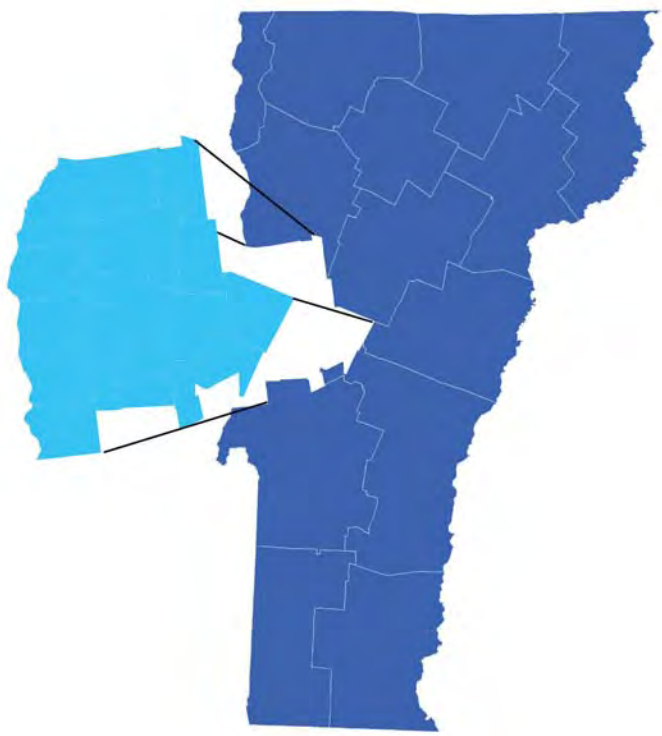
Solar Electricity Generation on Municipal Lands in Addison County, Vermont



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Ashley Bairos
Sarah Bryan
Patrick Burton
Brad Dickerson
Miriam Johnston

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PART I: INTRODUCTION

Goals and Scope

The aim of this project is to evaluate the potential for photovoltaic electricity generation in the 21 towns under the purview of the Addison County Regional Planning Commission (ACRPC). The energy section of the ACRPC's plan encourages local, renewable energy production and states a goal "to increase local energy production in an effort to move towards a less centralized and more reliable energy production system in the Addison Region" (ACRPC 2005). This report includes:

- A database of town-specific information that is relevant to photovoltaic renewable electricity generation,
- An in-depth analysis of photovoltaic power potential in three towns,
- Recommendations for future research and suggestions to streamline the bureaucratic process, and
- Sources of more information for towns that are interested in photovoltaic development.

The database will help the ACRPC in its evaluation of towns' solar potential and in its solicitation of grant money to support the development of solar projects. The in-depth analyses will serve as models for similar initiatives in other towns. The recommendations and suggestions will help the towns and the ACRPC to maintain current and relevant information and to communicate effectively with each other. The sources for more information will allow the towns to investigate additional sources of funding, if necessary.

Context: Renewable Energy

Mainstream, non-combustion-based renewable energy technologies include wind, hydroelectric, photovoltaic (solar), and geothermal power generation (Evans *et al.* 2009). There is a spectrum of scientific opinion regarding the advisability of renewable energy including those who believe that it can (and should) power the entire world in 20 years (Jacobson and Delucchi 2009), those who believe that such a goal is preposterous (Tucker 2009), and those who support a wide variety of intermediate strategies focused at different spatial scales (e.g. Dalton *et al.* 2009, Fthenakis *et al.* 2009).

Overall, each renewable energy technology has both advantages and drawbacks on environmental, social, and economic levels, but all (after manufacture and establishment) are supported by natural and renewable resources (Evans *et al.* 2009, Jacobson and Delucchi 2009). Local electricity production is especially desirable and can help achieve goals of energy independence and stability. Local generation fosters job growth and economic gain, and it is a much more energy-efficient choice because less energy is lost in transmission.

Context: Electricity Generation in Vermont

The Vermont Legislature has realized the importance of renewable and local electricity generation. In 2009, it passed H.446 (SPEED), an act relating to renewable energy and energy efficiency. H.446 developed a system of feed-in-tariffs to incentivize renewable energy generation. Solar, which was one of the methods of generation included in the bill, had a tariff of $0.30 per kWh, which made it a financially feasible alternative for those who participated in the program. The legislature is currently considering creating an additional, similar program to encourage renewable energy developments on dairy farms (ENVS401 2010*a*). In addition, approximately 150 schools and municipalities in Vermont were recently awarded approximately $6 million in federal stimulus funds from the American Recovery and Reinvestment Act to improve efficiency and pursue renewable energy (Hirschfeld 2010).

