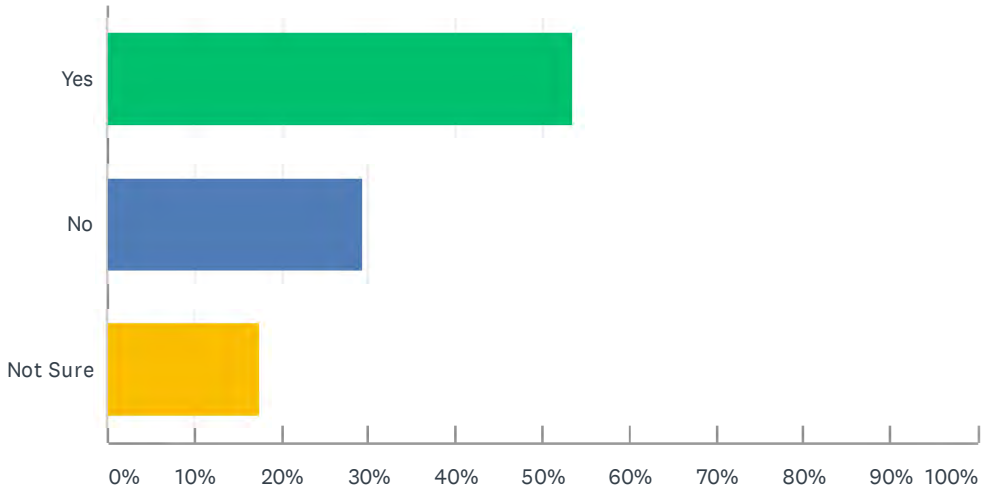



| ANSWER CHOICES | AVERAGE NUMBER | TOTAL NUMBER | RESPONSES |
|---|---|---|---|
| | 4 | 273 | 75 |

Total Respondents: 75

# Q10 In the past ten years, have you or your landlord/property manager made any energy efficient upgrades or participated in a weatherization program to reduce energy use and/or save money?

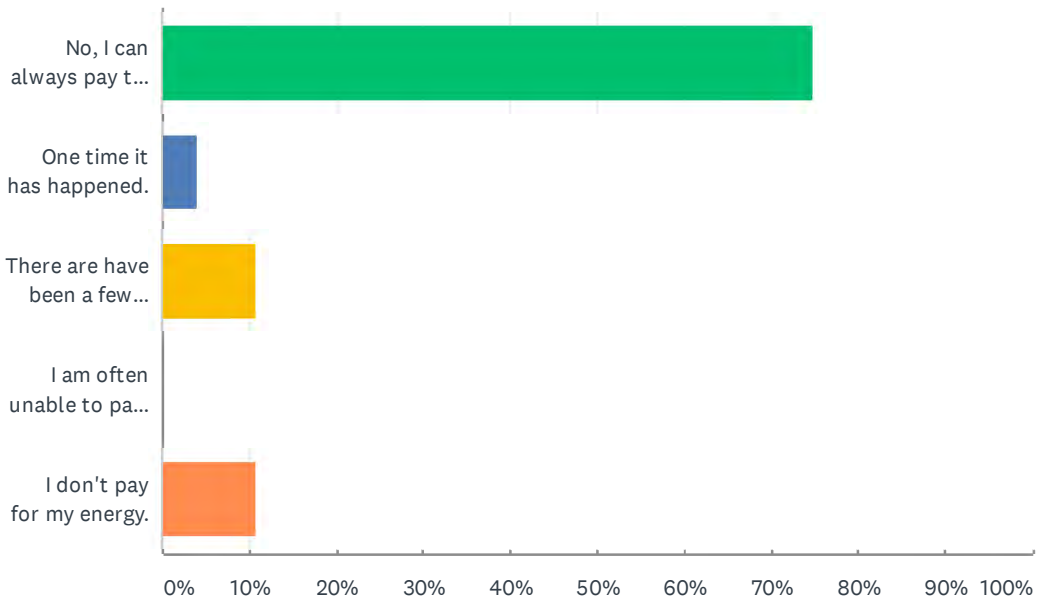
Answered: 75 Skipped: 0




| ANSWER CHOICES | RESPONSES | |
|---|---|---|
| Yes | 53.33% | 40 |
| No | 29.33% | 22 |
| Not Sure | 17.33% | 13 |
| TOTAL | | 75 |

# Q11 Are you sometimes unable to pay your energy bills?

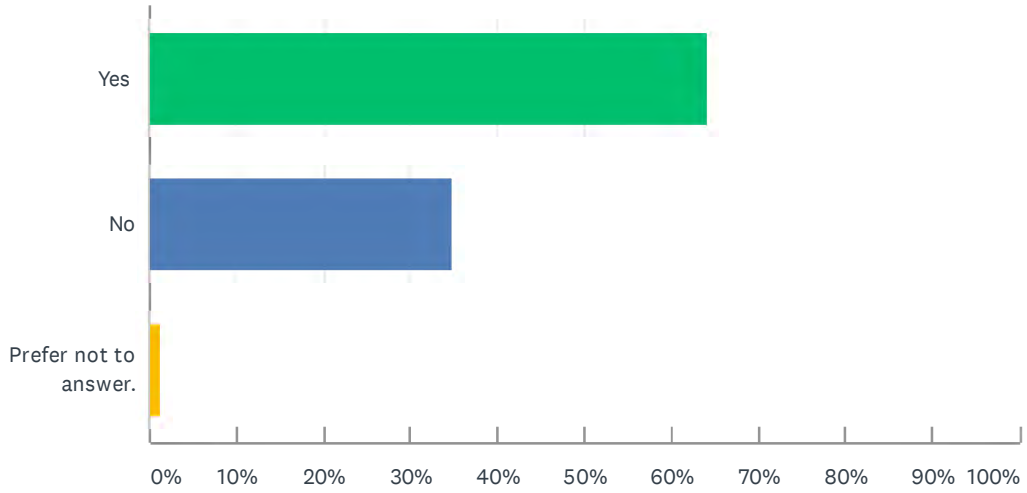
Answered: 75 Skipped: 0




| ANSWER CHOICES | RESPONSES | |
|---|---|---|
| No, I can always pay the energy bills. | 74.67% | 56 |
| One time it has happened. | 4.00% | 3 |
| There are have been a few times. | 10.67% | 8 |
| I am often unable to pay my energy bills. | 0.00% | 0 |
| I don't pay for my energy. | 10.67% | 8 |
| TOTAL | | 75 |

# Q12 Do you sometimes keep your house cooler than you'd like to save energy?

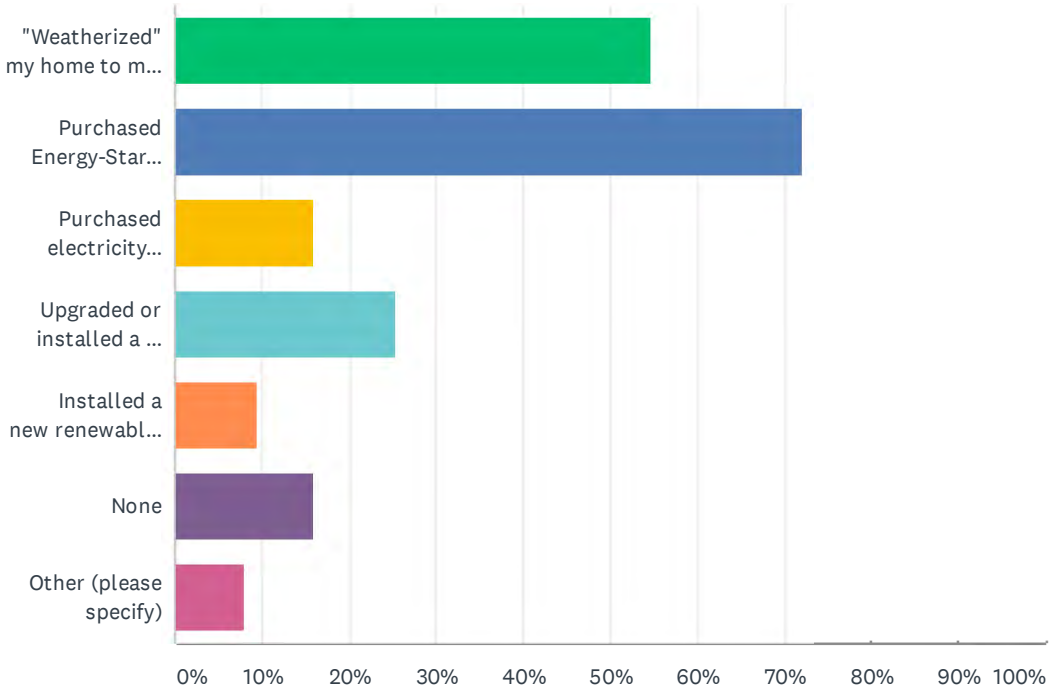
Answered: 75 Skipped: 0




| ANSWER CHOICES | RESPONSES | |
|---|---|---|
| Yes | 64.00% | 48 |
| No | 34.67% | 26 |
| Prefer not to answer. | 1.33% | 1 |
| TOTAL | | 75 |

# Q13 In the past ten years, have you done any of the following to reduce energy use and/or reduce energy cost? Check all that apply.

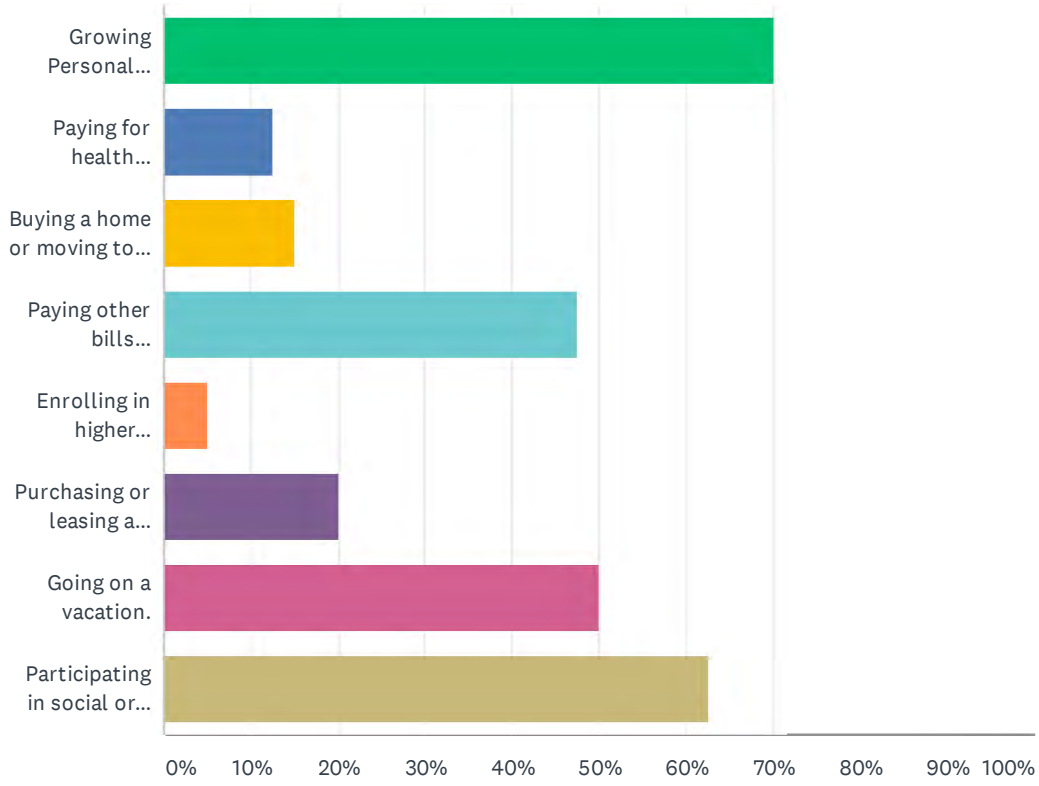
Answered: 75 Skipped: 0




| ANSWER CHOICES | RESPONSES | |
|---|---|---|
| "Weatherized" my home to make it more resistant to cold weather (e.g. added insulation, storm windows, seal gaps, etc.) | 54.67% | 41 |
| Purchased Energy-Star rated appliances and/or LED lights. | 72.00% | 54 |
| Purchased electricity through a competitive energy supplier. | 16.00% | 12 |
| Upgraded or installed a new heating system. | 25.33% | 19 |
| Installed a new renewable energy systems (e.g. solar panels, solar hot water). | 9.33% | 7 |
| None | 16.00% | 12 |
| Other (please specify) | 8.00% | 6 |
| Total Respondents: 75 | | |

# Q14 Has the cost of energy (electricity and heating) been a barrier to any of the following for you or your household? Please check all that apply.

Answered: 40 Skipped: 35



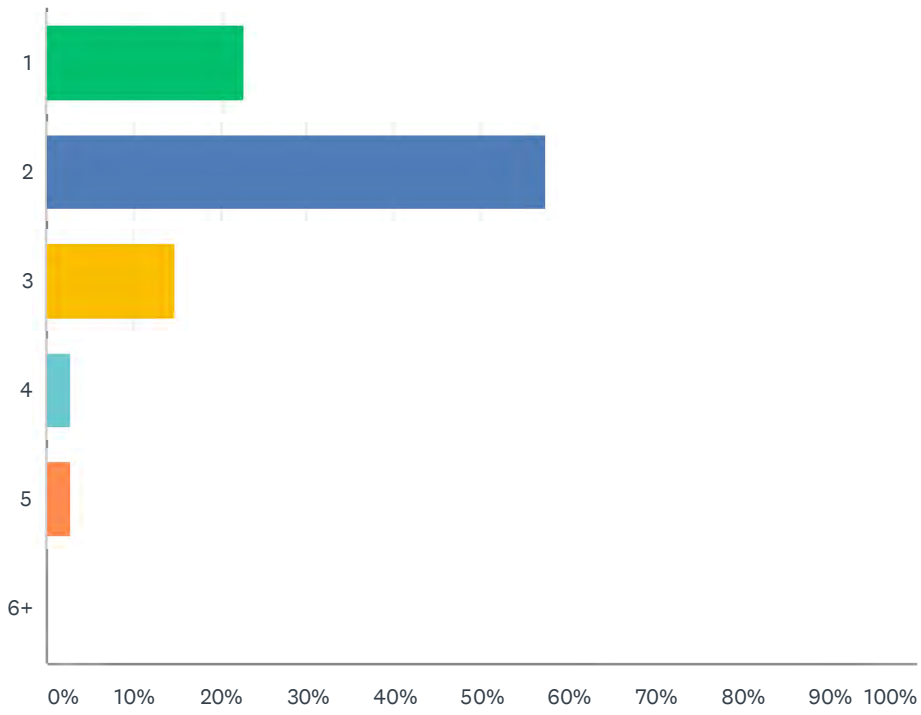

| ANSWER CHOICES | RESPONSES | |
|---|---|---|
| Growing Personal Savings or Contributing to Retirement savings. | 70.00% | 28 |
| Paying for health insurance or health care. | 12.50% | 5 |
| Buying a home or moving to a higher-quality home/apartment. | 15.00% | 6 |
| Paying other bills (internet, grocery, etc.). | 47.50% | 19 |
| Enrolling in higher education or a vocational training program (you or a dependent). | 5.00% | 2 |
| Purchasing or leasing a vehicle. | 20.00% | 8 |
| Going on a vacation. | 50.00% | 20 |
| Participating in social or recreational actives that cost money (e.g. movies, eating out, joining an athletic club, playing a game of golf, summer camp, etc.) | 62.50% | 25 |
| Total Respondents: 40 | | |

# Q15 Please provide additional information or comments regarding the cost of energy (heating and electricity) and its impact on you and/or your household below.

Answered: 22 Skipped: 53

# Q16 How many automobiles does your household own or lease?

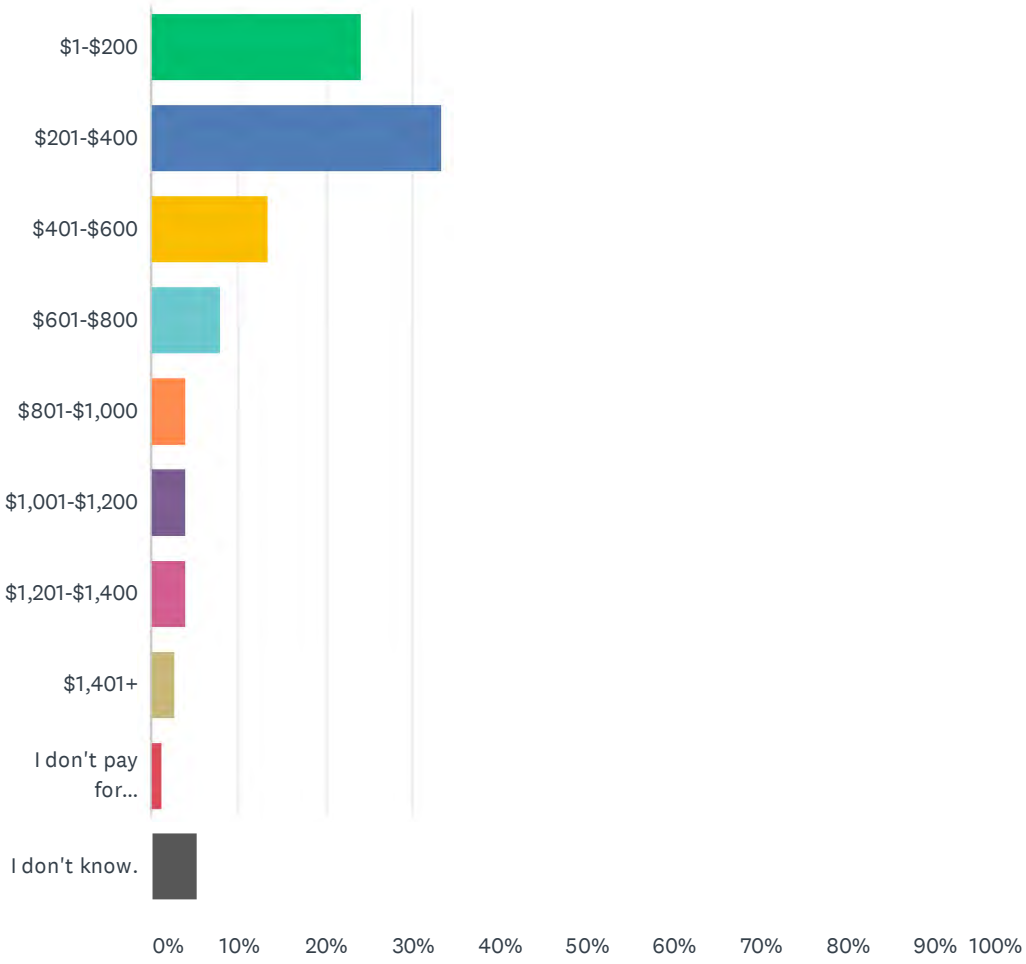
Answered: 75 Skipped: 0




| ANSWER CHOICES | RESPONSES | |
|---|---|---|
| 1 | 22.67% | 17 |
| 2 | 57.33% | 43 |
| 3 | 14.67% | 11 |
| 4 | 2.67% | 2 |
| 5 | 2.67% | 2 |
| 6+ | 0.00% | 0 |
| TOTAL | | 75 |

# Q17 On average, about much does your household spend per month on transportation? (For example car payments, automobile insurance, oil changes, gas, bus passes, train tickets, plane tickets, etc.)

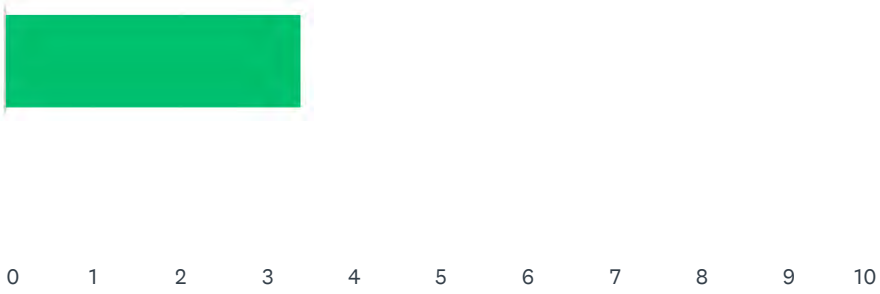
Answered: 75 Skipped: 0



| ANSWER CHOICES | RESPONSES | |
|---|---|---|
| $1-$200 | 24.00% | 18 |
| $201-$400 | 33.33% | 25 |
| $401-$600 | 13.33% | 10 |
| $601-$800 | 8.00% | 6 |
| $801-$1,000 | 4.00% | 3 |
| $1,001-$1,200 | 4.00% | 3 |
| $1,201-$1,400 | 4.00% | 3 |
| $1,401+ | 2.67% | 2 |
| I don't pay for transportation. | 1.33% | 1 |
| I don't know. | 5.33% | 4 |
| TOTAL | | 75 |

# Q18 Using the slider below, please indicate how concerned you are about the cost of transportation (including cost of owning and maintaining a vehicle, if applicable).

Answered: 75 Skipped: 0

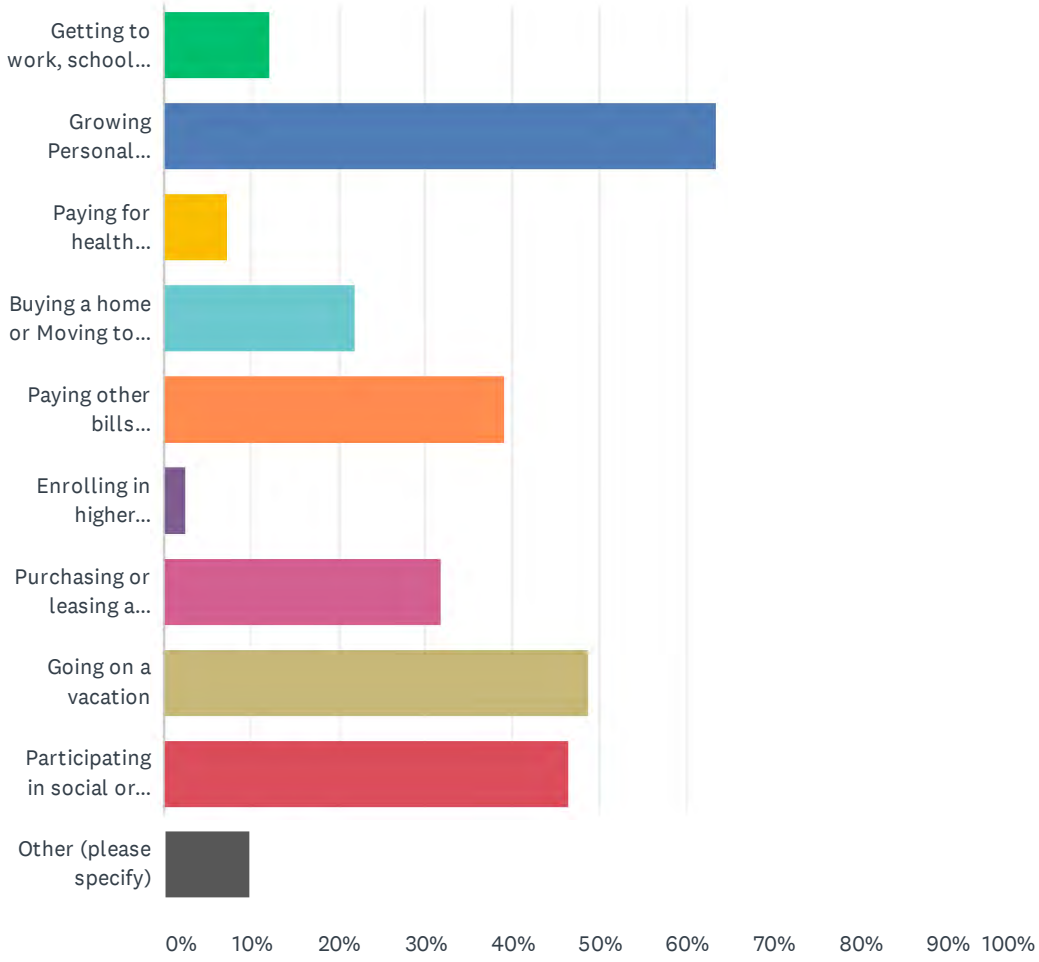



| ANSWER CHOICES | AVERAGE NUMBER | TOTAL NUMBER | RESPONSES |
|---|---|---|---|
| | 3 | 254 | 75 |

Total Respondents: 75

# Q19 Has the cost and/ or availability of transportation been a barrier to any of the following for you or your household? Please check all that apply.

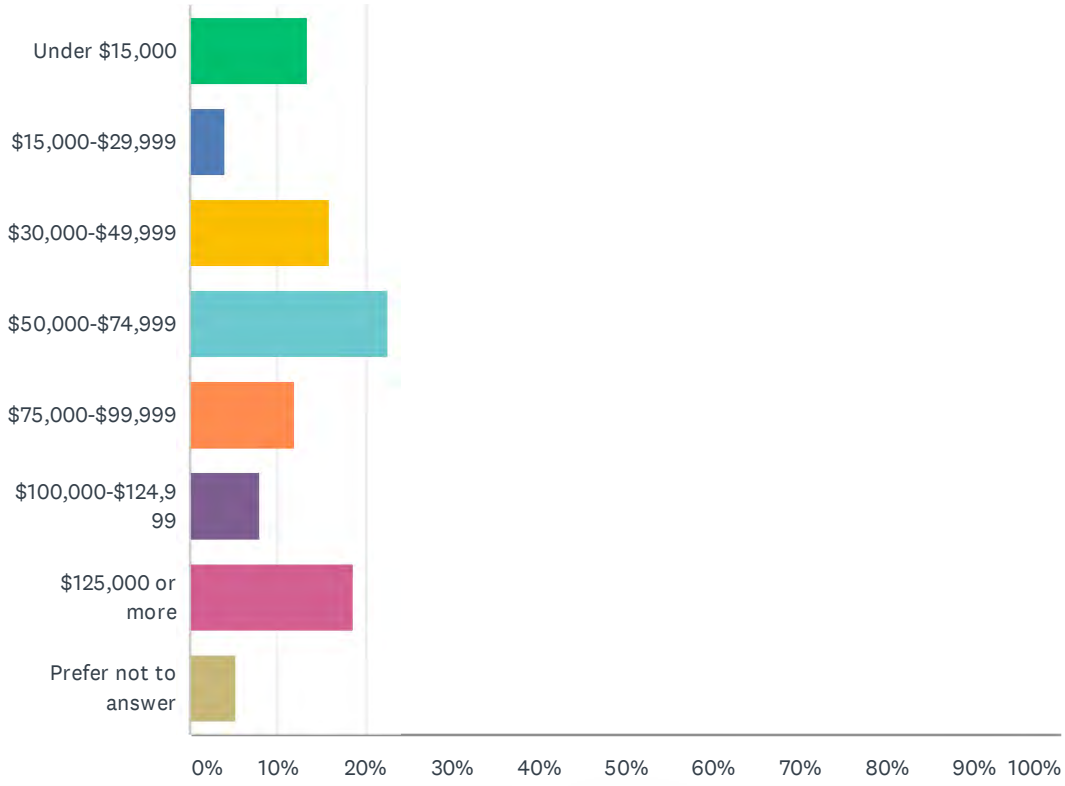
Answered: 41 Skipped: 34



| ANSWER CHOICES | RESPONSES | |
|---|---|---|
| Getting to work, school, medical appointments or other appointments | 12.20% | 5 |
| Growing Personal Savings or Contributing to Retirement savings | 63.41% | 26 |
| Paying for health insurance or health care | 7.32% | 3 |
| Buying a home or Moving to a higher-quality home/ apartment | 21.95% | 9 |
| Paying other bills (internet, grocery, etc.) | 39.02% | 16 |
| Enrolling in higher education or a vocational training program (you or a dependent) | 2.44% | 1 |
| Purchasing or leasing a vehicle | 31.71% | 13 |
| Going on a vacation | 48.78% | 20 |
| Participating in social or recreational activities (e.g. movies, eating out, joining an athletic club, playing a game of golf, summer camp, etc.) | 46.34% | 19 |
| Other (please specify) | 9.76% | 4 |
| Total Respondents: 41 | | |

# Q20 Please indicate your gross (before taxes) annual household income. (Note: this information will not be associated with any personal / identifying information, and will be kept confidential.)

Answered: 75 Skipped: 0




| ANSWER CHOICES | RESPONSES | |
|---|---|---|
| Under $15,000 | 13.33% | 10 |
| $15,000-$29,999 | 4.00% | 3 |
| $30,000-$49,999 | 16.00% | 12 |
| $50,000-$74,999 | 22.67% | 17 |
| $75,000-$99,999 | 12.00% | 9 |
| $100,000-$124,999 | 8.00% | 6 |
| $125,000 or more | 18.67% | 14 |
| Prefer not to answer | 5.33% | 4 |
| TOTAL | | 75 |

# Q21 Please provide any additional information or comments regarding the cost of transportation and its impact on you and/or your household below.

Answered: 18 Skipped: 57

City of Keene
*Transmittal Form*

January 5, 2021

**TO:** Mayor and Keene City Council

**FROM:** Councilor Terry M. Clark

**THROUGH:** Patricia A. Little, City Clerk

**ITEM:** 2.

**SUBJECT:** Councilor Clark - Relating to Small Wireless Facility Deployments in Public Rights-of-Way

**COUNCIL ACTION:**
In City Council January 7, 2021.
Referred to the Planning, Licenses and Development Committee.

ATTACHMENTS:
Description
Communication_Clark
Ordinance amendments
Pages from 5G Final Report

**BACKGROUND:**
Councilor Clark is requesting that the City Council revisit Ordinance O-2020-18-A in light of the final report on the Commission to Study the Environmental and Health Effects of Evolving 5G Technology.

In City Council January 7, 2021.
Referred to the Planning, Licenses
and Development Committee.

City Clerk

January 5, 2021

Re: Ordinance 2020-18-A - Relating to Small Wireless Facility Deployments in the Public Rights- of-Way

To Mayor and Council,

The ***Final Report on Commission to Study the Environmental and Health Effects of Evolving 5G Technology (RSA 12-K:12-14, HB 522, Ch. 260, Laws of 2019)*** was completed and sent to the governor, state senate and legislature on November 1, 2020.

In light of the recommendations made in that report, I ask the Council to revisit Ordinance 2020-18-A - Relating to Small Wireless Facility Deployments in the Public Rights- of-Way.

Thank you,

Terry M. Clark
Keene City Councilor
Ward 3
14 Barrett Ave.
Keene, NH 03431
(603)661-8347

attachments:

- ***a- Final Report on Commission to Study the Environmental and Health Effects of Evolving 5G Technology (RSA 12-K:12-14, HB 522, Ch. 260, Laws of 2019);***
- ***b- Proposed amended ordinance***
- ***c- Minutes to 5/13/2020 and 4/22/2020 PLD meetings***

**http://www.gencourt.state.nh.us/statstudcomm/committees/1474/reports/5G%20final%20report.pdf**

ARTICLE VIII. - SMALL WIRELESS FACILITY DEPLOYMENTS IN THE PUBLIC RIGHTS-OF-WAY

Sec. 82-201. - Purpose and intent.

(1) The purpose of this article is to establish reasonable standards and procedures for the siting, construction, installation, collocation, modification, operation, relocation and removal of SWFs (SWF) in the city's public rights-of-way, consistent with and to the extent permitted under federal and state law.

(2) The standards and procedures of this article are intended to protect and promote public health, safety and welfare. They are also intended to reflect and promote the community interest by:

a. Protecting and preserving the city's public rights-of-way and municipal infrastructure;

b. Maintaining the balance between public and private interests;

c. Protecting the city's visual character from potential adverse impacts;

d. Protecting and preserving the city's environmental resources; and,

e. Promoting access to high-quality, advanced wireless services for the city's residents, businesses and visitors.

(3) This article is intended to establish procedures for application intake and completeness review, and encourage applicants to timely respond to incomplete notices.

( Ord. No. O-2019-18-A , 5-21-2020)

Sec. 82-202. - Applicability.

(1) Except as expressly provided otherwise, the provisions in this article shall be applicable to all SWFs constructed and in operation as of the date of the adoption of this article, and to all applications and requests for authorization to construct, install, attach, operate, collocate, modify, reconstruct, relocate, remove or otherwise deploy SWFs within the public rights-of-way after the date of the adoption of this article.

(2) To the extent that other infrastructure deployments involve the same or substantially similar structures, apparatus, antennas, equipment, fixtures, cabinets, cables or improvements within the public rights-of-way, the director or other official responsible to review and approve or deny requests for authorization in connection with such other infrastructure deployment shall apply the provisions in this article, unless specifically prohibited by applicable law or ordinance.

(3) Any license issued pursuant to this article may be subject to retroactive modification in the event of changes in applicable federal or state law or rule requiring such modification, or in the event of revisions to this article necessitated for the protection of public health, safety and welfare. Any license issued subsequent to such change, or revision to this article shall be required to conform to the requirements of such change or revision.

( Ord. No. O-2019-18-A , 5-21-2020)

Sec. 82-203. - Required license and approvals.

(1) *SWF license.* A "SWF license," subject to the director's review and approval in accordance with this article, shall be required for all SWFs and other infrastructure deployments located in whole or in part within the public rights-of-way.

a. *Indemnification requirement.* The SWF license shall contain the city's usual and customary indemnification provisions and an executed indemnification agreement as set forth below, and documentation that applicant and any third party on whose behalf the small cell facility is being

constructed and any co-locator, is in possession of General Liability Insurance without a pollution ~~,~~exclusion.

Indemnification: Applicant shall provide an executed agreement in the form provided by the City of Keene, pursuant to which Applicant and any related third parties agree to defend, hold harmless and fully indemnify the City, its officers, employees, agents, attorneys, and volunteers, from (i) any claim, action or proceeding brought against the City or its officers, employees, agents, or attorney to attack, set aside, void, or annul any such approval of the Town or (ii) a successful legal action brought against the City for loss of property value or other harm caused by the placement or operation of a small cell installation. Such indemnification shall include damages, judgments, settlements, penalties, fires, defensive costs or expenses, including but not limited to, interest, attorney's fees and expert witness fees, or liability of any kind related to or arising from such claim, action or proceeding whether incurred by the Applicant, the City and/or a provision obligating the Applicant to indemnify the City for all of the City's costs, fees and damages which the City incurs in enforcing the indemnification provision of this Section.

b. Compliance Bond: Upon approval of the application, the Applicant shall be required to post a bond in the amount of $50,000 (fifty thousand dollars) for each small cell installation, such bond to be held and maintained during the entire period of the Applicant's operation of each small cell installation in the City as a guarantee that no such installation, including any co-located equipment, exceeds or will exceed the allowable FCC limits for radio frequency radiation exposure to the general public as determined by a qualified independent radio frequency engineer.

(2) *Other licenses and approvals.* In addition to a SWF license, an applicant must obtain all other licenses, permits and regulatory approvals as may be required by any other federal, state or local government agencies, which includes without limitation any approvals issued by other city departments or divisions.

