



A Carbon Neutral Camden: It's Time to Act



June 2015

A CARBON NEUTRAL CAMDEN: IT'S TIME TO ACT

by

Jillian Galloway

Peter Galloway

Warren Galloway

Isabel Hamill

Grace Kemberling

Madalina Lodge

August Rudy

Edited by Janet McMahon

June 2015



Watershed School
Camden, Maine

CONTENTS

Acknowledgments	3
INTRODUCTION	4
PROJECTED IMPACTS OF CLIMATE CHANGE - A BRIEF SYNOPSIS	5
METHODS	7
RESULTS	8
DISCUSSION AND RECOMMENDATIONS	11
LITERATURE CITED	14
APPENDICES	16
A. Camden's Municipal Energy Use (Preliminary Data)	
B. Carbon Neutral Camden Survey Results	
C. Definition of Terms and Abbreviations Used in This Report	

Acknowledgments

We are very grateful to:

Jennifer Albee, of ReVision Energy, who spoke to our class about how grid-tied solar works and what is happening with solar energy in Maine, and also enthusiastically answered our many questions on solar power.

Brian Robinson, of Evergreen Home Performance, for speaking to our class about building science and for letting us shadow him as he conducted an energy audit of a home in Camden.

Anita Scott-Brosius, Camden-Rockport Pathways Committee, for providing encouragement and helping us figure out who to talk to about the town's energy bills.

The following town employees for sharing invoices, account numbers and other municipal information: Janice Esancy (General Assistance Administrator), Marline Libby (Treasurer), David Boldridge (Dam Control Agent and Wastewater Department Superintendent), Ross Parker (former Dam Control Agent and Wastewater Department Superintendent), and Patricia Finnigan (Town Manager). This allowed us to calculate approximately how much energy the town uses.

Wes Robinson, former Assessor's Agent for Camden, who prepared detailed GIS maps of the land along the Megunticook River.

Jean Freedman-White, Camden Comprehensive Plan Coordinator, for making sections of Camden's draft comprehensive plan available.

INTRODUCTION

Scientists say that if we stay on our current emissions path, we have 35 years until our earth's climate is changed in an irreversible way [1]. The fact that humans are causing the planet to warm is widely accepted among scientists. To avoid consequences ranging from economic failure to infrastructure damage to ecosystem destruction, the Intergovernmental Panel on Climate Change (IPCC) says that we need to move away from business as usual as quickly as possible and reduce global emissions by 80% or more by 2050 [1]. To do this, we must employ large-scale efforts towards renewable and sustainable energy. Although it is important for highly populated countries and the highest emitters to reduce their CO₂ emissions, change needs to occur everywhere, including in our coastal home of Camden, Maine. Like most Americans, the average person in Camden has a large carbon footprint due to the amount of driving we do, the heating oil many of us use in our furnaces, our old housing stock, and our overall lifestyle. Given the urgency of the climate change problem, our global climate change class decided to explore how Camden uses energy and to identify actions the town could take to lower its carbon emissions and move toward becoming a carbon neutral town.

We would like to see Camden become one of the many towns and cities around the world that are transitioning from fossil fuel to renewables. Here are just a few examples. After a devastating tornado destroyed large sections of Greensburg, Kansas, the town managed to become 100% carbon neutral by switching from coal to solar and wind power [2]]. The city council and municipal services in Moreland, Australia, a metropolitan area of over 140,000 people, structured themselves like a carbon neutral business and has embarked on a plan to make the whole city carbon neutral in about 30 years [3].

Towns that become carbon neutral are not always motivated to do so for environmental reasons. Often, there are obvious economic benefits to reducing dependence on fossil fuels. Georgetown, Texas will obtain all of its electricity from renewables by 2017. The city had very little interest in reducing its carbon footprint until the municipal energy department discovered that the electricity bought from the newly constructed wind and solar farms in western Texas was considerably less expensive than that from fossil-fuel based companies [4]. Another example is Rutland, Vermont, which recently constructed a solar farm with battery storage. This arrangement allows the region to operate autonomously for certain periods of time, depending on the weather and power demands. During storms and blackouts, the system can be a valuable practicality as well as a tool to reduce the region's carbon footprint [5]. Energy technology is changing quickly and the cost of renewables, especially solar, are coming down and renewables are being considered by towns all over the world, including many in Maine.

Our class decided to focus on Camden's municipal energy use and how it is distributed across departments, such as street lights, the Snow Bowl, the wastewater treatment plant, and town buildings. We obtained town energy records for the past year and entered this information into a table. We then converted the different types of energy into Btus so we could compare energy use from electricity, fuel, and heating oil. This allowed us to create a graph that identified which municipal activities had the most impact, and figure out how much energy would need to be offset by renewables and consequently which renewable options would be the most viable for Camden. We also conducted a survey of Camden workers, residents, and students to find out what community members thought about climate change, the idea of becoming carbon neutral, and a variety of potential renewable options.

Although this process allowed us to determine which municipal activities in Camden used the most energy and informed us about how the public might receive infrastructure changes that would lower the town’s energy use and emissions, our work is far from finished. We have not examined the costs of each potential option, which is an important next step. We also would like to see the same process applied to Camden’s businesses and residences, and see how Camden could offset these emissions so the town truly could become carbon neutral. Therefore, this project should be seen as a preliminary analysis rather than a final report.

PROJECTED IMPACTS OF CLIMATE CHANGE ON CAMDEN - A BRIEF SYNOPSIS

It is important to understand how climate change is likely to affect Camden, because this will help the town plan ahead to reduce or avoid damage to the town’s environment, infrastructure, and economy. The impacts of a changing climate on Camden fall into three groups: impacts of higher temperatures and additional heat waves, impacts of more frequent and heavier precipitation, and impacts of changing ocean temperature and chemistry.

Maine’s average temperature has risen 3° F since 1895 [6]. If the current trend continues, by 2054, the *average* temperature will be 3.5-4 °F higher than it is today [6]. Because we are discussing averages, the impacts of a seemingly small change will be profound. Camden will likely see more insect pests and invasive species from farther south (such as Lyme disease and hemlock wooly adelgid) [6]. Our growing season is already two weeks longer than it was in the early 1900s and it continues to lengthen. As a result, farmers and fishermen will have to adapt to a longer warm season as well as disruptions in the seasonal migration of species on land and in the water [6]. Maine is expected to lose iconic animals and plants (such as moose, loons, and balsam fir trees) due to higher temperatures. We can also expect more heat waves, which can lead to numerous issues for children and the elderly [6]. Camden residents and business owners may have to install air conditioning and more infrastructure for use in extreme heat.

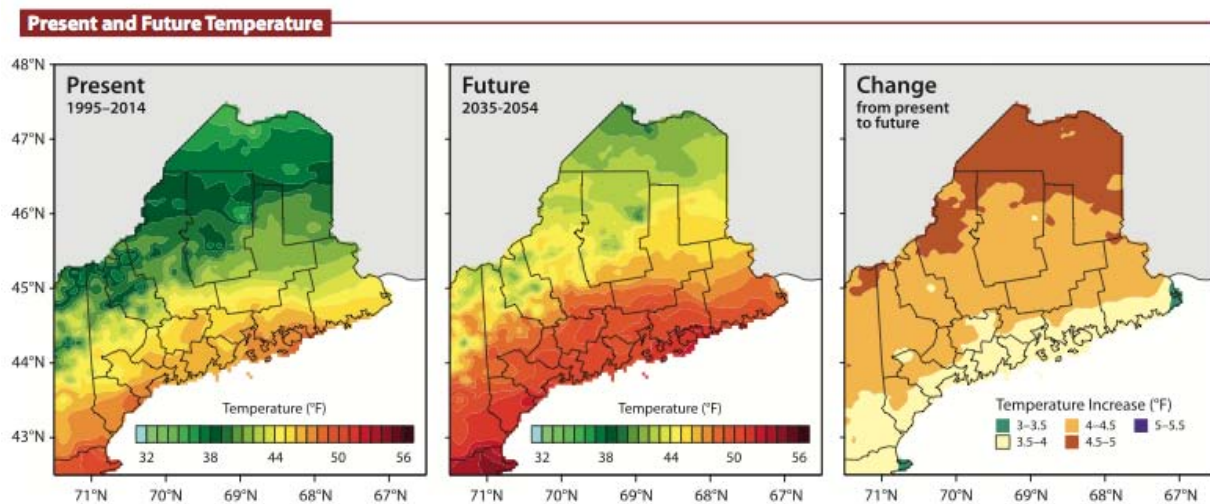


Figure 1. Maps showing mean annual temperature for 1995–2014 (left), 2035–2054 (center), and the predicted change or difference between the two time periods (right). The predicted rise in temperature by 2050 ranges 3.0–5.0 °F from the coast inland to the Canadian border. Maps derived from an ensemble simulation of the IPCC A2 emissions scenario [1].

Precipitation patterns are also expected to change. Average annual precipitation levels in Maine have increased by six inches since 1895, and are expected to increase another three to four inches in Camden by 2054. Most of this is expected to come as heavy rain storms. Given Camden’s many hills and mountains, the town can expect more runoff, increased water pollution, and more flood damage, especially to roads, and the many buildings built over and along the Megunticook River. Snowfall is projected to decrease 40% or more by mid century [6], which will have a huge impact on the Snow Bowl and make it less economical to run and maintain. Tourists will find fewer days for snowmobiling, ice skating, and cross-country skiing. Camden will need to plan for reduced numbers of winter tourists.

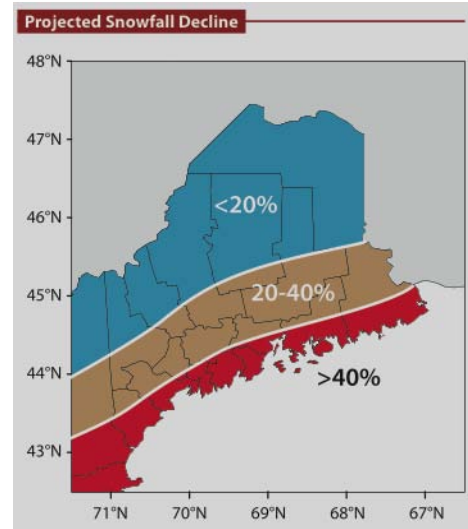


Figure 2. Map showing the predicted change or difference in total accumulated winter snow by climate zone from 1995–2014 to 2035–2054. The greatest changes are predicted to be along the coast, where many winters of the future will bring rain instead of snow. Map derived from an ensemble simulation of the IPCC A2 emissions scenario [1].

Camden will also be affected by changes in the ocean. Melting land ice in Antarctica and Greenland and thermal expansion from warmer water is projected to raise sea levels by six inches to two feet by mid century and one to five meters by the end of the century, depending on future emission scenarios [6]. Camden Harbor and the many commercial buildings and residences that border it are likely to suffer damages as a result of flooding and many homeowners will find their insurance costs rising (6). Surging Seas [7], which models the impacts of different sea levels on coastal towns in the US, shows that, even with a one foot rise in sea level, various areas around harbor and downtown Camden will be lost [7]. With a six foot (2 meter) rise, almost the entire waterfront area including the docks and piers in Camden Harbor will be submerged as well as large portions of Northeast Point and the waterfront properties on Sherman’s Cove [7].