Vermont, with a population of just over 620,000, is the second-least populous state in the U.S. and has the lowest total energy consumption (U.S. Census Bureau 2008, USEIA 2010). It is one of only two states in the U.S. without a coal-fired power plant (USEIA 2010). In 2009, Vermont's electricity portfolio was relatively clean with respect to carbon emissions (Figure 1).

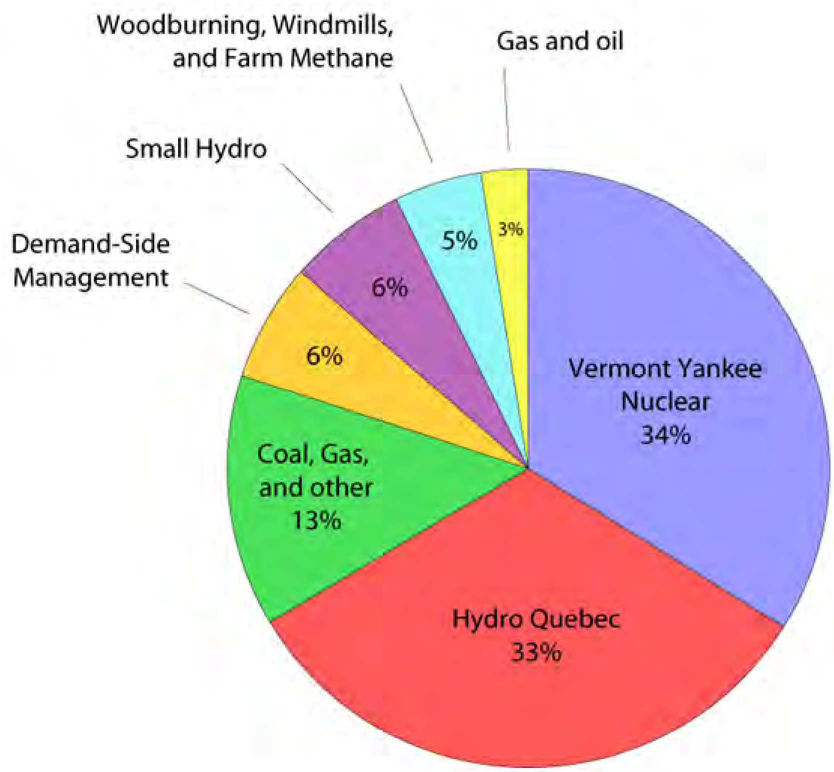

Figure 1. *Vermont's electricity portfolio in 2009. Only the electricity from HydroQuebec and "coal, gas, and other" is produced out of state.*

During the next two years, however, several significant changes are likely to affect Vermont's electricity portfolio.

- In February of 2010, Vermont state senators voted 26-4 not to renew Vermont Yankee's license in 2012 (Wald 2010). The infrastructure of the 38-year-old plant had deteriorated enough to release radioactive tritium, a suspected carcinogen, into the groundwater (Gram 2010). Plant executives also made concerning "misstatements" that suggested Vermont Yankee did not even have pipes that could be leaking tritium (Gram 2010).

- In March of 2010, Vermont's two largest electric utilities, Central Vermont Public Service and the Green Mountain Power Corporation, signed a new contract with HydroQuebec. At a currently confidential price, the utilities "anticipate purchases totaling up to about 225 megawatts starting in November 2012 and ending in 2038" (CVPS, 2010).

The imminent closure of Vermont Yankee and increased role of out-of-state HydroQuebec makes this a particularly relevant time for Vermont to consider generating renewable electricity. Otherwise, Vermont's electricity portfolio may soon become significantly dirtier and produced less locally.