(3) In the event that FCC Order WT Docket No. 17-79 and/or WC Docket No. 17-84 are rescinded, or determined by legal authority to be invalid or unenforceable, then this article shall be deemed to be null and void, and any licenses issued under the terms and conditions of this article shall be revoked upon written notice to licensee effective 90 days after the effective date of such rescission or determination, and all equipment or appurtenances thereto shall be removed prior to the revocation date of the license. The failure to remove all equipment or appurtenances thereto prior to the revocation date of the license shall be deemed an abandonment under section 82-210(1)(m).

( Ord. No. O-2019-18-A , 5-21-2020)

Sec. 82-204. - Exemptions.

(1) Notwithstanding anything in this article to the contrary, a SWF license shall not be required for the following:

a. Wireless facilities or other infrastructure deployments owned and operated by the city,

b. Over-the-air reception device (OTARD) facilities. (as per OTARD, a collocation for a wireless hub relay antennae for a third party, i.e other than the owner, is not exempt

c. Requests for approval to collocate, modify, replace or remove transmission equipment at an existing wireless tower or base station submitted pursuant to 47 U.S.C. § 1455(a).

(2) An exemption from the SWF license requirement under this section does not exempt the SWFs or other infrastructure deployments from any other permits or approvals as may be required by any

other federal, state or local government agencies, which includes without limitation any approvals issued by other city departments or divisions.

( Ord. No. O-2019-18-A , 5-21-2020)

Sec. 82-205. - Location standards.

(1) *Location preferences.* To better assist applicants and decision makers in understanding and responding to the community's aesthetic preferences and values, this section sets out listed preferences for locations to be used in connection with SWFs (emitting radio frequencies 4G, 4G plus, 5G and above) in an ordered hierarchy. An applicant is required to demonstrate with clear and convincing evidence that each ~~the~~ higher priority location~~s~~ is ~~are~~ not technically feasible in order for the director to approve a SWF in a lesser-preferred location.

a. The order of preference for locating SWFs from most preferred to least preferred is as follows:

i. Locations within non-residential districts; (with a preference for SWF to be collocated on existing cell towers, with lower band 5G signals)

ii. Any location more than ~~within~~ 1500 ~~400~~ feet from an existing small cell in a non-residential district;

iii. Any location more than ~~within~~ 1500 ~~750~~ feet from an existing small cell in a residential district;

iv. Any location more than w~~ithin~~ 1500 ~~750~~ feet from a K—12 school, pre-school, or daycare provider, residence, senior center, nursing home, hospital, fire station, police station, playground or park established as of the enactment of this ordinance; and

v. Any location on Central Square or on Main Street between Central Square and the Marlboro Street/Winchester Street intersection.

(2) *Prohibited support structures.* SWFs shall not be permitted on the following support structures:

a. New wood poles, unless it is a replacement for an existing wood pole

b. Existing city-owned decorative poles

(3) *Encroachments over private property.* No SWF antennas, accessory equipment or other improvements may encroach onto or over any private or other property outside the public rights-of-way without the property owner's written consent.

(4) *No interference with other uses.* SWFs and any associated antennas, accessory equipment or improvements shall not be located in any place or manner that would physically interfere with or impede access to any:

a. Above-ground or underground infrastructure;

b. Street furniture;

c. Fire hydrant or water valve; or

d. Doors, gates, stoops, fire escape, windows, or other ingress and egress points to any building appurtenant to the rights-of-way.

(5) *Replacement pole location.* All replacement poles must:

a. Be located within five feet of the removed pole; and

b. Be aligned with the other existing poles along the public rights-of-way.

(6) *Additional placement requirements.* In addition to all other requirements in this article, SWFs, other infrastructure deployments and all related equipment and improvements shall:

a. Be placed as close as possible to the property line between two parcels that abut the public rights-of-way;

b. Be placed so as to not obstruct a 200 foot all-season safe sight distance at any intersection;

c. Be placed at least five feet away from any driveway;

d. Be placed at least 50 feet away from any driveways for police stations, fire stations or other emergency responder facilities.

( Ord. No. O-2019-18-A , 5-21-2020)

Sec. 82-206. - Design standards.

(1) *Height.* New support structures for SWFs shall not be more than 35 feet in height, or ten percent taller than nearby structures within the public right-of-way, whichever is greater. In no instance shall the overall height of an existing or new structure, including any antennas, exceed 50 feet.

(2) *Colors and finishes.* All exterior surfaces shall be painted, colored and/or wrapped in muted, non-reflective hues that match the underlying support structure and blend with the surrounding environment; provided, however, that SWFs located on Central Square or Main Street between Central Square and the Marlboro Street/Winchester Street intersection shall be black in color. All surfaces shall be treated with graffiti-resistant sealant. All finishes shall be subject to the director's prior approval.

(3) *Lights.* All lights and light fixtures must be fully shielded, dark skies compliant, and directed downwards so that their illumination effects are confined entirely within the public rights-of-way in a manner consistent with specifications by the director. All antennas, accessory equipment and other improvements with indicator or status lights shall be installed in locations and within enclosures that mitigate illumination impacts visible from publicly accessible areas.

(4) *Trees and landscaping.* SWFs and other infrastructure deployments shall not be installed (in whole or in part) within any tree drip line. SWFs and other infrastructure deployments may not displace any existing tree or landscape features unless:

a. Such displaced tree or landscaping is replaced with native and/or drought-resistant trees, plants or other landscape features approved by the director, and

b. The applicant submits and adheres to a landscape maintenance plan.

Replacement trees must be installed under the supervision of a NH licensed arborist. Any replacement tree must be substantially the same size as the damaged tree unless approved by the director.

(5) *Signs and advertisements.* All SWFs and other infrastructure deployments that involve RF transmitters must include signage that accurately identifies the site owner/operator, the owner/operator's site name or identification number and a toll-free number to the owner/operator's network operations center. SWFs and other infrastructure deployments may not bear any other signage or advertisements, including logos, unless expressly approved by the city, required by law, or recommended under FCC or other United States governmental agencies for compliance with RF emissions regulations.

a. All SWF shall be labeled with RF warning signs indicating RF ~~warning signs~~, radiation being emitted above. ~~if required,~~ and shall be located as close to the antenna as possible and must face towards the street, be at eye level and be legible from 9 feet away.. Unless otherwise required by law or regulation, the background color of the sign must match the color of the pole or surface to which it is attached.

(6) *Site security measures.* SWFs and other infrastructure deployments may incorporate reasonable and appropriate site security measures subject to approval by the director. All exterior surfaces on SWFs shall be constructed from or coated with graffiti-resistant materials.

(7) *Compliance with state and federal regulations.* All SWFs and other infrastructure deployments must comply with all applicable state and federal regulations, including without limitation all applicable regulations for human exposure to RF emissions and the federal Americans with Disabilities Act of 1990 (42 U.S.C. §§ 12101 et seq.) and must submit a review and approval pursuant to NEPA, the National Environmental Policy Act. All required documentation must be demonstrated to show full compliance with NEPA as set forth by the FCC, unless exemption is claimed. If exempt, applicant must state the basis for such exemption and provide proof, including all supporting documents, that each and every exempt installation meets prescribed requirements. In the event that applicable federal or state laws or regulations conflict with the requirements of this article, the applicant shall comply with the requirements of this article to the maximum extent possible without violating federal or state laws or regulations.

(8) *Antennas.* The following provisions in this subsection are generally applicable to all antennas.

a. *Shrouding/concealment.* All antennas and associated equipment, including but not limited to cables, jumpers, wires, mounts, masts, brackets and other connectors and hardware, must be concealed from view within a single shroud or radome that is finished to match the color of the support structure.

i. For pole-top antennas, the shroud shall not exceed one and half-times the median pole diameter and must taper down to pole.

ii. For side-arm antennas, the shroud must cover the cross arm and any cables, jumpers, wires or other connectors between the vertical riser and the antenna.

b. *Antenna volume.* Each individual antenna associated with a single SWF shall not exceed three cubic feet. The cumulative volume for all antennas on a single small SWF shall not exceed:

i. Three cubic feet in residential districts; or

ii. Six cubic feet in nonresidential districts.

c. *Overall antenna height.*

i. Antennas placed on new structures may not extend more than five feet above the support structure, plus any minimum separation between the antenna and other pole attachments required by applicable health and safety regulations.

ii. Antennas placed on existing structures that meet the definition of a collocation or modification application as defined in NH RSA 12-K shall not increase the height of the structure by more than ten percent or five feet, whichever is greater.

d. *Horizontal projection.* Side-mounted antennas, where permitted, shall not project:

i. More than 18 inches from the support structure;

ii. Over any roadway for vehicular travel; or

iii. Over any abutting private property.

iv. If applicable laws require a side-mounted antenna to project more than 18 inches from the support structure, the projection shall be no greater than required for compliance with such laws.

(9) *Accessory equipment volume.* The cumulative volume for all accessory equipment for a single SWF or other infrastructure deployment shall not exceed:

a. Nine cubic feet in residential districts; or

b. 17 cubic feet in nonresidential districts.

The volume limits in this subsection do not apply to any undergrounded accessory equipment.

(10) *Undergrounded accessory equipment.*

a. *Where required.*

i. For proposed facilities on Central Square or on Main Street between Central Square and the Marlboro Street/Winchester Street intersection, accessory equipment (other than any electric meter emergency disconnect switch, where permitted) shall be placed underground.

ii. In all other locations, accessory equipment shall be placed underground unless the applicant demonstrates by clear and convincing evidence that compliance with this section would be technically infeasible.

b. *Vaults.* All undergrounded accessory equipment must be installed in a vault that is load-rated to meet the city's standards and specifications.

(11) *Pole-mounted accessory equipment.* The following provisions in this subsection are applicable to all pole-mounted accessory equipment in connection with SWFs and other infrastructure deployments.

a. *Minimum vertical clearance.* The lowest point on any pole-mounted accessory equipment, which does not project over the travel way, shall be a minimum of ten feet above ground level adjacent to the pole.

b. *Horizontal projection.* All pole-mounted accessory equipment shall be mounted flush to the pole surface. Pole-mounted accessory equipment shall not project:

i. More than 18 inches from the pole surface; or

ii. Over any abutting private property.

c. *Orientation.* Unless concealed in a manner approved by the director, all pole-mounted accessory equipment shall be oriented so as to reduce visibility from the nearest abutting properties. In general, the proper orientation will likely be toward the street to reduce the overall profile when viewed from the nearest abutting property. If more than one orientation would be technically feasible, the director may select the most appropriate orientation.

(12) *Ground-mounted or base-mounted accessory equipment.* The following provisions in this subsection are applicable to all ground-mounted and base-mounted accessory equipment in connection with SWFs and other infrastructure deployments.

a. *Concealment.* Where permitted, ground-mounted accessory equipment shall be completely concealed/shrouded or placed in a cabinet substantially similar in appearance to existing ground-mounted accessory equipment cabinets. Exterior colors shall be muted, non-reflective, and blend with the colors of the surroundings.

b. *Visibility.* No individual ground-mounted accessory equipment cabinet may exceed a height or width of four feet. Ground-mounted and base-mounted equipment cabinets shall not have any horizontal flat surfaces greater than 1.5 square feet.

(13) *Support structure attachments.* The following provisions in this subsection are applicable to all support structure attachments (other than pole-mounted accessory equipment) and other related improvements that serve SWFs and other infrastructure deployments.

a. *Overhead lines.* The director shall not approve any new overhead utility lines in areas within which wires, cables, cabinets and other equipment associated with SWFs or infrastructure deployment are primarily located underground. In areas with existing overhead lines, no new overhead utility lines shall be permitted to traverse any roadway used for vehicular transit.

b. *Vertical cable risers.* All cables, wires, conduit attachments and other connectors must be routed through conduits within the support structure to conceal from public view. If this is technically infeasible, applicants shall route through a single external conduit or shroud that has been finished to match the underlying pole.

c. *Spools and coils.* To reduce clutter and deter vandalism, excess fiber optic or coaxial cables shall not be spooled, coiled or otherwise stored on the pole outside equipment cabinets or shrouds.

d. *Electric Meters.* The director shall not approve a separate ground-mounted electric meter pedestal. If the proposed project involves a ground-mounted equipment cabinet, an electric meter may be integrated with and recessed into the cabinet.

e. *Existing conduit or circuits.* To reduce unnecessary wear and tear on the public rights-of-way, applicants shall use existing conduits and/or electric circuits whenever available and technically feasible. Access to any conduit and/or circuits owned by the city shall be subject to the director's prior written approval, which the director may withhold or condition as the director deems necessary or appropriate to protect the city's infrastructure and/or prevent interference with the city's municipal functions and public health and safety.

( Ord. No. O-2019-18-A , 5-21-2020)

Sec. 82-207. - Application requirements.

(1) *All applications.* All applicants for a SWF license must include the following information and materials as part of a formal SWF license application to the city:

a. *Application form.* The applicant shall submit a complete, duly executed SWF license application on the then-current form prepared by the city.

b. *Application fee.* The applicant shall submit the applicable SWF license application fee established in Appendix B of City Code. Batched applications must include the applicable SWF license application fee for each SWF in the batch.

c. *Project narrative and justification.* The applicant shall submit a written statement that explains in plain factual detail whether and why the proposed facility qualifies as a "SWF" as defined in this article. A complete written narrative analysis will state the applicable standard and all the facts that allow the city to conclude the standard has been met. As part of the written statement, the applicant must also include the following:

i. Whether and why the proposed support is a "structure" as defined by this article.

ii. Whether and why the proposed wireless facility meets each required finding for a SWF license as provided in section 82-209(2), "required findings for approval."

iii. A master plan showing the geographic service area for the proposed small cell installations(s), and all the Applicants's existing, proposed and anticipated installations in the City.

iv. Certification that the proposed small cell installations(s) addresses an existing and significant gap in coverage in the service area, such certification to include a detailed map of the "gap areas" and documentation of such gap causing an inability for a user to connect with the land-based national telephone network or maintain a connection capable of supporting a reasonably uninterrupted communication.

d. *Construction drawings.* The applicant shall submit true and correct construction drawings, prepared, signed and stamped by a New Hampshire licensed engineer that depict all the existing and proposed improvements, equipment and conditions related to the proposed project. This includes without limitation any and all poles, posts, pedestals, traffic signals, towers, streets, sidewalks, pedestrian ramps, driveways, curbs, gutters, drains, handholds, manholes, fire hydrants, equipment cabinets, antennas, cables, trees and other landscape features. The construction drawings must:

i. Contain cut sheets that contain the technical specifications for all existing and proposed antennas and accessory equipment, which includes without limitation the manufacturer, model number and physical dimensions;

ii. Identify all potential support structures within 400 feet from the proposed project site and call out such structures' overall height above ground level; and

iii. Depict the applicant's preliminary plan for electric and data backhaul utilities, which shall include the anticipated locations for all conduits, cables, wires, handholes, junctions, transformers, meters, disconnect switches, and points of connection.

e. *Photo simulations.* The applicant shall submit site photographs and photo simulations that show the existing location and proposed SWF in context from at least three vantage points within the public streets or other publicly accessible spaces, together with a vicinity map that shows the proposed site location and the photo location for each vantage point. At least one simulation must depict the SWF from a vantage point approximately 50 feet from the proposed support structure or location and from the perspective of any property owner within 250 feet..

f. *Radio frequency compliance report.* The applicant shall submit a radio frequency (RF) exposure compliance report that certifies that the proposed SWF will comply with applicable federal RF exposure standards and exposure limits. Signal strength measurements must be collected as part of the commissioning process and when changes are made to the system that might affect its radiation, such as changes in the software controlling it. Signal strength is to be assessed under worst-case conditions in regions surrounding the SWF that either are occupied or are accessible to the public and the results of the data collection effort is to be made available to the public via a website. In the event that the measured power for the SWF exceeds radiation thresholds, the City is empowered to immediately have that facility taken offline.. The RF report must be prepared and certified by an RF engineer acceptable to the director and the costs of the measurements will be borne by the site installer.. If the applicant submits a batched application, a separate RF report shall be prepared for each facility associated with the batch. If the SWF is collocated the applicant must submit a radio frequency, signal strength compliance report for the aggregate emissions from all collocated equipment.

g. Additionally, the applicant must create and maintain performance specifications and data that identify the maximum and minimum amount or level of radio-frequency emissions that are produced by the equipment when it is in full operating mode, and a monitoring plan for the applicant's equipment capable of tracking and recording the daily amounts or levels of radio-frequency emissions that are produced by the equipment in order to verify that the average and peak emissions do not exceed the applicable FCC regulations. The city may conduct random, unscheduled and independent testing of any SWF antenna installation to ensure compliance with the FCC radio frequency guidelines

~~g~~ h.. *Regulatory authorization.* The applicant shall submit evidence of the applicant's regulatory status under federal and state law to provide the services and construct the SWF proposed in the application.

(2) *Collocation applications.* In addition to the application requirements listed in section 82-207(1), all applicants proposing to place a SWF on an existing structure must include the following information and materials as part of a formal SWF License application to the city:

a. *Property owner's authorization.* For any SWF proposed to be installed on an existing support structure not owned or controlled by the city, whether in whole or in part, and which is not owned by the applicant, the applicant must submit a written authorization from the support structure owner(s). Public Notice is to be provided as stated in 3. A. below.

(3) *Applications to install a SWF on a new support structure.* In addition to the application requirements listed in section 82-207(1), all applicants proposing to install a SWF on a new or replacement support structure must include the following information and materials as part of a formal SWF License application to the city:

a. *Public notices.* For applications to locate a SWF on a new or replacement structure, the applicant shall include with the application a list that identifies all persons entitled to notice, including all owners of record and legal occupants of properties within a ~~3~~500-foot radius of the proposed SWF. In addition, the applicant shall submit two sets of mailing labels and pay a fee to

cover the cost of certified mailing to each person entitled to notice. Notice shall be filed within 5 days of filing an application and the application with all available documents will be made available for public inspection and copying.

b. ~~*Site*~~ *Site survey.* For applications to locate a SWF on a new or replacement structure, the applicant shall submit a survey prepared, signed and stamped by a New Hampshire licensed surveyor. The survey must identify and depict all existing boundaries, encroachments and other structures within 75 feet from the proposed project site and any new improvements, which includes without limitation all:

i. Traffic lanes;

ii. All private properties and property lines;

iii. Above and below-grade utilities and related structures and encroachments;

iv. Fire hydrants, roadside call boxes and other public safety infrastructure;

v. Streetlights, decorative poles, traffic signals and permanent signage;

vi. Sidewalks, driveways, parkways, curbs, gutters and storm drains;

vii. Benches, mailboxes, kiosks and other street furniture; and

viii. Existing trees, planters and other landscaping features.

( Ord. No. O-2019-18-A , 5-21-2020)

Sec. 82-208. - Application review procedures.

(1) *Presubmittal conference.* The city encourages applicants to schedule and attend a presubmittal conference with the director and other city staff. This presubmittal conference does not cause the FCC shot clock or NH shot clock to begin and is intended to streamline the review process through collaborative, informal discussion that includes, without limitation, the appropriate project classification and review process; any latent issues in connection with the proposed project and/or project site, including compliance with generally applicable rules for public health and safety; potential concealment issues or concerns (if applicable); coordination with other city departments implicated by the proposed project; and application completeness issues.

a. To mitigate unnecessary delays due to application incompleteness, applicants are encouraged (but not required) to bring any draft applications, plans, maps or other materials so that city staff may provide informal feedback and guidance about whether such applications or other materials may be incomplete or unacceptable in their then-current form.

(2) *Application submittal date.* All applications must be submitted to the city on the monthly application submittal date, which shall generally be the second Tuesday of every month unless specified otherwise by the director. Prospective applicants may submit up to five individual applications at one time as a batch. Any purported application received on a date other than the application submittal date, whether delivered in-person, by mail or through any other means, will be considered filed as of the next applicable application submittal date.

(3) *Additional administrative requirements and regulations.* The city council authorizes the director to develop, publish and from time to time update or amend license application requirements and technical standards that the director finds necessary, appropriate or useful for processing any application governed under this article, not otherwise inconsistent with the requirements of this article. The city council further authorizes the director to establish other reasonable rules and regulations for duly filed applications, which may include without limitation regular hours for appointments and/or submittals without appointments, as the director deems necessary or appropriate to organize, document and manage the application intake process. All such

requirements, materials, rules and regulations must be in written form, on file with the director, and publicly released, to provide all interested parties with prior notice.

(4) *Incomplete applications.*

a. *Initial completeness review.* Within 15 calendar days following the application submittal date, the director shall complete an initial review of each application to evaluate whether the submission requirements set forth in section 82-207 have been met. If the director determines that an application is incomplete, the director shall notify the applicant in writing of the application's nonconformance, including the specific deficiencies in the application, which, if cured, would make the application complete.

b. *Shot clock extensions.*

i. *Collocation applications.* Applicants proposing to collocate a SWF on an existing structure shall have 15 days to cure all deficiencies in the application.

1. If the applicant submits all information required for an application to be deemed complete by the director within 15 days, the shot clock shall not be suspended.

2. If the applicant submits all information required for an application to be deemed complete after 15 days, the shot clock shall be extended by the number of days beyond the 15-day period that it takes for the applicant to submit this information in accordance with NH RSA 12-K:10.

ii. *Applications to install a SWF on a new structure.* Applicants proposing to install a SWF on a new or replacement structure shall have 15 days to cure all deficiencies in the application. On the date of the issuance of a written incomplete notice, the shot clock shall be suspended until the applicant submits all information required for an application to be deemed complete by the director.

c. *Incomplete application deemed denied.* Any application governed under this article shall be automatically denied when the applicant fails to submit a substantive response to the director within 60 calendar days after the director deems the application incomplete by written notice. A "substantive response" must include, at a minimum, the complete materials identified as incomplete in the written incomplete notice.

(5) *Application submittal notice for SWFs proposed on new structures.* Within 15 calendar days after a complete application is received and prior to any approval, conditional approval or denial, the city shall mail public notice to all persons entitled to notice, including all owners of record and legal occupants of properties within a 5300-foot radius of the proposed SWF. The notice must contain:

a. A general project description;

b. The applicant's identification and contact information as provided on the application submitted to the city;

c. Contact information for the director for interested parties to submit comments; and

c. The date by which comments must be submitted to the director.

(6) *Application decision notice.* Within five calendar days after the director acts on a SWF license application, the director shall provide written notice to the applicant. If the director denies an application (with or without prejudice) for a SWF, the written notice must also contain the reasons for the denial.

( Ord. No. O-2019-18-A , 5-21-2020)

Sec. 82-209. - Decisions.

(1) *Decision deadlines.*

a. The director shall make a final decision to approve, approve with conditions, or deny a completed application to collocate a SWF on an existing structure within 45 days of application submittal, unless the NH shot clock was extended according to section 82-208(4)(b).

b. The director shall make a final decision to approve, approve with conditions, or deny an application to place or install a SWF on a new support structure within 90 days after the application is determined to be complete.

(2) *Required findings for approval.* The director may approve or conditionally approve a complete application for a SWF license when the director finds that the proposed project:

a. Meets the definition for a "SWF" as defined in this article, if it involves a wireless facility,

b. Complies with all applicable location standards in this article;

c. Complies with all applicable design standards in this article;

d. Would not be located on a prohibited support structure identified in this article; and

e. Will be in planned compliance with all applicable FCC regulations and guidelines.

(3) *Conditional approvals denials without prejudice.* Subject to any applicable federal or state laws, nothing in this article is intended to limit the director's ability to conditionally approve or deny without prejudice any SWF license application as may be necessary to ensure compliance with this article.

(4) *Appeals.* Any decision by the director shall not be subject to any administrative appeals, but may be appealable to a court of competent jurisdiction.

( Ord. No. O-2019-18-A , 5-21-2020)

Sec. 82-210. - Conditions of approval.

(1) *Standard conditions.* Except as may be authorized in subsection 82-210(2) of this section, all SWF licenses issued under this article shall be automatically subject to the conditions in this subsection.

a. *License term.* This license will ~~automatically~~ renew one year from its issuance, and each year thereafter, conditional upon receipt of the annual license fee established in Appendix B of City Code prior to the date of license expiration or $270 per installation, whichever is higher. And , submission of ongoing signal strength/radio frequency emissions as required in Section 82-207 (1) f. of this Ordinance, and

(i)) Each year commencing on the first anniversary of the issuance of the permit, the Licensee shall submit to the City an affidavit which shall list all active small cell wireless installations it owns within the City by location, certifying that (1) each active small cell installations is covered by liability insurance in the amount of $2,000,000 per installation, naming the City as additional insured and (2) each active installation has been inspected for safety by an independent radio frequency engineer hired by the Licensee with the approval of the Director and at the Licenseee's expense, and found to be in sound working condition and in compliance with all federal regulations concerning radio frequency exposure limits. .and

9ii) The City shall have the right to employ a qualified independent radio frequency engineer to conduct an annual random and unannounced test of the Licensee's small cell wireless installations located within the City to certify their compliance with all FCC radio frequency emission limits as they pertain to exposure to the general public. The reasonable cost of such tests shall be paid by the Licensee, and

(iii) In the event that such independent tests reveal that any small cell installation or installations owned or operated by Licensee or its Lessees, singularly or in the aggregate is emitting RF radiation in excess of FCC exposure guidelines as they pertain to the general public, the City shall notify the Licensee and all residents living within a 1500 feet of the small cell installation(s) of the violation, and the Licensee shall have forty-eight (48) hours to bring the small ell installation(s) into compliance. Failure to bring the small cell installation(s) into compliance and maintain them in compliance throughout the period of the lease shall result in the forfeiture of all or part of the Compliance Bond, and the City shall have the right to require the removal of such installation(s), as the City in its sole discretion may determine is in the public interest.

B . *Post-installation certification.* Within 60 calendar days after the final inspection for any building permit associated with a SWF, the applicant shall provide the director with documentation reasonably acceptable to the director that the SWF or other infrastructure deployment has been installed and/or constructed in strict compliance with the approved construction drawings and photo simulations. Such documentation shall include without limitation as-built drawings, GIS data and site photographs.

c. *Build-out period.* This SWF license will automatically expire 12 months from the approval date (the "build-out period") unless the applicant obtains all other permits and approvals required to install, construct and/or operate the approved SWF or other infrastructure deployment. Upon written request, the director may grant up to three extensions to the build-out period in 90-day increments if the applicant demonstrates justifiable cause. If the build-out period and any extension finally expires, the license shall be automatically revoked.

d. *Site maintenance.* The applicant shall keep the site, which includes without limitation all licensed improvements, in a safe condition in accordance with the approved construction drawings and all conditions in the SWF license. The applicant, at no cost to the city, shall remove and remediate any graffiti or other vandalism at the site within 48 hours after the applicant receives notice or otherwise becomes aware that such graffiti or other vandalism occurred.

e. *Compliance with laws.* The applicant shall maintain compliance at all times with all federal, state and local statutes, regulations, orders, permits or other rules ("laws") applicable to the applicant, the subject property, the SWF or other infrastructure deployment or any use or activities in connection with the use authorized in this SWF license. The applicant expressly acknowledges and agrees that this obligation is intended to be broadly construed and that no other specific requirements in these conditions are intended to reduce, relieve or otherwise lessen the applicant's obligations to maintain compliance with all laws. No failure or omission by the city to timely notice, prompt or enforce compliance with any applicable law shall be deemed to relieve, waive or lessen the applicant's obligation to comply in all respects with all applicable laws.

f. *Adverse impacts on other properties.* The applicant shall avoid, or immediately remedy if necessary, any adverse impacts on nearby properties that may arise from the applicant's or its authorized personnel's construction, installation, operation, modification, maintenance, repair, removal and/or other activities on or about the site.

g. *Inspections; emergencies.* The applicant expressly acknowledges and agrees that local, state, and federal officers, officials, staff, emergency personnel, agents, contractors or other designees may inspect the licensed improvements and equipment to disable or remove any licensed improvements or equipment in emergencies or when such improvements or equipment threatens actual, imminent harm to property or persons.

h. *Applicant's contact information.* Within ten days from the date of approval of the SWF license, the applicant shall furnish the city with accurate and up-to-date contact information for a person responsible for the SWF or other infrastructure deployment, which includes without limitation such person's full name, title, direct telephone number, mailing address and email address. The applicant shall keep such contact information up-to-date at all times and promptly provide the

city with updated contact information if either the responsible person or such person's contact information changes.

i. *Performance security.* Before the city issues any permits required to commence construction in connection with this license, the applicant shall post a security in a form acceptable to the director in an amount reasonably necessary to cover the cost to remove the improvements and restore all affected areas based on a written estimate from a qualified contractor with experience in wireless facilities or other infrastructure removal. The preferred forms of security are certified checks made out to the City of Keene and letters of credit.

j. *Truthful and accurate statements.* The applicant acknowledges that the city's approval relies on the written and/or oral statements by applicant and/or persons authorized to act on applicant's behalf. In any matter before the city in connection with the SWF license or the SWF or other infrastructure approved under the SWF license, neither the applicant nor any person authorized to act on applicant's behalf shall, in any written or oral statement, intentionally provide information that is materially and/or factually incorrect or omit any material information necessary to prevent any material factual statement from being incorrect or misleading. Failure to comply with this condition shall be grounds for license revocation.

k. *License revocation.* The director may revoke a license granted under this article when the director finds substantial evidence that the facility is not in compliance with the requirements of this article, and with any applicable laws, which includes without limitation, any license or permit issued in connection with the facility and any associated conditions required by such license(s) or permits.

   i. Before any decision to revoke a license granted under this article, the director must issue a written notice to the applicant that specifies the facility, the violation(s) to be corrected, the timeframe within which the applicant must correct such violation(s), which shall be a minimum of 30 days, and that the director may revoke the license for failure to correct such violation(s).

   ii. If the applicant does not correct the violations as specified in the written notice within the timeframe stated, the director may issue a decision to revoke the license. Within five business days after director makes a decision to revoke a license, the director shall provide the applicant with a written notice that specifies the revocation and the reasons for such revocation.

l. *Records.* Any and all documentation or data submitted to the city in connection with a SWF license application and license is a public record subject to the requirements of NH RSA 91-A, unless otherwise claimed to be confidential by the applicant and agreed to by the city in accordance with state law. In the event of a public record request for confidential information, the city shall notify the licensee within five calendar days of receipt of the request, and the licensee may, at its sole cost and expense, seek an immediate protective order from the NH Superior Court. In the event that the licensee does not take such action within 30 days of notification, the city shall release the record subject to redactions required by law.

m. *Abandoned facilities.* The SWF or other infrastructure deployment authorized under this SWF license shall be deemed abandoned if not operated under a valid license for any period of time that is 90 days or longer. The city shall notify the applicant in writing of the abandonment. Once deemed abandoned, the applicant and/or SWF owner shall completely remove the SWF or other infrastructure deployment and all related improvements and shall restore all affected areas to a condition substantially similar to the condition at the time the license was initially granted. In the event that neither the applicant nor the SWF owner complies with the removal and restoration obligations under this condition within a 30-day period after the notice by the city, the city shall have the right (but not the obligation) to perform such removal and restoration without further notice, and the applicant and SWF owner shall be jointly and severally liable for all costs and expenses incurred by the city in connection with such removal and/or restoration activities.

n. *Trees and landscaping.* The applicant shall replace any landscape features damaged or displaced by the construction, installation, operation, maintenance or other work performed by the applicant or at the applicant's direction on or about the site. If any trees are damaged or displaced, the applicant shall hire and pay for a NH licensed arborist to select, plant and maintain replacement landscaping in an appropriate location for the species. Any replacement tree must be substantially the same size as the damaged tree or as otherwise approved by the city.

o. *Utility damage prevention.* The applicant shall comply with the requirements of NH RSA 374:48—56, and any adopted administrative rules.

p. *Rearrangement and relocation.* The applicant acknowledges that the city, in its sole discretion and at any time, may perform any work deemed necessary, useful or desirable by the city (collectively, "city work") in the city right-of-way. If the director determines that any city work will require the applicant's SWF located in the public rights-of-way to be rearranged and/or relocated, the director shall issue written notice to the applicant of the work to be performed, and the action to be taken by the applicant. The applicant shall, at its sole cost and expense, do or cause to be done all things necessary to accomplish such rearrangement and/or relocation within ten days after the director's notice. If the applicant fails or refuses to either permanently or temporarily rearrange and/or relocate the applicant's SWF or other infrastructure deployment within ten days after the director's notice, the city may (but will not be obligated to) cause the rearrangement or relocation to be performed at the applicant's sole cost and expense.

i. The city may exercise its rights to rearrange or relocate the applicant's SWF or other infrastructure deployment without prior notice to applicant when the director determines that city work is immediately necessary to protect public health or safety.

ii. The applicant shall reimburse the city for all costs and expenses in connection with such work within ten days after a written demand for reimbursement and reasonable documentation to support such costs.

(2) *Modified conditions.* The city council authorizes the director to modify, add or remove conditions to any SWF license as may be necessary or required to ensure compliance with the City of Keene Code of Ordinances, this article or other applicable law. To the extent required by applicable FCC regulations, the director shall take care to ensure that any different conditions applied to SWFs are no more burdensome than those applied to other similar infrastructure deployments. The director shall provide written notice to the applicant of any required alteration to the license.

( Ord. No. O-2019-18-A , 5-21-2020)

Sec. 82-211. - Preapproved designs.

(1) *Purpose.* To expedite the review process and encourage collaborative designs among applicants and the city, the city council authorizes the director to designate one or more preapproved designs for SWFs and other infrastructure deployments. This section sets out the process to establish or repeal a preapproved design and the expedited review procedures and findings applicable to these applications.

(2) *Adoption.* The director may, in the director's discretion, establish a preapproved design when the director finds that a proposed preapproved design meets or exceeds the design standards in this article. The director shall make preapproved designs publicly available at the offices of the director and at the time of application.

(3) *Repeal.* The director may repeal any preapproved design by written notice posted at Keene City Hall and at the offices of the director. The repeal shall be effective to any application received after the date of the repeal.

(4) *Modified findings.* When an applicant submits a complete application for a preapproved design, the director shall presume that the findings for approval in section 82-209(2)(c) of this article are satisfied

and shall evaluate the application for compliance with the remaining findings for approval listed in section 82-209(2).

(5) *Nondiscrimination.* Any applicant may propose to use any preapproved design whether the applicant initially requested that the director adopt such preapproved design or not. The director's decision to adopt a preapproved design expresses no preference or requirement that applicants use the specific vendor or manufacturer that fabricated the design depicted in the preapproved plans. Any other vendor or manufacturer that fabricates a facility to the standards and specifications in the preapproved design with like materials, finishes and overall quality shall be acceptable as a preapproved design.

( Ord. No. O-2019-18-A , 5-21-2020)

Sec. 82-212. - Definitions.

The definitions in this section shall be applicable to the terms, phrases and words in this article. If any definition assigned to any term, phrase or word conflicts with any federal or state-mandated definition, the federal or state-mandated definition will control.

*Accessory equipment* means equipment other than antennas used in connection with a SWF or other infrastructure deployment. The term includes "transmission equipment" as defined by the FCC in 47 C.F.R. § 1.6100(b)(8), as may be amended or superseded.