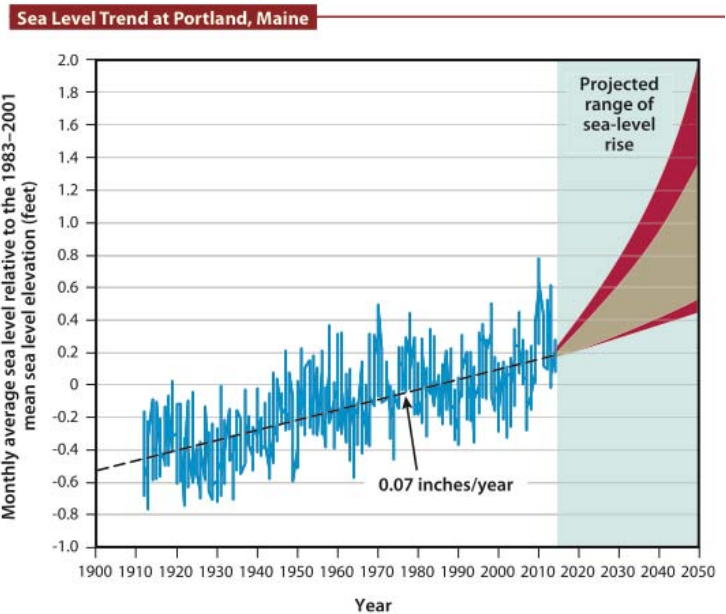


Figure 3. Sea level at Portland provided by the National Oceanic and Atmospheric Administration Center for Operational Oceanographic Products and Services. The mean sea level trend is 0.07 inches per year (1.9 mm/year) with a 95% confidence interval of +/- 0.006 in/yr (0.16 mm/yr) based on monthly mean sea level data from 1912 to 2013, which is equivalent to a change of 0.62 feet in 100 years. The currently projected range of sea-level rise of 0.5 to 2.0 feet by 2050 (1.0 to 4.0 feet by 2100) falls within a larger range that incorporates uncertainty about how glaciers and ice sheets will react to the warming ocean, the warming atmosphere, and changing winds and currents. The high end of these scenarios is provided for use by decision makers with a low tolerance for risk [1].

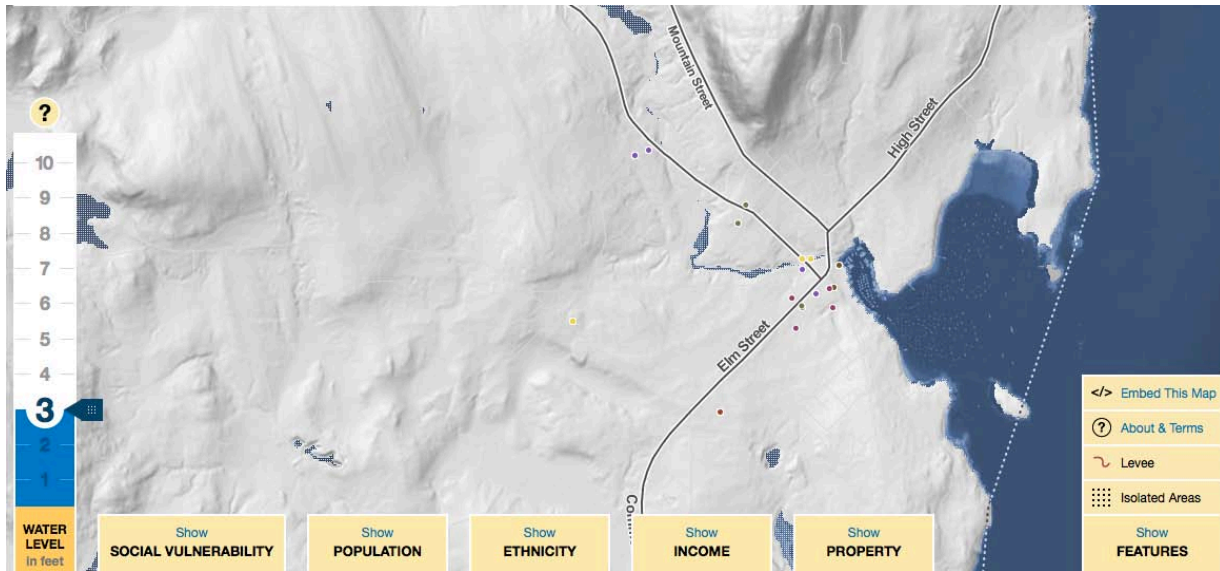


Figure 4. Modeled impact on Camden Harbor of a 3-foot rise in sea level (the middle range of what is projected by the IPCC by the end of the century). The light blue shaded areas show the current shoreline that would be underwater [7].

Many other towns in Maine and elsewhere have begun planning for sea level rise, and Camden cannot be left out of the race. Two bills were submitted to the Maine Legislature this year that would encourage or require coastal towns to include planning for sea level rise in their comprehensive plans. Camden has just prepared a draft plan that will be in effect until 2025, but it does not include specific recommendations to tackle this problem and like the previous plan, does not address climate change or energy issues [8]. It will take planning and organization to implement strategies to respond to rising sea levels. These strategies are essential for Camden to undertake, because the survival of its waterfront is key to its survival as a town.

The ocean’s chemistry is also changing due to increasing amounts of carbon dioxide in the ocean. Ocean acidification is causing shellfish and other marine creatures to die because they are unable to form shells [6]. The ocean is also warming as much if not more than the atmosphere, triggering the migration and extinction of many marine species. Changing ocean chemistry and migrating fish populations could mean that local restaurants may have to collect fish from other locations, and could wreak havoc on local lobstermen and other fishermen, although Camden has a relatively small amount of commercial fishing licenses.

METHODS

We spent five weeks working on this project, which involved the following steps.

Step 1: Determining Camden’s Municipal Energy Use

- We collected electricity invoices from the town office and contacted Central Maine Power Company to get monthly usage in kWh for the town’s many CMP accounts. The town office also

gave us records for heating oil, propane, gasoline and diesel fuel use. We then created a spread sheet that allowed us to convert the energy totals into Btus so we could compare how much energy different town departments used. The time period for the different records varied, but always included 12 consecutive months. For Seabright Dam, we averaged its energy output over a four year period, since output varies from year to year. Finally, we graphed energy totals for each department.

Step 2: Survey

- We designed a survey to find out what people in the Camden area think about the idea of becoming carbon neutral as well as different renewable and energy efficiency options. We created an online version on SurveyMonkey as well as a paper version.
- We posted a link to the on-line survey on the Watershed School website and Facebook site, and sent it to friends and neighbors in Camden. We placed paper surveys at the Bagel Cafe, Camden National Bank, Town Office, Zoot, Camden Hills Regional High School, and the Baptist Church. We collected results from May 20 to June 3, 2015 and used SurveyMonkey to analyze them.

Step 3: Research on carbon neutral towns

- We each researched a town that was working to become carbon neutral to see how they did it and what aspects might work for Camden. The towns we researched included Greensburg, Kansas, Georgetown, Texas, Eden Mills, Canada, Moreland, Australia, Samso, Denmark, Gussing, Austria, Ithaca, New York, and Leelanau Twp, Michigan.

Step 4: Research on renewable energy options and how some towns are preparing for sea level rise

- We researched renewable options that could have potential for Camden, including onshore wind, solar arrays, microgrids, EV charging stations, LED street lights, and adapting infrastructure for sea level rise.
- We also used what we learned about energy efficiency while shadowing an energy auditor and from doing preliminary walk-throughs of our own houses.

RESULTS

Municipal Energy Use

Through the information provided by the town office, we developed an idea of municipal power use in Camden. In the past year, Camden used 6536048 kWh of energy per year which equals 22234 million Btus (British thermal units). Almost half of this total is used for fueling municipal equipment. Annual power usage for electricity and heating oil are about 7000 and 5000 million Btus respectively. The Snow Bowl uses by far the most electricity, mostly to make snow, followed by the wastewater treatment facility. The Opera House building and the library use a large amount of heating fuel, suggesting that they could be made a lot more energy efficient. The Seabright Dam offsets the town's energy use by about 206,000 kWh a year. The graph on the following page shows the energy breakdown by department or service. A detailed breakdown of the town's energy use is included in Appendix A.

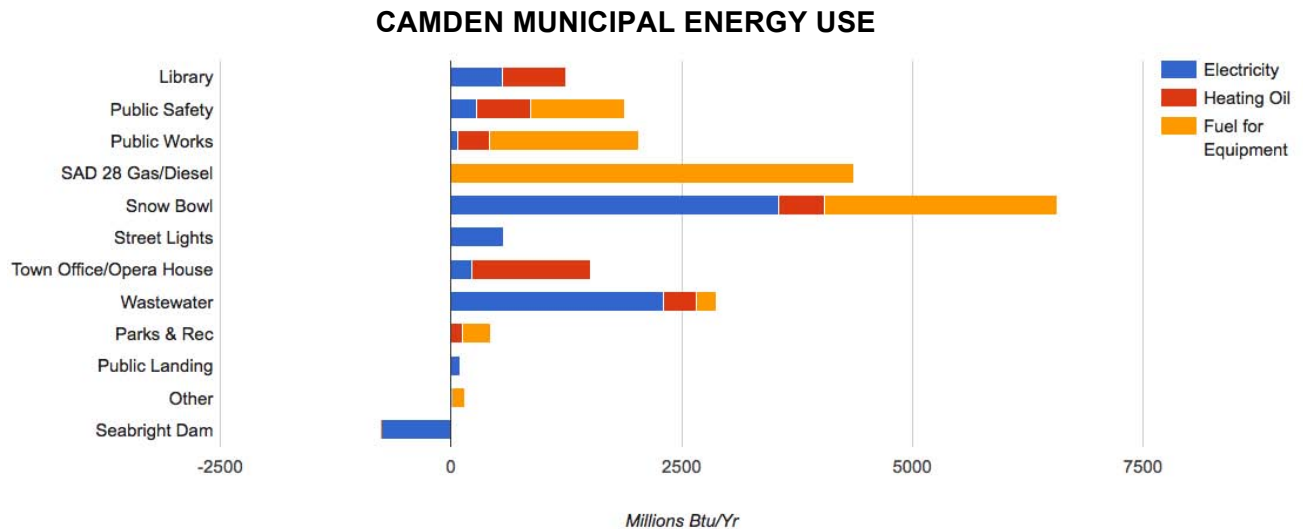


Figure 4: Energy use, in millions of Btu/yr, by Camden's different municipal departments (approximate time period – April 2014 to May 2015 – see Appendix A for specific time periods of different accounts).