Feasibility of Photovoltaic Power in Vermont

Although photovoltaic (PV) is currently the most expensive of the mainstream renewable energies, it also requires the least amount of land per kW generation and almost no maintenance (Elder pers. comm., Evans *et al.* 2009, Fthenakis and Kim 2009). Furthermore, the high initial economic cost of solar power is not necessarily insurmountable: the employment of new loan repayment methods and/or various economic incentives could make the cost considerably more manageable (Singh and Singh 2010, see Part IV: Costs). Also, if externalities such as damage to human health and the environment are taken into account, the difference between the costs of renewable and non-renewable energies is reduced dramatically (Jacobson and Delucchi 2009).

Another argument commonly levied against PV power is that insolation (sunshine), and therefore the power that can be generated by a PV cell, is intermittent. While this might indeed be problematic if solar energy made up 100% of an energy portfolio and there were no storage opportunities, it is not a significant issue if PV is simply part of a diverse energy portfolio that also included investment in a storage infrastructure (Fthenakis *et al.* 2009). Finally, while it is widely accepted that solar arrays installed in the sunny southwest of the U.S. could be productive, there are concerns that Vermont is too cold and cloudy for solar arrays to produce enough electricity to be worthwhile.

First, it is important to note that for each degree Celsius that a PV cell is above its rated operating temperature (usually about 25°C), it loses about 0.5% of the power that it could potentially be generating (Aldous *et al.* 2007, The Solarserver 2010). It is not uncommon for rooftop arrays to be at temperatures as much as 50°C above their optimal ratings, which translates to a 25% loss of efficiency (Aldous *et al.* 2007). In a colder climate like Vermont's there is less temperature-influenced inefficiency. With regard to Vermont's frequent cloudiness, Vermont actually has a greater solar resource (1400-1600 $kWh/m^2/year$) than Germany (1000-1500 $kWh/m^2/year$), which is a leader in renewable energy and had the largest market for solar installations worldwide in 2008 (AllSun 2010). If solar arrays are not problematic in Germany's climate, it is unlikely that their technical or chemical attributes would make them problematic in Vermont (Figure 2).