*Antenna* means an apparatus designed for the purpose of transmitting or receiving electromagnetic radio frequency signals used in the provision of personal wireless service and any comingled information services.

*Antenna facility* means an antenna and associated accessory equipment.

*Applicant* means any person who submits an application and is a wireless provider.

*Batched application* means more than one application submitted at the same time.

*Clear and convincing evidence* means the presentation of objective facts which are sufficient to show that it is highly probable, and not merely likely, that the higher priority location is not technically feasible.

*Collocation* means mounting or installing an antenna facility on a pre-existing structure, and/or modifying a structure for the purpose of mounting or installing an antenna facility on that structure, as defined by the FCC in 47 C.F.R. § 1.6102(g) (as may be amended or superseded). "Collocation" does not include a "substantial modification."

*Decorative pole* means any pole that includes decorative or ornamental features, design elements and/or materials intended to enhance the appearance of the pole or the public rights-of-way in which the pole is located.

*Director* means the public works director or their designee.

*FCC* means the Federal Communications Commission or its duly appointed successor agency.

*FCC shot clock* means the presumptively reasonable timeframe, accounting for any tolling or extension, within which the city generally must act on a request for authorization in connection with a personal wireless service facility, as such time frame is defined by the FCC and as may be amended or superseded.

*Height* means the distance measured from ground level to the highest point on the structure, even if such highest point is an antenna. The term "ground level" means the average existing grade or elevation of the ground surface within the footprint of the structure prior to any alterations such as grading, grubbing, filling, or excavating.

*NH shot clock* means the presumptively reasonable timeframe, accounting for any tolling or extension, within which the city generally must act on a request for authorization in connection with a

personal wireless service facility, as such time frame is defined in NH RSA 12-K:10 and as may be amended or superseded.

*Nonresidential district* means any zoning district that is not included in the definition of "residential district."

*OTARD* means an "over-the-air reception device" and includes all antennas and antenna supports covered by 47 C.F.R. § 1.4000(a)(1), as may be amended or superseded.

*Person* means an individual, corporation, limited liability company, partnership, association, trust, or other entity or organization.

*Personal wireless services* means commercial mobile services, unlicensed wireless services, and common carrier wireless exchange access services. See 47 U.S.C. § 332(c)(7)(C)(i).

*Personal wireless service facilities* means facilities for the provision of personal wireless services as defined in 47 U.S.C. § 332(c)(7)(C)(i), as may be amended or superseded.

*Persons entitled to notice* means the record owners and legal occupants of all properties within a 300-foot radius of the proposed SWF. Notice to the legal occupants shall be deemed given when sent to the property's physical address.

*Public right-of-way* or *public rights-of-way* means land or an interest in land which by deed, conveyance, agreement, easement, dedication, usage or process of law is reserved for or dedicated to or open to the use by the general public for road or highway purposes, or other public access.

*Residential district* means a zoning district that is intended primarily for residential uses. This term includes the following zoning districts:

(1) Rural.

(2) Low density.

(3) Low density-1.

(4) Medium density.

(5) High density.

(6) High density-1.

(7) Residential preservation.

*RF* means radio frequency or electromagnetic waves.

*Shot clock days* means calendar days counted toward the presumptively reasonable time under the applicable FCC shot clock or NH shot clock. The term "shot clock days" does not include any calendar days on which the shot clock is tolled (i.e., "paused").

*Small wireless facility* or *SWF* means the same as defined by the FCC in 47 C.F.R. § 1.6002(l), as may be amended or superseded, except as modified in this article. A SWF meets each of the following conditions:

(1) The facility is mounted on a structure that:

a. Is 50 feet or less in height including the antenna; or

b. Is no more than ten percent taller than other adjacent structures; or

c. Does not extend the existing structure on which it is located to a height of more than 50 feet or by more than ten percent, whichever is greater.

(2) Each antenna is located inside an enclosure of no more than three cubic feet in volume or, in the case of an antenna that has exposed elements, the antenna and all of its exposed elements could fit within an imaginary enclosure of no more than three cubic feet.

(3) All other wireless equipment attached directly to a structure associated with the facility is cumulatively no more than 28 cubic feet in volume.

*Support structure* means a "structure" as defined by the FCC in 47 C.F.R. § 1.6002(m), as may be amended or superseded. This section states that a "structure" means a pole, tower, base station, or other building, whether or not it has an existing antenna facility, that is used or to be used for the provision of personal wireless service (whether on its own or comingled with other types of services).

*Technically infeasible* means a circumstance in which compliance with a specific requirement within this article is physically impossible and not merely more difficult or expensive than a noncompliant alternative.

( Ord. No. O-2019-18-A , 5-21-2020)

# State of New Hampshire

GENERAL COURT

CONCORD

# MEMORANDUM

**DATE:** **November 1, 2020**

**TO:** **Honorable Christopher T. Sununu, Governor**
**Honorable Stephen J. Shurtleff, Speaker of the House**
**Honorable Donna Soucy, President of the Senate**
**Honorable Paul C. Smith, House Clerk**
**Honorable Tammy L. Wright, Senate Clerk**
**Michael York, State Librarian**

**FROM:** **Representative Patrick Abrami, Chair**

**SUBJECT:** **Final Report on Commission to Study the Environmental and Health Effects of Evolving 5G Technology (RSA 12-K:12-14, HB 522, Ch. 260, Laws of 2019)**

Pursuant to RSA 12-K:14, III, enclosed please find the Final Report of the Commission to Study the Environmental and Health Effects of Evolving 5G Technology.

If you have any questions or comments regarding this report, please do not hesitate to contact me.

I would like to thank those members of the commission who were instrumental in this study. I would also like to acknowledge all those who testified before the commission and assisted the commission in our study.

Enclosures

cc: Members of the Commission

# Final Report of the

# Commission to Study
# The Environmental and Health Effects of
# Evolving 5G Technology

(HB 522, Chapter 260, Laws of 2019, RSA 12-K:12–14)

## Membership

| Name | Organization/Representing |
|---|---|
| Rep. Patrick Abrami (Chair) | NH House of Representatives |
| Rep. Kenneth Wells | NH House of Representatives |
| Rep. Gary Woods | NH House of Representatives |
| Sen. James Gray | NH Senate |
| Sen. Tom Sherman | NH Senate |
| Denise Ricciardi | Public |
| Brandon Garod, Esq. | Attorney General's Office |
| Carol Miller | Department of Business and Economic Affairs |
| David Juvet | Business and Industry Association |
| Kent Chamberlin, PhD | University of New Hampshire |
| Bethanne Cooley | CTIA – wireless communications industry |
| Michele Roberge | Department of Health and Human Services |
| Paul Héroux, PhD | McGill University Medicine |

November 1, 2020

***Members of the Commission to Study the Environmental and Health Effects of Evolving 5G technology agree to the filing of this final report by the Chairman. This action should not be construed in any way as an adoption of any position by any Commission member or state agency or organization they represent on the underlying issue of the deployment of 5G technology.***

# Table of Contents

## INTRODUCTION

**Commission Responsibilities and Evolving Role**

The Commission to Study the Environmental and Health Effects of Evolving 5G Technology came about from the passage and signing into law of HB 522. The Legislature, after hearing testimony of potential health risks and the political ramifications of small cell antennae being deployed on the public rights-of-way throughout New Hampshire, agreed that a Commission be formed to take a deeper look at this evolving technology. For the record, 5G stands for the 5th Generation of wireless communication. This technology utilizes frequencies in the millimeter wave range of the electromagnetic spectrum. See Appendix A for a chart showing this spectrum.

What the Commission learned early on in its work is that you cannot talk about 5G without talking about the earlier generations 3G and 4G. Then the Commission embraced the concept of the Internet of Things (IoT) which is a world in which all electronic devices communicate via electromagnetic waves. This led to discussion of routers and other internal technologies. The devices receiving and sending signals via electromagnetic waves also became part of the discussion. So as the presentations and discussions went on, the Commission concluded that all things emitting radio frequency (RF) radiation needed to be considered together because of the interaction of all these waves. We also discovered early on that 5G means something different to each of the major cellular companies ranging from how 5G antennae interact with other generation antennae to whether small cell towers in the public right-of-way will be needed. The conclusion by many experts is that 5G is a marketing concept centered around speed of data transmission using many different engineering strategies.

At the heart of the discussion was the research as to whether non-ionizing radiation causes biological effects on humans as well as other living organisms, either animal or plant. No one argues that ionizing radiation from the high energy and frequency ultraviolet, x-ray, and gamma ray end of the electromagnetic spectrum are a danger to all living things. Of concern to the Commission, and internationally, are the electromagnetic waves in the microwave range of energy and frequency. There is mounting evidence that DNA damage can occur from

radiation outside of the ionizing part of the spectrum.[1, 2, 3, 4] The Commission heard arguments on both sides of this issue with many now saying there are findings showing biological effects in this range. This argument gets amplified as millimeter waves within the microwave range are beginning to be utilized.

Then the Commission was presented with varying facts about the Federal Communication Commission (FCC) having total say over this issue as granted to it by Congress in the Telecommunication Act of 1996. In brief, this Act says, among many other things, that the siting of any antennae cannot be denied due to health concerns. Many on the Commission are concerned that this Act did not contemplate small cell towers being located on the public rights-of-way in front of people's homes. In addition, the FCC, using the science that they receive from other agencies and scientific/engineering associations, has set the allowable power intensity that can be emitted from these antennae. Testimony shows these limits are set well above many other industrialized nations. There are concerns by many Washington, DC watchers that the FCC is a captive agency whose Commission members come from the industry they are overseeing. These are the realities that can only be altered by Congressional action. As a New Hampshire Commission, as we moved through the Commission process, many of the members concluded we could first encourage our federal delegation to enact changes and second, assuming the federal realities cannot be changed, recommend protective measures that will stay within the current federal framework.

As far as the FCC and federal agencies, we made several attempts to have them testify before the Commission. The Commission was disappointed that they did not reply to these requests, because we thought it important for completeness of our work to hear from these agencies. When the agencies did not reply, we asked several agencies to answer very specific written questions. Instead of answering

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[1] Aitken RJ, Bennetts LE, Sawyer D, Wiklendt AM, King BV. "Impact of radio frequency electromagnetic radiation on DNA integrity in the male germline." *Inter J Androl* 28:171-179, 2005, https://pubmed.ncbi.nlm.nih.gov/15910543/

[2] Akdag MZ, Dasdag S, Canturk F, Karabulut D, Caner Y, Adalier N. "Does prolonged radiofrequency radiation emitted from Wi-Fi devices induce in various tissues of rats?" *J Chem Neuroanat*, 75(Pt B):116-122, 2016, https://pubmed.ncbi.nlm.nih.gov/26775760/.

[3] Akdag M, Dasdag S, Canturk F, Akdag MZ. "Exposure to non-ionizing electromagnetic fields emitted from mobile phones induced DNA damage in human ear canal hair follicle cells." *Electromagn Biol Med*. 37(2):66-75, 2018.

[4] Al-Serori H, Ferk F, Kundi M, Bileck A, Gerner C, Mišík M, Nersesyan A, Waldherr M, Murbach M, Lah TT, Herold-Mende C, Collins AR, Knasmüller S. "Mobile phone specific electromagnetic fields induce transient DNA damage and nucleotide excision repair in serum-deprived human glioblastoma cells." *PLoS One*. 13(4):e0193677, 2018.

our specific questions, the responses directed Commission members to certain locations on websites for what turned out to be more general information on topics of public interest. The communications with these agencies are contained in Appendix B.

**Summary of Commission Meetings**

The Commission met a total of 13 times over a period from September 2019 to October 2020. Unfortunately, due to the Covid-19 pandemic, all activity at the NH State House came to a halt from mid-March to mid-June this year. This meant that the Commission missed four meetings and thus heard from fewer experts on this topic than planned. It is important to stress that the Chair was planning to call additional witnesses from the scientific community as well as the telecommunication industry. When we resumed meeting, starting with one on July 1, all remaining meetings were conducted via Zoom. After our July 24th meeting, a work group consisting of seven members was formed to start formulating recommendations for the full Commission to consider. This work group met approximately every other week through the finalization of this report at the end of October. The table below summarizes the full Commission meeting dates and who the main speakers were.

| # | Date | Major Topics and/or Guest Speakers |
|---|---|---|
| 1 | 9/16/19 | Organizational meeting |
| 2 | 10/10/19 | Electromagnetic Spectrum Physics Presentation<br>Dr. Kent Chamberlin, Chair of UNH Electrical and Computer Engineering Department<br><br>Presentation on Biological Effects of RF radiation<br>Dr. Paul Heroux, Professor of Toxicology, McGill University |
| 3 | 10/31/19 | National Toxicology Program Study on RF-Radiation<br>Michael Wyde, PhD<br><br>Framing the Issue Video<br>Frank Clegg, Former Microsoft Canada President |
| 4 | 11/21/19 | Non-Existence of RF-Radiation Biological Effects Argument<br>Eric Swanson, PhD, University of Pittsburgh. |
| 5 | 12/13/19 | Reinventing Wires and 5G in Colorado<br>Tim Schoechle, PhD, Colorado State University |

| | | |
|---|---|---|
| 6 | 1/10/20 | Studies Showing RF-Radiation Biological Effects<br>Devra Davis, PhD, MPH, Founder/President Environmental Health Trust (EHT)<br><br>The Landscape Nationally and Internationally Surrounding RF-Radiation, Theodora Scarato, Executive Director EHT |
| 7 | 2/14/20 | What is 5G and What Do We Know About the Health Effects of 5G<br>David Carpenter, MD, Director, Institute for Health and the Environment, University of Albany |
| *COVID-19 NH STATE HOUSE CLOSURE* | | |
| 8 | 7/1/20 | 13 Objections To 5G/4G<br>Herman Kelting, PhD, Retired Las Vegas, NV |
| 9 | 7/24/20 | Around the table discussion of where we are and next steps. Established a work group to formulate recommendations. |
| 10 | 8/31/20 | Presentation of work group recommendations and discussion. Discussed that a minority report would be required. |
| 11 | 9/22/20 | Discussion and voting on first half of recommendations |
| 12 | 10/8/20 | Discussion and voting on second half of recommendations |
| 13 | 10/27/20 | Review and vote on final report. |

There are extensive minutes of all of these meetings that are included at the end of this report in Appendix O. In addition, the Commission has maintained a webpage on which is posted the various documents and links to information that it has collected during the course of its study, including many of the presentations provided during the meetings.

**Questions Posed in HB 522**

There were eight questions asked in the legislation creating the Commission. Research by the Commission has resulted in lengthy answers with supporting credits. With that we are showing the questions asked in the body of this report only, with the answer to each question shown in Appendix C. The questions are as follows:

1. Why does the insurance industry recognize wireless radiation as a leading risk and has placed exclusions in their policies not covering damages by the pathological properties of electromagnetic radiation?
2. Why do cell phone manufacturers have in the legal section within the device saying keep the phone at least 5mm from the body?
3. Why have 1,000s of peer-reviewed studies, including the recently published U.S Toxicology Program 16-year $30 million study, that are showing a wide

range of statistically significant DNA damage, brain and heart tumors, infertility, and so many other ailments, been ignored by the Federal Communication Commission (FCC)?

4. Why are the FCC-sanctioned guidelines for public exposure to wireless radiation based only on the thermal effect on the temperature of the skin and do not account for the non-thermal, non-ionizing, biological effects of wireless radiation?
5. Why are the FCC radiofrequency exposure limits set for the United States 100 times higher than countries like Russia, China, Italy, Switzerland, and most of Eastern Europe?
6. Why did the World Health Organization (WHO) signify that wireless radiation is a Group B Possibly Carcinogenic to Humans category, a group that includes lead, thalidomide, and others, and why are some experts who sat on the Who committee in 2011 now calling for it to be placed in the Group 1, which are known carcinogens, and why is such information being ignored by the FCC?
7. Why have more than 220 of the world's leading scientists signed an appeal to the WHO and the United Nations to protect public health from wireless radiation and nothing has been done?
8. Why have the cumulative biological damaging effects of ever-growing numbers of pulse signals riding on the electromagnetic sine waves not been explored, especially as the world embraces the Internet of Things, meaning all devices being connected by electromagnetic waves, and the exploration of the number of such pulse signals that will be created by implementation of 5G technology?

The answers to these questions have been embraced by the majority of the members of the Commission.

## SUMMARY AND OBSERVATIONS

House Bill 522 established "a Commission to study the environmental and health effects of evolving 5G technology." The Commission that was convened as a result of this legislation is comprised of thirteen members with backgrounds that include physics, engineering electromagnetics, epidemiology, biostatistics, occupational health, toxicology, medicine, public health policy, business, and law. The Commission also has representation from the telecommunications industry. The Commission began its work on September 16, 2019 and submitted this report on November 1, 2020.

The Commission recognizes that cellular and wireless communications is very important to the citizens of New Hampshire. The rollout of wireless services and new products in the industry can be key to enhancing public safety, economic opportunity, and healthcare. Regardless of the evidence presented and the risks associated with RF electromagnetic field effects, business and residents alike want 100% coverage and seamless connectivity. The majority of the Commission believes that some balance can be struck to achieve the benefits of technology without jeopardizing the health of our citizens.

To become acquainted with the issues relevant to 5G radiation exposure and health, the Commission heard from ten recognized experts in the fields of physics, epidemiology, toxicology, and public policy. All but the presenter representing the Telecommunications Industry (the transcript of that presentation can be found in the Commission's minutes of Nov 21st) acknowledged the large body of peer-reviewed research that shows that the type of RF-radiation generated by wireless devices can have a deleterious effect on humans, especially children, as well as animals, insects, and vegetation (see Appendix D).

The Commission was unable to meet for four months due to the shutdown of the NH State House caused by COVID-19. While this loss of time did limit the number of presenters that could be accommodated, the majority of the Commission did not believe that additional presenters were necessary because the information provided by the ten experts was deemed sufficient.

5G is moving forward because of its potential benefits and because of assurances by federal regulatory agencies that 5G technology is not harmful. However, those

assurances have themselves come into question because of the thousands of peer-reviewed studies documenting deleterious health effects associated with cellphone radiation exposure. Most of the federal regulatory agencies' radiation exposure limits were established in the mid-1990s before the studies were carried out, so they did not take those studies into account when setting exposure limits. In addition, the initial exposure limits were developed at a time before wireless devices, and the radiation associated with them, became ubiquitous. Not only are wireless devices far more prevalent than in the past, but these radiating devices are typically carried in direct, or near direct, contact with peoples' bodies. Further, the total radiation exposure for individuals is compounded by the radiation from nearby sources, including others' devices, cell towers, wireless routers, Bluetooth devices, etc. Because of the large number of radiating devices in today's environments, exposure for people is many times greater than when radiation thresholds were established, and the nature of today's radiation (high-data-rate signals) has been shown to be more harmful than the lower-data-rate signals that were prevalent before.

The significant disconnect between the regulatory agencies' pronouncements that cellphone radiation is safe and the findings of thousands of scientific studies was one of the major issues that the Commission sought to address. The Commission is not alone in wrestling with this issue as many others (see Appendix E) have challenged the radiation thresholds specified. It is to be noted that the only country with higher radiation thresholds than the U.S. is Japan (see Appendix F), and a large number of independent scientists have concluded that the thresholds for Japan and the U.S. are unsafe.

A likely explanation as to why regulatory agencies have opted to ignore the body of scientific evidence demonstrating the negative impact of cellphone radiation is that those agencies are "captured" (see Harvard University publication entitled, "Captured Agency: How the Federal Communications Commission Is Dominated by the Industries It Presumably Regulates" linked in Appendix G). This report documents how the leadership roles in some agencies (the FCC in particular) are filled by individuals with strong industry ties and hence are more focused on industry interests than the health of citizens. As is shown in other sections of this report, federal legislation uses policy set by the regulatory agencies to wrest control of wireless facility placement from individuals, cities, and states. Consequently, some of the Commission's recommendations call for a

reassessment of the makeup and policies of federal regulatory agencies. Current policies in place by federal regulatory agencies (such as section 704 of the Telecommunications Act of 1996) are tailored to prevent local objections to cell tower siting that are based upon health or environmental concerns, and this leaves citizens with little legal recourse regarding equipment placement.

Industry projects that over 800,000 small cell towers[5] will be necessary to implement 5G. Many are being erected in the public rights-of-way in New Hampshire neighborhoods and mounted on new poles, streetlights, and utility poles directly in front of homes. However, because of the rules currently in place, individuals and municipalities cannot use health or environmental concerns as a reason to object.

The majority of the Commission has endorsed the 15 recommendations presented in this report. These recommendations are not in prioritized order, and each should be given equal consideration. The objective of those recommendations is to bring about greater awareness of cell phone, wireless and 5G radiation health effects and to provide guidance to officials on steps and policies that can reduce public exposure. We also recommend partnering with our federal delegation to facilitate the reevaluation of radiation exposure guidelines and policies by federal agencies (i.e., the FCC, FDA, NASA, NOAA, FAA, EPA, etc.) to protect people, wildlife, and the environment from harmful levels of radiation.

Since the Commission could not reach full agreement on all that is contained in this report, the minority of the Commission has been given the opportunity to express its opinion as provided in the Minority Report.

[5] The number of projected cell towers for 5G was taken from the CTIA website: "There are 154,000 cell towers today. To meet growing mobile data demands and win the Race to 5G Accenture projects we will need to install hundreds of thousands of small cells in the next few years. S&P Global Market Intelligence projects more than 800,000 small cells deployed by 2026."

## RECOMMENDATIONS

The Commission has heard from many experts on both sides of the argument concerning the health and environmental effects of 5G and RF-radiation in general; reviewed countless study reports; attempted to get direct answers to our specific questions from the FCC and other federal agencies to no avail; has become aware of a number of lawsuits against the FCC for not accounting for biological effects in the setting of their standards; is still not certain why the standards for acceptable RF-radiation are set so much higher in the United States than other industrialized nations; is concerned that the modulation of frequencies and the combined effect of "the soup" of RF-waves surrounding us today, which will likely increase with time; is aware that there is much research showing potential health risks and understands that much more research is required; is cognizant that our country historically has been beset by examples of products being declared safe only later to be proven unsafe; and is very aware that the World Health Organization and the whole insurance industry are hedging their bets against RF-radiation because of potential harm. Given these considerations, the majority of the Commission yields to the precautionary principle in formulating many of these recommendations. These recommendations cover a broad range of topics. One topic given much consideration had to do with liability from potential harm caused by small cell antennae placed on the public rights-of-way. A majority of the Commission could not agree upon a recommendation surrounding this topic.

***RECOMMENDATION 1- Propose a resolution of the House to the US Congress and Executive Branch to require the Federal Communication Commission (FCC) to commission an independent review of the current radiafrequency (RF) standards of the electromagnetic radiation in the 300MHz to 300GHz microwave spectrum as well as a health study to assess and recammend mitigation for the health risks associated with the use of cellular communications and data transmittal.*** The Telecommunications Act of 1996 was adopted before the health risks and biological effects of RF-radiation to the human body were fully known to the scientific community as well as the public. The majority of the Commission believes that the FCC has not exercised due diligence in its mission to manage the electromagnetic environment by not setting exposure limits that protect against health effects. They have failed to support technical means and investigations aimed at reducing human exposures to electromagnetic radiation (EMR) in

telecommunications systems and optimize wireless modulations to reduce biological and health impacts. Commissioned research should study the health effects and should be conducted by an independent research organization with standards which have been mutually agreed to by all the stakeholders. The FCC shall then ensure that the findings and recommendations are adequately disseminated to the public.

***RECOMMENDATION 2- Require that the most appropriate agency (agencies) of the State of New Hampshire include links on its (their) website(s) that contain infarmation and warnings about RF-radiation from all sources, but specifically from 5G small cells deployed on public rights-of-way as well as showing the proper use of cell phones to minimize exposure to RF-radiation, with adequate funding granted by the Legislature. In addition, public service announcements on radio, television, print media, and internet should periodically appear, warning of the health risks associated with radiation exposure. Of significant importance are warnings concerning the newborn and young as well as pregnant women.*** Even without further study, there is evidence that the public should be warned of the potential dangers of RF-radiation and be told simple steps to lessen the risks of unnecessary exposure. Appendix H shows an example of a simple RF-radiation warning.

The website must provide an option for visitors to register their opinions about current FCC exposure guidelines. In particular, this registry should provide a convenient and formal mechanism for New Hampshire municipalities and residents to weigh in concerning the 1996 Telecommunications Act Section 704 that disallows using radiation-related health concerns as a reason to challenge cell phone tower siting. The primary use for the data collected on this registry will be to gauge the level of interest about RF-radiation exposure on the part of New Hampshire citizens.

***RECOMMENDATION 3- Require every pole or other structure in the public rights-of-way that holds o 5G antenna be labeled indicating RF-radiation being emitted above. This label should be at eye level and legible from nine feet away.*** In the view of the Commission, the State of New Hampshire has the right to warn the public of potential harm of 5G antennae deployed in the public rights-of-way. Large cell towers all currently have fencing around them at their base to protect the public. This will not be the case with small cell towers or any pole with an

antenna on top in the public right-of-way. These public rights-of-way are the jurisdiction of our municipalities and not of the Federal Government. The Telecommunication Act of 1996 did not contemplate antennae being placed on the public rights-of way of municipalities. Thus, the State of New Hampshire has the right to warn the public by requiring the owners of these antennae to inform the public of potential harm from RF-radiation. See Appendix I for an example symbol.

***RECOMMENDATION 4- Schools and public libraries should migrate from RF wireless connections for computers, laptops, pods, and other devices, to hard-wired or opticol connections within a five-year period starting when funding becomes available.*** There is strong evidence that the younger the child the more susceptible they are to the negative impacts of RF-radiation. Hard-wired connections or optical wireless do not subject children to RF-radiation. The Commission is aware that school districts and public libraries have invested much in wireless infrastructure and that a movement to radiation-less connections would require additional investment of resources.

New optical networking solutions for the classroom and office spaces (such as LiFi) offer faster, healthier, and more secure connections than RF-based WiFi. This technology utilizes visible light, which organisms can withstand without any harm at far higher intensity levels (such as direct sunlight) than is required for data transmission. Such optical data transmission using visible light offers gigabit speed, as well as plug-and-play replacement of current RF WiFi routers. The optical wireless system can be incorporated in an upgrade to cost-efficient LED room lighting which can save schools and public libraries significant energy dollars.

The hard-wiring and/or optical projects should be completed within five years from when the federal funding (e.g., through the FCC's E-Rate program for telecommunications and IT in schools and public libraries) is procured.

***RECOMMENDATION 5- Signal strength measurements must be collected at all wireless facilities as part of the commissioning process and as mandated by state or municipal ordinances. Measurements are also to be collected when changes are mode to the system that might affect its radiation, such as changes in the software controlling it. Signal strength is to be assessed under worst-cose***

***conditions in regions surrounding the tower that either are occupied or ore accessible to the public, and the results of the data collection effort is to be mode ovailable to the public via a website. In the event that the measured power for a wireless facility exceeds radiation thresholds, the municipality is empowered to immediately have the facility taken offline. The measurements are to be carried out by an independent contractor and the cost of the measurements will be borne by the site installer.*** It is recognized that theoretical calculations show that existing FCC guidelines will be met by standard cell tower configurations. However, there are cases where the radiation from towers can be focused by buildings, terrain, and beamforming antennas, causing signal levels to be considerably higher than would be expected in theoretical calculations unless those effects are taken into account. Collecting field measurements provide the only valid approach for determining whether exposure guidelines have been met. It is to be noted that some municipalities (e.g., the town of Burlington, MA [1]) have ordinances requiring measurements at cell towers.

Federal law and NH law grant to municipalities the power to enact zoning rules regulating the placement of personal wireless service facilities within the geographic boundaries of the municipalities. Municipalities should be proactive in this area and, through the exercise of zoning power, establish where, how, and a process for compliance with existing FCC guidelines for signal strength in the surrounding coverage area. Municipalities should establish a hierarchy of siting values and compliance acknowledgements so that the siting most favored by the municipality is the easiest siting for the wireless applicant to obtain and, conversely, the siting which is least desirable should be the most difficult siting for the applicant to obtain. The zoning ordinance should lay out the compliance requirement as part of the zoning approval.

[1] Burlington, MA zoning Bylaw Wireless Facilities section 8.4.6.2 - "Annual RF emissions monitoring is required for all sites by an independent RF engineer to be hired with Planning Board approval and at the applicant's expense. Test results will be submitted to the Town as soon as available, and not later than the close of the calendar year. Annual testing of electromagnetic emission shall be required to ensure continual compliance with the FCC regulations."

***Recommendation 6- Establish new protocols for performing signal strength measurements in areas around wireless facilities to better evaluate signal characteristics known to be deleterious to humon health as has been documented through peer-reviewed research efforts. Those new protocols are to take into account the impulsive nature of high-data-rate radiation that a growing body of evidence shows as having a significantly greater negative impact on human health than does continuous radiation. The protocols will also enable the summative effects of multiple radiation sources to be measured.*** Contemporary approaches to performing signal level measurements do not provide a means to evaluate signal impulsiveness or the contribution of multiple radiation sources because of equipment limitations. The measurement protocols proposed will employ wideband equipment that is currently available but is not typically used to measure compliance with radiation safety limits. References that address the deleterious effects of impulsive radiation on organisms are given in Appendix J. The development of the proposed protocols should be funded by the appropriate federal agency (e.g., NSF, NIH, FCC, etc.) and should be facilitated by New Hampshire's federal delegation.

***RECOMMENDATION 7- Require that any new wireless antennae located on a state or municipal right-of-way or on private property be set back from residences, businesses, and schools. This should be enforceable by the municipality during the permitting process unless the owners of residences, businesses, or school districts waive this restriction.*** Local public rights-of-way are under the jurisdiction of municipalities, and the Commission feels that municipalities should uphold the rights of individuals impacted by antennae. The Commission also supports the right of property owners to manage decisions on non-essential devices being placed in front of their property.

The Commission believes that it is important to prioritize citizen safety, particularly as 5G is an upgrade, rather than the provision of wireless service to unserved areas. Additional rationale for this recommendation is shown in Appendix K.

***RECOMMENDATION 8- Upgrade the educational offerings by the NH Office of Professional Licensure and Certification (OPLC) for home inspectors to include RF intensity measurements.*** Home inspectors currently operate as private contractors who may be hired by citizens or enterprises to measure such things as

radon, to collect water quality samples, or search for mold or insect damage. Home inspectors routinely supply test results to both their clients and government entities.

The majority of the Commission believes the public has the right to discover, on a voluntary basis, the RF power intensity related to radio frequencies at a property which they will be purchasing or renting before the transaction is closed. Also, the proprietors of publicly accessible venues may wish to reassure the public about the RF power intensity within their establishments, by posting the data collected by a state-approved inspector. In addition, such testing should be paid for by the party requesting it and the testing itself should be performed by a professional who owns or rents the test equipment and has met the state requirements for training of home inspectors regarding RF measurements.

The majority of the Commission proposes that home inspectors be offered training by NH OPLC on how to measure on-site peak and 24-hour average RF intensities. Measurements of frequencies and intensities will be performed using low-cost equipment (such as GQ-390 meters). [Description of existing home inspector training offered for radon, mold, etc. may be seen at https://oplc.nh.gov/home-inspectors/index.htm]

***RECOMMENDATION 9- The State of New Hampshire should begin an effort to measure RF intensities within frequency ranges throughaut the state, with the aim of developing and refining a continually updated map of RF exposure levels across the state using data submitted by state-trained home inspectors.*** The data should be collected in such a way as to identify geographic areas of notably high RF exposure, places where RF signal for wireless communication is inadequate (dead spots), and places where RF is unusually low (white spots) sought by people who wish to minimize their RF exposure. One possible use of this data will be buyers/renters of property or the public, in general, using benchmark values to make comparisons and make their own decisions based on their comfort level with RF exposure. After a while, an extensive New Hampshire RF database will exist to provide useful maps and data for future public health investigations. Appendix L outlines in more detail the technical aspects of this recommendation.

***RECOMMENDATION 10- Strongly recommend all new cell phones and all other wireless devices sold come equipped with updated software that can stop the phone from radiating when positioned against the body.*** The Commission has been made aware that cell phones contain proximity sensors that will allow a cell phone to only radiate signals when a certain distance from the body, for example, held in the fingers or placed on a table. This does not change the functionality of the device, only the way it is used, specifically not held against the head or body. Implementation is a software update in the cell phone, as these phones already have a proximity detector to turn off the screen and soft keys when an obstacle is present. With this change, the screen and the RF circuit are automatically turned off. This removes the problems of brain cancers (glioblastomas and acoustic neuromas) and the issue of SAR limits for the industry. See Appendix M for more detailed references to the science behind this recommendation. Cell phones should come set with this inhibition, with instructions in the manual on how to disable it. There should be a soft button on the unit to easily re-enable the radiation inhibition, for example if the unit is handed to a child. In all cases, it should be easier to enable the restriction than to disable it. Cellular phones marketed specifically for children should stop radiating when positioned against the body under all circumstances. The installation of such proximity sensors is also encouraged in laptops and tablets.

***RECOMMENDATION 11- Promote and adopt a statewide position that would strongly encouroge moving forward with the deployment of fiber optic cable connectivity, internal wired connections, and optical wireless to serve all commercial and public properties statewide.*** The majority of the Commission believes that fiber optic transmission is the infrastructure of the future. When compared, RF wireless transmission lacks fiber optic characteristics: speed, security, and signal reliability while avoiding biological effects on humans and the environment.

The State should encourage partnerships between towns to make this happen and encourage our federal delegation to support grant money to assist with such deployments when it comes to funding fiber optic cable deployment, especially in rural locations.

***RECOMMENDATION 12- Further basic science studies are needed in conjunction with the medical community outlining the characteristics of expressed clinical symptoms related to radio frequency radiation exposure.*** Further studies are just beginning to explore the quantum mechanical mechanisms which are the fundamental basis for understanding the biological changes occurring during the interaction of radio frequency radiation and molecules. These mechanisms can affect cells, tissues, and whole organs, as well as accumulate over time.

The majority of the Commission feels the medical community is in the ideal position to clarify the clinical presentation of symptoms precipitated by the exposure to radio frequency radiation consistent with the Americans with Disabilities Act (ADA) which identifies such a disability. The medical community can also help delineate appropriate protections and protocols for affected individuals.

All of these endeavors (basic science, clinical assessment, epidemiological studies) must be completely independent and outside of commercial influence.

***RECOMMENDATION 13- Recommend the use of exposure warning signs to be posted in commercial and public buildings. In addition, encourage commercial and public buildings, especially healthcare facilities, to establish RF-radiation free zones where employees and visitors can seek refuge from the effects of wireless RF emissions.*** Many NH citizens report sensitivity to electromagnetic radiation emitted from devices used in the delivery of in-building cellular and fixed wireless services. A majority of the Commission suggests that owners of commercial and public buildings, especially healthcare facilities, voluntarily place signage at entrances concerning RF-levels and RF-free zones within these structures so those entering the building are aware.