Carbon Neutral Camden Survey

We received 196 responses to our survey. It was not a random sample, but were surprised at the overwhelming support for the idea of becoming carbon neutral and for most renewable and energy efficiency options. Here are some highlights. The complete survey results are included in Appendix B. Note that the software program weighted the answers to question 17. We did not assign weights, so the graph is misleading. The table below the graph shows the actual response percentages.

- The majority of responders were under 18 (33%) or 51-70 (34%)
- On questions regarding improving home efficiency (q3-q6), an average of 78.67% people responded positively, but only 31% of people knew about the PACE loan program, which offers low interest loans so that residents can afford the upfront costs of making their homes more comfortable and efficient.
- About 50% of responders use cars with gas mileage of 20-30.
- 55% responders support the idea of buying an electric car if Camden had an EV charging station, 30% weren't sure and only 15% would not consider it. The results were similar for mass transit and carpooling and mass transit.
- 93% of responders agree that climate change is happening.
- 89% of responders agree that people should be acting to counter climate change.
- 64% of people would be willing to do everything they can to counter climate change, 32% would be willing to make small changes/sacrifices.

- 84% of responders support the idea of Camden becoming a carbon neutral town.
- The ideas of solar panels on municipal buildings, installing more efficient streetlights, and making municipal buildings more energy efficient had over 90% support from responders.
- The ideas of installing offshore wind farms, retrofitting existing dams to produce hydropower, and installing a multi-acre solar farm on unusable areas such as Tannery had over 65% support.
- 60% of people were against the idea of a nuclear power plant in midcoast Maine.
- Younger responders are the least willing to sacrifice things, while older people (51+) responded over 75% that they would do everything they could.

Calculating energy production from renewable options (some examples)

We calculated how many kWh would be needed if all of the town's energy came from electricity, which equals 6536048 kWh. This allowed us to figure out (roughly) how much energy could be produced by different renewable options. Here are two examples.

1) Using a 1.5 MW wind turbine:

1.5 MW turbine X number of hours in a year (365 X 24) X 25% (approximate efficiency of wind turbines) X 1000 (number of kilowatts in 1 megawatt)

$1.5 \times 8760 \times 0.25 \times 1000 = 3285000 \text{ kWh}$

This equals about half of the town's total municipal energy use.

2) Using solar panels:

In a good sunny southern spot, 1 kW of solar installed (which would take 3-4 panels, depending on their efficiency) will produce 1200 kWh of electricity per year (Jennifer Albee, ReVision Energy, personal communication). To produce all of Camden's current electricity use (~2000000 kWh/year) from solar you would need:

$2000000 \text{ kWh divided by } 1200 = 1667 \text{ kW or } 1.67 \text{ MW of energy}$

Divide by 255 W (the standard wattage panel = 6549 solar panels. Based on the Mt. Abram project, you can fit 830 panels on an acre, so this would take about 8 acres of land.

It would make the most sense for Camden to reduce the energy used by buildings, and then combine different renewable options. For example, one wind turbine, 8 acres of rooftop and on the ground solar, and adding electric vehicles to the town's fleet could provide the municipal energy needed and would probably save the town money, especially at the Snow Bowl.

DISCUSSION AND RECOMMENDATIONS

Our survey results show that there is strong support for renewable energy and becoming carbon neutral in Camden and our research show that there are many ways to do it. The options below are just a few ideas that could be feasible in Camden.

- Focus on making the Snow Bowl more efficient, especially because it is by far the highest energy user in Camden. Since the Snow Bowl is already committed to building a new lodge, this is the perfect time to research potential building efficiency and renewable energy options. Even orienting the building differently so that its main roof (which could be metal for ease in solar installation) is facing south and making the majority of the windows face south to allow for passive solar heat could cut fuel and electricity usage significantly. Making buildings tight, extra insulation, and installing heat pumps could reduce energy use and costs by more than 50 percent, and is the simplest first step towards becoming carbon neutral.
- Build a solar array at the Snow Bowl to produce energy similar to the one at Mt. Abram, which has offset 70 percent of that ski area's electricity use, mainly for snowmaking. At Mt. Abram, 803 panels take up approximately one acre of land and can produce about 300,000 kilowatt hours per year with an estimated 5-year payback period [10]. The Snow Bowl uses about 1 million kWhs, which means about three acres of land would be needed for a solar farm here. There is plenty of space to do this at the Snow Bowl. Because the snowfall is predicted to decrease in the coming decades, which means the Snow Bowl will have to make more snow, in the long term, switching to renewables could make the Snow Bowl more economical to run.
- Make the municipal buildings (like the Opera House and library) more energy efficient (and encourage business owners to do the same). Insulation, stopping leaks, window inserts, and heat pumps can reduce energy costs by 25 to 50 percent or more. In addition, rooftop solar could be installed on buildings like the Fire Station and at the Wastewater Facility that have south-facing roofs. Many other towns are moving in this direction. In Belfast, for example, there are 180 solar panels being installed on their Public Works building [11] which will produce more than 45 kW of energy, and Rockland expects to save taxpayers \$10,000 annually after doing energy retrofits on its public library [12].
- Build a 1.5 MW wind turbine on land. Just one wind turbine could produce more energy than the entire Camden municipal system uses, a worthwhile step towards becoming carbon neutral. A real-world example of this is Samso Island, Denmark, which has about 3,000 inhabitants. The island has become completely carbon neutral by installing 21 wind turbines (10 onshore and 11 offshore) and large-scale solar farms [13, 14]. The houses are also heated by using hay and straw for fuel and all of the community's cars are electric. The island is now a net exporter of energy [13, 14]. And the three turbines that are part of the Beaver Ridge Wind Project in Freedom provide enough energy for 2000 homes [15], which is about how many homes there are in the downtown area of Camden. According to wind speed monitors, Ragged Mountain, which already has a cell tower, is an excellent site for wind power (Leonard Lookner, personal communication).

- Build EV charging stations to encourage electric car use both in Camden and the five-town area and to raise awareness of the possibilities and advances of EV technology. There are currently no EV charging stations between Brunswick and Bar Harbor (see following figure) [16]. Locating one in Camden could draw visitors to the town and would fill this gap.

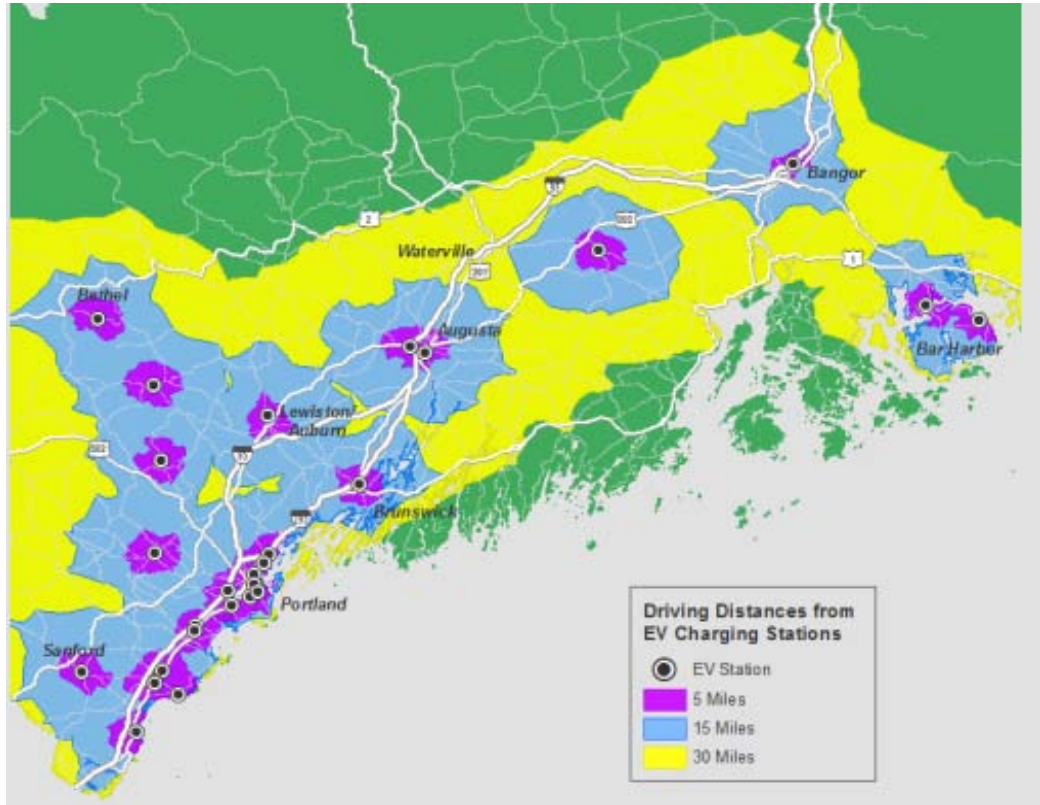


Figure 5: Showing the miles statewide from an EV charging station. Camden is located right where a charging station is needed in the midcoast [16].

There is also the possibility of hybrid electric school buses, which are being used in Michigan [17], California, and elsewhere. The buses are expensive, but eventually, this could be a valuable conversion since our data shows that fuel for school buses (for SAD 28) is the second highest municipal energy use in Camden.

- Install more efficient lighting on Main Street and other areas; this could be a relatively simple step toward using less electricity. One option is to convert streetlights and/or other lighting to full cut-off LEDs both to reduce sky glow and to save electricity. Just this year, York, Maine has proposed converting all of its 830 streetlights to LEDs [18] and Brunswick expects to save 80% on lighting and maintenance costs at Brunswick Landing, where it has installed LEDs with state of the art dimming technology [19].
- Retrofit one or more of the dams along the Megunticook River for hydropower. The Montgomery Dam looks like it has a similar head as the Seabright Dam and there are two other privately owned dams that could have potential. One issue with this plan is that rebuilding a dam

and installing turbines is probably more expensive than installing a solar array or wind turbine that produces the same amount of energy.

- Educate the public about how Camden can become carbon neutral, steps individuals can take to reduce their carbon footprint, and about the very real issue of global climate change. If everyone knew about the steps towns and cities around the world have taken to reduce carbon emissions, our town would become much more inspired about our options for the future, and would be more apt to strive for change. For example, in Samsø, Denmark, many residents were at first resistant to the idea of becoming carbon neutral, but after a series of meetings with town people, there is now wide support and the island has become a renewable energy showcase [12, 13]. Also, many youth in our school systems do not realize the full implications of climate change, or what they can do to counter it as individuals. If the information about the possibilities for our town was given to children in schools, there could be a real heightening of awareness of the options for our planet and for Camden. Expanding and refining our survey and distributing it to all town residents would be one place to start. Awareness is the first place to start to bring about positive change in a community.
- Enhance communication between town officials, committees, and community members. For example, Camden passed a PACE ordinance in 2011. This allows residents who cannot afford the upfront costs of building efficiency upgrades to take out a low interest loan. The interest is often less than the amount saved in increased energy efficiency. This is one of several loan programs offered by Efficiency Maine. In the survey, the majority of respondents said they had not heard of this program, even though most were willing to make their homes more energy efficient.
- Finally, the town must commit to becoming carbon neutral. For example, many towns that have the potential to become seriously damaged by rising sea levels are developing action plans and establishing processes for the future to install proper fortifications and building codes to protect against and adapt to sea level rise. Camden, although very vulnerable to sea level rise, has just finalized a comprehensive plan for the future that has no specific recommendations for dealing with this problem. The plan also does not address rising energy costs and the need to reduce fossil fuel use. This signifies a lack of awareness about the problem, or perhaps, reluctance to move with the times and accept our future. Establishing an energy committee that includes some people with expertise on climate change and energy is a very important first step.