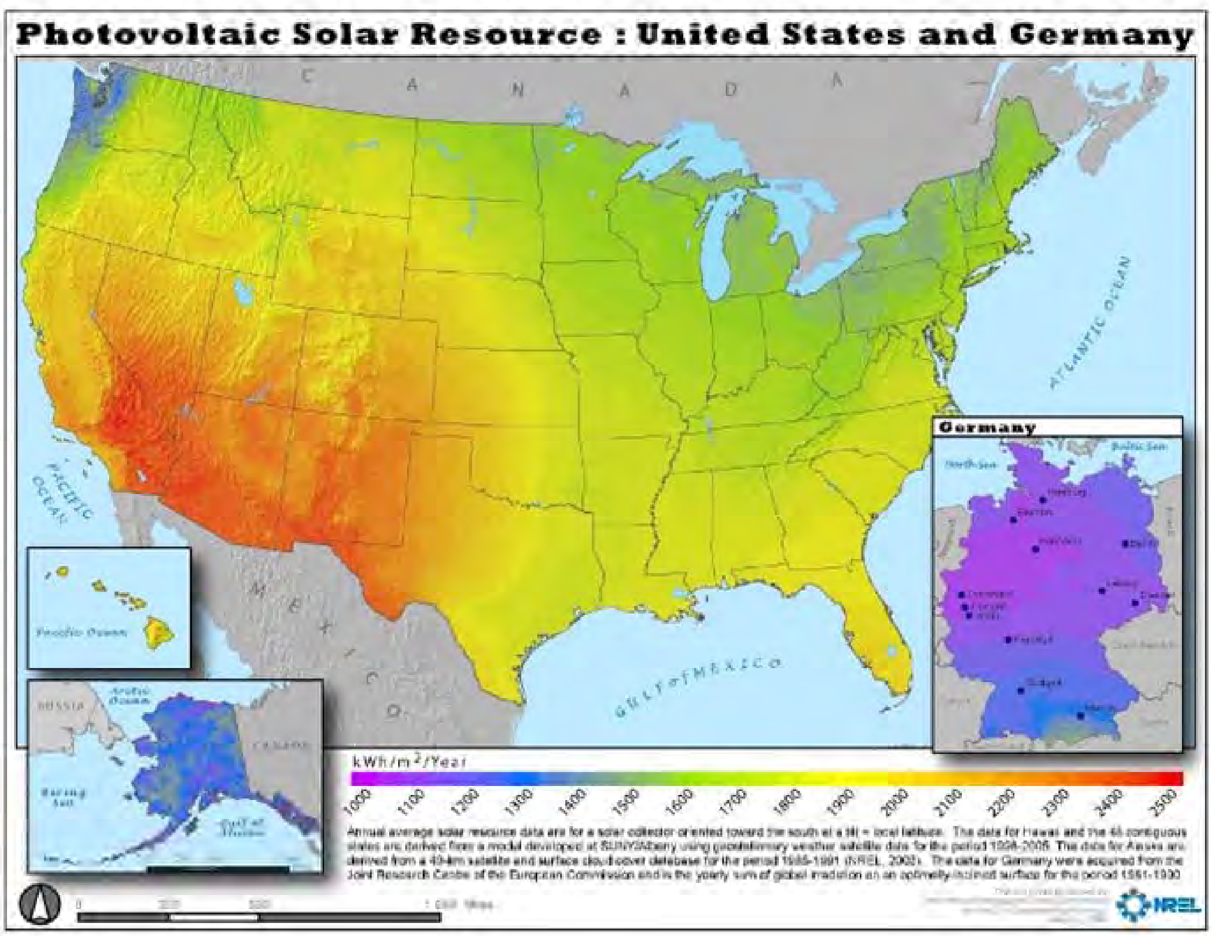

Figure 2*. Insolation map. Image from AllSun Trackers (http://www.allsuntrackers.com/solar/vt_solar.php).*

PART II: CASE STUDIES

There have been several solar photovoltaic installations proposed and completed in Vermont and in municipalities in other parts of the country. Brief introductions to these installations serve as case studies for how towns in Addison County might be able to proceed with solar development in the future. In Vermont, installations are at various stages of development: there is a working 50 kW array in Rutland, a planned 1 MW array in Ferrisburgh, a proposal for a 2.2 MW array in South Burlington, and a pending grant request in the town of Middlebury. Nationwide, the approved and in-progress 5 MW solar array in San Francisco is one of the largest and most influential municipal solar developments.

Rutland, VT

Central Vermont Public Service (CVPS) has installed a 50-kilowatt fixed solar array in its front lawn in Rutland, directly adjacent to Route 7. The full array consists of about 265 3 x 5 foot panels mounted on 33 ground-mounted modules. At $405,000, the expected payback period is 20-25 years. Though the array does not produce enough electricity to power the adjacent CVPS office building, which would require an output of about 105 kW, it does power a maintenance shed and serve an educational purpose (the value of which is not included in the calculation of the expected payback period).

Specifically sited to be highly visible, the reasons for erecting the array were largely educational, and CVPS president Robert Young mentioned that, in conjunction with Glen Station hydroelectric station on the other side of Route 7 across from the array, the array was meant to "provide a working classroom for students interested in how energy can be produced through clean, renewable sources" (Edwards 2009). CVPS hopes to demonstrate that investing in a small-scale solar array is feasible and desirable for businesses and homes (Bowen pers. comm.).

Ferrisburgh, VT

A 1 MW, 186-module solar array has been approved for construction in Ferrisburgh, VT. The fixed modules will cover about eight acres of a currently-undeveloped tract of land located at the southwest corner of Route 7 and Monkton Road, and are meant both to produce substantial electricity to power Ferrisburgh buildings and as an educational resource for nearby Vergennes Union High School (Ferrisburgh Planning Commission and Selectboard 2009). The expected output after DC to AC conversion is approximately 1,200 MWh/year, which is enough to power about 170 homes. The land is owned by a small group of investors in Addison Solar Farm LLC. Ernest Pomerleau, president of Pomerleau Real Estate in Burlington, is one of the principle investors in the project, and chief developer (Flagg 2010).

South Burlington, VT

The 2.2 MW array proposed for South Burlington would be the largest solar array north of Pennsylvania (The Solar Angels Blog 2010). Tentatively scheduled to be completed in December 2010, about 498 solar trackers on 32 acres would produce enough electricity to power about 430 households (Baird 2010). Also proceeding under the SPEED program, VESCO, LLC, the array's developer, suggests that it will promote long-term energy stability, help Vermont to achieve its goal of receiving 25% of its energy from renewable resources by 2025, and bolster the local economy (South Burlington Planning Commission and City Council 2010).