***RECOMMENDATION 14- The State of New Hampshire should engage agencies with appropriate scientific expertise, including ecological knowledge, to develop RF-radiation safety limits that will protect the trees, plants, birds, insects, and pollinators.*** The majority of the Commission understands that current federal safety limits were made with the intention of only protecting humans from short term effects, but not protecting flora or fauna from harm. The State of New Hampshire needs to ensure our natural environment and wildlife are protected by effective safety standards. Tree limbs, birds, and pollinators will be closer than

humans to 5G cell antennae and associated 4G densified infrastructure. In fact, the wireless radiation from cell antennae is very high in a plume surrounding the antennae. It could exceed FCC limits for several feet in this area, yet this is the exact area where leaves of trees, birds, and pollinators live. Thus, they may have higher exposures being in direct line of sight of wireless RF beams. When pollinators are impacted so are all forms of vegetation that depend on them for reproduction. Research on this issue is shown in Appendix N.

***RECOMMENDATION 15- The State of New Hampshire should engage our Federal Delegation to legislate that under the National Environmental Policy Act (NEPA) the FCC do an environmental impact statement as to the effect on New Hampshire and the country as a whole from the expansion of RF wireless technologies.*** Concern comes from the FCC projection that there will be numerous low orbit satellites and 5G small cell antennae, plus many additional macro towers required for these networks to function. The majority of the Commission is concerned that any new large-scale project that will densify antennae networks to this extent truly requires an environmental impact study. The NEPA statute requires that the agency consider environmental concerns in its decision-making process. NH should be provided documentation of such considerations. Until there is Federal action, NH should take the initiative to protect its environment.

## MINORITY REPORT

The following members, being unable to agree with the majority of the Commission, endorse this Minority Report:

Senator James Gray, David Juvet, and Bethanne Cooley

Contrary to the position taken in the Recommendations section, the science related to radiofrequencies, wireless devices, and health is well studied and well known: The consensus of the U.S. and international scientific community is that there are no known adverse health risks from the levels of RF energy emitted at the frequencies used by wireless devices (including cellphones) and facilities (including small cells). Some of those who presented to the NH 5G Commission have sought to sow confusion, but the facts demonstrate otherwise.[6] *First*, when setting limits for the RF emissions of wireless devices, the Federal Communications Commission ("FCC") intentionally provided a significant safety margin—50 times below the threshold at which adverse effects have been observed in laboratory animals.[7] And in its 2019 order, the FCC assessed the available science, including studies related to the safety of 5G networks, and based on the relevant scientific research, concluded that wireless devices and small cells are safe when they adhere to the FCC's current RF exposure limits, as required by law. *Second*, numerous, independent analyses of peer-reviewed studies conducted over several decades by national and international organizations conclude that there are no known health risks to humans from RF

[6] Commission discussions indicated that the Commission was comprised of many individuals who had preconceived opinions about the safety of RF devices and wireless technology in general. Due to many factors, experts in favor of wireless technology were cut short in participating. For example, an additional expert in favor of wireless technology was offered as a speaker during the summer and the Commission indicated no additional experts would be permitted. However, after that request was denied, an "expert" opposed to RF devices and wireless technology spoke at a subcommittee meeting of the majority. In addition, the Commission heard only a portion of expert Eric Swanson's testimony and failed to consider in a balanced fashion the well-developed reviews of the science from the U.S. and international health and safety organizations. Thus, in this report we have cited those authorities even though the Commission did not include them as part of the formal record.

[7] The threshold for adverse effects was set at the level at which heating caused a "disruption of observable behavior" in animals. *See Proposed Changes in the Commission's Rules Regarding Human Exposure to Radiofrequency Electromagnetic Fields*, First Report and Order, Further Notice of Proposed Rulemaking, and Notice of Inquiry, 28 FCC Rcd. 3498, 3582 ¶ 236 (2013) ("FCC NOI") ("exposure limits are set at a level on the order of 50 times below the level at which adverse biological effects have been observed in laboratory animals as a result of tissue heating resulting from RF exposure"); IEEE Standard for Safety Levels with Respect to Human Exposure to Electric, Magnetic, and Electromagnetic Fields, 0 Hz to 300 GHz, IEEE Std C95.1-2019, Annex B Sec. B.5.3.3 and Annex C Sec. C.2.1 (2019) ("Typically, the effect observed has been a decreased rate of responding or decreased reaction time.").

energy emitted by wireless devices and infrastructure. Thus, the scientific consensus as evaluated by experts, international standard-setting bodies, and federal health and safety agencies is that wireless devices and base stations at the FCC's RF exposure levels is safe.

Given the scientific consensus, it is our opinion that the Recommendations exceed what a reasonable response should be to the evidence on this issue. This Minority Report purposely chose not to highlight each recommendation but instead highlights findings from federal agencies, including the FCC and the Food and Drug Administration (FDA), studies conducted by leading international and national health organizations, the IEEE and the scientific community at-large. It will also note the federal preemption issues associated with the Recommendations. Given the scientific consensus, it is our opinion that the Recommendations have no basis in scientific fact, are irresponsible, and will subject the state and any localities implementing these Recommendations to needless and expensive challenges that will drain time and resources from more important and credible priorities.

**THE FCC SAFETY REGULATIONS**

FCC limits govern RF energy from antennas used in all wireless devices including cellular transmissions from cellphones, cell towers, and 5G small cells. The FCC based these limits on recommendations from the scientific community and expert non-government organizations; the FCC limits currently cover frequencies from 100 kHz to 100 GHz, including the "millimeter wave" or "mmW" frequencies.[8] These guidelines—based on internationally-recognized scientific organizations—set limits for the maximum amount of RF exposure from wireless devices and include a significant margin of safety.[9] Specifically, the FCC has set its limit for a consumer device's Specific Absorption Rate—the measurement for RF emissions for consumer devices such as cellphones—"at a level on the order of *50 times below* the level at which adverse biological effects have been observed in laboratory animals."[10] The agency explained that this 50-fold factor can well

[8] NPRM, 34 FCC Rcd at 11742 ¶ 120.
[9] Testimony of Christopher C. Davis, Professor of Electrical and Computer Engineering, University of Maryland, *Hearing on S.B. 637 and S.B. 894 Before the Mich. H. Comm. on Energy Policy*, 2018 Leg., 99th Sess., at 4:17 (May 29, 2018) ("Professor Davis Testimony"), http://www.house.mi.gov/SharedVideo/PlayVideoArchive.html?video=ENER-052918-2.mp4.
[10] FCC NOI at ¶236 (emphasis added).

accommodate a variety of variables such as different physical characteristics and individual sensitivities—and even the potential for exposures to occur in excess of [FCC] limits without posing a health hazard to humans."[11] In reality, wireless devices and antennas typically operate well under FCC thresholds.[12]

Further, all wireless devices sold in the U.S. must go through a rigorous approval process to ensure they meet the science-based guidelines set by the FCC.[13] The FCC's testing regime requires cellphones to be tested under "the *most severe, worst-case (and highest power) operating conditions for all the frequency bands* used in the USA for that cell phone" to ensure that they meet the limits under everyday (non-worst-case) conditions.[14] The FDA stands in full support of the adequacy of the FCC's standards. The Director of the FDA's Center for Devices and Radiological Health wrote in 2018: "[B]ased on our ongoing evaluation of this issue and taking into account all available scientific evidence we have received, ***we have not found sufficient evidence that there are adverse health effects in humans caused by exposures at or under the current radiofrequency energy exposure limits.***"[15]

## HEALTH ORGANIZATIONS AND FDA STUDIES

International health organizations have also studied the effects of RF exposure and determined that there is no risk from RF emissions from modern wireless device usage. The World Health Organization ("WHO") concludes "[c]onsidering the very low exposure levels and research results collected to date, there is no

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[11] *Id.*; *see also Targeted Changes to the Commission's Rules Regarding Human Exposure to Radiofrequency Electromagnetic Fields*, Resolution of Notice of Inquiry, Second Report and Order, Notice of Proposed Rulemaking, and Memorandum Opinion and Order, 34 FCC Rcd 11687, 11696 ¶14 (2019) ("Order") ("[O]ur existing exposure limits are set with a large safety margin, well below the threshold for unacceptable rises in human tissue temperature.").

[12] *See* Professor Davis Testimony (6:00-7:45) (discussing the 50-fold safety factor and typical emissions from small cells); Christopher C. Davis, Professor of Electrical and Computer Engineering, University of Maryland, *Hearing on S.B. 637 and S.B. 894 Before the Mich. H. Comm. on Energy Policy*, 2018 Leg., 99th Sess., Written Testimony at 2 (May 29, 2018), http://www.wirelesshealthfacts.com/wp-content/uploads/2019/06/Davis-Testimony.pdf (observing that "RF exposure levels from wireless base stations are invariably far below the FCC limits").

[13] *See generally* 47 C.F.R. § 1.1307; *id.* part 2 Subpart J; Order, 34 FCC Rcd at 11697-742 ¶¶ 17-118.

[14] FCC, Consumer Guides, Health, Safety and Emergencies, *Specific Absorption Rate (SAR) for Cell Phones: What It Means for You* (emphasis in original), https://www.fcc.gov/consumers/guides/specific-absorption-rate-sar-cell-phones-what-it-means-you (last updated Oct. 15, 2019).

[15] News Release, FDA, *Statement from Jeffrey Shuren, M.D., J.D., director of the FDA's Center for Devices and Radiological Health on the recent National Toxicology Program draft report on radiofrequency energy exposure* (Feb. 2, 2018) ("Shuren Statement"), https://www.fda.gov/news-events/press-announcements/statement-jeffrey-shuren-md-jd-director-fdas-center-devices-and-radiological-health-recent-national.

convincing scientific evidence that the weak RF signals from base stations and wireless networks cause adverse health effects."[16] The WHO has also concluded that "research has not been able to provide support for a causal relationship between exposure to electromagnetic fields and self-reported symptoms, or 'electromagnetic hypersensitivity'".[17] Likewise, both the United Kingdom Health Protection Agency Independent Advisory Group on Non-Ionizing Radiation and Swedish Council for Working Life and Social Research agree that RF exposure below guideline levels consistent with FCC limits do not cause health effects.[18]

The majority also justifies its recommendations by referencing "the problems of brain cancers (glioblastomas and acoustic neuromas) and the issue of specific absorption rate (SAR) limits for the industry." Some have raised questions with respect to cancer and tumors, but experts in cancer have repeatedly found no link between mobile devices and cancer. For example, the National Cancer Institute reported that: "although many studies have examined the potential health effects of non-ionizing radiation from radar, microwave ovens, cell phones, and other sources, there is currently no consistent evidence that non-ionizing radiation increases cancer risk in humans."[19] Likewise, the American Cancer Society explained that the "RF waves given off by cell phone towers don't have enough energy to damage DNA directly or to heat body tissues. Because of this, it's not clear how cell phone towers might be able to cause cancer."[20]

Earlier this year, the FDA released a large-scale review of published literature to

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[16] WHO, *Electromagnetic fields and public health: Base stations and wireless technologies*, Backgrounder (May 2006), https://www.who.int/peh-emf/publications/facts/fs304/en/.

[17] WHO, *Electromagnetic fields and public health: mobile phones*, Backgrounder (Oct. 8, 2014) ("*WHO Mobile Phones Fact Sheet*"), https://www.who.int/news-room/fact-sheets/detail/electromagnetic-fields-and-public-health-mobile-phones.

[18] *See* Health Protection Agency Independent Advisory Group on Non-Ionizing Radiation, *Health Effects from Radiofrequency Electromagnetic Fields* (RCE-20), at 3 (Apr. 2012), https://webarchive.nationalarchives.gov.uk/20140722075005/http://www.hpa.org.uk/webc/HPAwebFile/HPAweb_C/1317133827077 ("The evidence suggests that RF field exposure below guideline levels does not cause acute symptoms in humans, and that people, including those who report being sensitive to RF fields, cannot detect the presence of RF fields."); Anders Ahlbom, et al., Radiofrequency Electromagnetic Fields and Risk of Disease and Ill Health: Research during the last ten years, Swedish Council for Working Life and Social Research, at 6 (2012), https://forte.se/app/uploads/sites/2/2015/11/10-y-rf-report.pdf ("Extensive research for more than a decade ... has found no evidence for health risks below current exposure guidelines.").

[19] National Cancer Institute *Cell Phones and Cancer Risk*, (Jan. 9, 2019) https://www.cancer.gov/about-cancer/causes-prevention/risk/radiation/cell-phones-fact-sheet.

[20] American Cancer Society, Cell Phone Towers (emphasis omitted) ("*ACS Cell Phone Towers*"), https://www.cancer.org/cancer/cancer-causes/radiation-exposure/cellular-phone-towers.html (last visited October 7, 2020).

"assess any possible causal relationship between [RF energy] exposure and the formation of tumors."[21] After examining approximately 125 animal studies and 70 epidemiological studies, the FDA stated that "there are no quantifiable adverse health effects in humans caused by exposures at or under the current cell phone exposure limits."[22] As Dr. Jeffrey Shuren, Director of the FDA's Center for Devices and Radiological Health, observed in 2018: "Even with frequent daily use by the vast majority of adults, we have not seen an increase in events like brain tumors."[23] Courts too, after hearing extensive testimony, have determined that there is "no sufficiently reliable and relevant scientific evidence in support of either general or specific causation" that cellphone use caused the plaintiff's brain cancer.[24] Dr. Otis Brawley, chief medical officer of the American Cancer Society, explained that "[t]he incidence of brain tumors in human beings has been flat for the last 40 years. ... That is the absolute most important scientific fact."[25]

## THE SCIENCE AROUND EXPOSURES FROM 5G TECHNOLOGY

The majority has expressed concern with exposures from 5G technology using millimeter wave ("mmW") bands and on the proliferation of small cell network architecture, and whether there are studies demonstrating that 5G does not create risks to human health.

Although 5G represents a new frontier for wireless communications, mmW frequencies do not. mmW frequencies are well understood by the international scientific community. The Institute of Electrical and Electronics Engineers ("IEEE") has assembled a list of dozens and dozens of studies on mmW frequencies. The IEEE's RF exposure standards over the last thirty years have cited 85 different mmW studies, the earliest was published in 1976 and the most recent in 2018.[26]

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[21] FDA, *Review of Published Literature between 2008 and 2018 of Relevance to Radiofrequency Radiation and Cancer*, at 4 (Feb. 2020), https://www.fda.gov/media/135043/download.
[22] *Id.* at 5.
[23] Shuren Statement.
[24] *Newman v. Motorola, Inc.*, 218 F. Supp. 2d 769 (D. MD 2002), *aff'd per curiam Newman v. Motorola, Inc.*, 78 Fed.Appx. 292 (4th Cir. 2003); *see also Murray v. Motorola, Inc.*, Memorandum Opinion and Order on Expert Witness Admissibility, Case No. 2002 CA 001371 A (Aug. 8, 2014).
[25] Lauran Neergaard & Seth Borenstein, *Cross talk: Federal ogencies clash on cellphone cancer risk*, Associated Press (Nov. 1, 2018), https://apnews.com/4da5f1cdfd774af29143ff3f5ccffa0b; *see also* IEEE Std C95.1-2019 at 16 n.8 ("The preponderance of epidemiologic evidence does not provide a sufficient basis for concluding that adult brain cancer is positively associated with mobile telephone use and, by implication, with RF exposures.").
[26] CTIA, Resources, *Millimeter Wave Studies Cited by IEEE*, http://www.wirelesshealthfacts.com/wp-content/uploads/2020/01/Millimeter-Wave-Studies.pdf (last visited October 7, 2020).

Common equipment such as "airport scanners, automotive collision avoidance systems and perimeter surveillance radar security systems" all use mmW technology.[27]

Acting responsibly, scientists and engineers continue to research RF exposure, including RF exposure with 5G technology. IEEE's Committee on Man and Radiation just completed a comprehensive review of 5G systems concluding that, based on the evidence to date, "the likelihood of yet unknown health hazards at exposure levels within current limits to be very low, if they exist at all."[28] The authors explained that "one can expect that exposures from 5G networks will not differ greatly from those associated with present generation networks" because, like "previous generations of cellular systems: [5G must] provide a signal that is strong enough to be useful within a given cell but not so strong as to cause interference to users in nearby cells."[29] In other words, 5G base stations are limited in their power because of the potential for those emissions to cause interference with other base stations.

The American Cancer Society explained that "[w]hile [5G] RF waves are higher frequency (higher energy) than those used by older generations, they are still forms of non-ionizing radiation, so they still lack the ability to directly damage DNA."[30] Further, "these higher frequency RF waves are less able to penetrate the body than lower frequency waves, so in theory they might be less likely to have any potential health effects."[31]

5G will also take advantage of small cell network architecture, which results in more base stations operating at *lower* power levels. A recent overview of exposure from small cells determined that such "[f]ixed small cell wireless communication installations ... that operate in compliance with the regulations of the FCC will produce RF exposures well within the recommended exposure limits of the FCC, ICNIRP [International Commission on Non-Ionizing Radiation Protection], and IEEE."[32] Further, "[r]esearch to date does not provide a reliable

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[27] Joan Conrow, *Three reasons why 5G is unlikely to cause harm*, Cornell Alliance for Science, (June 26, 2020), https://allianceforscience.cornell.edu/blog/2020/06/three-reasons-why-5g-is-unlikely-to-cause-harm/.
[28] *Id.*
[29] *Id.*
[30] *ACS Cell Phone Towers*
[31] *Id.*
[32] William H. Bailey, *Wireless 5G Radiofrequency Technology: An Overview of Small Cell Exposures, Standards and*

scientific basis to conclude that the operation of these facilities will cause or contribute to adverse health effects in the population."[33]

In March 2020, ICNIRP released updated, modernized guidelines that expressly cover the new frequencies that 5G will use. Announcing their release, ICNIRP Chairman, Dr. Eric van Rongen, advised that "[t]he most important thing for people to remember is that 5G technologies will not be able to cause harm when these new guidelines are adhered to."[34] The FCC's rules are also designed to protect health and safety, and prevent harm. Indeed, the FCC notes that "the possibility that a member of the general public could be exposed to RF levels in excess of the FCC guidelines is extremely remote."[35]

**FEDERAL PREEMPTION**

The majority makes several recommendations related to mandated warnings, labeling, compliance regulations, and zoning requirements based on health and safety concerns. These recommendations are not warranted based on the science discussed above, but are also not viable because federal law preempts state and local action that conflicts with the FCC's determination that compliant devices and equipment are safe. Congress determined that the FCC should be the "central[] authority" for regulating communications in the U.S.[36] This charge includes the regulation of "the kind of apparatus to be used" for wireless radio communications and "the emissions" that such equipment may produce.[37] The FCC promulgated its RF exposure rules to ensure that they protect human health nationwide as technology evolves, relying on sound scientific research of government and other expert organizations.

The FCC acted in its role as, in the words of the Supreme Court, the "exclusive"

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*Science*, at 7, Exponent (Apr. 2020), http://www.wirelesshealthfacts.com/wp-content/uploads/2020/04/Bailey-5G-Whitepaper-4-15-20.pdf.

[33] *Id.*

[34] Media Release, International Commission on Non-Ionizing Radiation Protection, *New Guidelines Released by the International Commission on Non-Ionizing Radiation Protection (ICNIRP)*, at 2 (Mar. 11, 2020), https://www.icnirp.org/cms/upload/presentations/ICNIRP_Media_Release_110320.pdf.

[35] FCC Consumer Guide, *Human Exposure to Radio Frequency Fields: Guidelines for Cellular Antenno Sites*, at 2 (Oct. 15, 2019), https://www.fcc.gov/sites/default/files/human_exposure_to_radio_frequency_fields_-_guidelines_for_cellular_antenna_sites.pdf.

[36] 47 U.S.C. § 151.

[37] *Id.* § 303(e).

arbiter in the "technical matters" of radio,[38] which includes control for any environmental effects, including, among other things, RF emissions.[39] For example, the FCC recognized that "very high levels of RF radiation can be harmful due to the ability of RF energy to heat biological tissue rapidly."[40] Accordingly, the FCC's rules *limit* RF exposure to humans "from *all* transmitting facilities, operations, and devices it regulates."[41]

By way of background, the FCC first adopted RF exposure rules in the 1980s and has updated its rules in response to new scientific evidence.[42] In 1996, Congress reaffirmed the FCC's authority to set standards on RF emissions to provide "adequate safeguards of the public health."[43] The FCC updated its RF exposure rules and relied on sound scientific research of government and other expert organizations. In particular, the FCC synthesized "submissions from the Environmental Protection Agency ("EPA"), the Food and Drug Administration ("FDA"), the Occupational Safety and Health Administration ("OSHA"), and the National Institute for Occupational Safety and Health ("NIOSH")."[44] Several courts have examined and affirmed the FCC's process to develop its RF exposure limits.[45] The Third Circuit observed that "the FCC is well positioned to solicit expert opinions and marshal the scientific data to ensure its standards both protect the public and provide for an efficient wireless network."[46] And courts have confirmed that the agency has done so. For example, the D.C. Circuit upheld the

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[38] *Head v. New Mexico Bd. of Exam'rs in Optometry*, 374 U.S. 424, 430 n.6 (1963) (observing that the "Commission's jurisdiction over technical matters ... is clearly exclusive").

[39] *Robbins v. New Cingular Wireless LLC*, 854 F.3d 315, 319-20 (6th Cir. 2017) (noting that Congress "delegate[ed] the task of setting RF emission levels to the FCC"). Of course, government entities can and have participated in the notice-and-comment aspect of the FCC's rulemaking. *See, e.g.*, City of Boston, Massachusetts, ET Docket No. 19-226 (filed June 17, 2020).

[40] FCC, RF Safety FAQ, *What Biological Effects Can Be Caused By RF Energy?*, https://www.fcc.gov/engineering-technology/electromagnetic-compatibility-division/radio-frequency-safety/faq/rf-safety#Q5 (last visited October 7, 2020).

[41] Letter from Thomas M. Johnson, Jr., General Counsel, FCC, to Joseph H. Hunt, Assistant Attorney General, DOJ, N.D. Cal. No. C 19-05322 WHA, at 3 (Apr. 13, 2020) (citing 47 C.F.R. §§ 1.1307, 1.1310, 2.1091, 2.1093) (emphasis added), https://docs.fcc.gov/public/attachments/DOC-363717A1.pdf.

[42] Letter from Thomas M. Johnson, Jr. General Counsel, FCC, to Joseph H. Hunt, Assistant Attorney General, DOJ, N.D. Cal. No. 3:15-cv-02529 EMC, at 3-5 (June 22, 2020) (examining the adoption and evolution of the Commission's RF exposure rules).

[43] *Id.* at 4-5 (quoting H.R. Rep. No. 204, 104th Cong., 1st Sess. Pt. 1, at 94 (1995)).

[44] *Cellular Phone Taskforce v. FCC*, 205 F.3d 82, 88 (2d Cir. 2000).

[45] *See, e.g., id.* at 89 (rejecting an APA challenge to the FCC's RF emissions decisions in the 1996 and 1997 proceedings).

[46] *Farina v. Nokia Inc.*, 625 F.3d 97, 126 (3d Cir. 2010); *see also id.* at 129 (confirming the Commission's expertise to select an appropriate standard for RF limits).

agency's reliance on the views of expert agencies.[47]

Every court since 2005 that has addressed this issue has held that federal law preempts state action that challenges the safety of wireless devices including zoning decisions based on safety concerns. The Telecommunications Act itself has an express preemption provision that prohibits state or local regulation of cellular equipment based on alleged health effects.[48] Courts have also struck down state law regulation of RF emissions from cell phones based on alleged health effects as impliedly preempted by the FCC's regulation.[49] And most recently, a United States District Court in the Ninth Circuit held that federal law preempts the City of Berkeley's Ordinance requiring warnings at the point of sale.[50] Preemption, therefore, would invalidate many of the Recommendations, which if adopted, would subject the state and localities to expensive challenges and litigation, and almost certain defeat.

The minority does not oppose individuals or communities who want to convert to technology that better suits their needs, so long as those decisions do not conflict with the FCC's goal of the rapid deployment of wireless technology. We also do not oppose communities providing individuals with information about how to reduce their exposure to RF emissions, consistent with what the FCC already does. While individuals should have access to equipment to measure the levels in apartments they are contemplating renting or homes they want to purchase, testing should not be mandated. Access to the testing or the equipment to conduct the test could be provided by various groups such as home inspectors, real estate agents and the county cooperative extension. Similarly, we do not agree to establishing a State funded oversight group or state funding of the measurement equipment. Nor do we believe, as a practical matter, that any of

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[47] *EMR Network v. FCC*, 391 F.3d 269, 272-73 (D.C. Cir. 2004).

[48] 47 U.S.C. § 332(c)(7)(b)(iv); *See, e.g., Cellular Phone Taskforce*, 205 F.3d at 96 (interpreting the TCA to preempt a state and local government's power to regulate the placement, construction and modification of personal wireless services facilities on the basis of health effects of RF emissions); *Santa Fe Alliance for Public Health and Safety v. City of Santa Fe, N.M.*, 2020 WL 2198120, at *7 (D.N.M. May 6, 2020) (noting the TCA explicitly preempts states and local governments from considering environmental effects of RF emissions in siting decisions).

[49] *Farina*, 625 F. 3d at 129 ("there is no indication . . . that either Congress or the FCC traditionally viewed state regulation of RF emissions as a necessary complement to federal regulation"); *Murray v. Motorola, Inc.*, 982 A.2d 764, 777–778 (D.C. 2009) ("insofar as Plaintiffs' claims rest on allegations about the inadequacy of the FCC's RF radiation standard or about the safety of their FCC-certified cell phones, the claims are preempted under the doctrine of conflict preemption.").

[50] *CTIA – The Wireless Association v. City of Berkeley*, No. 15-cv-02529-EMC, 2020 WL 5576135 (N.D. Cal. Sept. 17, 2020) (holding the Berkeley Ordinance "overwarns and stands as an obstacle to the accomplishment of balancing federal objectives by the FCC.").

the Recommendations have any chance of receiving funding.

The minority feels strongly that the full body of literature of the science on wireless technology was ignored. Furthermore, the Commission neglected to carry out its mandate to study "...the advantages and risks associated with 5G technology."[51] Had this been done, the Commission would have been made aware of the significant economic and societal benefits that 5G is predicted to provide.[52] The minority has strong concerns that should the majority's conclusions regarding 5G safety – despite their complete odds with the overwhelmingly majority of verified scientific evidence – lead to the enactment of any of the majority's recommendations, the citizens of New Hampshire would be deprived of the enormous benefits of wireless innovation in a time when wireless connectivity could not be more important.

[51] See HB 522: http://gencourt.state.nh.us/bill_Status/billText.aspx?sy=2019&id=267&txtFormat=pdf&v=current (last visited October 14, 2020).

[52] Accenture predicts deploying the next generation of high-speed 5G wireless networks could create up to three million jobs and add approximately $500 billion to U.S. GDP through direct and indirect potential benefits, https://newsroom.accenture.com/content/1101/files/Accenture_5G-Municipalities-Become-Smart-Cities.pdf (last visited October 14, 2020).

City of Keene
*Transmittal Form*

January 12, 2021

**TO:** Planning, Licenses and Development Committee

**FROM:** Lori Schreier

**THROUGH:** Patricia A. Little, City Clerk

**ITEM:** 3.

**SUBJECT:** Lori Schreier - Relating to Small Cell Wireless Facility Deployments in Public Rights-of-Way

ATTACHMENTS:
Description
Communication_Schreier

**BACKGROUND:**
Lori Schreier is commenting on the final report released by the NH Commission to Study the Health and Environmental Effects Evolving 5G Technology and she is suggesting language changes to Ordinance O2019-18-A (which was originally provided as an attachment to Councilor Clark's communication).

To: Mayor Hansel, Keene City Council and Planning, Licensing and Development Committee
From: Lori Schreier, 916 River Road Westmoreland, NH 03467
Date: January 12, 2021

Re: In Support of Proposed Amendments to 0-2019—18-A, Related to Small Wireless Facility Deployments in the Public Rights- of- Way

On November 1, 2020 the New Hampshire Commission to Study the Health and Environmental Effects of Evolving 5G Technology released its final report (hereinafter referred to as the report) to the Legislature and Governor. The Commission did an extensive study of the large body (thousands) of peer reviewed research showing deleterious effects to human health, especially children, animals, insects and plants, from radio frequencies emitted from wireless radiation. The harm is likely to be much worse from exposure to the higher frequencies of 5G small cells, which can emit pulsed, beam formed signals close to people's homes and businesses when deployed in the public rights of way. The report also identifies earlier generation 4G wireless, as posing concerns, especially when 4G will be deployed with 5G in small cells, when they will later be upgraded to 5G through a software update. This is why I added 4G and above small cells to the proposed Ordinance amendments.

The report made 15 specific recommendations, which yield to the precautionary principle, and " ….to bring about greater awareness of cell phone, wireless and 5G radiation health effects and to provide guidance to officials on steps and policies that can reduce exposure." (report on p.8) It is my hope that the Keene City Council will heed the advice of the Commission report and further strengthen its small cell Ordinance to protect the public welfare and interests.

To that end, utilizing the Commission's recommendations, its answers to 8 of its mandated specific questions, and research from model codes of this nature, I prepared suggested amendments as track changes to the Ordinance (see attached word document) that I believe will enhance its benefits to the citizens of Keene. Below I attempt to answer two questions 1) how do the proposed amendments align with the intent and specific report recommendations and 2) can they be adopted with minimal legal risk. To guide my answers to the second question I refer to sources with remarks from two seasoned telecommunications

attorney's, Andrew Campanelli, and Mark Del Bianco. However, actual legal implications can only be decided by your own City Attorney.

**Increased Insurance protection** – I propose increased insurance, general liability rather than indemnification, and without a pollution exclusion. The report in Appendix C, pages 46-49 clearly outlines the evidence that insurers "classify 5G mobile networks as "off-the-leash" "HIGH" risk, " meaning a high impact emerging risk that will affect property and casualty claims." Also. the report acknowledges insurers concerns that an increase in electromagnetic fields are only likely to increase creating an uptick in liability claims. Since insurers generally categorize electromagnetic fields as a pollutant it would be necessary to require NO pollution exclusion to be sure lawsuits alleging damage from electromagnetic fields are covered. How will the City of Keene choose to protect its citizens and financial assets? To my knowledge, and as suggested by telecom attorney, Andrew Campanelli, (transcript page 3-4) the Telecommunications Act does not limit the ability of a municipality to protect itself with insurance from potential hazards caused by telecommunications installations.

**Setbacks and Spacing of Small Cells**. I propose increasing the setbacks of small cell placement from other small cells, from residences, schools, churches, parks, senior centers, hospitals, fire and police stations, etc. The report on page 13, Recommendation 7 states

"Require that any new wireless antennae located on a state or municipal right-of-way or on private property be set back from residences, businesses, and schools. This should be enforceable by the municipality during the permitting process unless the owners of residences, businesses, or school districts waive this restriction. Local public rights-of-way are under the jurisdiction of municipalities, and the Commission feels that municipalities should uphold the rights of individuals impacted by antennae. The Commission also supports the right of property owners to manage decisions on non-essential devices being placed in front of their property. The Commission believes that it is important to prioritize citizen safety, particularly as 5G is an upgrade, rather than the provision of wireless service to unserved areas. Additional rationale for this recommendation is shown in Appendix K. "

Appendix K discusses how 5G small cells in the public rights of way means increased power density exposures which are more irregular due to beam forming and that they will originate from multiples sources. Furthermore, the report recommends that "best engineering practices would therefore apply a set-back requirement for new cellular towers, including 5G micro-towers" and then adds

that “setback for all new cell towers should be 500 meters which translates to 1,640 feet.” Report at page 99-100.

The FCC Order of 2018 regarding small cells does not dictate what setbacks and spacing are acceptable. It does say that substantial evidence must show that the requirements are reasonable and objective, are specified in the ordinance with advance notice and that they do not effectively prohibit the service.

As an example, telecom attorney Andrew Campanelli stated in a public webinar (transcript on page 1) that adverse aesthetic impacts and reduction in property values on someone’s private property, either because a small cell tower is too close to their home or in view of their home is a valid reason to deny an application. I would think that similarly, one could argue that laying out the setbacks ahead of time proactively addresses these issues.

Regarding spacing between small cell towers, telecom attorney Mark Del Bianco, in a memo for Next Century Cities (at p. 5) , has stated that the FCC Order of 2018 considers spacing requirements to be a subset of aesthetics requirements and gives no guidance on what might be a reasonable spacing distance.

**Warning Labels on Small Cells**. The proposed amendments for warning labels are in line with Recommendation 3 in the report.

“RECOMMENDATION 3- Require every pole or other structure in the public rights of-way that holds a 5G antenna be labeled indicating RF-radiation being emitted above. This label should be at eye level and legible from nine feet away. In the view of the Commission, the State of New Hampshire has the right to warn the public of potential harm of 5G antennae deployed in the public rights-of-way. Large cell towers all currently have fencing around them at their base to protect the public. This will not be the case with small cell towers or any pole with an antenna on top in the public right-of-way. These public rights-of-way are the jurisdiction of our municipalities and not of the Federal Government. The Telecommunication Act of 1996 did not contemplate antennae being placed on the public rights-of way of municipalities. Thus, the State of New Hampshire has the right to warn the public by requiring the owners of these antennae to inform the public of potential harm from RF-radiation.”

**Requirement to show gaps in service.** I have proposed that applications for 5G small cells should show a gap in wireless service, especially in residential areas, before being approved.

The report makes an indirect reference to gaps in service by saying this - "The Commission believes that it is important to prioritize citizen safety, particularly as 5G is an upgrade, rather than the provision of wireless service to unserved areas." (report on p. 13).

Again, based on attorney Andrew Campanelli's opinion, (at p. 8) a locality has every right to require a wireless provider that wants to put a wireless facility in a residential area, to show a significant gap in personal wireless services, that the proposed installation is the least intrusive means affirming that gap, and there's no potential less intrusive alternative locations.

**Measurement of Signal Strength to Show Compliance with FCC Radio Frequency Exposure Limits**. The amendments propose testing radio frequencies for small cell installations as per report Recommendations 5 and 6.

Recommendation 5 states: "Signal strength measurements must be collected at all wireless facilities as part of the commissioning process and as mandated by state or municipal ordinances. Measurements are also to be collected when changes are made to the system that might affect its radiation, such as changes in the software controlling it. Signal strength is to be assessed under worst-case conditions in regions surrounding the tower that either are occupied or are accessible to the public, and the results of the data collection effort is to be made available to the public via a website. In the event that the measured power for a wireless facility exceeds radiation thresholds, the municipality is empowered to immediately have the facility taken offline. The measurements are to be carried out by an independent contractor and the cost of the measurements will be borne by the site installer."

The report recommends that municipalities be proactive in this area through the exercise of their zoning power since field measurements are the only way for determining whether exposure guidelines have ben met.

Attorney Campanelli (at p. 3) says "As a general rule the FCC never ever tests, and never requires the owners to test them. So local governments are the first and only line of defense against their constituents being exposed to illegally excessive levels of radiation emanating from wireless facilities in their jurisdiction."