Many parts of the world are moving towards creating a greener planet, and the town of Camden must move along with them by committing to lower energy use and transitioning to renewables. We have abundant resources such as solar, wind and hydro. As we've shown in this report, there are many examples to follow and learn from. It is our hope that our work will provide a catalyst for changing how Camden uses energy and that this, in turn, will lead the town government and individual residents to reduce the amount of energy they use and make the shift to renewables. Becoming carbon neutral and living in a sustainable way need to be part of our future. It is time for all of us to act.

LITERATURE CITED

- [1] IPCC. 2014. Climate change 2014: The physical science basis. Contribution of Working Group 1 to the fifth assessment report of the Intergovernmental Panel on Climate Change. Cambridge, UK: Cambridge University Press.
- [2] Wallach, D., S. Pless, and L. Billman. 2013. "From tragedy to triumph: Rebuilding Greensburg, Kansas, to be a 100% renewable energy city." *National Renewable Energy Laboratory*. <http://energy.gov/sites/prod/files/2013/11/f5/48300.pdf> (accessed May 17, 2015).
- [3] Moreland City Council. 2014. "Zero carbon evolution." Moreland Energy Foundation. Moreland, Texas.
- [4] Ross D. 2015. "Mayor: Why my Texas town ditched fossil fuels." *Time: 2015 Ideas Issue*. <http://time.com/3761952/georgetown-texas-fossil-fuel-renewable-energy/> (accessed May 18, 2015).
- [5] Green Mountain Power. 2014. "GMP announces first-of-its-kind solar project to increase resiliency and improve safety during storms." Green Mountain Power. Rutland, VT. <http://news.greenmountainpower.com/press-releases/gmp-announces-first-of-its-kind-solar-project-to-i-1137231?feed=d51ec270-a483-4f6c-a55e-8e5fbe2238c2> (accessed June 1, 2015).
- [6] Fernandez, I.J., C.V. Schmidt, S.D. Birkel, E. Stancioff, A.J. Pershing, J.T. Kelley, J.A. Runge, G.L. Jacobson, and P.A. Mayewski. 2015. Maine's climate future: 2015 update. University of Maine, Orono, ME.
- [7] Climate Central. "Surging Seas: Sea level rise analysis by climate central." <http://sealevel.climatecentral.org/> (accessed June 7, 2015).
- [8] Town of Camden. 2005. Town of Camden comprehensive plan. Camden, ME. http://www.camdenmaine.gov/index.asp?Type=B_BASIC&SEC={CB77F0F2-97B9-44C2-80CA-D62A5F229057} (accessed June 1, 2015).
- [10] Turkel, T. 2014. "Mt. Abram skiing green with \$940,000 solar power project." *Portland Press Herald*. <http://www.pressherald.com/2014/10/30/skiing-green/> (accessed June 8, 2015).
- [11] Andrews, E. 2014. "Belfast approves deal to install solar panels on fire station." *Penbay Pilot*. <http://www.penbaypilot.com/article/belfast-approves-deal-install-solar-panels-fire-station/41997> (accessed June 6, 2015).
- [12] Evergreenyourhome, Public Relations Manager. 2015. "Behind the scenes: Energy efficiency at the Rockland Public Library." *Bangor Daily News*. <http://bangordailynews.com/community/behind-the-scenes-energy-efficiency-at-the-rockland-public-library/> (accessed June 8, 2015).
- [13] Spear, S. 2014. "Samso: World's first 100% renewable energy-powered island is a beacon for sustainable communities." *EcoWatch*. <http://ecowatch.com/2014/05/01/samso-renewable-energy-island-sustainable-communities/> (accessed June 8, 2015).
- [14] International Study of Renewable Energy Regions. "Samso, Denmark."

<http://reregions.blogspot.com/search?q=samso+island,+denmark> (accessed June 8, 2015).

- [15] Patriot Renewables. "About the Beaver Ridge wind project." Beaver Ridge Wind. <http://www.patriotrenewables.com/BeaverRidgeWind.html> (accessed June 2, 2015).
- [16] Greater Portland Council of Governments. "Electric vehicles: Map of EV registrations and charging stations 2014." <http://www.gpcog.org/energy/maine-clean-communities/electric-vehicles/> (accessed June 2, 2015).
- [17] U.S. Department of Energy. 2014. "Michigan transports students in hybrid electric school buses." U.S. Department of Energy Case Studies. <http://www.afdc.energy.gov/case/625> (accessed June 8, 2015).
- [18] McDermitt, D. 2015. "York committee wants to switch to LED lights." *SeacoastOnline*. <http://www.seacoastonline.com/article/20150219/NEWS/150219003> (accessed June 6, 2015).
- [19] The Times Record. 2015. "LED street lighting project complete at Brunswick Landing." *The Times Record*. http://www.timesrecord.com/news/2015-04-08/Business/LED_street_lighting_project_complete_at_Brunswick_.html (accessed June 7, 2015).
- [20] California Energy Commission. "Glossary of Energy Terms." www.energy.ca.gov/glossary (accessed June 7, 2015).

Cover Photo Credit: Alison Langley www.gettyimages.com

APPENDICES

APPENDIX A. CAMDEN MUNICIPAL ENERGY USE (Preliminary Data)

	CMP Account #	Time Period	kWh/year	Electricity (Btu/Yr)	Electricity (Million Btu/Yr)	Heating Oil (gal)	Propane (gal)	Propane (Million Btu/Yr)	Heating Oil (Btu/Yr)	Heating Oil (Million Btu/Yr)	Gasoline	Diesel	Fuel for Equipment (Btu/Yr)	Fuel for Equipment (Million Btu/Yr)	Comments
Library			162467	554360415	554	5000			690000000	690			0	0	
Public Safety			82854	282709583	283	4208			580731600	581	7024	986	1014439072	1014	fuel for equipment includes gasoline and diesel
Public Works			21729	74142426	74	2448			337837800	338	6033	6208	1617581053	1618	
SAD 28 Gas/Diesel			0	0	0	0	0		0	0	0	31368	4366425600	4366	assuming this is Camden's share of fuel
Snow Bowl			1045457	3552506903	3553	3572	1079	99	494722000	495	1901	106	252327200	2523	
Street Lights			166970	569725290	570	0	0		0	0	0	0	0	0	
Town Office/Opera House			67831	231448979	231	9243	0		1275534000	1276	0	0	0	0	
Wastewater			675869	2306160753	2306	2519	0		347622000	348	1612	134	219966418	220	
Parks & Rec			0	0	0	898	0		123910200	124	2364	40	301048000	301	summer lodge electricity counted with Snow Bowl
Public Landing			27476	93752004	94	0	0		0	0	0	0	0	0	not sure if this includes street lights
Other			2141	7305395	7	0	0		0	0	1165	12	147289400	147	includes cemeteries, harbor, waste transfer, town clock
Seabright Dam			-205715	-753946815	-754				0	0				0	average for 4-yr period (2011-2014); offsets town energy use
<i>total kWh/year or kWh equivalent</i>			2047079				29014			1502868				2986101	6536048
RAW DATA															
Camden Public Library		12/13-12/14	162467	554360415	554	5000			690000000	690			0	0	totals from Nikki Maounis, library director
Cemeteries - (fuel for equipment)		1/14-12/14		0	0				0		464		57946351	58	all heating oil figures for period 4/14-3/15
Cemetery (Mountain St)	231-013-0542-011	6/14-5/15	182	621010	1				0				0	0	
Cemetery (Oak Hill)	231-021-9565-012	6/14-5/15	7	23885	0				0				0	0	
Harbor (fuel for equipment)		1/14-12/14		0	0				0		384	12	49626001	50	
Parks and Rec (lodge)		4/14-3/15		0	0	660			91052400	91			0	0	
Parks and Rec (maintenance blg)		4/14-3/15		0	0	238			32857800	33			0	0	
Parks and Rec (fuel for equipment)		1/14-12/14		0	0				0		4265	146	552955073	553	
Public Landing Restrooms etc. P&R	231-026-6161-001	6/14-5/15	7160	24430934	24				0				0	0	
Public Landing/Main St	231-012-7602-011	6/14-5/15	20316	69321069	69				0				0	0	
Public Safety (Tannery La)	231-012-9788-011	6/14-5/15	82854	282709583	283	4208			580731600	581	7024	986	1014439072	1014	gasoline/diesel fuel figure is for both police and fire station
Public Works (John St)	231-011-8643-011	6/14-5/15	21729	74142426	74	2448			337837800	338	6033	6208	1617581053	1618	
SAD 28 (fuel for buses)		1/14-12/14		0	0				0			20037	2789150400	2789	
SAD 28 (fuel for buses - Luce)		1/14-12/14		0	0				0			11331	1577275200	1577	
Seabright Dam (power generated)		2011	-220960	-753946815	-754				0					0	minus indicates this offsets town energy use
Seabright Dam (power generated)		2012	-201880	-688843153	-689				0					0	
Seabright Dam (power generated)		2013	-227200	-775238579	-775				0					0	
Seabright Dam (power generated)		2014	-172823	-589696553	-590				0					0	
Snow Bowl (Big T)	231-021-7607-014	7/13-5/14	87360	298084693	298				0				0	0	
Snow Bowl (Chair lift)	231-033-4325-100	5/13-5/14	37886	129272398	129				0	0			0	0	
Snow Bowl (kitchen)		12/14 - 2/15		0	0		1079		98170800	98			0	0	
Snow Bowl (Lift Shack)	231-045-5772-001	2/15-4/15	4320		0				0				0	0	
Snow Bowl (Lodge)	231-021-7589-012	5/14-4/15	33782	115268969	115	2488			343344000	343			0	0	
Snow Bowl (Maintenance Blg)				0	0	1070			147632400	148			0	0	
Snow Bowl (Pump House)	231-021-7575-015	4/14-5/14	322880	1101712291	1102				0				0	0	
Snow Bowl (Race Building)	231-024-7137-001	5/13-4/14	934	3186940	3				0	0			0	0	
Snow Bowl (snowmobile/chair/comp)	231-045-4022-001	2/15-5/15	224800	767049439	767				0	0			0	0	
Snow Bowl (Tower Shop)	231-034-6110-001	7/13-6/14	37886	129272398	129				0				0	0	
Snow Bowl (Tower)	231-021-7594-015	5/14-4/15	291480	994571043	995				0				0	0	
Snow Bowl (Tube Hill)	231-040-8382-001	5/14-4/15	4129	14088733	14				0				0	0	
Snow Bowl (fuel for equipment)		1-4/14; 10-12/14													
Street Lights	231-023-0373-011	6/14-5/15	112474	383777218	384				0				0	0	
Street Lights (High St/Mountain St)	231-013-2533-011	6/14-5/15	114	388984	0				0				0	0	
Street Lights (Arch)	231-011-3001-001	6/14-5/15	871	2971975	3				0				0	0	
Street Lights (Atlantic/Main St)	231-028-6427-001	6/14-5/15	28926	98699609	99				0				0	0	
Street Lights (Bayview St)	231-028-6431-001	6/14-5/15	6827	23294691	23				0				0	0	
Street Lights (E/m/School St)	231-011-7124-011	5/14-4/15	2253	7687555	8				0				0	0	
Street Lights (Elm/Washington St)	231-028-6412-001	6/14-5/15	9409	32104841	32				0				0	0	
Street Lights (State Park Light/High)	231-040-2349-001	5/14-4/15	61	208141	0				0	0			0	0	
Street Lights (Mechanic St)	231-012-0485-011	6/14-5/15	1882	6421651	6				0				0	0	
Street Lights (Shopping Center)	231-027-8913-001	5/14-4/15	77	262735	0				0				0	0	
Street Lights (Xmas lights)	231-011-4713-011	6/14-5/15	1978	6749216	7				0				0	0	
Town Clock (Chestnut St)	231-011-4695-011	6/14-5/15	1952	6660500	7				0	0			0	0	