Middlebury, VT

The town of Middlebury is in the very early stages of photovoltaic development. Middlebury submitted a proposal to the Vermont Clean Energy Development Fund (CEDF) in March, 2010, for a Middlebury municipal photovoltaic solar feasibility study. The feasibility study, directed by ReKnew Energy Systems, would assess the feasibility for solar development on 4 sites, project kWh production and payback period, and "recommend implementation requirements" (Town of Middlebury 2010). Middlebury requested $16,100 from the CEDF, which is not quite the full cost of the study. If Middlebury's grant proposal is successful, it will contribute a cash match of 20% of the granted money.

San Francisco, CA

San Francisco, CA recently announced that construction is underway on one of the largest municipal solar developments in the country (City and County of San Francisco Press Release 2010). The 5 MW project will consist of over 23,000 Suntech solar modules on the expansive rooftop of the municipal water reservoir. The electricity produced will be fed into the grid and used by the General Hospital, San Francisco International Airport, municipal light rail, public schools throughout the city, and streetlights.

This case provides an excellent example of how a municipality can finance a large solar project (SunLink 2010). The San Francisco Public Utilities Commission collaborated with Recurrent Energy, a leading developer of solar power projects, for this job in order to take advantage of tax incentives that cut overall costs by 30%. This was made possible through Recurrent's novel Power Purchase Agreement, in which the company will own the solar modules and sell the power produced back to the city of San Francisco at a discounted rate, leading to a savings of $26 million over the lifetime of the project (City and County of San Francisco Press Release 2010). This example demonstrates that it is possible for a municipality that would normally be ineligible for particular tax incentives to take advantage of possibilities through an agreement with a third-party developer.

PART III: PROJECT COMMUNITY PARTNER AND GOALS

According to the Addison County Regional Planning Commission (ACRPC)'s published plan, the Energy Committee was "formed to address energy inefficiency and support local energy production in Addison County" (ACRPC 2005).

Goals of Energy Section of ACRPC Plan

" increase local energy production in an effort to move towards a less centralized and more reliable energy production system in the Addison Region"

"support innovative, experimental energy projects in the region, especially those utilizing local resources, such as wind, solar, hydro, and biomass"

"work toward the phasing out of fossil fuels and adopting cleaner energy solutions"

We worked with Elizabeth Golden, the environmental and land-use planner at the ACRPC, to further the stated goals of the ACRPC and its Energy Committee regarding local and renewable energies. Specifically, we examined the feasibility of installing rooftop and/or ground-mounted solar arrays on municipal lands in Addison County.

The main project has two parts. First, we collected detailed, town-specific information about the 21 towns under the purview of the ACRPC. Second, we did an analysis of potential solar development for three responsive and geographically-varied towns. The information will help Ms. Golden aid the towns in applying for renewable energy grants, should they be interested in doing so.

PART IV: TOWN-SPECIFIC INFORMATION

The first step in determining potentially appropriate sites for solar development in Addison County was to gather basic data for each town. Ms. Golden requested that we compile information including location and acreage of municipal lands, current municipal land use, electrical consumption rates of municipal buildings, and interest of the town energy coordinator in pursuing solar projects (Appendix A). *We note here that the Town of Addison in not included in Appendix A because there was no baseline information available on municipal lands there, and that consumption rates are not provided for the towns of Middlebury, Monkton, or Panton.*

Locating Municipal Lands

A single dataset of municipal lands in Addison County in digital form does not exist, nor does a county tax map that has consistent codes across municipalities. To determine specific lands that could be appropriate for solar development, we interviewed town clerks, town energy coordinators, and interested town members. We traveled to each town office to obtain or make copies of the tax maps that identify municipal lands. These parcels use specific lot numbers and were digitized into polygon shapefiles using GIS. GIS analysis produced acreage for each plot. To determine current use of the municipal lands, the new municipal map was overlayed with satellite imagery and existing land use maps. We also drove to several municipal parcels to make on-the-ground observations.

Consumption Rates of Municipal Buildings

Green Mountain Power (GMP) and Central Vermont Public Service (CVPS) are the two utilities that service towns in Addison County. Thirteen towns receive electricity solely from CVPS, five solely from GMP, and three from both. Electricity consumption of municipal buildings was acquired either directly from town clerks, in those cases where they have it on file, or it can be acquired from the utility companies. Utility companies keep energy consumption information confidential, so we had town clerks send a form to the utility companies granting us rights to access consumption rates. In the permission form, town clerks were asked to include lot numbers of each municipal building. Towns that buy electricity from GMP sent the permission form to Melissa Kern, the Customer Service Representative of GMP. Towns that buy electricity from CVPS sent the form to Brenda Spafford.