It is important to note that even f compliance is met this does not ensure safety, since FCC standards do not take into account non thermal effects of radiation at the biological level.

An important note about **Non-Discrimination Requirements**. This is a common concern that needs clarification. According to attorney, Mark Del Bianco in his memo to the Next Century Cities organization regarding the FCC Small Cell Order of 2018, municipalities do not need to treat wireless carriers the same as they treat electric companies, cable companies and other utilities. It bears quoting his remarks here.

"Does the Order impose non-discrimination requirements, i.e., does it require municipalities to treat wireless carriers the same as they treat electric companies, cable companies or other utilities? No. The non-discrimination requirements identified in the Order are the FCC's interpretations of the language of Sections 253 and 332(C)(7), and are limited in scope. Section 253(a) addresses only state or local government actions (including discrimination) that effectively prohibit "any interstate or intrastate telecommunications service," while Section 332(c)(7)(B)(i)(II) is even narrower: only actions that effectively prohibit "personal wireless services," which is a small subset of telecommunications service. Thus, Section 253 only limits discrimination between providers of "telecommunications service," and the only type of discrimination that could potentially be problematic under Section 332(C)(7) would discrimination between "competing wireless services." Therefore, the Order does not (and the FCC could not) prohibit discrimination in fees, aesthetic requirements and application requirements as between wireless carriers and companies that do not provide "telecommunications service," a category that includes not only traditional utilities, but also cable companies and even wireline broadband Internet access providers (which under current FCC rules are not providers of telecommunications services). " Page 11

Thank you for considering these important changes to the Keene Ordinance.

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City of Keene
*Transmittal Form*

January 11. 2021

**TO:** Planning, Licenses and Development Committee

**FROM:** Herman Kelting, PhD

**THROUGH:** Patricia A. Little, City Clerk

**ITEM:** 4.

**SUBJECT:** Herman Kelting - Relating to Small Wireless Facility Deployments in Public Rights-of-Way

ATTACHMENTS:
Description
Communication_Kelting

**BACKGROUND:**
This communication from Herman Kelting is commenting on the Radio Frequency Compliance Report as contained in Ordinance O-2019-18-A.

To: Keene New Hampshire City Council, PLD Committee meeting January 13, 2020

From: Herman Kelting PhD

Date: January 11, 2020

I. The purposes of this e-mail

I wish to comment on the following paragraph in Ordinance O-2019-18-Article VIII. Small Cell Wireless Facility Deployments in the Public Rights of Way."

> "f. Radio Frequency Compliance Report. The applicant shall submit a Radio Frequency (RF) exposure compliance report that certifies that the proposed SWF will comply with applicable federal RF exposure standards and exposure limits." [p. 8]

FCC regulations provide safe antennae limits between 6,000,000 to 10,000,000 $\mu W/m^2$ which are preposterously high power densities; much lower power densities have been shown to cause harm to living organisms. The standards of the Building Biology Institute recommend ten (10) $\mu W/m^2$ safe for sleeping and 1,000 $\mu W/m^2$ are an extreme anomaly. Based upon my research and personal observations, I am in agreement with the Building Biology Institute standards.

In the following sections of this e-mail, I will show that:

- RFR causes harm to living organisms at generally lower than FCC antenna safety limits.
- RFR causes harm at specific lower PD limits;
- High school and college students are facing increased anxiety, stress, depression, and suicides since 2008.
- Barrie Trower, a UK weapons expert, has predicted only one baby in eight will be born normal, if 5G/4G is installed in urban areas.
- Species have been extinguished over several generations at lower-than-FCC PD safety limits.
- Cell phones should be used sparingly, Wi-Fi should not be used in buildings, and hard-wired routers and Ethernet cables should be used as an alternative to Wi-Fi.
- 5G/4G Small Cell Antennas should not be permitted because of high and perhaps uncontrollable[1] power densities, lack of reasonably priced meters to measure their radiation, and near certainty of harm to living organisms.
- RFR is known to damage the immune system making RFR one of the links to increased severity of the CoronaVirus.

I invite comments to this e-mail and will issue revisions as necessary.

[1] "uncontrollable" refers to outside-of-planned operation and transmission requiring daily metering by nearby residents. I make this observation as a manufacturing engineer and observing consistent errors in manufacturing process; RFR antenna are the result of manufacturing processes.

## II. Abbreviations

CPs: Cell phones

EFs: Electric fields

FAA: Federal Aviation Agency

FCC Federal Communication Commission

MCPBSs: Macro Cell Phone Base Stations generally 4G and lower technology.

MFs: Magnetic Fields

NIH: National Institute of Health.

PD: Power density

RFR: Radio Frequency Radiation measured by power density in micro Watts per square meter ($\mu W/m^2$). RFR is composed of EFs and MFs joining at about three wave lengths at the beginning of the far field, which is about 36" for typical wireless equipment frequencies. In my earlier writings, I have used "RFFR."

SCAs: Small cell antennas containing one 5G on-demand, beam formed signal antenna and three 4G signal antennas; 4G provides continuous 24/7 RFR emissions and the combined power densities of SCAs may emit up to about 100,000 $\mu W/m^2$ based upon my discussion with other RFR professionals.

Wi-Fi: Wireless network technology under Institute of Electrical and Electronic Engineers 802.11 standards. In my opinion, Wi-Fi was introduced early to have people adapt to dense 4G/5G SMAs in urban areas.

## III. Evidence of harm to living organisms from RFR emitters

This section provides evidence of 28 illnesses caused by RFR, 20 symptoms reported by those in close proximity to RFR emitters including MCPBSs and body-proximate wireless devices, significant increases in anxiety, stress, depression, and suicides of people under age 25, a 50% increase in physician burnout from 2013 to 2016, an increase of only 0.5% in the Labor Force Productivity Rate 2011 to 2016 and 1.2% in 2017, increases in electromagnetic hypersensitivity, labeling of RFR as a possible carcinogen in 2011 by the WHO International Institute for Research on Cancer, rejection by National Institute of Health in October 2018 of my charges that RFR is causing injury to young people, *etc.*[2] All of the injuries I describe are within the FCC's antenna safe limits of 6,000,000 to 10,000,000 $\mu W/m^2$. References for each are provided in the attached article, research letter, and the Lesson Plan to the NH "Commission to Study the Environmental and Health Effects of Evolving 5G Technology." This list of harm to

[2] Evidence of harm to living organisms is in the attached IJAR article, research letter and attachments thereto, *New Hampshire 5G/4G Lesson Plan* dated July 1, 2020, and *Guidelines to Prevent and Treat SARS-CoV-2.*

humans is an introduction to the injury to living organisms if 5G is installed with FCC safety limits of 6,000,000 to 10,000,000 $\mu W/m^2$ but is also associated with 4G and earlier technology

1. Twenty-eight (28) adverse changes in cells, symptoms, and illnesses to RFR. These include ADHD, cancer of the brain, salivary gland, and breasts; leukemia, anxiety, depression, sleep disturbances, stress, reduction in melatonin, cataracts, increases in inflammation; damage to the testes, sperm, blood brain barrier, DNA, eyes, heart, thyroid hormones, etc. ["United States Congressional Research and Legislative Proposals to Educate the American People About the Power Density Safety of Wireless Communication ($\mu W/m^2$)" [*Indian Journal of Applied Research*, Jan 2018, 8(1): 263-271,264-265 ("IJAR 1;" Exhibit C); Hernandez and Morris, "Risk of ADHD Grows with Screen Time." *Wall Street Journal* ("*WSJ"*, 07.18.2018, A3; Exhibit D]
2. Twenty (20) symptoms and illnesses reported by those living in close contact with RFR-emitting MCPBSs, Wi-Fi, and cell phones including headache, depression, fatigue, dysesthesia, concentration dysfunction, memory changes, dizziness, irritability, anxiety, nausea, skin warning EFG changes appetite loss, sleep disturbances, neurobehavioral symptoms, etc.
3. The percentage of college students who "felt so depressed that it was difficult to function at any time during the last 12 months" increased from 29.5% in Fall 2012 to 39.3% in Fall 2017. [American College Health Association *National College Health Assessment* (NCHA); IJAR 1, 266; NCHA 2017 update Exhibit E].
4. The percentage of college students who "seriously considered suicide" increased from 6.0% in Fall 2010 to 10.4% in Fall 2016 and to 12.1% in 2017; thus, college students who seriously considered suicide doubled in seven years. [NCHA; IJAR 1, 266; NCHA 2017 update Exhibit E]. It is a well-accepted fact that Jenny Fry, A UK teenager, committed suicide because of Wi-Fi at her school. I have other medical evidence that doctors know cell phones cause suicide.
5. Suicide rates in the United States increased dramatically starting in 2008 compared with the preceding seven years. The number of suicides for the 10-14 year age group declined from 300 in 2000 to 180 in 2007 (40% total decline; 7% annual decline) and increased to 436 in 2016 (142% total increase or an annual increase of 10.3%). For the 15-24 year age group suicides increased from 3,994 in 2000 to 4,140 in 2007 (0.4% total increase) to 5723 in 2016 (38% total increase; 4.7% annual increase), (Exhibit F)
6. Up to 25% of college students claimed mental disabilities from anxiety and depression to take longer course testing times and private testing rooms in 2018. At Pomona College, students claiming mental disabilities increased from 5% in 2014 to 22% in 2018, an average increase of about 4% per year. [Belkin, "Colleges Give the Disabled More Leeway," *Wall Street Journal*. 05.25.2018: A3, Exhibit G]. Because these students were first introduced to cell phones in about 2008 when they were about eight years old, the percentage of mentally disabled students will probably increase as the introductory age to RFR declines to fetus exposure to RFR.
7. Up to 20% of high school students in upper income high schools claimed mental disabilities from anxiety and ADHD to take longer testing times for classroom, SAT, and ACT tests. [Belkin and Hobbs, "More K-12 Students Get Special Help," *Wall Street*

*Journal*. 07.05.2018: A4, Exhibit H]. RFR is a stimulant like caffeine [see Herman Kelting. "Recommendations to Prevent and Treat Post-Traumatic Stress Disorder for Military Personnel." *Indian Journal of Applied Research* 6(9), (September 2016): 510-518, Exhibit I] and is a known cause of ADHD.

8. The percentage of physician burnout increased from 26% in 2013 to 39% in 2016—a 50% increase in three years paralleling the increases in depression and suicide rates for college students in the *NCHA* survey. [*Stanford Magazine*, May 2018, p. 28-29, Letter to the Editor Exhibit J]. I metered a power flux density of 1,500 $\mu W/m^2$ in a private room of one doctor's office where 1,000 $\mu W/m^2$ is considered an extreme anomaly by the Building Biology Institute. In my opinion, the increase in physician burnout is caued largely by RFR in their offices, homes, and automobiles.
9. The Labor Force Productivity Rate has increased an average of only 0.5% annually from 2011 to 2016 and 1.2% in 2017 [Exhibit C p. 265] when it should have increased about 3% during an expansion. In my opinion, this decline may be due to declines in adult IQs from RFR. It has been shown that neurons (carrying electrical impulses in brain nerve cells) in rats are subject to lasting damage when exposed to RFFR.
10. Electromagnetic hypersensitivity (EMH) is believed to be on the increase. Haifa, Israel banned Wi-Fi in all schools in 2016 because of its local increase. France has banned RFFR in child day care centers for children under 3 years of age because of the harm from RFR power densities and has banned cell phones in all schools for children under 16 because of reduced sociability. I have been unable to find public measures of the historical rate of EMH in the United States.
11. The final report of the NH "Commission to Study the Environmental and Health Effects of Evolving 5G Technology" dated November 1, 2020 has recommended that Wi-Fi be removed from all schools and replaced with hard wired or optical wireless computers in Recommendation 4, p. 11.
12. The WHO International Institute for Research on Cancer has labeled RFR a possible carcinogen in 2011.
13. In my research letter[3] to the Secretaries of the U.S. Department of Health and Human Services and Homeland Security dated October 3, 2018 opposing the use of RFR wireless technology, I stated:

    "This data indicates the possibility of a catastrophic health crisis is upon us that will damage our labor force and economy for years to come." (p. 1)

    In the same paragraph, I summarized symptoms of anxiety, depression, stress, and increases in contemplation of and actual suicides mentioned in the numbered sections described above. One of the secretaries immediately referred my letter to the National Institute of Health (about October 5, 2019) and NIH rejected further research three days later. Given my 30 years of federal employment and research letters, I concluded that NIH's rejection violated the Federal Code of Conduct and referred my concern to

[3] "research letter" refers to a letter I have written with health studies reported in peer-reviewed journals.

appropriate federal officials. My principal concern was that NIH is concealing harm to millions of high school and college students caused by wireless emitters supporting the preposterously high FCC antennas safety limits of 6,000,000 to 10,000,000 μW/$m^2$, and failure to include measures of radiation other than heat for body-proximate wireless devices.

14. As an example of the type of people who manage federal agencies is the following: FAA administrator Steve Dickson, former Senior Vice President of Flight Operations Delta Airlines, "…participated in efforts by Delta Air Lines, Inc. management to wrongly use a psychiatric evaluation to retaliate against a pilot who raised safety concerns….[He] knew about and approved punitive moves against veteran co-pilot Karlene Petitt, who was deemed unfit to fly in December 2016 after being diagnosed with bipolar disorder. The diagnosis eventually was reversed and she resumed flying. The ruling supported Ms. Petitt's claims that she was singled out for special scrutiny to try to keep her quiet about safety issues. Scott Morris, the judge who presided over the long running litigation, determined that Delta punished and discriminated against a federally protected whistleblower without any evidence indicating her 'performance as a pilot was deficient in any way.'" According to the decision, 'not a single witness questioned her flying acumen.'" [Pasztor, Andy. "FAA Chief had helped Delta retaliate against whistleblower, Administrative Judge Rules" Wall Street Journal, Dec 28, 2020]

IV. Evidence of harm to living organisms from RFR emitters at specific power densities far in excess of FCC antenna safety limits.

There is research evidence of harm to living organisms at specific power densities at small fractions of the FCC's safe antenna limits between 6,000,000 to 10,000,000 μW/$m^2$. The evidence I furnish in this section shows injury to living organisms from 0.002% to 1.123% of the FCC maximum safety limit of 10,000,000 μW/$m^2$.

- Six CA firemen living in fire stations with MCPBSs on the roofs of their fire stations emitting 10,000 (0.1% of FCC max) to 20,000 μW/m2 (0.2% of FCC max) suffered symptoms of "headaches, extreme fatigue, sleep disruption, anesthesia-like sleep where the men woke up for 911 calls as if they were drugged, inability to sleep, depression, anxiety, unexplained anger, getting lost on 911 calls in the town they grew up in, a twenty (20) year medic forgetting basic CPR in the midst of resuscitating a coronary victim, immune-suppression manifest, frequent colds and flu-like symptoms." Neurological testing and SPECT scans [single-photon emission computed tomography] by Dr. Gunnar Heuser, MD, PhD and J. Michael Sulzer, MD showed brain abnormalities caused by "…pervasive, hyper-excitability of the neurons which suggested the exposure to RF (microwave) radiation was causing the neurons to continually fire, without rest. RF radiation appeared to act as a constant stimulant even when the men were away from the station, and in repose. The SPECT scans were considered abnormal in all 6 firefighters." There was impaired "cognitive function, reaction time and impulse control." [Affidavit, Susan Foster, 02.02.2013, p. 2 and 3;

Exhibit N] This means that power densities of between 0.1% to 0.2% of the FCC safe limit for RFFR exposure caused medically proved brain and neurological damage to these firemen. Thus, based upon this evidence, FCC power density safe limits set by Congress are grossly overstated and grossly unreliable as indicators of RFR safety.

- 153.6 $\mu W/m^2$ and 2,126 $\mu W/m^2$: Increases of cortisol and alpha-amylase, two markers of stress, near cell phone base station simulations at power densities of 153.6 $\mu W/m^2$ (0.002% of FCC max) and 2,126 $\mu W/m^2$ (0.021% of FCC max); increases in these stress hormones from RFFR may explain mental disabilities of high school and college students claiming mental disabilities from anxiety, depression and stress for preferred testing times and private testing rooms.
- 8,980 to 30,660 $\mu W/m^2$: Increased deaths from neoplasia for those living near cell phone base stations in the range of 8,980 (0.09% of FCC max) to 30,660 $\mu W/m^2$ (0.3% of FCC max).
- 995 $\mu W/m^2$ median: Caused damage to trees on the side facing the CPBS with a median power density of 995 $\mu W/m^2$ (0.01% of FCC max). This is obviously far less than the FCC MPE of 6,000,000 to 10,000,000 $\mu W/m^2$ and close to the Building Biology Institute extreme anomaly of 1,000 $\mu W/m^2$.
- "far below" 5,300 $\mu W/m^2$: Cancer rates from a cell phone base station were 4.15 times the entire population and 10.5 for women at power densities "far below" 5,300 $\mu W/m^2$ (0.053% of FCC max).
- 20,000 to 67,000 $\mu W/m^2$: Cell phone base station with three antennas on the roof of an apartment with power densities of 20,000 (0.2% of FCC max) to 67,000 $\mu W/m^2$ (0.67% of FCC max) caused increases in headaches, memory changes, dizziness, depressive symptoms, and sleep disturbances.
- The cancer risk for those living near base stations was three times greater than for those living at a distance. There also was evidence from those living near base stations of irritability, appetite loss, fatigue, headache, difficulty concentrating, sleep disruption, visual disturbance, loss of memory, dizziness, and skin problems. One apartment building with a cell phone tower on the building had a mean power density of 3,811 $\mu W/m^2$ (0.038% of FCC max) and a variation of 15 to 112,318 $\mu W/m^2$ (1.123% of FCC max).

## V. Specie extinction from 5G/4G and prior technology

### A. Introduction

There is evidence that 5G/4G and earlier technologies have extinguished species. Barrie Trower, A UK 5G weapons expert, has predicted that only one baby in eight will be born normal if 5G/4G SCAs are installed in urban areas, insects and rodents have been extinguished in the presence of RFR, male sperm is reduced by up to 55%, garden cress seeds failed to grow in the presence of Wi-Fi, and white stork eggs hatching was reduced by 50%.

B. Evidence of specie extinction

1. Barrie Trower, UK 5G weapons expert

Based upon statements by Mr. Barrie Trower, a physicist and well-known UK 5G weapons expert, (1) the only difference between weapons grade 5G and 5G SCAs is the time it will take for human injury to occur, (2) there will be injury to the endogenous, RFR-governed 4,500 enclosed electrical systems in the human body in their endogenous and exogenous communication with other RFR-governed electrical systems, and (3) installation of 5G/4G SCAs will result in only one child in eight births being born normal three generations (60 years) from date of 5G/4G SCAs installation. [

Evidence of shortened specie life spans is supported by the following scientific studies and other evidence:

2. Rodent births exposed to RFR

A Greek study of the reproduction of rodent births exposed to RFR resulted in "…mice exposed to 0.168 μW/cm$^2$ (1,680 μW/m$^2$; 0.017% of FCC max) became sterile after five generations, while those exposed to 1.053 μW/cm$^2$ (10,530 μW/m$^2$; 0.105% of FCC max) became sterile after only three generations." [A Balmori, 194] "A progressive decrease in the number of newborns per dam was observed, which ended in irreversible infertility" [Magras IN, Xenos, TD. "Radiation Induced Changes in the Prenatal Development of Mice." *Bioelectromagnetics* 18 (6) (1997): Abstract, 455-461 cited in A Balmori. "Electromagnetic Pollution from Phone Masts. Effects on Wildlife." *Pathophysiology* 16 (2009): 191-199, 194]

**3.** Damage to male sperm

In a review of the literature finding damage to male sperm from RFR associated with cell phones, laptops, Wi-Fi, and microwave ovens, the authors found "…deleterious effects on sperm parameters (like sperm count, morphology, motility), affects the role of kinases in cellular metabolism and the endocrine system and produces genotoxicity, genomic instability, and oxidative stress…with an increased level of reactive oxygen species, which may lead to infertility." [Kesari, KK, Agarwei, A, and Henkel, R. "Radiations and Male Fertility" *Reproductive Biology and Endocrinology.* 16:118 (Dec. 9, 2018); Agarwal A, et. al. "Effect of cell phone usage on semen analysis in men attending fertility clinic." Fertility and Sterility 89(1) (2008): 124-128. Cited in IJAR, Jan 2018, Ref 47] This article provides 179 references and may be supportive of Mr. Trower's prediction of only one child in eight being born normal in three generations if 5G/4G is installed.

4. Decline in insect reproductive capacity

Experiment showed that the reproductive capacity of the insect Drosophila Melanogaster declined 36.4% (1 min), 42.5% (6 min), 49.2% (11 min), 56.1% (16 min), and 63.0% (21 minutes) exposure to a GSM 900 MHz carrier frequency and 217 Hz information frequency with

exposure at a power density of 100,000 μW/m$^2$ [4] (10 μW/cm$^2$; 1% of FCC max). Again, this power density of 100,000 μW/m$^2$ is far less than the 6,000,000 to 10,000,000 μW/m$^2$ FCC MPE safe limits. This experiment showed the important relationship between time of exposure to RFFR and injury to a living organism. [Panagipoulos DJ et.al. "The Effect of Exposure Duration on the Biological Activity of Mobile telephony Radiation." Mutation Research 699 (2010): 17:22. About a week ago, I submitted a letter of complaint to a county board of commissioners of radiation power densities from one set of two sets of MCPBSs that had average MAX power densities varying from 67,570 μW/m$^2$ to 137,190 μW/m$^2$ (MAX of 218,000 μW/m$^2$).[5]

5. Garden cress seeds failed to grow in presence of Wi-Fi

Five ninth grade girls in Denmark noticed that if they slept with their mobile phones near their head at night, they had trouble concentrating at school the next day. In order to test the effect of cell phone radiation, they place six trays of garden cress seeds in a room without radiation and six trays in another room with two Wi-Fi routers that were about equivalent to a cell phone. The seeds in the clean room grew in a 12-day period, while the seeds in the room with the Wi-Fi routers did not grow. They concluded that radiation defeated growth of the cress seeds.

6. Reduction in hatching of White Stork eggs

White stork eggs within 200 meters of MCPBSs resulted in total productivity of 0.86 and beyond 300 meters doubled to 1.6; There were no chicks in 40% of the nests within 200 meters and 3.3% no chicks beyond 300 meters. [Balmori A. "Possible effects of EMF phone masts on a population of white storks." *Electromagnetic Biology and Medicine.* 24 (July 2005): 109-119.

## VI. Recommended use and detection of RFR power densities from body-proximate wireless devices

### A. Introduction

Its important to be aware of the injury to living organisms from RFR; and EMF generally. If you think RFR is safe, please recall the leadership of this country, including Congress, approved the draft of United States citizens to fight in Viet Nam leading to 58,000 dead, 200,000 hard wounded, and 300,000 with PTSD—a casualty rate of about 50%. On the day Congress passed the Gulf of Tonkin resolution, I predicted we would be sucked into a major war with heavy causalities, would spend billions of dollars, and lose—and that is what happened.

### B. Recommendations to reduce RFR in your environment

[4] 100,000 μW/m$^2$ is at the upper end of the range I have metered of MCPBSs about 100 meters from the tower and in the presence of homes. I have reason to believe that 5G/4G SCAs will emit about 100,000 μW/m$^2$ in the presence of nearby homes.

[5] Harm from on-off pulsating power densities is measured by maximum (MAX; peak) power density pulses, not by averages. I used a SLT Safe and Sound Pro II supported by a GigaHertz Solutions HF 59 B and D.

I recommend the following steps be taken to reduce RFR environmental contamination and contribute to improved health.

1. Reduce the use of your cell phone to only those calls absolutely necessary[6].
2. Do not use wireless devices in enclosed areas particularly in the presence of young children. Metal enclosed spaces are the worst because the emissions bounce off the metal, although dry wall will also contain some RFR while residual RFR will pass through the drywall.
3. Terminate Wi-Fi, and use a land-line telephone, hard-wired router, and Ethernet cable to connect the land line phone with the computer for Internet access.
4. Do not use wireless security systems, wireless baby monitors, or other wireless devices in the home.
5. Purchase an RFR power density meter and meter your environment. "Environment" means all spaces within which you travel. Make sure the meter reads "peak" (max) and "peak hold" (max hold) power densities in $\mu W/m^2$. Do not rely on "average" because peak pulses are what injure and averages are usually less than 10% of peaks.[7] If you are making wireless legislative decisions or wireless decisions affecting other people, it is essential that you use meters and sensible safe standards (not FCC preposterous standards of 6,000,000 to 10,000,000 $\mu W/m^2$) in your decision model.
6. If you live in attached housing (e.g., apartment, condominium), use an RFR meter[8] to measure RFR emissions originating in adjacent apartments through party walls; these PDs may exceed 1,000 $\mu W/m^2$. If, for example, you have a crib for a new-born next to a party wall with a Wi-Fi on the other side of the wall, the child's brain and neurological systems may be injured along with other cells and organs. Can you sue for damages? First, you probably can't prove damages because the RFR crap is everywhere, and second, insurance companies exclude liability insurance for RFR injuries so the only recourse is the company's equity. Obviously, use the RFR meter to evaluate power densities throughout the housing unit and outdoors as well.

[6] "absolutely necessary" means failure to make the call would result in extreme hardship. While to those of you who have not read several thousand scientific articles and contacts with the opinions of others who are concerned with the long-term consequences of non-ionizing radiation, this may seem preposterous. Recall, however, that non-ionizing radiation places a force on charged particles in the human body, which place cells and organs in disequilibrium with the natural environment (*e.g.*, Schumann Resonance).

[7] I have read peer-reviewed articles using average PDs and in my opinion these studies are worthless because they should use peaks.

[8] I use a Safe Living Technology Safe and Sound Pro II ($400 delivered) and GigaHertz Solutions HF 59B and D for RFR and an NFA 1000 to measure EFs and MFs. I do not receive any compensation to recommend these meters. Notably, meters to measure 5G above about 8-10 GHz are massively expensive at +$10,000 to the best of my present knowledge.

## VII. Recommended control and disclosure of wireless communications

### A. Introduction to control and disclosure issues

It is essential that legislative bodies control and disclose all wireless emissions in their jurisdictions. Presently, virtually no one knows much about power densities of RFR emissions and in a very few cases, MCPBSs are concealed from view and can only be identified with RFR meters. Radiation places a force on charged particles (e.g., free electrons and electrons in the outer rings of an atom), cells, and organs placing them in disequilibrium, and thereby causing symptoms and illnesses which I describe elsewhere in this document. For example, there is a near 100% chance of a MCPBS emitting peak emissions of 10,000 $\mu W/m^2$ within 500 meters and about a 10% chance of RFR peak emissions over 50,000 $\mu W/m^2$ within 200 meters; I have measured over 70,000 $\mu W/m^2$ within 150 line-of-sight meters to homes and 1,000,000 $\mu W/m^2$ in the near field of a Wi-Fi in a home. Thus, it is crucial that the public be informed of power densities in their homes, workplaces, and environment.

### B. My recommendations for control of wireless emissions and PD environmental disclosure

I recommend the following control of MCPBSs, SCAs, and disclosure of power densities in private and public spaces. Items 2-4 were reported in *New Hampshire 5G/4G Lesson Plan* testimony on July 1, 2020 (31 pages) and earlier reporting in the IJAR article (Exhibit C)

1. Prohibit operation of 5G/4G Small Cell Antennas anyplace in your jurisdiction. There is no public disclosure of power densities of existing 5G/4G SCAs and the only information of power densities is word-of-mouth of about 100,000 $\mu W/m^2$. While RFR PD meters are available up to 8 GHZ and perhaps up to 10 GHZ, the cost of RFR meters over 20 GHz is in excess of $10,000. Since 4G antennas emissions are 24/7, the emissions of 5G/4G SCAs will be 24/7 and will prohibit outdoor activity and probable indoor injury as well. Since the New Hampshire Commission has proposed converting Wi-Fi wireless in libraries and classrooms at an enormous cost, it is rather preposterous and incongruous to add many multiples of that radiation to your front yard particularly in view of the illnesses from RFR I have supported in this document. Can you imagine a two-year old riding her tricycle within a few feet of an SCA emitting massive power densities.
2. Require power density disclosure to buyers and lessees of residential real estate.[9] Prior to transfer of residential real property interests to buyers and lessees, the property should be inspected to disclose power densities in all rooms under the following standards and disclosed in writing to the prospective buyer or lessee. This recommendation may lead to legislative

[9] I am deliberately omitting commercial real estate to simplify this presentation.

restrictions on the use of Wi-Fi and cellphones in attached housing units. In my opinion, there should be no source of exogenous wireless emission from adjacent housing units in attached housing units. The purpose of restricting the use of wireless technology in attached housing units is to protect all building occupants, particularly very young children from playing and sleeping near an outdoor wall or party wall from otherwise unknown, high RFR on the other side of the wall. **Imagine a six-month old baby crawling on the floor with a 1,000,000 μW/m$^2$ Wi-Fi at the party wall in an adjacent apartment spilling over and frying his or her small brain and body with grossly excessive RFR/EFs.**

3. Require power density disclosure and prohibition of RFR emitting devices in public buildings. "Public buildings" mean all buildings that have unrestricted public access including government buildings, retail stores or services, restaurants, exercise facilities, *etc.* above a threshold size (e.g., 50,000 square feet). The disclosure should be made using a visible, time-dynamic RFR meter showing power densities in μW/m$^2$ with one time-dynamic meter.
4. Prohibit use of portable wireless devices (e.g., cell phones, tablets, etc.) in public buildings.
5. Require power density/e*lectric field* disclosure to buyers of RFFR-emitting personal property (e.g., cell phones, Wi-Fi, cordless phones, automobiles) at point-of-sale.
6. Discover power density and student mental illness in public schools.
    a. The genesis of the following school disclosure recommendations come from three articles in the Wall Street Journal described briefly in this section:
        1. Belkin, Douglas "Colleges Bend the Rules for More Students, Give Them Extra Help." *Wall Street Journal*, May 24, 2018. "As many as one in four students at some elite U.S. colleges are now classified as disabled, largely because of mental-health issues such as depression or anxiety, entitling them to a widening array of special accommodation like longer time to take exams." Since it is known that RFR from cell phones cause anxiety, stress, and depression, I believe the principal cause of these mental-health issues is RFR from cell phones and Wi-Fi in schools and at home. Thus, it is necessary to meter power densities in all schools and particularly high schools because of what has become exposure from the womb to their present age.
        2. Belkin, Douglas "Colleges Give The Disabled More Leeway." *Wall Street Journal*, May 25, 2018. This article is nearly identica to the article published on May 24, 2018
        3. Belkin, Douglas and Tawnell D. Hobbs. "More K-12 Students Get Special Help." *Wall Street Journal.* July 5, 2018: A4.

b. The *Wall Street Journal* articles suggest two types of research is necessary to assure student safety from RFR in public school classrooms described as follows:

(1) Metered inspections of classroom power densities in all schools and particularly high schools where the intensity of mental health problems should logically be more severe than in elementary schools because of bombardment with RFR from Wi-Fi, cell phones, and MCPBSs in the prior eight years. Metered inspections should be during active classroom activities simulating actual RFR exposure with Wi-Fi, cell phones, and nearby exogenous MCPBSs. Be aware that RFR meters may measure "peaks" and "peak hold" for only one pulse.

*(2)* History of high school student health problems. I have recently written a model Information Document Request (IDR) to a school district that requests the number and percentage of students with mental health problems by high school by high school district family income, and by year 2000 to 2020. This full range of years is chosen as a parallel time period for historical suicides of younger people.

*VIII.* Linking RFR with the Corona Virus: *Guidelines to Prevent and Treat SARS-CoV-2*

In conjunction with my research for *Six Pillar Tips for Health Management* (Author House, Sept 2019), I have performed research to produce *Guidelines to Prevent and Treat SARS-CoV-2* attached. I have found research evidence that shows RFR from CPs, WI-Fi, MCPBSs and other wireless emitters damages the immune system. (See *Lesson Plan,* Item 10, page 5-11) Because the immune system involves very complex reactions in the body, it is very difficult to provide a quantitative measure of cellular/organ damage compared with sperm which is reduced by up to 55% with four hours of daily cell phone usage—thus, concluding that (1) in three generations only 16.6 % (0.55x0.55x0.55 = .166) of sperm will be active, and (2) in three generations reproduction will be nearly impossible or will lead to damaged children at birth.

I urge that you read *Guidelines to Prevent and Treat SARS-CoV-2* for the link between RFR and the Corona Virus, and tips on preventing and treating SARS-CoV-2. I have used colloidial silver and Echinecca to defeat many viruses in the past.

I thank you for the opportunity to shares these ideas with you and I hope they lead to markedly reduced RFR in your environment.

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Herman Kelting PhD Date

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Engineering

# UNITED STATES CONGRESSIONAL RESEARCH AND LEGISLATIVE PROPOSALS TO EDUCATE THE AMERICAN PEOPLE ABOUT THE POWER DENSITY SAFETY OF WIRELESS COMMUNICATIONS ($\mu W/M^2$)

**Herman Kelting**

**ABSTRACT** The purposes of this article are to provide research and legislative recommendations to the United States Congress to increase education of and protection from adverse health conditions associated with wireless communications. I discuss 48 adverse health conditions caused by radio frequency field radiation (RFFR) and hypothesize that the decline in labor force productivity and increases in depression and contemplation of suicide rates of college students may be caused by RFFR. I offer 11 research suggestions including determining if an RFFR source is more dangerous indoors than outdoors, whether RFFR interfere with the Schumann Resonance and/or human brain waves, and if there is a natural limitation of RFFR beyond which an individual becomes electromagnetic hypersensitive. I propose seven legislative activities including creation of a new federal agency to support research of and protection from RFFR-emitting equipment, and notices of RFFR power densities expressed in µW/m2 on RFFR-emitting equipment and in enclosed public spaces housing Wi-Fi.

**KEYWORDS :** Radio frequency harm to humans, Wi-Fi and cell phones adverse health conditions, Research and legislative protection from cell phones

## I. Introduction

During the past five years I have been engaged in research of health management literature to produce Six Pillar Tips for Health Management (SPT) the latest edition of which is Edition 25, June-July 2017 [1]. The principal objective of SPT is to provide readers with a Six-Pillar classified set of health recommendations to guide their life style from strategic planning and vision building through reduction of stress and pollution to symptom relief using alternative and complimentary medicine, and dietary planning.

In June 2014, I began to research the literature of electromagnetic fields (EMFs), which include magnetic fields and electric fields, radio frequency field radiation (RFFR), and dirty electricity; my principal interest in EMF research became radio frequency field radiation because of the explosive growth of RFFR-emitting cell phone base stations, cell phones, Wi-Fi, smart meters, and cordless phones. My initial research findings were published in SPT October 2014 and updated continuously since then. In my research of the literature and occasional home inspections of EMFs, I have become deeply concerned with the potentially catastrophic health consequences of wireless technology. I have found what appears to be overwhelming evidence that RFFRs cause cellular changes, symptoms, and illnesses in humans and rats which I call "adverse health conditions." Further, there is inferential evidence that RFFRs are causing injury to broad classes of Americans so severe that it could lead to the decline in human health and economic productivity of our civilization—which appears to have already begun.