Carbon Neutral Camden Survey

This survey is being conducted by sophomores at Watershed School in Camden.

Many towns and cities in the United States are working to reduce fossil fuel emissions and energy costs. We are interested in how people of the Camden area feel about this issue. We would like to have your comments back by May 29, 2015. We plan to summarize the survey results on the Watershed School web site (www.watershed-school.org).

CHOOSE THE ANSWER THAT BEST REPRESENTS YOUR OPINION

1. Check all that apply,

I...

- live in Camden
- work in Camden
- go to school in Camden
- own a business in Camden
- am a visitor to Camden

2. HOW OLD ARE YOU?	UNDER 18	19-30	31-50	51-70	71-90	91+
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

HOME	YES	NO	NOT SURE
------	-----	----	----------

3. Would you consider committing to making your home or business more energy efficient? YES NO NOT SURE

4. Do you think new houses should be built to high energy efficiency standards using mandatory building codes? YES NO NOT SURE

5. Would you consider installing a solar array on your home, or being part of a community solar project? YES NO NOT SURE

6. Would you consider installing a heat pump in your home to save on heating costs? YES NO NOT SURE

7. Have you heard of the Efficiency Maine's PACE (Property Assessed Clean Energy) loan program, which was adapted by the town of Camden in 2011? YES NO NOT SURE

8. How do you heat your home? (check all that apply)
 Oil Natural Gas Propane Heat Pump Electric Solar Wood

TRANSPORTATION	YES	NO
----------------	-----	----

9. Would you consider purchasing a plug-in hybrid/electric or an electric vehicle if Camden had EV charging stations? YES NO

10. If there was a commuter bus or there were carpooling options, would you use them? YES NO

11. On average, how many miles do you drive a week?
 Under 25 25-50 50-100 100-200 200-500 500+

12. What is the gas mileage of the car you use most often?
 under 10 10-20 20-30 30-40 40-50 50-60 60+

continued on reverse

CHOOSE THE ANSWER THAT BEST REPRESENTS YOUR OPINION

GENERAL QUESTIONS

13. What are your views on the global climate change issue?

- Climate change is definitely happening
- Climate change is not happening
- I don't know and/or don't care

14. To what extent do you think that people should be acting to counter climate change?

- People should do everything they can
- People should do nothing at all
- People should make small-scale changes

15. To what extent are you willing to sacrifice many of your everyday habits/traditions to counter climate change and decrease carbon emissions?

- I'll do everything I can
- I won't do anything at all
- I would be willing to make small-scale changes

16. What is your opinion about Camden becoming a carbon neutral town?

- I support the idea of Camden becoming a carbon neutral town
- I oppose the idea of Camden becoming a carbon neutral town
- I don't know and/or don't care

17. WHAT IS YOUR OPINION ON THESE RENEWABLE/NON CARBON ENERGY OPTIONS?

SUPPORT

OPPOSE

NOT SURE

Installing solar panels on municipal and other downtown buildings

Installing offshore wind farms in the Gulf of Maine

Installing wind turbine(s) on land in Camden

Retrofitting dams in the Megunticook River for hydro power

Installing a multi-acre solar farm on a piece of land that can't be used for other purposes, such as the town dump or the Tannery site

Installing more efficient street lights and lighting along Main Street

full cut-off lighting restrictions to reduce light pollution

making municipal buildings more energy efficient

a nuclear power plant in midcoast Maine

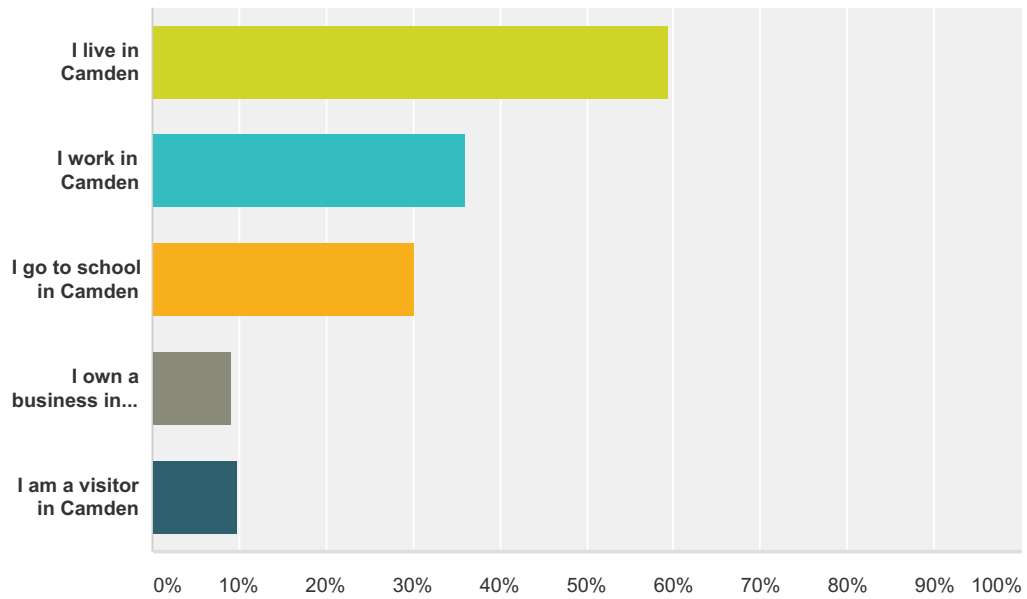
FEEL FREE TO ADD ANY ADDITIONAL COMMENTS YOU MAY HAVE

Please mail or deliver this survey to Watershed School, 32 Washington St, Camden, ME 04843 by **May 29, 2015**.

Thank you for your participation!

Q1 Check all that apply.

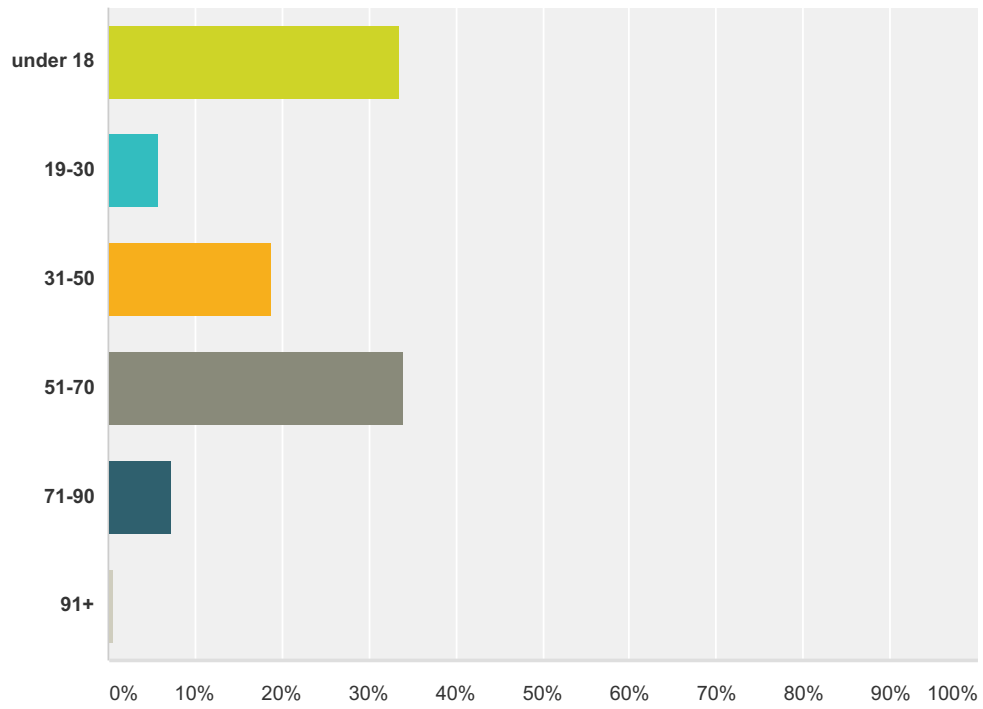
Answered: 185 Skipped: 11



Answer Choices	Responses
I live in Camden	59.46% 110
I work in Camden	36.22% 67
I go to school in Camden	30.27% 56
I own a business in Camden	9.19% 17
I am a visitor in Camden	9.73% 18
Total Respondents: 185	

Q2 Your age

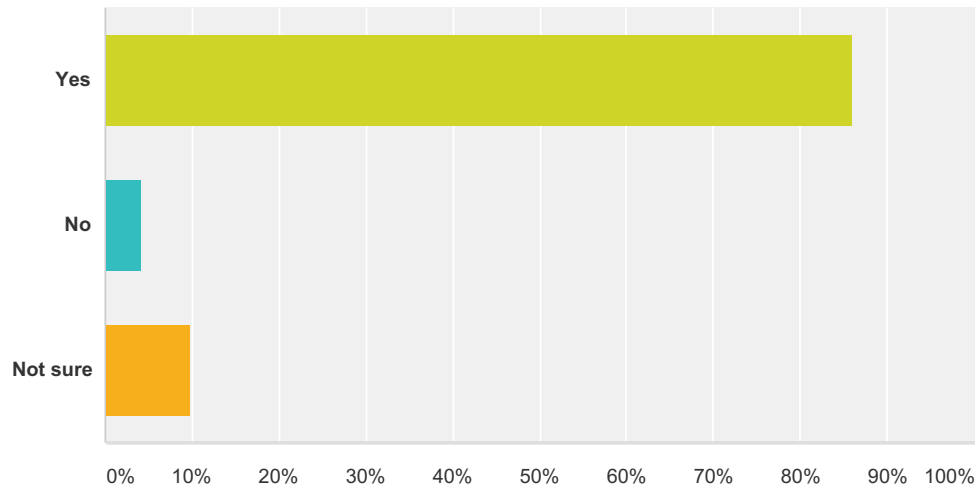
Answered: 191 Skipped: 5



Answer Choices	Responses	Count
under 18	33.51%	64
19-30	5.76%	11
31-50	18.85%	36
51-70	34.03%	65
71-90	7.33%	14
91+	0.52%	1
Total		191

Q3 Would you consider committing to making your home or business more energy efficient?

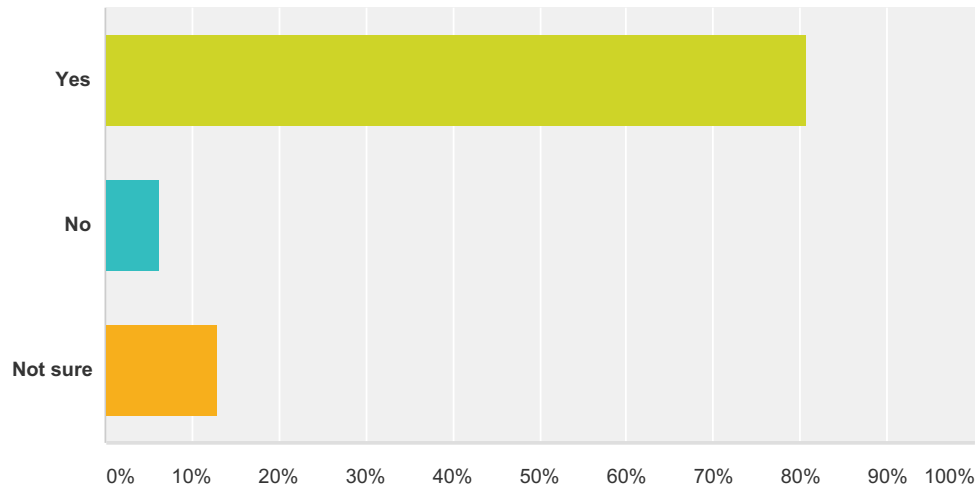
Answered: 192 Skipped: 4



Answer Choices	Responses
Yes	85.94% 165
No	4.17% 8
Not sure	9.90% 19
Total	192

Q4 Do you think new houses should be built to high energy efficiency standards using mandatory building codes?

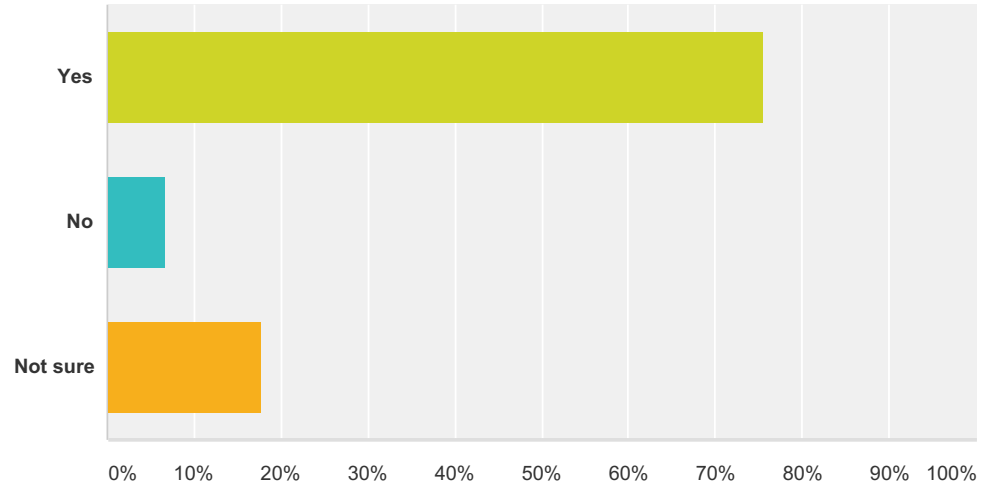
Answered: 192 Skipped: 4



Answer Choices	Responses
Yes	80.73% 155
No	6.25% 12
Not sure	13.02% 25
Total	192

Q5 Would you consider installing a solar array on your home, or being part of a community solar project?

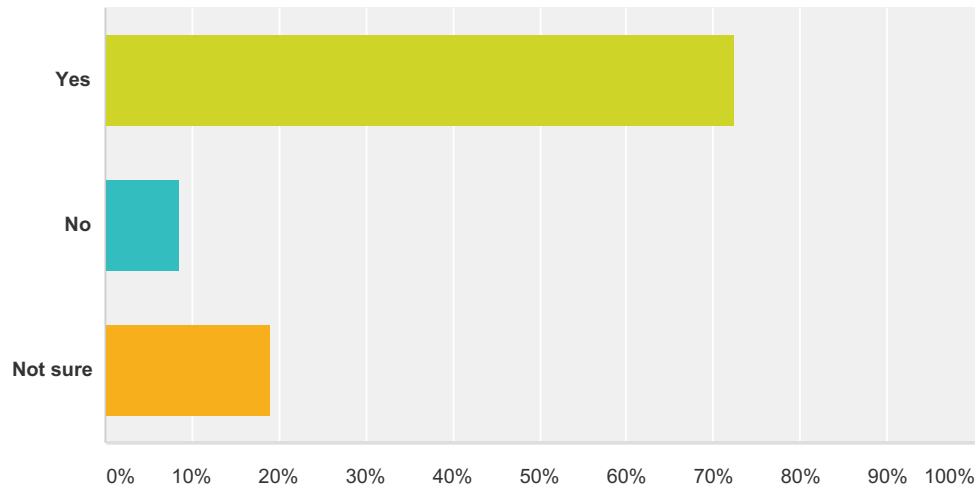
Answered: 192 Skipped: 4



Answer Choices	Responses
Yes	75.52% 145
No	6.77% 13
Not sure	17.71% 34
Total	192

Q6 Would you consider installing a heat pump in your home to save on heating costs?

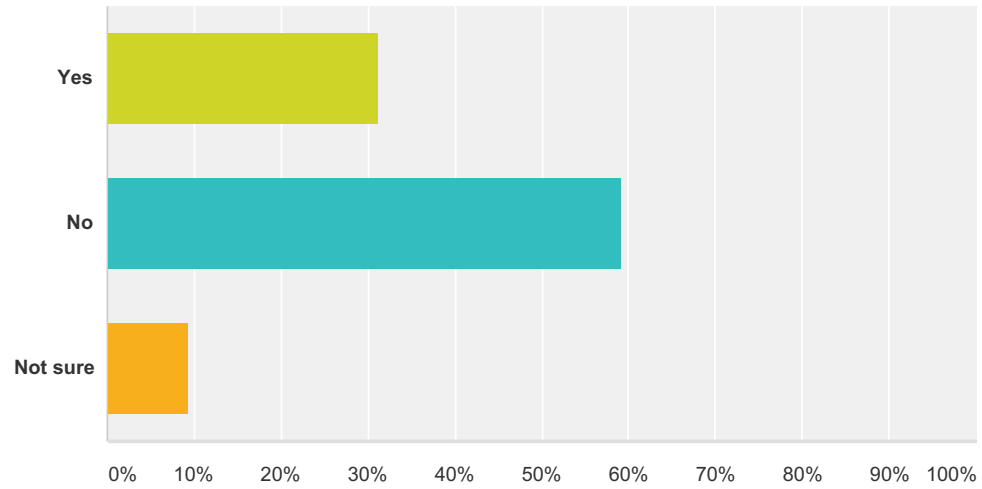
Answered: 189 Skipped: 7



Answer Choices	Responses
Yes	72.49% 137
No	8.47% 16
Not sure	19.05% 36
Total	189

Q7 Have you heard of Efficiency Maine's PACE (Property Accessed Clean Energy) loan program, which was adopted by Camden in 2011?

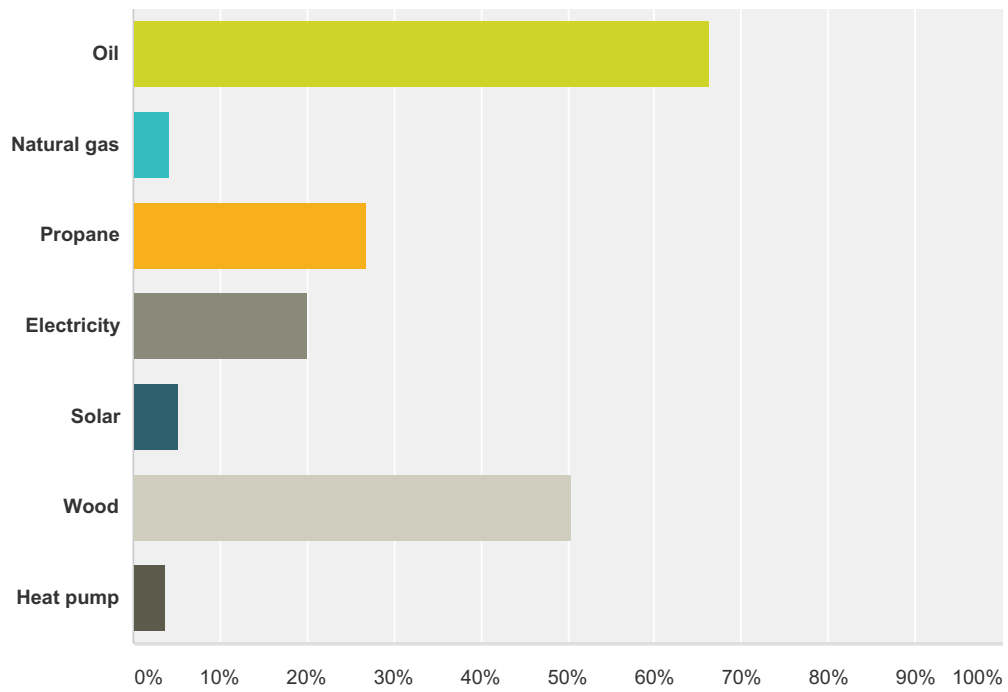
Answered: 192 Skipped: 4



Answer Choices	Responses
Yes	31.25% 60
No	59.38% 114
Not sure	9.38% 18
Total	192

Q8 How do you heat your home? (check all that apply)

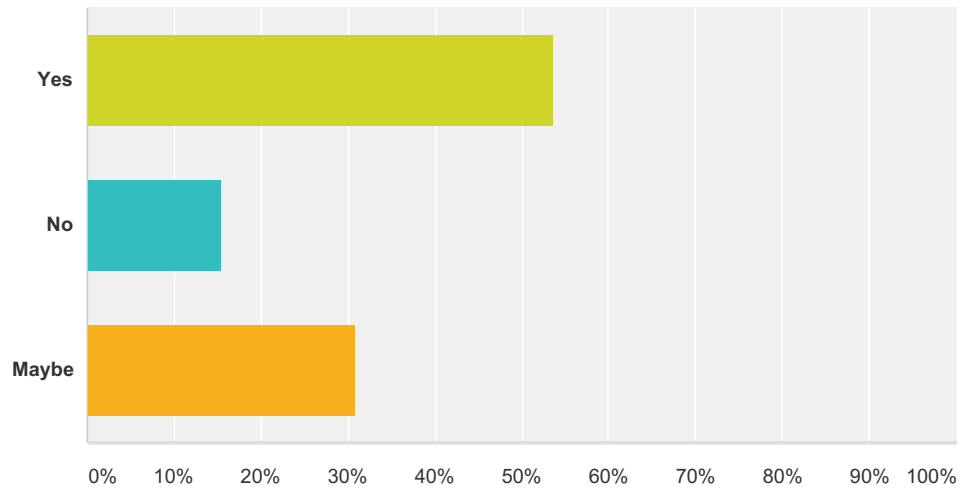
Answered: 190 Skipped: 6



Answer Choices	Responses
Oil	66.32% 126
Natural gas	4.21% 8
Propane	26.84% 51
Electricity	20.00% 38
Solar	5.26% 10
Wood	50.53% 96
Heat pump	3.68% 7
Total Respondents: 190	

Q9 Would you consider purchasing a plug-in hybrid/electric or an electric vehicle if Camden had EV charging stations?