I have reached these conclusions from a broad background in academic fields of engineering and business, and business experience in accounting, business valuation, engineering, engineering economics, finance, law, statistics, real estate appraisal and investment, and history. Indeed, my PhD dissertation, *The Great Bong Bungle*, was a historical analysis of a 15-year land use problem caused by United States Air Force abandonment of the partial construction of a joint intercontinental bomber-fighter interceptor base in southeast Wisconsin. This PhD research, in conjunction with five history courses I took at Stanford University, has made me uniquely sensitive to the importance of evaluating present events in the context of their future environmental effects, and building hypotheses predicting the future from present statistical data.

The scope of this article is to offer evidence supporting the probable harm to humans from radio frequency field radiation, offer U.S. Congressional proposals for research issues which should lend support to the safety of or harm from RFFR, and Congressional legislative proposals to educate and protect the American people from the harm from RFFR, if such harm exists based upon medical evidence. This article began with an unsolicited report I sent to Senator Catherine Cortez-Masto on November 9, 2017, which has been article-revised to internalize citations and expand ideas.

## II. Evidence linking 48 adverse health conditions in humans and rats to RFFR wireless equipment

### A. Scope of research selections for the 48 symptoms

The scope of the research of the literature in this section are from medical studies showing a causal relationship between electromagnetic fields (generally RFFR but a few examples of magnetic fields) and adverse health conditions of cellular damage, adverse symptoms, and/or illnesses in humans or rats induced mostly by RFFR. I would estimate that at least 80 percent of the medical research articles I have read concluded there were causal links between RFFRs and adverse health conditions, but these are not necessarily a random sample of all medical research articles relating adverse health conditions to RFFR.

Indeed, not all would agree with my selection of the medical research articles in this section. In their 2004 "International Workshop on EMF Hypersensitivity," the World Health Organization reported that the symptoms of electromagnetic hypersensitivity are "certainly real" but that "…there presently is no scientific basis to link EHS with EMF exposure." Further, WHO recommended treatment options focusing on "health symptoms" including "…assessment… of indoor air pollution, excessive noise, poor lighting (flickering light) or ergonomic factors" and psychiatric causes. [2]

In their 2005 summary of the 2004 workshop, WHO stated that "The collection of symptoms is not part of any recognized syndrome." and "Treatment of affected individuals should focus on the health symptoms and the clinical picture, and not on the person's perceived need for reducing or eliminating EMF in the workplace or home." [3] In 2014, WHO stated "To date, research does not suggest any consistent evidence of adverse health effects from exposure to radio frequency fields at levels below those that cause tissue heating." [4]

In my opinion, the level of evidence to support a causal relationship between RFFR and adverse health conditions for public health organizations to inform the public of a health hazard from wireless personal property is not a *global* body of "consistent evidence" but rather evidence from a measurable *subset* of medical research evidence *within* the global body that provides a consistent causal link between EMFs and adverse health conditions. "Subset" refers to those medical research studies that show a causal link between any adverse health condition and RFFR for a variety of adverse health conditions. Indeed, it is a sample of these subsets showing a causal relationship between EMFs—principally radio frequencies—and adverse human health that I am providing in the material which follows in this section.

### B. The 48 adverse health conditions caused by RFFR

In my research of the literature linking RFFR emissions from wireless equipment to adverse health conditions, I have found 48 adverse health conditions in humans and rats that have been shown to be caused by wireless equipment (e.g., cell phone base stations, cell phones, Wi-Fi, smart meters, cordless phones). The sources for the 48 adverse conditions are clinical research studies and the opinions of medical professionals with references for each provided at the end of this report.

The list of 48 (20 listed under "Adverse human health conditions from RFFR-emitting sources" plus 28 (29-1=28) numbered adverse health conditions) are listed in the order of importance, understandability, and category association.

1. *Adverse human health conditions from RFFR-emitting sources:* Questionnaire research has indicated about 20 adverse human health conditions from RFFR-emitting sources including sleep disturbances (1), headache (2), depression (3), fatigue (4), dysesthesia (5), concentration dysfunction (6), memory changes (7), dizziness (8), irritability (9), anxiety (10), nausea (11) skin buffing or warming (12), EEG changes (13) and others. [5] In one study of 25 individuals exposed to radio and TV broadcasting transmitters, it was found they suffered from somatization (multiple symptoms with no discernable organic cause) (14), obsession-compulsion (15), paranoid states (16), and sleeping disturbances (17). [6] In a study of 17,000 individuals, 31% of respondents in Norway and 13% in Sweden reported at least one symptom from cell phone use of warmth on the ear, burning sensation on the face, and/or headaches. [7] In a Spanish study, it was found that those living near a cell phone base station suffered from discomfort, irritability, appetite loss (18), fatigue, headache, difficulty concentrating, and sleep disturbances. [8]. In a review of ten studies, reviewers found increased incidence of adverse neurobehavioral symptoms or cancer for individuals living less than 500 meters from cell phone base stations; power output of all were within international guidelines indicating guidelines are inadequate. [9] Thirty-seven individuals living under a mobile phone base station and 48 opposite the station reported a significantly higher prevalence of neuropsychiatric symptoms such as headache (23.5%), memory changes 28.2%), dizziness (18.8%), tremors (9.4%; 19), depressive symptoms (21.7%), and sleep disturbances (23.5%) than controls. [10] In a questionnaire survey of EHS individuals in Japan, symptoms reported were fatigue/tiredness (85%) and headache-concentration-memory-thinking (81%). Sixty-five percent (65%) experienced health problems due to radiation from other passengers' mobile phones in trains or busses and 12% reported they could not use public transportation. Fifty-three percent (53%) had a job before the onset of EHS, but most had lost their job or had reduced income. [11] In a questionnaire study of 206 EMH individuals, it was found that the most common symptoms were nervous system related disorders of stress (60.3%), sleeping disorders 59.3%), and fatigue (57.2%). Seventy-six percent (76%) reported reduction or removal of the sources helped in full or partial recovery. [12] Mobile phones caused marked changes in the C-fiber nerves in the scalp. [13; #20]
2. *Fetuses: Increased risk of brain damage.* Pregnant rats were exposed to 900 MHz radio frequency 60 minutes per day during gestation (carrying of embryo). Four weeks after birth it was found that there was a decrease in the number of granule cells in the dentate gyrus in the rats' brain hippocampus. [14]
3. *Fetuses: Miscariages* In an occupational setting, mothers exposed to microwaves were more likely to have miscarriages and the rate was dose dependent. [15]
4. Children, Attention Deficit Hyperactive Disorder (ADHD): About 3-7% of school aged children suffer from ADHD and the rate is growing about three percent per year since 1997. ADHD children have deficiencies in working memory controlled by neurons in the prefrontal cortex. In a study of in-utero (pregnant) rats exposed to radiofrequencies similar to cell phones/Wi-Fi, it was found that after birth the rats were hyperactive and had impaired memory caused by altered neuronal development in the prefrontal cortex. Thus, there appears to be a causal link between ADHD and exposure to radio frequencies from cell phones, Wi-Fi, cordless phones, and other sources of radio frequencies during pregnancy. [16]
5. Children, behavioral difficulties: In a study of 13,159 children exposed before or after birth to cell phones, the odds ratio was 1.80 the children had behavioral difficulties or were hyperactive at the beginning of school. Since this study was completed in 2006 before extensive cell phone use, the present odds ratio may be much higher. [17] Children living near a radio station in Latvia were found to have reduced developed memory, attention, reaction time, and neuromuscular apparatus vs. control group. [18] Exposure to 2450 MHz radio frequency field for prenatal and postnatal rats resulted in increased total oxidant stress and oxidative stress indicating chronic stress, postnatal growth restriction, and delayed puberty. [19] In a study of children and adolescents exposed to radio frequencies for 24 hours, 7% of the children and 5% of the adolescents showed abnormal behavior. [20]
6. Children, myelin sheath, damage to: The myelin shield protects the electrical activity of brain neurons and develops from mid-gestation to two years of age and through adolescence. It is adversely affected by radio frequency fields. [21][22]
7. Children: Dry eye disease. Up to 9.1% of children had dry eye disease which improved when smartphone use discontinued for four weeks. [23]
8. Brain damage: Brain neuronal damage was found in the cortex, hippocampus, and basal ganglia in rats exposed to two hours of GSM. [24] Rat brain exposed to 15 minutes of 900 MHz RF induced glial (cells which surround neurons) and neuronal damage and changes in the dopamine transporters. [25] Rats exposed to 900 MHz RF for one hour per day for 28 days showed reduced number of Purkinje cells in the cerebellum. [26] Oxidative stress in the brain increased from cell phone use and reduced by melatonin; oxidative stress continued for 40 and 60 days after end of exposure. [27] Humans exposed to a GSM 900 cell phone for 45 minutes showed intracordal excitability in the brain near the cell phone. [28]
9. Cancer, brain tumors: Glioma and acoustic neuroma. Research of the Hardell group of studies found odds ratios of 1.71 for cancer of the temporal lobe, 1.81 for acoustic neuroma, and 2.29 for lpsilateral cumulative use. Cordless phone use increased the odds ratios for glioma and acoustic neuroma. [29]
10. Cancer, leukemia: Radio frequencies of 2.48 GHz increase lipid peroxidation and proliferation of leukemia cancer cells. [30]
11. Cancer, parotid (salivary) gland. Mobile phones have a causal relationship with parotid gland tumors for regular cell phone users or high-power density conditions with odds ratios of about 1.50. [31]
12. Cancer, various organs: Radar technicians exposed to high levels of RFFR for long periods are candidates for cancer if various organs including melanoma of the eye, testicular cancer, nasopharyngioma, non-Hodgkin's lymphoma, and breast cancer. [32]
13. Cancer: heat shock proteins: Chronic expression of heat shock proteins are a known cause of oncogenesis, metastasis, and/or resistance to anti-cancer drugs. The hypothesis is that cell phone radiation triggers repetitive stress leading to heat shock proteins and, thereby, cancer. Heat shock protein HSP 70 increased after 4 hours of 1800 MHz exposure suggesting that cell phones may cause cancer from extended cell phone use. [33][34]
14. Calcium ion changes: Exposure to 2.48 MHz radio frequency field led to an increase in calcium ion efflux and ornithine decarboxylase activity with a decrease in calcium-dependent protein kinase. These changes promote cell proliferation and differentiation leading to tumors. [35]
15. Melatonin reduction: There is evidence that EMFs disrupt and reduce melatonin perhaps because the pineal gland interprets EMFs as light. Melatonin is a very powerful anti-oxidant, is believed to defeat several types of cancer, and enhances sleep. [36][37]
16. Blood brain barrier, increased permeability of. After one, non-thermal GSM exposure of two hours increases in the BBB was found seven days later, and dark and damaged neurons after14 days. [38][39]
17. DNA damage: In a study of 900 MHz, 1800 MHz, and 2450 MHz radio frequencies applied to rats for 30 days, it was found that brain DNA strands were broken indicating damage to brain DNA from radio frequencies similar to cell phones and Wi-Fi. [40][41]
18. Eye damage: Rats were exposed to Wi-Fi for one hour per day for 30 days resulting in statistically significant lower glutathione peroxidase (GSH-Px), an enzyme family that protects the eye from oxidative damage. Melatonin supplementation reversed the damage, but radio frequency radiation reduces natural melatonin and if you do not take melatonin supplements the lens damage may be permanent. [42]
19. Cataracts: Mobile telephone radiation leads to oxidative stress in the corneal and lens tissues and Vitamin C may help to correct. [43]
20. Stress, sleep disturbances, and depression: A one-year follow up study of 4,156 young adults (20-24 years of age) found a correlation between mobile phone exposure (frequency of use, availability, awakened at night, personal overuse) and stress, sleep

disturbances, and symptoms of depression for men and women. [44]

21. Heart, adverse influence on: It was found that 2.48 GHz radio frequency for 60 minutes per day for 28 days increased lipid peroxidation (*i.e.*, free radicals steel electrons from lipids such as fats and fat-soluble vitamins leading to damaged molecules) in the heart and decreased concentrations of Vitamins A, C, and E. Improvements were shown by supplementation with selenium and L-carnitine. [45] RFFRs increased oxidative stress in the heart. [46]
22. Sperm damage. Study of 361 men in fertility clinic had reduced sperm count, motility (moving properly through the female reproductive tract), viability, and normal morphology (size and shape of sperm under microscope; >14% normal) as daily cell phone usage increased from zero, <2 hours daily, 2-4 hours daily, and to >4 hours daily usage. [47]
23. Testes damage: Rats were exposed to 2.437 GHz Wi-Fi for 24 hours per day for 20 weeks resulting in a significant increase in serum 8-hydaoxy-2-deoxyguanosine levels and 8-hydroxguanosine staining indicating DNA damage in the testes due to Wi-Fi exposure. [48] The exposure in this experiment for 24/7 may be similar to anyone living at home with the WiFi on 24/7.
24. Thyroid hormones: A 2480 MHz radiofrequency field decreased thyroid hormone T3, increased T4, and caused hyperactive and aggressive behavior after 16-21 days. [49]
25. Electromagnetic hypersensitivity (EMH): EMH is a collection of symptoms including redness, tingling, burning sensations, fatigue, tiredness, concentration difficulties, dizziness, headaches, nausea, heart palpitations, digestive disturbances, etc. [2] In October 2014, the World Health Organization of the United Nations stated, "To date, no adverse health effects have been established as being caused by mobile phone use…Further research has not been able to provide support for a causal relationship between exposure to electromagnetic fields and self-reported symptoms or 'electromagnetic hypersensitivity'." [4] In a study of 23 individuals claiming EHS it was demonstrated that transcranial magnetic stimulation resulted in alternations to the central nervous system from altered cortical excitability showing that there ARE objective measures of a causal relationship between EMH claims and changes in body function indicating that EMH is a real, not imagined illness. [50]
26. Autoimmune processes: In a study of the effect of 2.450 GHz on autoimmune processes, it was found that there was a non-thermal effect on autoimmune processes measured by increases in formation of antibodies in the brain, which did not appear to be pathological, and possible adverse effects of blood serum affecting pregnancy and fetal development. [51]
27. Inflammation: Radio frequency radiation of 2.48 GHz significantly increased lung multinucleated giant cells associated with inflammation formed by fusion of macrophages as a measure of pulmonary stress. [52]
28. Internet addiction disorder: Research indicated that internet addiction disorder results in multiple structural changes in the brain. [53]
29. Gene expression, changes in. It was found that a radio frequency field of 2.48 GHz changed 221 genes in two hours of exposure and 759 in six hours for human cultured HL-60 cell genes through a non-thermal mechanism. [54]

This list of 48 adverse health conditions in humans and rats is the first set of data I provide in this report to support the research and legislative proposals I offer in Sections VI and VII.

## III. Evidence supporting my ability to specify and support medical hypotheses: Prevention and treatment of Post-Traumatic Stress Disorder

As a result of my membership in the Newport Beach Sunrise Rotary Club (NBSRC), their association with Wounded Warrior Battalion West at Camp Pendleton, and my publishing *Six Pillar Tips for Health Management* [1] on the NBSRC web site for 19 editions starting in January 2013, I hypothesized that excess stimulants (e.g., caffeine, refined carbohydrates, electromagnetic fields) were contributing to Post-Traumatic Stress Disorder (PTSD). Because I had access problems to Camp Pendleton personnel after I objected to their not providing dietary intervention for PTSD victims to reduce stimulants, I contacted the office of Senator Diane Feinstein and had a meeting with one of her staff members; he asked me to write a report to support my stimulants/PTSD hypothesis. This led to "Recommendations to Prevent and Treat Post-Traumatic Stress Disorder for Military Personnel" [55] Notably, one research article ["Strom in a Coffee Cup."] linked caffeine to PTSD.

I recommended elimination of caffeine, reduction of refined carbohydrates, increased sleep, metaphysical modeling, improved indoor air quality, and reduction of electromagnetic fields to prevent and treat PTSD for military personnel.

I am offering this PTSD hypothesis-based research article as evidence that I have the ability and training to develop medical hypotheses with supportive research in the absence of academic or career medical training. Indeed, I have found that interest, focus, and concentrated research are the keys to developing and supporting new ideas to solve business and societal problems. Further, in my research as an engineer with the Internal Revenue Service for 30 years, I frequently worked financial issues that had unique intellectual components and utilized principles of accounting, business valuation, economics, federal (for rules and economic models) and state (for rights in property) statutory and case law, finance, and statistics.

## IV. Hypothesis: Wireless technology may be causing potentially catastrophic harm to humans

As I began to research the literature linking wireless equipment in June 2014 for the October 2014 issue of *Six Pillars Tips for Health Management*, I began to build the following hypotheses or predictions of future harm to humans from wireless equipment:

1. There would be a decline in the Labor Force Productivity annual growth rate because proven damage to rat brains probably applied to humans.
2. There may be a similarity between the delayed symptoms from brain damage from contact-sport concussions (Chronic Traumatic Enceptalopathy, CTE, or nerve damage) and delayed symptoms from brain damage from wireless technology estimated by some medical professional at about ten years. Presently, I have no evidence linking concussion brain damage to RFFR brain damage, but there is evidence of delayed-onset brain damage from RFFR.
3. Human depression rates would increase. I provide evidence of this below.
4. Human suicides and suicide contemplation rates would increase. I provide evidence of this below.
5. Drug use would increase because of adverse changes in mental condition from depression, contemplation of suicide, and other mental problems. The epidemic in opiate use may support this hypothesis, but I expect increases in recreational drug use.
6. There may be increases in violent crime. Presently, I have no specific evidence this is occurring, but I am suspicious that some of the mass shootings may be influenced by RFFRs from wireless equipment.
7. Working lives would decline from the mid-60s to the mid-50s and perhaps even lower because of damage to human cells and organs. Presently, I have no evidence this is occurring.

## V. Statistical evidence supporting my hypothesis that wireless equipment is causing potentially catastrophic harm to humans in the United States

### A. Declines in Labor Productivity: 2011-2016

Table 1 shows Labor Productivity for 2000-2016. Based upon this data and other older data not shown, I have concluded that the expected labor productivity is about 3.0% coming out of a recession compared with average labor productivity of 0.5% from 2011 to 2016 when wireless technology had been used extensively for many years. This is a decrease of over 80%. Labor productivity is the key to increasing incomes and if the decline in Labor Productivity continues, our standard of living will stagnate and perhaps decline.

**Table 1: Decline in Labor Productivity 2000 to 2016**

"Bureau of Labor Statistics"
"Major Sector Productivity and Costs"
"Original Data Value"
"Labor productivity (Output per hour)"

| Year | Increase | Year span | Av Prod |
|---|---|---|---|
| 2000 | 3 | | |
| 2001 | 2.7 | | |

| | | | |
|---|---|---|---|
| 2002 | 4.4 | | |
| 2003 | 3.7 | | |
| 2004 | 3.1 | | |
| 2005 | 2.1 | 2000-5 | 3.2 |
| 2006 | 0.9 | | |
| 2007 | 1.6 | | |
| 2008 | 0.8 | 2006-8 | 1.1 |
| 2009 | 3.1 | | |
| 2010 | 3.3 | 2009-10 | 3.2 |
| 2011 | 0.1 | | |
| 2012 | 0.9 | | |
| 2013 | 0.3 | | |
| 2014 | 0.8 | | |
| 2015 | 0.9 | | |
| 2016 | 0.2 | 2011-16 | 0.5 |
| | | | |

**B. Increases in depression and suicide contemplation rates for college students**

**Table 2** Percentage of respondents who "Felt so depressed that it was difficult to function at any time in the last 12 months." and who "Seriously considered suicide."

| | Depression | Suicide |
|---|---|---|
| Fall 2008 | 30.6% | 6.4% |
| Spring 2009 | 30.7 | 6.0 |
| Fall 2010 | 28.4 | 6.0 |
| Spring 2010 | 30.7 | 6.2 |
| Fall 2010 | 28.4 | 6.0 |
| Spring 2011 | 31.1 | 6.4 |
| Fall 2011 | 30.3 | 6.6 |
| Spring 2012 | 31.3 | 7.1 |
| Fall 2012 | 29.5 | 6.9 |
| Spring 2013 | 31.3 | 7.4 |
| Fall 2013 | 30.9 | 7.5 |
| Spring 2014 | 32.6 | 8.1 |
| Fall 2014 | 33.5 | 8.7 |
| Fall 2015 | 35.3 | 9.6 |
| Spring 2016 | 36.7 | 9.8 |
| Fall 2016 | 38.2 | 10.4 |

Table 2 data is taken from the semi-annual survey of about 33,500 college students by The American College Health Association National College Health Assessment. The questions were "Felt so depressed that it was difficult to function at any time in the last 12 months" and Seriously considered suicide." The percentages shown are for males and females combined. Depression rates have increased from 30.6% in the Fall of 2008 to 38.2% in the Fall of 2016 for an average increase of about one percent per year. But most of the increase has been from Fall 2013 (30.9%) to Fall 2016 (38.2%), a three-year span, for an average rate of increase of 2.4%. If these rates of increase continue, the adverse health effects on college students and their aging cohort groups will be catastrophic.

Table 2 also indicates that suicide contemplation rates have increased steadily from 6.0% in Spring 2009 to 10.4% in Fall 2016, or 0.6% per year. The suicide contemplation rates in conjunction with the increases in depression and 48 adverse health conditions discussed elsewhere indicate potentially catastrophic health problems in the future. Notably, Jenny Fry, a UK teenager, committed suicide because of Wi-Fi at school. [56]

**VI. Proposed research issues for the RFFR-oversight/education/protection federal agency**

**A. Research Issue #1: The institutional setting for research—a proposed RFFR-oversight/education/protection agency**

In June 1994, the United States Air Force's Rome Laboratory published a report summarizing harm to humans from radio frequencies and microwaves. [57] The report listed a number of known adverse biological effects mostly attributable to the nonthermal effects shown in medical studies cited in the report. These biological effects included radiation burns on dogs visibly appearing weeks after exposure (p. 3), hyperthermia (4), disruption of blood vessel integrity in the brain (4), fever (4), fatigue (4), injury to the blood brain barrier (4), increases in cancer rates (5, 8), cellular mutagenic effects (5), damage to chromosomes (6) lymphoblastold transformations (6), aberrations in the cardiovascular system (e.g., increase in heart rate) (7-8), changes in the heart rate (7), changes in bone marrow (8), damages to the central nervous system (8-9), behavioral changes (9) damages to the immune system (11), cataracts and other damage to the eye that can result in loss of vision (11-12), buzzing noise emanating from the head (13), etc.

Given that harm from wireless communications was known in June 1994, the federal government should have commenced research, education, and protection activities prior to the extensive proliferation of cell phones. Having failed that, it is now essential to (1) confirm my research findings of adverse health conditions from RFFRs in the literature with independent research findings, (2) educate and inform the American people pf the potential harm to humans from wireless technology if the medical research findings of adverse health conditions is correct, and (3) protect the American people by controlling the use of wireless equipment. To accomplish these tasks, I recommend creating a new federal agency because the Environmental Protection Agency has contributed to the present problems of grossly excessive power density standards and no education to the American people of potential harm from RFFR.

Presently, the federal government does not appear to be conducting any research studies to support the safety or show harm from RFFR-emitting equipment. Further, the FCC/RCRF has such high limits of dangerous power densities—up to 10,000,000 $\mu W/m^2$ – in contrast to IIBBE safety limits of well less than 1000 $\mu W/m^2$ that it is essential for Congress to review scientific data with a view to lowering these limits through the NCRF, a Congressional corporation.

The strategic objectives of this oversight/education/protection agency would be to:

1. Review and set power density standards for RFFR emitting equipment and facilities based upon $\mu W/m^2$ to assure the long run safety of the American people.
2. Fund research to determine if there is a casual link between RFFR and adverse health conditions and assure that foreign research groups are included in the funding activity.
3. Set standards to notify the public of RFFR power densities associated with wireless equipment at point-of-sale and in enclosed spaces (e.g., buildings including spill-over space in buildings, automobiles, busses, aircraft).
4. Set and implement standards for environmental impact statements for RFFR-emitting equipment.
5. Suggest and implement assistance to those suffering from electromagnetic hypertension.
6. Work with Congress in the safe use of wireless communications.
7. Manage strictly the integrity of its funded and internalized research.

**B. Research issue #2: Fund general research to test hypothesizes that a causal relationship exists between RFFRs and potential adverse health conditions.**

I have provided a list of 48 adverse human health conditions caused by RFFRs from medical research articles and opinions of experts. I recommend that the RFFR-federal oversight/education/protection agency review these adverse health conditions and others and fund integrated research to test whether there are causal relationships between varying power density RFFRs and adverse human conditions. The power densities should emulate those emitted by cell phones, Wi-Fi, cordless phones, cell phone base stations, and other RF emitting equipment being sensitive to emissions that are a function of signal strength—as signal strength declines, cell phone search power densities increase dramatically. I have metered RFFRs up to 25,000 $\mu W/m^2$ from RFFR-emitting equipment including Wi-Fi, cell phones, cordless phones, and cell phone base stations.

**C. Research issue #3: Do RFFRs decrease melatonin in the body of individuals in the radiation field?**

One important and relatively simple research issue is whether melatonin is reduced in the bodies of individuals in the presence of the radiation field, which has been found in existing research. Melatonin reduction by RFFRs is important because (1) melatonin is an extraordinarily important nutrient as a super anti-oxidant and as a contributor to good sleep—it is very important to sleep in a very dark room to generate melatonin, (2) adequate levels of melatonin are

believed to prevent and defeat cancer, (3) research suggests melatonin interprets RFFRs as light and shuts down, (4) the melatonin/RFFR relationship can be *quickly* tested for the precise relationship to various power densities of RFFRs to melatonin reduction, and (5) if there is a strong negative relationship (i.e., high power density/low levels of melatonin), it would lend support for further research linking RFFRs to harm to humans.

**D. Research issue #4: Does RFFR-emitting wireless equipment in enclosed spaces (e.g., buildings, automobiles, trucks, busses, aircraft) cause more human harm than the same power density (measured in μW/m$^2$) equipment in open spaces?**

Faraday Cages are metal enclosures designed to keep RFFRs *outside* the Cage. When RFFR-emitting equipment is placed *inside* an enclosure of metal, glass, stone, metal-reinforced concrete, painted dry wall, etc., I believe the power density fields measured in μW/m$^2$ (micro watts per square meter) are magnified because they bounce off the enclosed space walls just as RFFRs bounce off the outside enclosure of a Faraday cage. In essence, these enclosed spaces become reverse Faraday cages by *containing* RFFRs within the enclosure. I have found no RFFR research literature that has mentioned or addressed the issue of increased harm to humans inside an enclosure vs. the same power density outdoors.

In my opinion, there is a near 100% chance that equal power density RFFR-emitting equipment magnifies harm to humans in enclosed spaces vs. outdoors. It is important to understand the magnitude of this additional harm from endogenous RFFRs because of the extensive use of cell phones and Wi-Fi in buildings, automobiles, busses, and aircraft occupied by pregnant women, children, and adults. For example, busses with Wi-FI may have power densities of 12,500 μW/m$^2$ (12.5 times an extreme anomaly by IIBBE and less than one percent of maximum FCC/NCRF safety standards) net of exogeneous (e.g., cell phone base stations) and other endogenous sources (e.g., passenger/driver cell phones) of RFFR emissions.

**E. Research issue #5: Do recommended power densities set by the Institut fur Baubiologie + Okologie IBN and accepted by the International Institute of Building Biology and Ecology provide more reliable limits of safe exposure to RFFRs than the FCC/NCRP limits?**

The radio frequency guidelines for sleeping areas set by the Institut fur Baubiologie + Okologie IBN (German) and accepted by the International Institute of Building Biology and Ecology (IIBBE) in μW/m$^2$ (micro watts per square meter) are as follows:

**Table 3: Building Biology Evaluation Guidelines for RFFRs in sleeping areas**

| Radio-frequency radiation | No Anomaly | Slight Anomaly | Severe Anomaly | Extreme Anomaly |
|---|---|---|---|---|
| μW/m$^2$ (micro watts per square meter) | <0.1 | 0.1 – 10 | 10-1000 | >1000 |

"Anomaly," in the context of RFFRs, refers to a power density that is in excess of the power densities that would exist were wireless-equipment RFFRs not present. It is an unsatisfactory abnormality that is interpreted by building biologists as a concern for human health but is not referenced to a specific adverse human condition.

The data in FCC OET Bulletin 65 (August 1997) [58] indicates that the safety limit for radio frequencies of 1000 MHz (a common frequency of cell phones) is a power density of 0.67 mW/cm$^2$ (a nice small number…) which translates to 6,666,667 μW/m$^2$ (…until you translate it to μW/m$^2$) and for 1500 MHz is 1.00 mW/cm$^2$ which translates to 10,000,000 μW/m$^2$. These FCC power density safety limits compare with an IIBBE Extreme Anomaly of 1,000 μW/m$^2$. Thus, the FCC safety limits for 1000 MHz are 6,666 times the IIBBE Extreme Anomaly and for 1,500 MHz are 10,000 times the IIBBE Extreme Anomaly based upon the Institut fur Baubiologie + Okologie IBN accepted by the International Institute of Building Biology and Ecology (IIBBE). The safety limits for IIBBE is based upon the opinions of a panel of ten experts (nine German and one American) from its German counterpart organization, Institut fur Baubiologie + Okologie IBN. The German standards are reviewed by IIBBE annually. Hereinafter, the term "IIBBE" in reference to RFFR power density standards refers to Institut fur Baubiologie + Okologie IBN (German) power density standards accepted after annual review by the International Institute of Building Biology and Ecology (United States).

The FCC/NCRP standard recognizes cellular damage from heat but does not recognize cellular damage from any other RFFR adverse attribute or differential damage to fetuses, children, and adults even though the Bolen/Rome report indicated non-thermal damage to cell and organs in 1994. [57] Fetuses and children absorb much more radiation because of their thinner skulls.

The last time the FCC/NCRP standard was reviewed was in August 1997 before the vast increase in wireless equipment. Thus, the time has come for Congress to review the FCC/NCRP RFFR power density standards in the light of (1) the explosive growth of wireless equipment since August 1997, (2) the lack of government-funded research on the adverse health effects of radio frequency field radiation, (3) 48 adverse health conditions caused by RFFRs I have found in medical research literature (4) scientific support I offer for my hypotheses that wireless equipment may be causing the decline in Labor Force Productivity from about three percent to 0.5 percent and increasing depression and suicide contemplation rates of college students, and (5) the failure of the FCC/NCRP standard to consider harm to humans from other than cellular damage from heat, (6) the failure of the FCC/NCRP standard to consider the differential damage

Indeed, Congress should investigate the qualifications and criteria of the ten-member German committee that sets RFFR standards with a view to accepting the German standard used by its American counterpart, IIBBE, unless Congress finds flaws in the German standard-setting procedures. The FCC/NCRP standard of up to 10,000 times the IIBBE Extreme Anomoly standard (i.e., 10,000,000 μW/m$^2$ for FCC/NCRP vs 1,000 μW/m$^2$ for IIBBE) is preposterous for the immediate human environment.

For further comments on excess FCC/NCRP safety limits see Legislative Proposal #1.

**F. Research issue #6: Is there a link between delayed onset CTE brain damage from concussions and delayed onset symptoms of brain cancer and other brain damage from RFFRs.**

It is well known that symptoms from CTE from concussions generally do not occur during contact-sport playing years but occur after retirement from the sport. It is further believed, based upon limited evidence, that symptoms from damage to the brain from cell phone use most typically begins many years later—ten years later is the commonly predicted guideline time period. Thus, the ten-year delayed onset to symptoms of brain damage from cell phone use may be related directly to the recent growth in college students' depression rates starting in 2013, about ten years after the beginning of heavy cell phone usage.

The research issue is whether there is similarity in brain damage between concussions and cell phone use; indeed, there is scientific evidence of neuronal brain damage to rats from cell phones. If there is similarity between brain damage from concussions and cell phone use, it would lend support to the serious long-term harm from wireless equipment. Concussion brain damage research has generally found that athletes with at least ten years of contact sports have an approximate 95 percent chance of suffering from CTE later in life. [59]

**G. Research issue #7: Does Wi-Fi damage plant seeds from growing?**

Several Danish teenagers, who were having sleep problems with Wi-Fi, experimented with plant seeds placed in water in two rooms, one with Wi-Fi and the other with no Wi-Fi. They discovered the seeds in the room with Wi-Fi died while the plant seeds in the room without Wi-Fi grew normally. [60] This research must be conducted in a controlled scientific experiment funded by the RFFR-oversight agency to determine if the results of the Danish teenagers can be replicated. If they are, it would be partial evidence that Wi-Fi is harmful to living cells and organs.

**H. Research issue #8: Is there a causal link between the Schumann Resonance (SR) and human brain waves, and do RFFRs from cell phone base stations, cell phones, Wi-Fi, smart meters, and/or cordless phones interfere with the Schumann**

**Resonance or human brain waves independent of the SR thus destabilizing the human brain?**

The Schumann Resonance is generated in the Ionosphere from lightning strikes, has a principal frequency of 7.83 Hz (7.83 cycles per second), additive harmonics at about 5-6 Hz (1st harmonic at 13 Hz), and a range up to about 60 Hz although some sources indicate a somewhat higher frequency. Human brain waves have a range of up to about 60 Hz as well. Some have hypothesized that the RFFRs of human brain waves are derived from the SR, and indeed if the SR were removed, life on our planet would become unbearable because of harm to humans. [61]

There is evidence that humans, separated from the Schumann Resonance (e.g., underground bunkers and perhaps outer space in enclosed capsules), may become ill until the SR is restored to their environment. [62] I have tried to trace the original article on the underground bunker experiments of Rutger Wever at the Max Planck Institute in Germany without success (phone calls at 4:00 AM to Germany), and NASA and the Russian space agency to determine if the SR is added to United States or Russian space craft. NASA sent me articles on the SR, but neither they nor the Russian space agency has answered my e-mail inquiry regarding adding the SR to space craft to promote human health in space. Since neither has responded to my question regarding adding the SR to space craft, I assume it is secret and that it is probably added to space craft. If true, this would affirm the importance of the SR to support human life.

The extended importance of having continuous human access to the SR is two-fold. First, if high-energy, RFFR emitting equipment interferes with the reception of the SR by the human brain, RFFRs may be harmful to the brain and other organs as indicated in the alleged bunker experiments of Rutger Wever. Second, independent of the SR-human brain frequencies interdependency, RFFR emitting equipment may interfere directly with human brain RFFRs, and perhaps other RFFRs in the human body. This may demonstrate human cell and organ damage from non-heat (SAR) sources of RFFRs and undermine dramatically the FCC/NCRP safety standards protection which disregards non-heat harm to humans.

Indeed, research describing the relationship of the SR to human life could unleash a treasure of information about human existence and our interdependency with the NATURAL environment—an environment free of massive, additive RFFRs from wireless equipment.