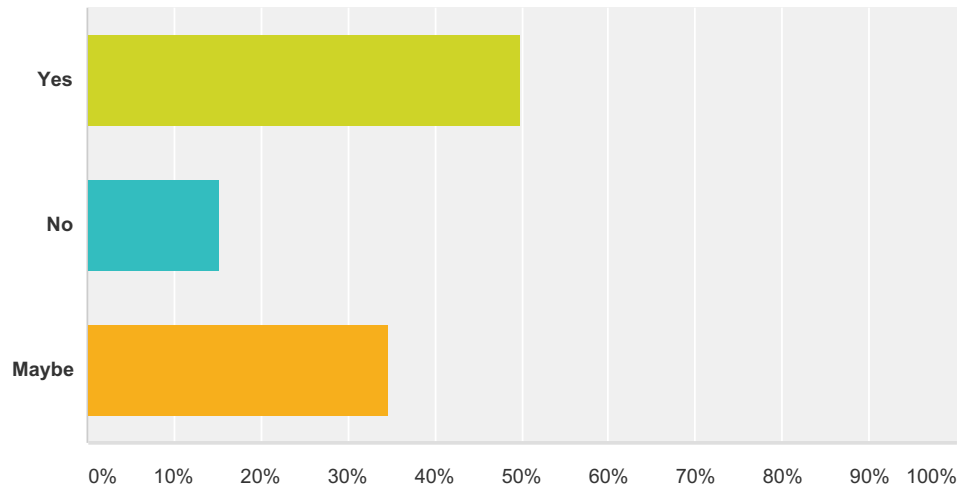
Answered: 188 Skipped: 8



Answer Choices	Responses
Yes	53.72% 101
No	15.43% 29
Maybe	30.85% 58
Total	188

Q10 If there was a commuter bus or if there were carpooling options, would you use them?

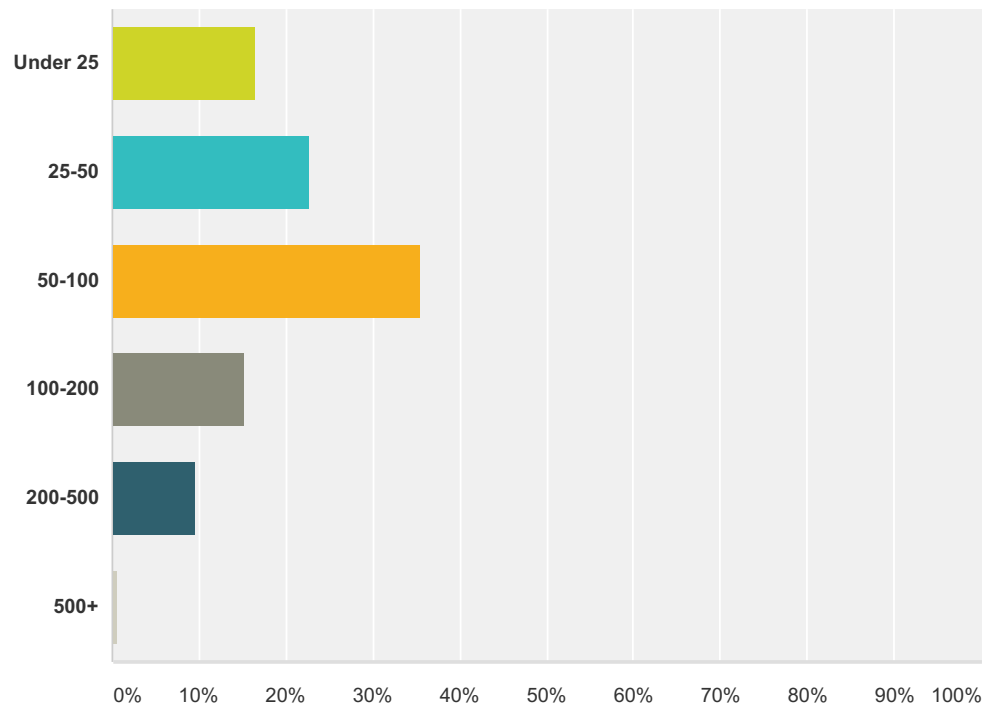
Answered: 190 Skipped: 6



Answer Choices	Responses	Count
Yes	50.00%	95
No	15.26%	29
Maybe	34.74%	66
Total		190

Q11 On average, how many miles do you drive a week?

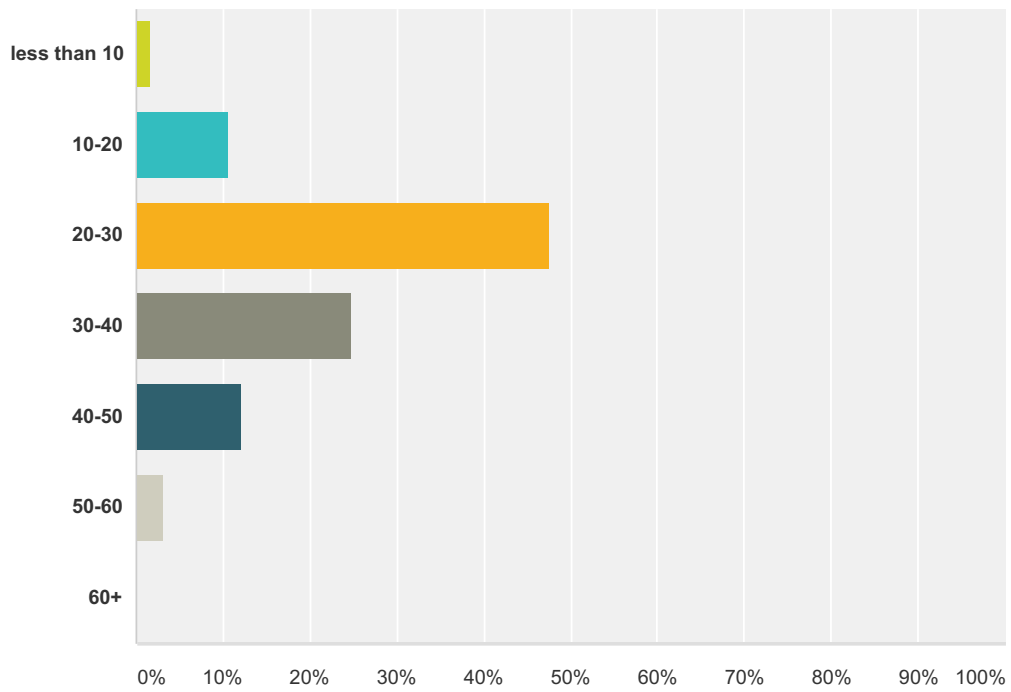
Answered: 189 Skipped: 7



Answer Choices	Responses
Under 25	16.40% 31
25-50	22.75% 43
50-100	35.45% 67
100-200	15.34% 29
200-500	9.52% 18
500+	0.53% 1
Total	189

Q12 What is the gas mileage of the car you use most often?

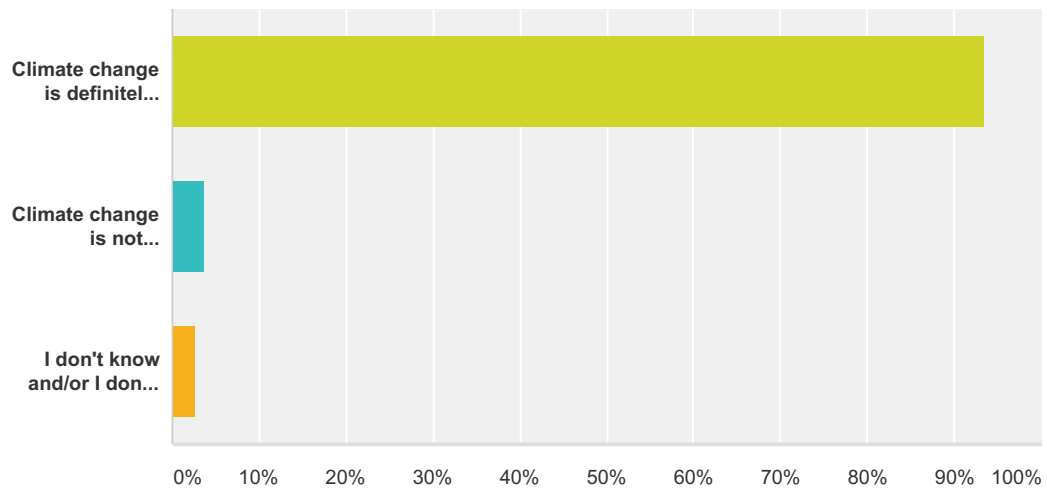
Answered: 189 Skipped: 7



Answer Choices	Responses
less than 10	1.59% 3
10-20	10.58% 20
20-30	47.62% 90
30-40	24.87% 47
40-50	12.17% 23
50-60	3.17% 6
60+	0.00% 0
Total	189

Q13 What are your views on the global climate change issue?