**I. Research Issue #9: Issue: Does EMF radiation have a cap for each person beyond which a person is more likely to be afflicted with EMH and are there functional relationships that affect the cap?**

To the best of my present knowledge, there has been no research linking non-ionizing radio frequencies with a maximum amount beyond which a person enters EMH. But as research proceeds in these other areas, it would be wise to be alert to the amount of non-ionizing radiation different individuals may sustain before they become EMH. Indeed, there may be a relationship between the total RFFR and other unique human attributes. [63]

**J. Research Issue #10: Are there objective bodily changes that occur when individuals who claim to be Electromagnetic Hypersensitive (EMH) are in the presence of a measurably high RFFR?**

The World Health Organization states that "To date, no adverse health effects have been established as being caused by mobile phone use." [4] I have provided 48 adverse health conditions shown by clinical research to be caused by RFFRs and Langrebe [50] has shown altered nervous system function by those claiming EMH.

Thus, I propose research of potential bodily changes suffered by EMH claimants thus showing that EMH is an actual illness and providing these individuals special protection in the law and rights to claim financial damages as appropriate.

**K. Research Issue #11: What can be done to accommodate individuals who suffer from electromagnetic hypersensitivity (EMH)?**

It is generally accepted that at least three percent of the population has EMH and is suffering from one or more symptoms they believe are caused by RFFRs. In one case, Jenny Fry, a UK teenager committed suicide because of Wi-Fi in her school. [56] Further, I have identified 48 adverse health conditions caused by RFFRs and a hypothesis inferentially linking the decline in labor productivity and increases in depression and contemplation of suicide to RFFRs. EMH individuals could also influence adversely the labor force participation rate.

The issue is what is being done to accommodate individuals with EMH under current RFFRs and how this will change when wireless 5G is placed on telephones poles on every urban block. A few ideas follow:

1. Recognize that the percentage of EMH individuals will increase, but we will not know the expansion of these percentages unless there is medical monitoring and reporting to a central federal health agency.
2. Set aside areas in every city which are RFFR-free to accommodate those with EMH. Unfortunately, these people must work and travel to areas which may not be RFFR-free.
3. Set aside specific cities and geographical areas that are RFFR-free. One of these already exists on the east coast.
4. Disregard EMH-sensitive individuals and face the consequences of more homeless, more violent crime, more poverty, and other degenerate processes to further weaken our society to assure money flows to those producing RFFRs in the form of more cell phone base stations, cell phones, Wi-Fi, smart meters, and cordless phones with no regard for their adverse consequences to human life.
5. Reign in the expansion of wireless technology.
6. Expand federal legislation to prohibit the expansion of cell phone base stations until there has been at least five years of federal RFFR-oversight agency monitoring of present and future RFFR systems and finding all, including wireless 5G, are safe. It is my understanding that wireless 5G will expand the broadband from about 6 GHz now to 100 GHz. Presently, RFFR meters measuring over 10 GHz are rare and expensive.

**VII. Proposed legislation for the United States Congress**

**A. Strategic objectives of U.S. Congressional legislative proposals**

The federal legislative proposals I suggest in this section are intended to educate, inform, and protect the American people from the potential danger from wireless technology and have the following strategic objectives:

1. Understand the scope of human harm from (1) wireless equipment emissions based upon the 48 adverse health conditions supported by medical research in this report, (2) my hypotheses related to declines in labor force productivity and increases in depression and contemplation of suicide by college students, and (3) any other scientific evidence uncovered by the oversight/education/protection agency.
2. Correct the natural inertia that exists when one uses technology believed to be safe and gives so much personal pleasure when the technology is harmful.
3. Increase the education of all Americans regarding the metered measurement of power densities in $\mu W/m^2$ as a negative attribute of wireless equipment.
4. Further the education of Americans by labeling all products sold with wireless communications at point-of-sale with near (i.e., MF, EF) and far field (i.e., power densities in $\mu W/m^2$) EMF/RFFR strength. These labels will assist purchasers of equipment or devices with wireless communications to become aware of the radiation power intensity of this equipment in $\mu W/m^2$.
5. Further the education of Americans by demonstrating how RFFR-emitting equipment spills over into adjacent housing units in multifamily housing. In one case, I discovered a 900 $\mu W/m^2$ power density in an apartment bedroom when the outside power density was about 200 $\mu W/m^2$ and the Wi-Fi and cell phones were turned off in the subject apartment. This indicated the likelihood of neighboring Wi-Fi (horizontally and/or vertically) broadcasting a 700 $\mu W/m^2$ power density into the subject apartment. The intrusion of a power density into another's real estate constitutes a probable trespass violation under state law[1], acts as a stimulant to disturb sleep, and may injure cells and organs in the spillover housing unit. While education of spillover RFFRs is a portion of the solution for multifamily housing safety, prohibitions against spillover RFFRs should be included in the solution. Remember, fetuses and young children have very thin skulls and absorb much higher amounts of RFFRs and must be accorded special protection from spill-over RFFR under trespass

law. Notably, the FCC/NPRC SAR safety standard has no provision recognizing non-heat injury to cells and organs or the thinner skulls of fetuses and children.

6. Set standards for environmental impact statements for selected sources of RFFRs in urban areas.
7. Demonstrate how hard-wired routers and Ethernet cables (connecting the land line telephone with the computer) may be used as substitutes for Wi-Fi and reduce substantially power densities in enclosed spaces. This could reduce power densities up to 5,000 $\mu W/m^2$ (and perhaps more) from Wi-Fi in the source and spillover apartment—I have measured 4,000 $\mu W/m^2$ 12 feet from a Wi-Fi and 25,000 $\mu W/m^2$ in the chair serving a computer.

[1]Corpus Juris Secundum defines trespass in part as "…any misfeasance, transgression or offence that damages another's person, health, reputation, or property;" It is a "…wrong against the right of possession…any invasion of the interest in exclusive possession of property...an unauthorized entry on another's property." [Footnotes 6, 7, 8, 10, p. 711-712] There is, however, a distinction between a willful trespasser and an innocent trespasser, which illustrates the importance of educating the public of the nature and seriousness of spillover RFFRs. For example, one victim may be EMH and would be immediately and seriously harmed while other victims may simply lose sleep and not know the cause and suffer immediate cell or organ damage and have no immediate symptoms. Trespass is a very complex concept in law and the material I present here is obviously incomplete.

**B. Legislative Proposal #1: Congress should critically review RFFR safety limits set by the FCC/NCRP and recommendations by IIBBE with a view to rejecting the former and accepting the latter to reduce human harm from radio frequency radiation fields.**

The FCC/NCRP has set RFFR safety limits which are taken from the FCC, Office of Engineering & Technology, *Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields, OET Bulletin 65, Edition 97-01 (August 1997), Appendix A, Table 1.* [58] This FCC safety standard was taken from the National Council on Radiation Protection and Measurements (NCRP), "…a non-profit corporation chartered by the U.S. Congress to develop information and recommendations concerning radiation protection." [58, p. 7] NCRP developed the standard from the Institute of Electrical and Electronics Engineers, and adopted by the American Standards Institute. The FCC also considered comments by the Environmental Protection Agency, Food and Drug Administration, and "…other federal health and safety agencies..." [58, p. 7-8]. The sole criteria used in judging harm to humans is the "averaged SAR." [58, p. 8] The SAR refers to the Specific Absorption Rate, a measure of heat absorption in watts per kilogram/gram (W/kg, mW/gm) [58, p. 5, 10]. Use of the SAR, a thermal measure, as a measure of harm to humans is disputed by many scientists. One research article stated "…the vast majority of the recorded biological effects from man-made non-ionizing environmental radiation are non-thermal." [64]

Thus, the FCC/NCRP radiation standards disregard all damage to human organs caused by radio frequency fields not measured by heat absorption, disregard the higher RFFR absorption rates by fetuses and children, and assume that SAR safety standards are correct, which is a false assumption.

The FCC/NCRP standards often seem to be associated with antennas with an implied association with human spatial fields; "human spatial fields" are RFFR that directly influence the
space around a person. My recommendations in this report disregard antenna standards *per se* and set safety standards exclusively for the space around a human even though they are transmitted by an antenna.

IIBBE sets its safety standards from standards set by a committee of ten members of Institut fur Baubiologie + Okologie IBN (German) which are reviewed annually by IIBBE experts. These experts set the anomaly standards based upon harm they have perceived from their experience of harm to humans from heat and non-heat electromagnetic energy in their RFFR inspections and other sources. Further, substantially all RFFR inspectors use $\mu W/m^2$ not $mW/cm^2$. Obviously, the RFFR industry prefers 1 $mW/cm^2$ to its equivalent, 10,000,000 $\mu W/m^2$ because 1 $mW/cm^2$ is so much smaller than 10,000,000 $\mu W/m^2$.

Since NCRP is a chartered corporation of the United States Congress, it should be a simple and direct process of holding Congressional hearings to form opinions about RFFR safety limits and have NCRP conform to those set by IIBBE unless Congress finds clear evidence the IIBBE standards are too low. Since EPA has participated in acceptance of FCC/NCRF RFFR safety standards, it may be best for Congress to rely on an alternate RFFR-oversight/education/protection agency, medical authorities who have treated EMH-sensitive individuals, and others with RFFR symptoms and illnesses.

**C. Legislative Proposal #2: Execute enabling legislation to create a new federal agency to have jurisdiction to fund research, set integrity standards governing research, provide public education of the potential harm to humans from RFFR, and warn the public of harmful power densities from RFFR-emitting equipment.**

Since the preceding section has shown that FCC/NCRF, with the input of EPA, disregard all human injury other than that from heat using the SAR, has preposterously high safety limits, and disregards the higher RFFR absorption rates of children and fetuses, there is no federal agency that has oversight control over wireless equipment safety from radio frequency field radiation. In essence, the FCC/NCRP have accepted safety limits derived from other government and private entities in its primary mission of disseminating and allocating broadcasting band widths. There are indications that wireless 5G may expand the band widths from about 6GHz currently to 100 GHZ and thereby increase greatly band width energy. This may require Environmental Impact Statements for cell phone base stations measured by increases in power densities for line-of-sight buildings.

I have provided substantial evidence that radio frequency field radiation is linked to at least 48 adverse health conditions and possibly to the decline in labor force productivity and increases in depression and suicide contemplation rates for college students. Thus, it is crucial that Congress empower a federal RFFR-oversight agency independent of any agency which has participated in the current FCC/NCRP safety standards. Since EPA has participated in the current FCC/NCRP standards, it is necessary to create a new agency. And this must be done immediately to assure the American people are protected from a potentially catastrophic health crisis.

**D. Legislative Proposal #3: Require point-of-sale notices on all personal property (e.g., cell phones, Wi-Fi, cordless phones, automobiles) containing wireless transmission equipment indicating the near-field magnetic (A/m) and/or electrical fields (V/m), the far-field power densities ($\mu W/m^2$) at prescribed distances, and warning of dangers found from funded and non-funded research.**

Presently, wireless equipment including cell phones, Wi-Fi, cordless phones, and automobiles are sold with no notice to consumers of the strength of the power density of the RFFR or warnings of harm. Since RFFR has both near- and far-field components, the strength of each should be shown on point-of-purchase materials. The near-field consists of an independent magnetic (MF) and electrical field (EF) beginning at the antenna and extending about three wave lengths or about three feet depending upon frequency. The far field begins when the MF and EF join after about three feet to form an integrated far-field RFFR.

The posted notice on automobiles should be on the MSRP sticker and may be reduced to only the far field to simplify reporting. Since cars are similar to a Faraday Cage, their internal RFFR may be more harmful particularly to fetuses and young children, if the windows are closed.

The principal objective of showing the near- and far-field antenna outputs is to begin an educational campaign to inform the public of these two measures of EMF/RFFR power. In the longer run with greater public knowledge, equipment may adapt to serve better the health needs of all Americans. It is essential that any standard for far-field power densities be in **micro Watts per square meter** ($\mu W/m^2$) because the numbers are large enough to have meaning and because $\mu W/m^2$ is used by EMF inspectors in the United States and Canada.

The notice could also provide a measure of IIBBE safety standards I show in Table 3.

**E. Legislative Proposal #4: Require posted notice of power densities from radio frequencies in enclosed public spaces**

**containing Wi-Fi.**
In order to educate the public about harmful power densities from RFFR emitting equipment, notices of power densities should be posted in all public enclosed spaces containing Wi-Fi including buildings, busses, trains, and aircraft. The posted power densities should be periodically updated.

For enclosed building space containing Wi-Fi, public notices of power densities should provide the power density at times of approximate peak occupancy, which would include RFFRs from endogenous Wi-Fi, spillover RFFRs from other space, customer and staff cell phones, and exogeneous sources.

Busses and trains containing Wi-Fi should report the power density inside the bus/train with approximately peak occupancy and include Wi-Fi and cell phones. I measured one city bus at 12,500 $\mu W/m^2$ attributable to Wi-Fi excluding exogenous sources of RFFR (e.g., cell phone base stations) and cell phones inside the bus.

Aircraft containing Wi-Fi should report the power density inside the aircraft at approximately peak occupancy and include Wi-Fi and cell phones.

**F. Legislative Proposal #5: Require medical doctors to report illnesses caused by RFFRs to the United States Department of Health and Human Services.**
Presently, there is no knowledge of the percentage of EMH individuals or others who have symptoms (e.g., headaches, anxiety, unable to sleep) or illnesses (e.g., EMH, brain tumors) attributable to RFFRs. In order to evaluate the safety of the present system and on-coming wireless 5G, it is crucial to understand the medical conditions, if any, caused by wireless technology.

All doctors should report the names of individuals with illness with a high probability caused by RFFR to the U. S. Department of Health and Human Services. This should include those that have a high probability of being Electromagnetic Hypersensitive, having same side brain tumors, low sperm count, etc. where there is a high probability that RFFR emitting equipment is the cause. While I am aware that it may be difficult to assign a high probability of cause of a specific illness to RFFR, this must be done to have a measure of safety of RFFR-emitting devices. Reporting standards could be written by the oversight/education/protection agency with the input of the American Medical Association and other medical associations.

**G. Legislative Proposal #6: Measure far-field RFFR in $\mu W/m^2$ (micro watts per square meter) not $\mu W/cm^2$ (micro watts per square centimeter).**
It is important to measure far-field RFFR in $\mu W/m^2$ (micro watts per square meter) not $\mu W/cm^2$ (micro watts per square centimeter) because substantially all EMF/RFFR inspection personnel use $\mu W/m^2$, and (2) $\mu W/cm^2$ is a very small number that seems inherently safe and is favored by manufacturers and installers of wireless equipment for that reason.

**H. Legislative Proposal #7: Establish a plan to accommodate EMH individuals**
It is necessary for Congress to hold hearings to determine the problems faced by EMH sensitive individuals and from this evidence establish a plan to accommodate them with reduced RFFR geographical areas, special transportation accommodations, living spaces free of spill over RFFRs from Wi-Fi and cell phones, and other accommodations

**VIII.Discussion**
This article (1) provides a list of 48 adverse health conditions in humans and rats having a causal link to radio frequency field radiation (RFFR) supported by medical research, (2) supports my hypothesis that the decline in labor force productivity from about three percent to 0.5 percent from 2011 to 2016 and the increases in college student depression and contemplation of suicide rates may be caused by wireless communications, (3) suggests creation of a new federal oversight/education/protection agency to fund research to determine if there are causal linkages between wireless devices and adverse human conditions, and inform and protect the public from harmful power densities from wireless devices, (4) offers 11 research suggestions for the oversight/education/protection agency, and (5) offers seven U.S. Congressional legislative proposals to educate and protect the American people from the adverse health effects of uncontrolled and unbounded expansions of wireless communications. The electromagnetic field scope of this article emphasizes principally radio frequency field radiation and secondarily magnetic fields from electrical current.

The 11 federally funded research issues I offer include the following:
1. Discussion of the institutional setting to create a new federal oversight/education/protection agency to fund research providing scientific evidence which asserts or denies a causal link between RFFR and adverse health conditions, and to educate and inform the American people of the potential harm from wireless communications.
2. Fund general research to develop scientific evidence which asserts or denies a causal link between RFFR and adverse health conditions.
3. Assert or deny a causal link between RFFR and reduction of melatonin.
4. Determine if adverse health conditions from RFFR are increased in enclosed spaces.
5. Determine if the lower power density standards set by IIBBE provide more reliable exposure limits than FCC/NCRP the latter of which are about 7,000 times or more greater than the former.
6. Determine if there is a medical link between delayed onset brain damage from concussions and delayed onset brain damage from RFFRs.
7. Determine if Wi-Fi damages plant seeds from growing.
8. Determine if RFFR interferes with the Schumann Resonance (SR) in combination with human brain radio frequency waves or interferes with human radio frequency brain waves separately and independent of the Schumann Resonance.
9. Determine if there is a natural cap of RFFR for each person based upon their body's functional relationships beyond which they become afflicted with electromagnetic hypersensitivity (EMH).
10. Do EMH individuals exhibit objective bodily changes when they are exposed to RFFR proving that EMH is a diagnosable illness?
11. Provide a reasonable accommodation model for those with EMH.

The seven legislative proposals I offer to assure the safety of the American people from wireless communications are:
1. Congressional review of RFFR power density safety standards through the National Council on Radiation Protection and Measurement, a non-profit corporation chartered by the United States Congress.
2. Pass enabling legislation to fund a new federal oversight/education/protection agency to fund research providing scientific evidence which asserts or denies a causal link between RFFR and adverse health conditions, and to educate and inform the American people of the potential harm from wireless communications..
3. Require point-of-sale notice of the strength of near field and power density of the far field for all personal property emitting RFFR, if it is shown that RFFR causes adverse health conditions.
4. Require posted notice of power densities from RFFR in any public enclosed space containing Wi-Fi, if it is shown that RFFR cause adverse health conditions.
5. Require medical doctors to report RFFR illnesses to the United States Department of Health and Human Services, if it is shown that RFFR cause adverse health conditions.
6. Require far-field RFFR to be measured in micro watts per square meter ($\mu W/m^2$), not milli Watts per square centimeter ($mW/cm^2$).
7. Establish a plan to accommodate EMH individuals.

The emphasis of these recommendations is to educate, inform, and protect the American people from the adverse health conditions from RFFRs supported by RFFR agency research, if, in fact, scientific evidence shows that RFFR causes significant adverse health conditions.

I have no conflict of interest related to the material in this article.

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# Risk of ADHD Grows With Screen Time

By Daniela Hernandez And Betsy Morris

The more teens use social-media networking sites, video-games and streaming services, the higher their risk of developing symptoms of attention-deficit hyperactivity disorder, or ADHD, a new study found.

The study, published Tuesday in the Journal of the American Medical Association, tracked 2,500 teens over two years and monitored their usage and symptoms.

It doesn't prove a causal link. The study also didn't rule out other possible causes such as lack of sleep, family stress at home or a family history of the disorder. But it was the first longitudinal study to follow so many teens over a two-year period, according to experts, going straight to an issue that pits parents and teachers against the tech industry in a battle for children's attention.

"I don't think it's reason for panic. But I'm a clinician who sees kids with ADHD all the time, and I don't want to see an increase," says Jenny Radesky, a University of Michigan assistant professor of pediatrics, who specializes in developmental and behavioral health.

"Executive function and flexible problem solving—all that matters for long-term success," she said. "Even if it's a small increase in ADHD, I think that's important." Such skills are often affected by ADHD. Dr. Radesky, who wrote a JAMA editorial about the new study, wasn't involved in the work.

Use of technology could be one of several environmental factors related to ADHD. Research suggest that smoking and drug use during pregnancy and lead exposure during childhood may also increase the risk of developing the disorder, according to the U.S. National Institutes of Health. Genetics frequently come into play.

Many of the major tech companies this year have said they are mindful of the risks of too much screen time, and are launching various measures to curb the use by those who might be susceptible to overload. It isn't yet clear whether those nascent efforts are having an effect.

The new study is an important early step toward understanding the impact on the developing brain of media enabled by the internet, apps and mobile devices, and shows that more research is needed, scientists said.

For the study, students answered questionnaires every six months about their media diet—including checking social media, browsing videos, video chatting and online shopping—and frequency of use, plus assessments of ADHD-related symptoms.

If students reported experiencing six or more symptoms on these self-assessments, researchers considered them positive for ADHD symptoms. Because the researchers wanted to assess whether media use was associated with new symptoms, the study excluded teens who exceeded that threshold when the study began, said Adam M. Leventhal, the study's lead author and the director of the University of Southern California's Health, Emotion and Addiction Laboratory at USC's Keck School of Medicine.

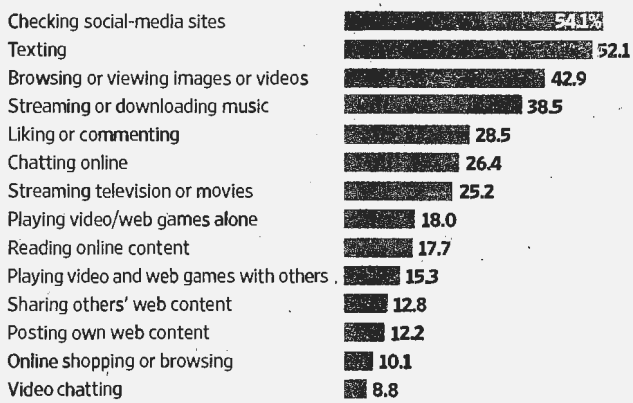
The roughly 500 teens who didn't report using digital media multiple times each day had a 4.6% rate of having ADHD symptoms, such as difficulty completing tasks or remaining still. Among the roughly 50 who reported daily use of all 14 different types of digital media included in the study, the rate was 10.5%.

Previous research has shown that incessant distractions and stimuli from tech use might diminish children's ability to concentrate. Scientists worry this could also harm the ability to develop skills like patience and delayed gratification.

## Teens and Technology

A new study tracking the media diets of 2,500 teenagers found links between frequency of use and ADHD symptoms.

**Share of adolescents who performed these media activities more than twice a day**




Note: A sample size of 2,587 10th grade public school students.

Source: The Journal of the American Medical Association THE WALL STREET JOURNAL.

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FALL 2017

**Felt very sad**

| Percent (%) | Male | Female | Total |
|---|---|---|---|
| No, never | 26.5 | 14.2 | 18.1 |
| No, not last 12 months | 17.5 | 13.4 | 14.6 |
| Yes, last 2 weeks | 24.0 | 34.3 | 31.3 |
| Yes, last 30 days | 11.4 | 14.7 | 13.6 |
| Yes, in last 12 months | 20.7 | 23.5 | 22.4 |
| ***Any time within the last 12 months*** | 56.1 | 72.4 | 67.3 |

**Felt so depressed that it was difficult to function**

| Percent (%) | Male | Female | Total |
|---|---|---|---|
| No, never | 49.4 | 36.4 | 40.2 |
| No, not last 12 months | 19.4 | 21.3 | 20.5 |
| Yes, last 2 weeks | 12.0 | 16.0 | 15.2 |
| Yes, last 30 days | 5.6 | 8.5 | 7.6 |
| Yes, in last 12 months | 13.6 | 17.8 | 16.4 |
| ***Any time within the last 12 months*** | 31.2 | 42.4 | 39.5 |

**Felt overwhelming anxiety**

| Percent (%) | Male | Female | Total |
|---|---|---|---|
| No, never | 39.3 | 21.4 | 27.0 |
| No, not last 12 months | 14.9 | 10.7 | 12.1 |
| Yes, last 2 weeks | 18.8 | 32.6 | 28.5 |
| Yes, last 30 days | 10.4 | 14.7 | 13.2 |
| Yes, in last 12 months | 16.6 | 20.5 | 19.2 |
| ***Any time within the last 12 months*** | 45.7 | 67.9 | 60.9 |

**Felt overwhelming anger**

| Percent (%) | Male | Female | Total |
|---|---|---|---|
| No, never | 42.8 | 35.3 | 37.4 |
| No, not last 12 months | 22.3 | 21.8 | 22.0 |
| Yes, last 2 weeks | 11.1 | 14.2 | 13.4 |
| Yes, last 30 days | 7.3 | 9.5 | 8.9 |
| Yes, in last 12 months | 16.6 | 19.1 | 18.4 |
| ***Any time within the last 12 months*** | 34.9 | 42.9 | 40.6 |

**Seriously considered suicide**

| Percent (%) | Male | Female | Total |
|---|---|---|---|
| No, never | 76.6 | 71.1 | 72.0 |
| No, not last 12 months | 13.1 | 16.8 | 15.9 |
| Yes, last 2 weeks | 2.6 | 2.5 | 2.7 |
| Yes, last 30 days | 1.7 | 2.1 | 2.0 |
| Yes, in last 12 months | 6.0 | 7.6 | 7.3 |
| ***Any time within the last 12 months*** | 10.3 | 12.1 | 12.1 |

**Attempted suicide**

| Percent (%) | Male | Female | Total |
|---|---|---|---|
| No, never | 91.5 | 88.4 | 88.8 |
| No, not last 12 months | 6.9 | 9.9 | 9.3 |
| Yes, last 2 weeks | 0.4 | 0.2 | 0.3 |
| Yes, last 30 days | 0.2 | 0.1 | 0.2 |
| Yes, in last 12 months | 1.0 | 1.4 | 1.4 |
| ***Any time within the last 12 months*** | 1.6 | 1.8 | 1.9 |

**Intentionally cut, burned, bruised, or otherwise injured yourself**

| Percent (%) | Male | Female | Total |
|---|---|---|---|
| No, never | 86.4 | 75.4 | 78.2 |
| No, not last 12 months | 8.9 | 16.1 | 14.0 |
| Yes, last 2 weeks | 1.3 | 2.0 | 2.0 |
| Yes, last 30 days | 0.8 | 1.4 | 1.3 |
| Yes, in last 12 months | 2.7 | 5.0 | 4.5 |
| ***Any time within the last 12 months*** | 4.8 | 8.5 | 7.8 |

**Item 1, Exhibit E: National College Health Assessment Survey, Fall 2017, p. 14.**

# Colleges Give The Disabled More Leeway



## Students who have mental-health issues get extra time on tests, other accommodations

By Douglas Belkin

As many as one in four students at some elite U.S. colleges are now classified as disabled, largely because of mental-health issues such as depression or anxiety, entitling them to a widening array of special accommodations like longer time to take exams.

Under federal law, students can be considered disabled if they have a note from a doctor. That label requires schools to offer accommodations depending on the student's needs. A blind student, for example, would have access to specialized software or a reader for an exam.

A rise in disability notes for mental-health issues has led to a surge in the number of students who take their exams in low-distraction testing centers, are allowed to get up and walk around during class, or bring a comfort animal to school, among other measures.

"At Pomona, we have extremely talented bright students with very high expectations who are coming in with [illegible] and are highly stressed," says Jan Collins-Eaglin, the Claremont, Calif., college's associate dean of students for personal success and wellness. "Our job here is to help them really thrive."

*Some college professors question how this affects the fairness of exams.*

Students with disabilities. Among the 100 four-year, not-for-profit colleges with the highest percentage of disabled students, 93 are private, according to a WSJ analysis of federal data.

Public schools have also seen a significant uptick in test accommodations. From 2011 to 2016, the number of students with special accommodations increased by an average of 71% among 22 flagship state schools, according to data obtained by The Wall Street Journal.

The most common accommodations come during testing. Students who receive extended time may get twice as long as their classmates to take an exam.

Some professors question how this affects the fairness of exams.

"If you grade on a curve, does it disadvantage the rest of the class?" asks Ari Trachtenberg, a professor of electrical and computer engineering at Boston University who is critical of the rise in accommodations.

Lila Manstein double-majored in chemistry and math at Amherst and will graduate this year with a B-plus average.

She was given 50% more time than her classmates on exams because she was diagnosed with reading-comprehension difficulties and Attention Deficit Disorder.

A classmate once told her she would have had a 4.0 GPA if she, too, had extended time. "I told her it wasn't the sort of thing I would have if I didn't really need it," Ms. Manstein says. "That shut her up."

At the University of Minnesota, a test center for students entitled to low-distraction environments or extended time on exams administered 9,681 tests last year, nearly double the number in 2013. The growth has forced staff to give up their offices during finals to make room for students. This past year, the school rented out an additional 10,000 square feet of space in a nearby hotel.

At the University of Kentucky, a dozen students at a time took finals inside cubicles in a room in the testing facility with carpeted floors and dim lights. Blue painter's tape covered door latches so they open and close silently. Students being tested on computers each sat in a private room so the clickety-clack of the keyboards wouldn't disturb classmates. The facility administered 7,827 tests in 2016-17, up from 853 in 2007-08.

"We're seeing a lot more requests for private rooms," says David Beach, director of the school's disability resource center.

At Pomona, 22% of students were considered disabled this year, up from 5% in 2014. Other elite schools have also seen a jump in disabilities, according to data from the federal government and from the schools. At Hampshire, Amherst and Smith colleges in Massachusetts and Yeshiva University in New York, one in five students are classified as disabled. At Oberlin College in Ohio, it is one in four. At Marlboro College in Vermont, it is one in three.

Psychologists have many theories to explain the rise in mental-health diagnoses among college-age students, from social-media habits to less stigma around mental illness.

Small, private schools have the greatest concentration of

https://www.wsj.com/articles/colleges-bend-the-rules-for-more-students-give-them-extra-help-1527154200

EDUCATION

# Colleges Bend the Rules for More Students, Give Them Extra Help

With an influx of students classified as disabled, schools move to accommodate their needs

At Pomona College, 22% of students were considered disabled this year, up from 5% in 2014. PHOTO: PATRICK T. FALLON FOR THE WALL STREET JOURNAL

*By Douglas Belkin*

May 24, 2018

As many as one in four students at some elite U.S. colleges are now classified as disabled, largely because of mental-health issues such as depression or anxiety, entitling them to a widening array of special accommodations like longer time to take exams.

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Small, private schools have the greatest concentration of students with disabilities. Among the 100 four-year, not-for-profit colleges with the highest percentage of disabled students, 93 are private, according to a WSJ analysis of federal data.

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Some professors question how this affects the fairness of exams.

"If you grade on a curve, does it disadvantage the rest of the class?" asks Ari Trachtenberg, a professor of electrical and computer engineering at Boston University who is critical of the rise in accommodations. "There's no calibration between how much extra time they want me to give and any sense how that would actually affect the exam."

MORE ON COLLEGE

- Education Department Plans to Help Some Borrowers Seeking Loan Forgiveness (May 23)
- Where Are Graduates Moving After College? (May 15)
- How Success Academy Got Its First Seniors to College (March 22)
- The Truth About the SAT and ACT (March 8)

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At the University of Kentucky, a dozen students at time took finals inside cubicles in a room in the testing facility with carpeted floors and dim lights. Blue painter's tape covered door latches so they open and close silently. Students being tested on computers each sat in a private room so the clickety-clack of the keyboards wouldn't disturb classmates. The facility administered 7,827 tests in 2016-17, up from 853 in 2007-08.

"We're seeing a lot more requests for private rooms," said David Beach, director of the school's disability resource center.

More than a decade ago, the College Board, which administers the SAT and PSAT among other tests, stopped alerting colleges when students received extra time, and the numbers who requested it began to increase. From 2010-11 to last year, the number of accommodations requests jumped 171%, while the number of people taking the exams increased 22%. Last year, 94% of those requests were approved.

The extra time allows students to use various strategies to reduce stress levels so they can overcome their disabilities, administrators say. Without them, many wouldn't graduate, says Monique Burgdorf, the assistant dean of students and interim director of disability resources at Oberlin.

"If I have anxiety and get panic attacks during exams, extended time will give me a chance to check in with myself and calm myself down," Ms. Burgdorf says.

Miriam Kurtzig Freedman, an attorney who has represented public schools in special-education and disability law and has written several books about accommodations, said that giving some test takers extended time on the SAT is "like lowering the basket from 10 feet to eight feet; you're changing the game."

"The reason we pay all this money for the test is so that we can compare someone from South Dakota to someone from California," she says. "If the test is no longer standardized, then what

are we paying for?"

The ACT, which has seen a similar uptick in requests for extra time, said this past week it would limit the additional time students can take on each section. The company said it made the change "to improve fairness for all examinees."

Wealthier students are more likely to receive accommodations than poor students, Ms. Freedman said.

Other expensive liberal arts colleges with high percentages of disabled students include Pitzer in California (18%), Vassar in New York, Reed in Oregon and Mount Holyoke in Massachusetts (all three at 16%) and Haverford in Pennsylvania (15%).

Among the nation's most elite institutions, those with the highest percentage of disabled students were Stanford (14%), Brown (12%), Yale (11%) and Columbia University (8%).

Public flagships with the highest percentages include the University of Vermont (16%), University of Massachusetts, Amherst (10%) and University of Arkansas (10%).

The rise hasn't impacted the academic rigor of the school, says Jodi Foley, Amherst director of accessibility services. "The academic profile of Amherst's student population continues to increase as it continues to diversify."

**Write to** Douglas Belkin at doug.belkin@wsj.com

**Corrections & Amplifications**

Students may report more than one type of disability. A previous version of this article included a chart that didn't account for students reporting multiple disabilities. (May 24, 2018)

*Appeared in the May 25, 2018, print edition as 'Colleges Give The Disabled More Leeway.'*

Item 1, Exhibit H: WSJ, 07.05.2018, A4

# More K-12 Students Get Special Help

By Douglas Belkin And Tawnell D. Hobbs

More students are getting extra help for a range of issues including ADHD and anxiety, data show, with a disproportionate amount of those receiving support attending schools in wealthier districts.

From the 2009-10 school year to 2015-16, the number of public school students in kindergarten through 12th grade granted accommodations known as 504 plans more than doubled, from 1% to 2.3%, or more than 1.2 million students, according to a Wall Street Journal analysis of federal data.

504 plans are designed to level the academic playing field for K-12 students who face a variety of physical and emotional challenges by providing services such as extended time for tests, including college entrance exams like the SAT and ACT.

The data show high rates of students receiving accommodations in wealthier districts and lower rates in poorer ones. In some wealthy schools, as many as one in five students receive this type of accommodation.

Awareness and diagnoses of mental-health issues have been rising in recent years, according to the Centers for Disease Control and Prevention. Factors in the lopsided growth include gaps in both resources at schools and information among parents about the plans, advocates say.

"I think that we are to a great extent seeing eligibility numbers that are heavily impacted by parental knowledge," said Candace Cortiella, director of the Advocacy Institute, a Washington, D.C.-based organization focused on improving the lives of disabled people.

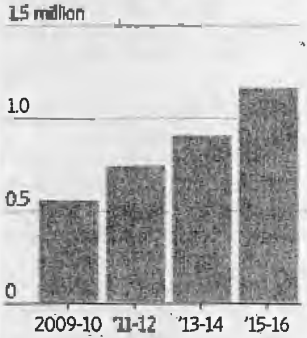
Nationally, white students received 63% of accommodation plans, while making up about 49% of the student population. Black students received 14% and make up about 15% of the student population, while Hispanic students received 21% and make up about 26% of students.

The rate at which students get a different, typically more intensive type of accommodation, called an Individual Education Plan, has remained relatively constant at 12% of K-12 students, over the past decade.