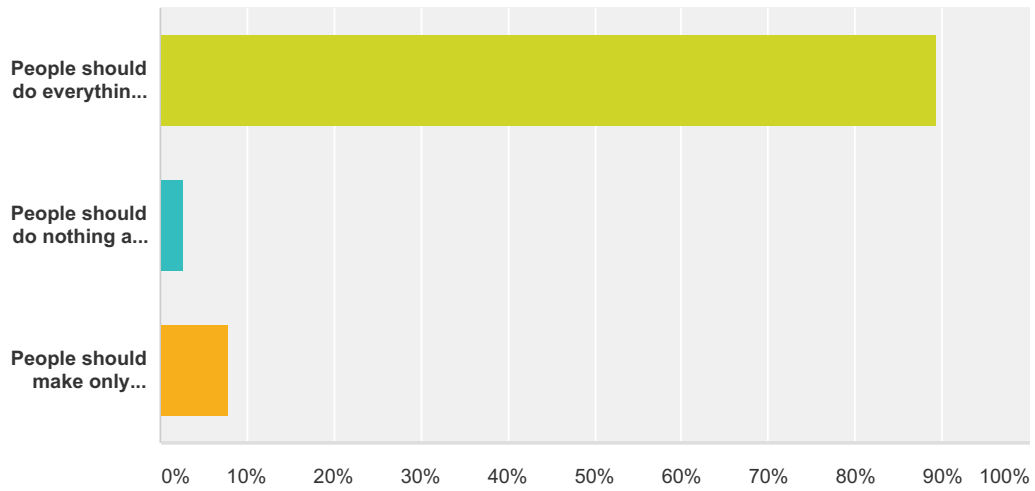
Answered: 188 Skipped: 8



Answer Choices	Responses
Climate change is definitely happening	93.62% 176
Climate change is not happening	3.72% 7
I don't know and/or I don't care if climate change is happening	2.66% 5
Total	188

Q14 To what extent do you think that people should be acting to counter climate change?

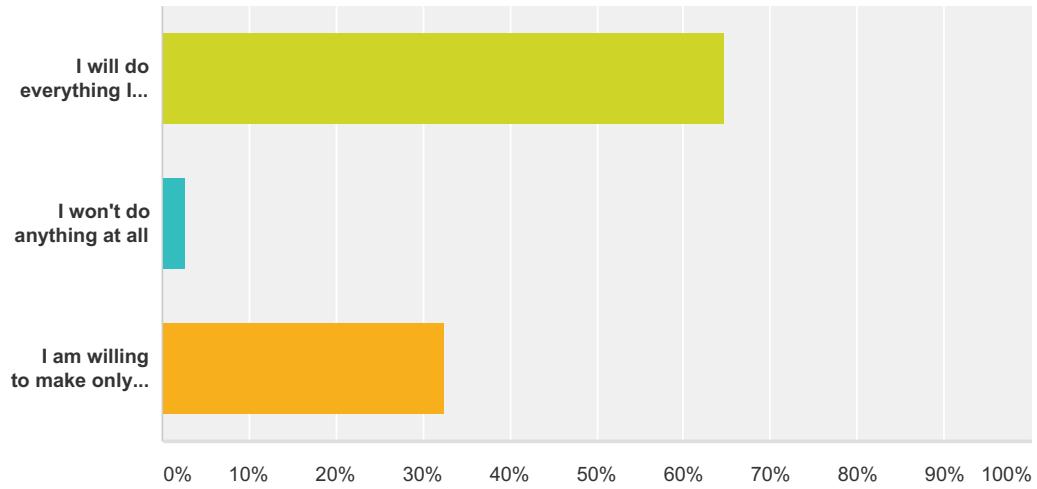
Answered: 188 Skipped: 8



Answer Choices	Responses
People should do everything they can	89.36% 168
People should do nothing at all	2.66% 5
People should make only small-scale changes	7.98% 15
Total	188

Q15 To what extent are you willing to sacrifice many of your everyday habits/traditions to counter climate change and decrease carbon emissions?

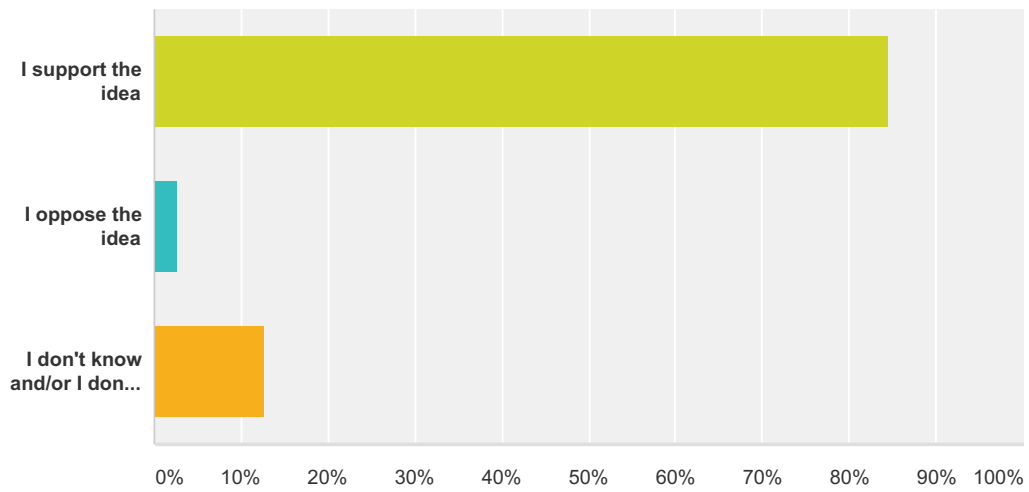
Answered: 184 Skipped: 12



Answer Choices	Responses
I will do everything I can	64.67% 119
I won't do anything at all	2.72% 5
I am willing to make only small-scale changes	32.61% 60
Total	184

Q16 What is your opinion about Camden becoming a carbon neutral town?

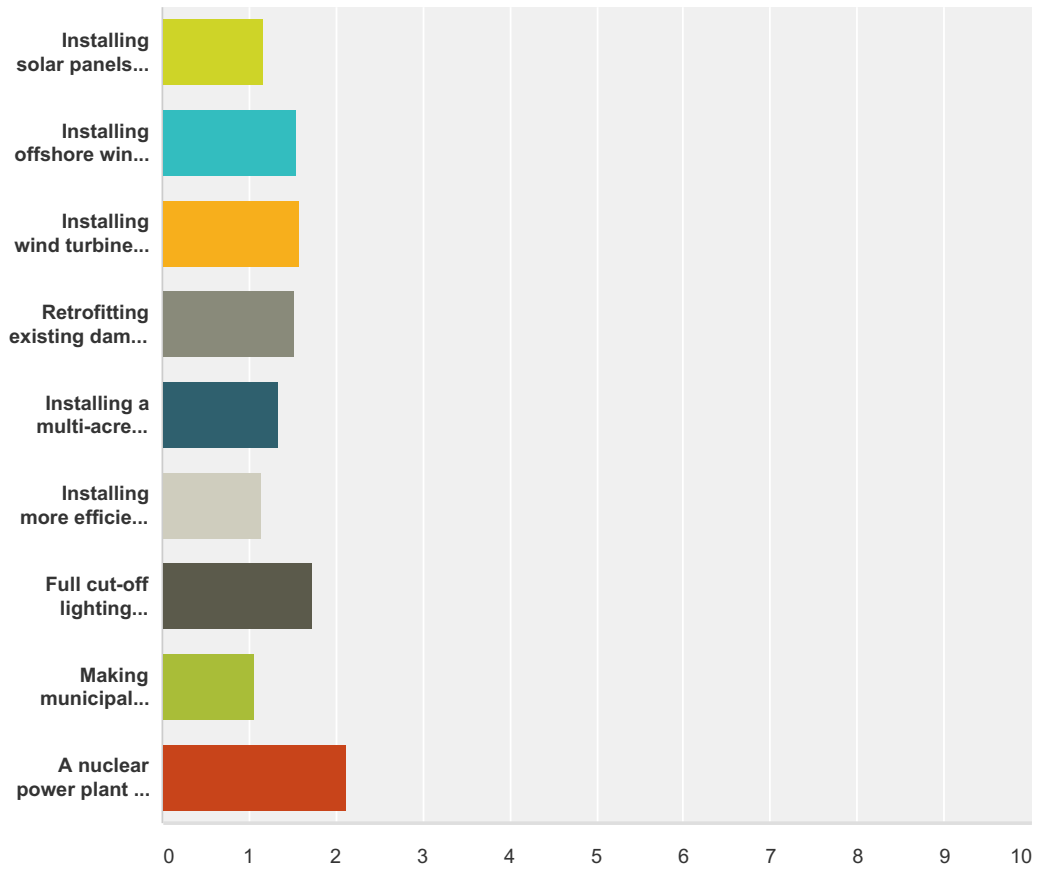
Answered: 187 Skipped: 9



Answer Choices	Responses
I support the idea	84.49% 158
I oppose the idea	2.67% 5
I don't know and/or I don't care about the idea	12.83% 24
Total	187

Q17 What is your opinion on these renewable or non carbon energy options?

Answered: 195 Skipped: 1



	Support	Oppose	Not sure	Total	Weighted Average
Installing solar panels on municipal and other downtown buildings	90.67% 175	2.07% 4	7.25% 14	193	1.17
Installing offshore wind farms in the Gulf of Maine	69.95% 135	6.22% 12	23.83% 46	193	1.54
Installing wind turbine(s) on land in Camden	65.98% 128	8.76% 17	25.26% 49	194	1.59
Retrofitting existing dams in the Megunticook River for hydro power	71.50% 138	5.18% 10	23.32% 45	193	1.52
Installing a multi-acre solar farm on a piece of land that cannot be used for other purposes, such as the town dump or the Tannery site	81.87% 158	3.63% 7	14.51% 28	193	1.33
Installing more efficient street lights and lighting along Main Street	92.19% 177	2.08% 4	5.73% 11	192	1.14
Full cut-off lighting restrictions to reduce light pollution	55.50% 106	14.66% 28	29.84% 57	191	1.74
Making municipal buildings more energy efficient	95.21% 179	2.66% 5	2.13% 4	188	1.07

APPENDIX C. DEFINITION OF TERMS AND ABBREVIATIONS

Btu British Thermal Unit – a measure of power equal to the amount of energy needed to cool or heat 1 pound of water 1°F (the energy in 1 match stick). In North America, heat value (energy content) of fuels is expressed in Btus.

W watt – a unit of power equal to 1 joule per second. The work done to produce 1 W of power for 1 second

kW kilowatt – one kilowatt equals 1000 watts. When you turn on an electric light or machine, a “demand” for power is created. This instantaneous amount of electricity demand is measured in kilowatts (kW)

kWh kilowatt hour - Most electric bills summarize how much electricity is used over time in kilowatt hours. For example, Seabright Dam has two 50 kW turbines. If both turbines run for 2500 hours in a year, the dam would produce $100 \text{ kW} \times 2500 \text{ hours} = 250,000$ kilowatt hours.

MW megawatt – one megawatt equals 1 million watts

EV electric vehicle

PV photovoltaic cell used to collect solar energy

Power and energy are often confused. Power is a rate – energy used per unit time, e.g., a 100 W light bulb turned on for 1 hour (100 kWh).

Source: California Energy Commission, Glossary of Energy Terms [19]