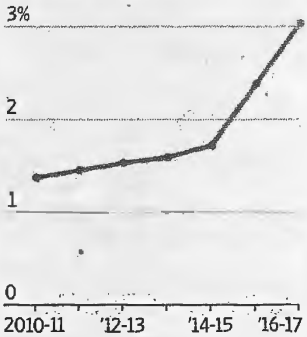
## Making Accommodations

More students are seeking help in school and on college entrance exams for various disabilities such as ADHD and anxiety.

**Number of 504 disability accommodations issued to U.S. public school students**




**Percentage of test takers requesting accommodations on high school exams***




*Includes AP, PSAT/NMSQT, PSAT 10, SAT, or subject tests

Sources: Civil Rights Data Collection, Education Department (number); The College Board (percentage)

THE WALL STREET JOURNAL.

**Before the**
**Federal Communications Commission**
**Washington, D.C. 20554**

**Item 1, Exhibit N: Affidavit of Susan Foster to FCC 02.02.2013**

| | | |
|---|---|---|
| In the Matter of | ) | |
| | ) | |
| Notice of Proposed Rulemaking | ) | |
| 18 FCC Rcd 13187, 13188 ¶1 (2003) | ) | ET Docket No. 03-137 |
| | ) | |
| And | ) | |
| | ) | |
| Service Rules for the Advanced Wireless Services | ) | WT Docket No. 12-357 |
| H Block---Implementing Section 6401 of the | ) | |
| Middle Class Tax Relief and Job Creation Act of | ) | |
| 2012 Related to the 1915-1920 MHz and | ) | |
| 1995-2000 MHz Bands ¶53 footnote 95 | ) | |

To: Office of the Secretary
Federal Communications Commission
Washington, DC 20554

Comment Filed by:

Susan D. Foster, MSW
15957 Avenida Calma
Rancho Santa Fe, CA 92091
susan.foster04@gmail.com
(858) 756-3532

February 2, 2013

# AFFIDAVIT OF SUSAN D. FOSTER, MSW

State of California ]

San Diego County ]

I, Susan D Foster, MSW, attest that my statements are true to the best of my knowledge.

**Comment** round for ET Docket No. 03-137 and WT Docket No. 12-357.

1. My name is Susan D Foster, MSW. My address is 15957 Avenida Calma, Rancho Santa Fe, California 92091.

2. I am a medical writer and the organizer of a brain study of firefighters exposed to RF radiation from a cell tower adjacent to their fire station of over 5 years.

3. In 2004 I organized a pilot study of California firefighters who worked up to ninety (90) hours per week in fire stations with cell towers in close proximity to the two (2) stations where the firefighters work, eat, and sleep. The men were experiencing profound neurological symptoms following activation of the towers in 1999.

4. The symptoms experienced by the firefighters, all of whom had passed rigorous physical and cognitive exams prior to being hired by the fire department, included but were not limited to the following: headaches, extreme fatigue, sleep disruption, anesthesia-like sleep where the men woke up for 911 calls "as if they were drugged", inability to sleep, depression, anxiety, unexplained anger, getting lost on 911 calls in the town they grew up in, a twenty (20) year medic forgetting basic CPR in the midst of resuscitating a coronary victim, immune-suppression manifest in frequent colds and flu-like symptoms.

5. The neurological testing and SPECT scans [single-photon emission computed tomography] of the brain were conducted by Gunnar Heuser, MD, PhD and J. Michael Uszler, MD. All six (6) firefighters were found to have brain abnormalities on SPECT scan. The doctors thought they would find areas of limited function in the brain based on

the symptomatology. Instead, they found a pervasive, hyper-excitability of the neurons which suggested the exposure to RF (microwave) radiation was causing the neurons to continually fire, without rest. RF radiation appeared to act as a constant stimulant even when the men were away from the station, and in repose. The SPECT scans were considered abnormal in all 6 firefighters.

6. Cognitive function, reaction time, and impulse control were measured objectively using T.O.V.A. testing [Test of Variables of Attention]. In all six (6) firefighters, impairment was found with cognitive function, reaction time and impulse control. Three (3) of the six (6) firefighters were captains. The captain on each shift is in charge of making life altering decisions for all firefighters and potential victims. They order firefighters into a burning building, and conversely, they order them out before a roof may collapse, for example. Impairment of all three critical functions could cost firefighters and the community they serve either life or limb.

7. The testing was conducted in 2004. The cell towers are in place at the two (2) fire stations where the test subjects work for the duration of a twenty-two (22) year lease. The men we tested have remained at the stations as this is the only work they know in the only community they have ever lived in. One (1) of the six (6) men tested did move to another department after his wife gave birth to an a boy who was diagnosed with Autism at age 2. This was the first live birth experienced by the "firefighter family" at this department since activation of the tower three (3) years earlier.

8. I have followed up with the firefighters who report continued symptoms as described in paragraph 4. Additionally, all firefighters report profound memory loss.

9. Two (2) of the firefighters, men we did not test in the pilot study but men who were exposed to RF radiation from the cell tower since their installation and activation in 1999, have gone out on psychiatric disability. This is almost unheard of among firefighters. The diagnoses were Post Traumatic Stress Disorder for one firefighter: he went out on an emergency run, and simply stopped talking after he returned to the station. The second

firefighter suffered an apparent break with reality. This occurred in the fire station when he returned following a short term disability for an unrelated injury. This break with reality was followed by an abrupt collapse and loss of consciousness. Because two (2) women have suffered strokes while in the fire station with the towers fully activated, Vascular Spasm Stroke (VSS) is suspected by Dr. Heuser and myself of having caused the two (2) "psychiatric" diagnoses. If not treated with rest and supplemental oxygen, it is possible for some VSS patients to have difficulty regaining speech and full cognitive abilities. This may be a case of misdiagnosis by the treating physicians who were unfamiliar with the potential of cell towers to create thermal effects well under the FCC limit of 1,000 uW/cm2, thus heating blood in the brain and inducing VSS. Further study of these men is imperative.

10. What is particularly germane to the critical decisions the FCC is currently facing regarding RF safety guidelines is the fact the FCC currently allows 1,000 microwatts per centimeter squared (uW/cm2) as an emission standard from cell towers. Yet all the symptoms attributed by the firefighters, as well as measurable brain and central nervous system abnormalities described above, occurred within close proximity to a cell tower measured at between 1 - 2 uW/cm2 by Peter Sierck, BBEC, CEO of Environmental Testing & Technology in Encinitas, CA. Thus the emissions from towers were measured at approximately 1/1000$^{th}$ to 1/500$^{th}$ of the FCC's allowable limit. "Hot spots" of reflected radiation were measured at 15 and 30 uW/cm2, yet these "hot spots" were still a fraction of what the FCC allows. Therefore, I strongly suggest the FCC is not basing its standards on biological effects, but rather physics, and principles of physics do not protect the brains and central nervous systems of the strongest among us, our firefighters.

11. The failure to protect our populations based on biological effects of exposure to RF (microwave) radiation is an inherent shortcoming of the current FCC policy with respect to cell tower emissions and cell phone absorption. The adverse biological impact of these exposures are grossly underestimated. The FCC does not have independent science that can justify the massive exposure to RF radiation that currently exists from cell towers and

cell phones. The story told by our small pilot study of firefighters in California should be a warning with respect to cell phone absorption levels.

12. The FCC is being lobbied by the telecommunications industry to harmonize US standards with those of Europe, as dictated by ICNIRP. To do so would be a grave mistake. The only change that should be implemented with respect to cell phones is a reduction in allowable absorption of RF radiation. We are now dealing with 4G which is untested, and it does appear to have a thermal effect. Many countries keeping brain tumor statistics, especially those countries taking into account the two brain tumors associated with RF radiation exposure, gliomas and acoustic neuromas, are showing clear increases in these two tumors. The increases in brain tumors does appear correlated with the increased use of cell phones.

13. Based on the neurological abnormalities Dr. Heuser and I found in the firefighters, including hyper-excitability of the neurons which can results in cell death and consequent neuro-degenerative diseases such as Alzheimer's, Parkinson's Disease and ALS, I urge the FCC to reflect on the gravity of the decision facing you now, and I implore all Commissioners to reduce the allowable level of RF radiation absorbed by the human brain upon exposure to cell phones.

Respectfully Submitted by

Susan D. Foster, MSW
15957 Avenida Calma
Rancho Santa Fe, CA 92091
February 2, 2013

Six Pillar Tips for Health Management

*Guidelines to Prevent and Treat SARS-CoV-2*

Herman Kelting PhD[1]

tergie@cox.net

January 5, 2021

**Executive Summary:**

*Guidelines* offers suggestions to prevent and treat SARS-CoV-2 (Covid-19) though improved nutrition, food supplements, and reduction of RFR, and Sars-CoV-2 in one's environment using ozone. There is evidence that RFR damages the immune system and its reduction may provide better defenses to SARS-CoV-2. Further, many of the recommendations in *Guidelines* apply to flu and cold symptoms generally. These are medical ideas I am sharing with you and not medical recommendations

**Abbreviations:**

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[1] Herman Kelting has degrees in industrial engineering/engineering economics from Stanford University (1958), an MBA (evening division) in managerial accounting from Northwestern University (1964), and a PhD in real estate and urban land economics from the University of Wisconsin (1974) under Professor James A. Graaskamp. He has ten years teaching experience in real estate, urban land economics, and finance (professor) at three universities, and 30 years as an engineer/financial analyst for the Internal Revenue Service in which he developed a gross revenue multiplier stock pricing model. His recent publication include:

- *Six Pillar Tips for Health Management* (Author House, Sept 2019).
- "Statistical Models Applied to a Log-Normally Distributed Assert/Stock-Pricing Statistic: The Asset Gross Revenue Multiplier (AGRM)" with co-author Sadri Khalassi. *Indian Journal of Applied Research* 6(8) (August 2016): 136-144. *This singular publication furnishes evidence that the AGRM is the principal stock pricing statistic used by professionals in valuing businesses.*
- "Recommendations to Prevent and Treat Post-Traumatic Stress Disorder for Military Personnel." *Indian Journal of Applied Research* 6(9) (Sept 2016): 510-519. (adapted from a report requested by a staff member of Senator Dianne Feinstein (CA)
- "United States Congressional Research and Legislative Proposals to Educate the American People About the Power Density Safety of Wireless Communications ($\mu W/m^2$)," *Indian Journal of Applied Research* 8(1) (Jan 2018): 263-271.
- "Pinocchio and the Spiritual Limit: A Model for Prayer and Health." *International Journal of Scientific Research* 7(6) (June 2018): 25-28. The reporting standard used in this document follows the reporting guidelines described in *Pinocchio*.

Herman has written about a dozen RFR research letters to Senator Catherine Cortex Masto, Senator Jackie Rosen, the Nevada governor, two Nevada legislators, two members of the President's cabinet, the Nevada Attorney General, Clark County Board of Commissioners, the mayor of Costa Mesa, CA,. and a New Hampshire Commission opposing, depending upon the research letter, radio frequency radiation (RFR) generally and specifically from macro cell phone base stations (MCPBS), 5G/4G Small Cell Antennas (SCAs), cell phones, and Wi-Fi in Clark County busses. He has opposed 5G/4G SCAs before the Costa Mesa, CA City Council and New Hampshire "Commission to Study the Environmental and Health Effects of Evolving 5G Technology," and conducts EMF/RFR home inspections and furnishes clients written EMF/RFR reports.

CP: Cell Phone

CS: Colloidal Silver is very small particles of silver suspended in pure water that defeats some viruses by disabling their reproductive capacity.

SARS-COV-2: Corona Virus SARS-CoV-2; Covid-19.

E: Echinacea.

H/D: Hours per day

MCPBSs: Macro Cell Phone Base Stations

RFR: Radio frequency radiation from cell phones, Wi-Fi, MCPBSs, SCAs, wireless security systems, and other RFR emitters. Radiation in general places a force on charged particles in the human body causing disequilibrium and thereby causing injury. Measured in microWatts per square meter ($\mu W/m^2$) by the Building Biology Institute and most articles, and microWatts per square centimeter ($\mu W/cm^2$) by industry.

SCAs: Small cell antennas housing one 5G antenna and three 4G antennas. 4G antennas broadcast RFR 24/7, and 5G antennas are beam forming enveloping humans including pregnant women with radiation. 5G, at higher frequencies, has been used as a high-frequency weapon system.

V/m: Volts per meter

Wn: Wobenzym-N, a protein digesting enzyme and pain killer.

**Guidelines to Prevent and Treat SARS-CoV-2**

The following *guidelines* offer tips to prevent and treat the CoronaVirus (SARS-COV-2), which is a lipid encapsulated, Viral Spike Protein, and flus and colds generally. These are not medical recommendations but a sharing of ideas I have learned from my research for *Six Pillar Tips for Health Management* (Author House: Sept. 2019) and personal use. It would be helpful to research these supplements as alternative and complimentary medicine ideas for side effects before use. I personally use many of these ideas with no problem.

1. Wear a protective mask in public. If a regulation mask is unavailable, a clean handkerchief tied behind the neck may work, but wash it after each use, and thoroughly rinse the soap out. It may be helpful to back-wash a mask frequently in a sink with reverse-direction running water. Using soap may contribute to adverse air quality.
2. The principal method of spreading SARS-CoV-2 is from close-up, person-to-person interactions for extended periods such as crowed events, poorly ventilated areas, and places where people are talking loudly or singing. Distance, masks, and plexiglass

barriers are excellent prevention tactics. Contaminated surfaces are not a significant source, if you keep your fingers out of your mouth, nose, ears, and eyes. [WSJ 06.17.2020, A-1]

3. Social distancing of six feet has been established as the safe distance to minimize contact with the nose and mouth emissions of the SARS-Cov-2 virus from others. This distance rule applies to normal activity/contact and does not apply to indoor exercise where the volume of emitted air is several multiples of normal breathing. Therefore, it is essential that anyone exercising in a building have a face mask and carefully respect social distancing. Anyone exercising in a building without a face mask, or any building manager knowingly permitting such uncontrolled emissions, may be in violation of Nevada Directive 024 and similar regulations in other states.
4. Take one or more of the following food supplements immediately with any throat discomfort. "Immediately" means within five minutes. Once the area of throat discomfort deepens or expands, these ideas are less likely to be effective.

    a. Echinacea (E): Open capsule with powder (i.e., august folia is preferred for flavor, purpurea, or a combination of both, which I prefer) and place powder from ½ capsule in throat and do not wash with beverage. Repeat this at 15-minute intervals for about three servings with no beverage. I have defeated throat discomforts with no more than two servings about 95% of the time. E stimulates the immune system in the throat. It is important to carry two E capsules at all times. If you do not defeat the discomfort immediately, getting ill is more likely. If you have no echinacea, oregano or pepper from a restaurant may work.
    b. Ginger: Ginger by New Chapter contains ginger in a gel form. Place the ginger capsule in your mouth, break it with your teeth, swallow contents, and discharge the capsule. Ginger in this form is very hot so be prepared for a hair-raising event. I find ginger is best for more serious sore throats. There may be more mild forms of ginger, which means it could be used more universally instead of echinacea.

5. Take one probiotic daily; probiotics destroy bad bacteria in the large intestine, add healthy bacteria, and may improve elimination velocity. Two-thirds (2/3) of the immune system is located near the large intestine and if the large intestine contains bad bacteria, the immune system may be damaged. Select a probiotic that has over 30 strains and perhaps one that is refrigerated. "The concept of the gut-brain axis suggests that bowel injury [for new-borns] initiates systemic inflammation potentially affecting the developing central nervous system." [Clariton Moschopoulos, et.al. "The Neurodevelopment Perspective of Surgical Necrotizing Enterocolitis: The Role of the Gut-Brain Axis." Mediators of Inflammation 2018 (Article ID): 8 pages, Abstract.]

6. Since SARS-COV-2 is a protein, a protein-digesting supplement like Garden of Life's Wobenzym-N may digest the SARS-CoV-2, a Viral Spike Protein encapsulated in a lipid membrane, but I have no proven authority for this. Take between five and 20 capsules daily one hour before meals depending upon symptoms. It is necessary for WN to pass the tummy intact and enter the blood stream to digest the bad proteins (fibrin, amyloid beta plaque, tau tangles, SARS-COV-2). This is my idea and

generally unsupported elsewhere; however, I am sure that it improves memory by digesting amyloid beta plaque and tau tangles in the brain. WN is the second most popular pain killer sold in Germany, and I have defeated severe back pain with dosage of 20 capsules per day (5x4) for two weeks then declining to 16, 12, 8, and a steady level of five per day before breakfast. Earthing is another useful pain killer. (Earthing.com)

7. Take colloidal silver (CS; "Sovereign Silver" 10 ppm; Vitamin Shoppe) as directed for a preventive or after you think you have the SARS-COV-2. CS may disable the replication of a virus, but it does not work against all viruses. It is essential that if CS reduces the flu symptoms, the normal dosage should be continued until the flu is 100% defeated; if you stop the dosage too soon, the flu may return (which means the CS worked) and you will have to start the dosage over. Silver has been used for thousands of years to defeat pathogens and was used extensively before antibiotics. Armies used to put silver coins in water barrels to defeat bacteria. CS contains silver 0.6 nano meters in diameter (0.6 billionths of a meter); surface area on the silver is crucial to its antipathogenic benefits.

8. Take the following vitamins, minerals, and water daily in the brands and quantities I suggest as ideas:

    a. Carlson's Vitamin D3. Dosage each is 2000 IU (50 mcg) and its best to vary between 2,000 to 4,000 IU daily. Do not take 4,000 IU daily for more than a few consecutively days. The risk is Vitamin D3 overdose which is difficult to diagnose, terrible to live with, and about a week to overcome. Almost everyone is Vitamin D3 deficient.
    b. Life Extension Neuro-Mag Magnesium L-Thonate or equivalent. Almost everyone is magnesium deficient.
    c. Plnt Mushroom Immune Formula contains 14 mushrooms and boosts the immune system.
    d. Alive Vitamin C, 125 mg each capsule. Take two capsules daily for 250 mg total. Do not overdose on supplemental forms of Vitamin C. Mayo Clinic lists seven symptoms that result.
    e. Two pieces of fresh fruit daily with one being an organic orange. Alive Vitamin C comes from natural sources which may overcome the caveats from synthetic Vitamin C.
    *f. Significant amounts of raw, green and multicolored vegetables. Cooking at 119 degrees destroys enzymes.*
    g. Vitamins A and E are important for the immune system. Vitamin E comes in alpha, beta, delta, and gamma tocopherol and tocotrienol. "d" is natural and preferred and "dl" is synthetic.
    h. A daily multi-vitamin with naturally sourced ingredients. Be aware that multivitamins often do not contain adequate amounts of vitamins and minerals and it may be necessary to use a dedicated supplement for specific nutrients.
    i. Zinc is very important for the immune system and one should take zinc lozenges or syrups, but not pill dietary supplements.

j. Take a full-bodied digestive enzyme (digesting proteins, fats, carbohydrate, cellulose, etc). with selective meals. The pancreas produces fewer enzymes over age 27 leadings to poor digestion as one ages. One suggestion is to take a digestive enzyme with meats and fats (e.g., Garden of Life Omega Zyme Ultra).
k. The purest water to avoid adverse constituents is distilled or reverse osmosis. One should remineralize distilled water with organic lemon juice or a few drops of a mineral supplement

9. If you get *ordinary* flu, take 3 oz of hot chicken soup every three hours during the day. The chicken soup should be prepared by cooking chicken wings or legs with a bit of cayenne. Carrots and other vegetables may be added after cooling a bit to preserve enzymes which are damaged at 119 degrees F.

10. There are indications that current exposure to RFR from wireless communications damages the immune system thereby intensifying the number and severity of SARS-CoV-2 cases. The rules are:

- Reduce the use of your cell phone to only those calls absolutely necessary[2].
- Do not use wireless devices in enclosed areas particularly in the presence of young children. Metal enclosed spaces are the worst because the emissions bounce off the walls.
- Terminate Wi-Fi, and use a land-line telephone, hard-wired router, and Ethernet cable to connect the land line phone with the computer for Internet access.
- Do not use wireless security systems, wireless baby monitors, or other wireless devices in the home.
- *If you live in attached housing (e.g., apartment, condominium), it is important to use an RFR meter to measure RFR emissions through party walls; these may exceed 1,000 µW/m$^2$. If for example, you have a crib for a new-born next to a party wall with a Wi-Fi on the other side of the wall, the child's brain and neurological systems may be injured along with other cells and organs.*
- *Purchase an RFR power density meter and meter your environment. "Environment" means all spaces within which you travel. Make sure the meter reads "peak" (max) and "peak hold"*

[2] "absolutely necessary" means failure to make the call would result in extreme hardship. While to those of you who have not read several thousand scientific articles and contacts with the opinions of others who are concerned with the long-term consequences of non-ionizing radiation, this may seem preposterous. Recall, however, that non-ionizing radiation places a force on charged particles in the human body, which place cells and organs in disequilibrium with the natural environment (*e.g.*, Schumann Resonance).

*(max hold) power densities in µW/m$^2$. Do not rely on "average" because peak pulses are what injure and averages are usually less than 10% of peaks. If you are making wireless legislative decisions or wireless decisions affecting other people, it is essential that you use meters and sensible safe standards (not FCC preposterous standards of 6,000,000 to 10,000,000 µW/m$^2$) in your decision model.*

- Support for these suggestions follow:

a. On March 21-22, 2020, the Wall Street Journal reported health care workers in New York City hospitals were surprised by "Far more young people than they expected are falling very ill [with the SARS-CoV-2]." [Ramachandran, Shalini, Joe Palazzolo, Melanie Grayce West, and Melanie Evans. "Virus Cases Strain New York Hospitals. Wall Street Journal, March 21-22, 2020, A5] I believe this severity affecting young people (who should be more resistant than older individuals to viruses) is supported by probable injury to the immune system from cell phone RFR and other environmental wireless communications.

b. The observation that young people are falling very ill with the SARS-CoV-2 may be correlated with (in other words, RFR emitters cause the following adverse results):

1. Suicide rates for 10-14-year age group increased from 180 in 2007 to 517 in 2017 after declining from 242 in 1999 to 180 in 2007. [National Center for Injury Prevention and Control: Center for Disease Control and Prevention].
2. Contemplation of suicide by college students doubled from about six percent in 2008 to 12% in 2016. [National College Health Assessment Survey]
3. About 25% of college students and 20% of high school students are claiming mental disabilities from anxiety, stress, and depression for longer testing times and private testing rooms. [Douglas Belkin. "Colleges Give the Disabled More Leeway." Wall Street Journal 05.25.2018; Douglas Belkin. "More K-12 Students Get Special Help." Wall Street Journal 07.05.2018]

4. It is known that RFRs cause anxiety, stress, and depression. [Thomas, S., Harvestman, A., and Hagberg, M. "Mobile phone use and stress, sleep disturbance, and symptoms of depression among young adults—a prospective cohort study." BMC Public Health (Jan. 31, 2011)]

c. "An immune system gone haywire may be doing more damage than the coronavirus itself in patients with the severest forms of SARS-CoV-2, doctors and scientists say, a growing theory that could point the way to potential treatments." The damaging cycle is caused by SARS-CoV-2 lung infection, macrophages (immune cells) producing cytokines as a cycle of an inflammatory response which turns into a "cytokine storm" that damages the lung cells through the formation of fibrins (scar tissue) that impede oxygen from passing into the bloodstream. [Joseph Walker and Jared S. Hopkins. "Haywire Immune Reaction Linked to Most Severe Cases." Wall Street Journal. April 10, 2020, A1] Wobenzym-N may digest the fibrin. The next two paragraphs offer evidence that RFR damaged immune systems contribute not only to cytokine storms, but to the SARS-CoV-2 illness itself because an RFR-damaged immune system is unable to contain the virus upon inception.

d. "EMFs disturb immune function through stimulation of various allergic and inflammatory responses, as well as effects on tissue repair processes. Such disturbances increase the risks for various diseases, including cancer. These and the EMF effects on other biological processes (e.g., DNA damage, neurological effects, etc.) are now widely reported to occur at exposure levels significantly below most current national and international safety limits." [Olle Johansson. "Disturbance of the immune system by electromagnetic fields potentially underlying cause for cellular damage and tissue repair reduction which could lead to disease and impairment." Pathophysiology 16(2-3) (Aug 2009): 137-177, Abstract]

e. "Certain premises exist which indicate that, in general, short-term exposure to weak MW radiation may temporarily stimulate certain humoral or cellular immune functions, while prolonged irradiation inhibits the same functions. [Szmigielski, Stanislaw. "Reaction of the immune system to low level RF/MW exposures." Science of the Total Environment. Vol. 454-455 (June 1, 2013): 393-400, Abstract]. Present use of cell phones today is much more prolonged than it was when this article was written in 2013 with greater probability the immune function is being inhibited.

f. Exposure of wall lizards 24 h/day for eight weeks to a DECT transmitter mitting 3.2 V/m resulted in a 45% suppression of immunocompetence inflammatory responses. [Mina D. et. al. "Immune responses of a wall lizard to whole-body exposure to radio frequency electromagnetic radiation." International Journal of Radiation Biology. 92(3) (2016): 162-168].

g. RFR from a mobile phone (1800 MHz) with a power density of 1,000,000 $\mu W/m^2$ ($0.1 mW/cm^2$) was applied to leukocytes (white blood cells) within five (5) cm of the microscopic stage for +- 15 minutes of experiment beginning time. There was "…significant changes in leukocytes movement direction…more rapid changes in shape (cells shrinking, expanding, and

rolling…leukocytes movement speed will rise by about 50% above the speeds at the same temperature without the RF." Leukocytes cell velocity approximately doubled from 3.45 +-1.12 μ/min (mean, stddev) to 6.40 +-0.90 μ/min from no exposure to RFR exposure. It took an average time of 2.7 minutes of exposure for damage to begin and the "…cells expanded and lost its ability to move." [Aly AA, et.al., "The Effects on Cells Mobility Due to Exposure to EMF Radiation." Advanced Computing: An International Journal. 2(4) (July 2011.

h. Nineteen women with at least two years exposure to radio television broadcasting stations with a mean Electric Field F of 4.3 +- 1.4 V/m experienced a significant reduction in Natural Killer cells and, thereby, had reduced cytotoxic activity of the immune system. [Boscol P. et.al. "Effects of Electromagnetic Fields Produced by Radio television Broadcasting Stations on the Immune System of Women." Science of the Total Environment. (June 12, 2001) 273 1-3: 1-10].

i. A MCPBS installed in a small Bavaria town in 2004 resulted in increases in the stress hormones adrenaline and noradrenaline, and dopamine decreased substantially. About 90% of the power densities around the homes were less than about 200 $\mu W/m^2$. The article concluded:

"Chronic dysregulation of the catecholamine system (i.e., adrenaline, dopamine) has great relevance for health and is well known to damage human health in the long run." [Buchner K and Eger H. "Changes of Clinically important neurotransmitters Under the Influence of Modulated RF Fields—A Long-term Study under Real-Life Conditions." Umwelt-Medizim-Gesellschaft 24(1): 44-57]

j. Many studies have found that modulated RFR stimulates the immune system (e.g., T-cells, macrophages, natural killer cells, mast cells). [Dabrowski MP, et.al. "Immunotropic Effects in Cultured Human Blood Mononuclear Cells Pre-exposed to Low-Level 1300 MHZ Pulse-Modulated Microwave Field. Electromagnetic Biology and Medicine. 22(1) (29 Apr 2003): 1-13; Nakamura H et. al. "Effects of exposure to microwaves on cellular immunity and placental steroids in pregnant rats." Occupational and Environmental Medicine 54 (1997): 676-680; Donnellan M, et. al. "Effects of exposure to Electromagnetic radiation at 835 MHz on growth, morphology and secretory characteristics of a mast cell analog, RBL-2H3" Cellular Biology International 21(7) (Jul 1997): 427-39; Elekes E, et. al. "Effect on the immune system of mice exposed chronically to 50 H amplitude-modulated 2.45 GHz microwaves. Bioelectromagnetics 17(3) (1996): 246-8; Yang HK et. al. "Effects of microwave exposure on the hamster immune system. I. Natural

killer cell activity. Bioelectromagnetics 4(2) (1983): 123-39; Fesenko EE, et. al. "Stimulation of murine natural killer cells by weak electromagnetic waves in the centimeter range." Biotizika 44(4) (Jul-Aug 1999): 737-41; Novoselova EG, et. al. "Microwaves and cellular immunity: II. Immunostimulating effects of microwaves and naturally occurring antioxidant nutrients" Bioelectrochemistry and Bioenergetics 49(1) (October 1999): 37-43; Stankiewicz W, et. al. "Immunotropic influence of 9009 MHz microwave GSM signal on human blood immune cells activated in vitro." Electromagnetic Biology and Medicine. 25(1) (2006): 45-51. Thus, the body's immune system is identifying RFR as it would a physical pathogen resulting in inflammation which may be chronically harmful.

k. In South Korea, 162 recovered SARS-CoV-2 patients tested positive a second time (reinfected) after being discharged suggesting that the immune system did not produce adequate antibiotics to eradicate permanently the virus. This may suggest a weakened immune system because of age, or, I suggest, by RFR emitting devices that are known to damage immune systems. [Dasl Yoon and Timothy W. Martin. "Recovered Patients Test Positive." WSJ April 18-19, 2020 A7].

l. An excellent list of references supporting disruption to the immune system from low-intensity, radio frequency radiation may be found in "Studies Reporting Disrupted Immune Function from Exposure to Low Intensity Radiofrequency Radiation (non-thermal)," by Cindy Sage, MA, Sage Associates, and Stephanie Kerst, Certified Electromagnetic Radiation Specialist. [https://bioinitiative.org/rf-color-charts/disrupted-immune-function/]

m. If you live or work within 500 yards of a MCPBS, it is likely that your environment contains a power density of between 20,000 to 100,000 $\mu W/m^2$ plus power densities from other RFR emitters. The Building Biology Institute has a sleeping standard of 1,000 $\mu W/m^2$ as an extreme anomaly and six California firemen received brain and neurological damage from MCPBSs on the roofs of their fire stations emitting 10,000 to 20,000 $\mu W/m^2$. [Affidavit of Susan Foster to the FCC dated 02.02.2013]. 5G/4G SCAs may emit up to several hundred thousand $\mu W/m^2$. There is evidence that if 5G/4G SCAs are installed in residential neighborhoods, only one baby in eight will be born normal in three generations. [Research letter from Herman Kelting to Mayor of Costa Mesa, CA dated January 24, 2020 with oral presentation to the Costa Mesa City Council on February 18, 2020] The installation of 5G/4G Small Cell Antennas in residential neighborhoods will multiply by many times total RFR received by living organisms causing associated illnesses, and probably lead to the extinction of all local wildlife.

n. A study of 361 men in a fertility clinic reported reduced sperm count, motility, (moving property through the female reproductive tract), viability, and normal

morphology (size and shape of sperm under microscope, >14% normal) as daily cell phone usage increased from zero, < 2 hours/day, 2-4 hours daily, and >4 hours daily usage. For example, the sperm count declined from 85.89 for no use of cell phone to 50.30 for over four hours per day, and % normal morphology declined from 40.32 to 18.40. [Agarwal A, et. al. "Effect of cell phone usage on semen analysis in men attending fertility clinic." Fertility and Sterility 89(1) (2008): 124-128. Cited in IJAR, Jan 2018, Ref 47] I am offering the decline in sperm as correlative support for impairment of the immune system and for the 28/20 illnesses I cite elsewhere.

| Gp | CP Usage | Sperm Ct | Motility | Viability | WHO Morphology % Normal |
|---|---|---|---|---|---|
| A | No use | 85.89 | 67.80 | 71.77 | 40.32 |
| B | < 2 H/D | 69.03 | 64.57 | 68.21 | 31.24 |
| C | 2-4 H/D | 58.87 | 54.72 | 57.95 | 21.36 |
| D | > 4 H/D | 50.30 | 44.81 | 47.61 | 18.40 |

o. The WSJ indicated that men have a higher SARS-CoV-2 infection and death rates than women caused in part by higher consumption rates of tobacco and alcohol than women. But, women have more robust immune systems than men and can clear infections more easily. Globally, it is estimated that men have three times the risk of dying in a hospital from the SARS-COV-2 than women. [Katie Camero, Wall Street Journal, April 3, 2020, A6]. In my opinion, damage to men's reproductive organs from cell phone RFR (see item 7g) is an additional causal factor or true correlated link between the SARS-CoV-2 and/or men's damaged immune system. Thus, it is highly likely that RFR from cell phones and other sources are causing increases in the incidence and death rate of men from SARS-COV-2 and the addition of 5G/4G SCAs will make SARS-COV-2 even worse setting the stage for a continuing year-to-year crisis from new viruses. Moreover, because SARS-COV-2 is so contagious, increases in SARS-COV-2 in men will obviously increase the incidence of SARS-COV-2 in women.

p. RFR has been shown to cause 28 illnesses including ADHD, cancer of the brain, salivary gland, and breasts; leukemia, anxiety, depression, sleep disturbances, stress, reduction in melatonin, cataracts, increases in inflammation; damage to the testes, sperm, blood brain barrier, DNA, eyes, heart, thyroid hormones, etc. One small study indicated that the expected probability of breast cancer from storing a cell phone in the bra for five years was 100%. [Herman Kelting. "United States Congressional Research and Legislative Proposals to Educate the American People About the Power Density Safety of Wireless Communication ($\mu W/m^2$)" Indian Journal of Applied Research, Jan 2018, 8(1): 263-271,264-265]

q. Some believe that viruses are energized by (i.e., correlated with or causally related to) electrification in general and high frequency radiation (RFR) in

particular; it has been hypothesized recently that SARS-COV-2 was related to 5G installations in Wuhan, China (10,000 SCAs two months before SARS-COV-2 started), South Korea, Iran, and the Diamond Princess. This idea appears to have no scientific support.

r. I urge using an RFR meter to detect the power density of your environment.
s. Ozone ($O_3$) has been used to sanitize buildings to defeat SARS-CoV-1, the predecessor to SARS-CoV-2. O3 defeats Sars-CoV-1 by breaking into the outer shell, and accessing the core which oxidizes RNA, which proteins carries the genetic information for the virus. It is believed that $O_3$ may defeat SARS-CoV-2 because of its effectiveness against SARS-CoV-1.
t. Ozone is not healthy for humans to breath, so a plan is necessary to sanitize the building when people are not present. I use it by placing the $O_3$ generator at the entrance to the air handler with 15-minute bursts every four hours, and having it on for the portion of the home that I am not in because I have two HVAC zones. $O_3$ has a half-life of about 7-10 minutes. I observed one office building with terrible IAQ improve dramatically with the addition of $O_3$. (summer humidity of about 90%). Research the Internet for more information.

11. I sent an e-mail to the White House Action Line on March 26, 2020 asking that a moratorium be placed on the installation of 5G Small Cell Antennas because of the probable damage to the immune system and other living organisms including local wildlife.
12. When the threat of SARS-COV-2 ends, eliminate or modify the following ideas previously discussed and continue the rest.
    a. Reduce probiotics to about five servings per week.
    b. Colloidal silver, except as needed for new bacterial and virus infections.