Attitudes Toward Solar

The general cultural climate of the towns was appraised through conversation with energy coordinators, some town clerks, and people who attended the Green Energy Expo. At the Energy Expo, a majority of visitors to our booth expressed an interest in developing not only solar but other renewable energies in their town. Interest of energy coordinators, town clerks, and town members varied on a town by town basis. Some were concerned with aesthetics while others were concerned with costs.

PART V: DETAILED ANALYSES OF SELECTED TOWNS

The following analyses include site information, production potential of a solar array, and issues that limit potential for development in the towns. This includes simple calculations of land availability, suitability, and potential development size. Case studies are valuable as examples. If other towns wish to perform similar analyses, please see our attached documentation and files.

Towns Selected: Lincoln, Shoreham, and Salisbury

After compiling the basic data for each town, three towns were chosen for a more comprehensive analysis. We chose to report on Lincoln, Salisbury, and Shoreham for three reasons:

- Their general interest and willingness to collaborate with us;
- Availability of suitable municipal land; and,
- Variety in topography and size: Lincoln is in the Green Mountains, Salisbury is in the Champlain Valley at the base of the mountains, and Shoreham is on the shore of Lake Champlain.

These three towns serve as a representative sample of the county as a whole.

Constraints

To determine which of the municipal lands are most suitable for solar development, we established two constraints:

- Slope: land needs to be ≤15% grade for construction purposes (Elder pers. comm.).
- Land use: using the land-use map from USGS Land Cover Institute, we categorized the layers into types of land suitable and unsuitable for solar development (Table 1).

Table 1. *Suitable and unsuitable land for solar development.*

Suitable Land	**Unsuitable Land**
Developed (open space and low to high intensity)	Open water
Barren Land	Deciduous Forest
Shrub/Scrub	Evergreen Forest
Grassland/Herbaceous	Mixed Forest
Pasture/Hay	Woody Wetlands
Cultivated Crops	Emergent Herbaceous Wetlands

Lands considered viable for development had both suitable slope and suitable land use. Total acreage of each municipal parcel was calculated. Given the area of a parcel, the area requirements for fixed and tracking modules, and module production potential, we calculated how many modules could possibly fit on the parcels and how much electricity they could produce.

We assume:

- Fixed modules require 225 ft^2 (0.00516 acres), and tracking modules require 2500 ft^2 (0.05739 acres) (Bowen pers. comm.)
- Fixed modules are 1.5 kW and tracking modules are 4 kW
- Values from existing arrays in Vermont (AllSun's tracking installation in Hinesburg and CVPS's fixed array in Rutland) suggest that fixed modules produce 1.09 kWh/year/W installed, and tracking modules produce 1.41 kWh/year/W installed (ENVS401 2010*b*)
- Each 1.5 kW fixed module produces 1,635 kWh/year, and each 4 kW tracking module produces 5,640 kWh/year

These calculations do not take the following into consideration:

- Buildings on the parcel or any land use that is not present in the attribute data of the land use layer from USGS (such as athletic fields or smaller trees)
- Irregular shapes of the parcels – we did not include a buffer around the edge of the parcels

It is important to note that the calculated number of modules in each municipal parcel (Tables 2- 4) is the possible number rather than the realistic number. Several parcels are large enough to hold many more modules than would be socially and financially feasible. As a result, calculations of potential electricity production tend to represent maximum potential.

Lincoln

Known widely for its beautiful natural surroundings, Lincoln is nestled at the base of Mount Abraham, and the town center lies on the banks of the New Haven River. The small town of 1214 residents is scattered over 44.4 square miles. The energy co-coordinators for the town are Henry Wilmer and Stephen Taylor, both of whom have been an integral part of the research for this project. Although there is significant tree cover and large mountain ridges on either side of Lincoln, solar electricity generation is feasible.

The Central Vermont Public Service (CVPS) supplies Lincoln's two municipal buildings with electricity. In 2009, the buildings consumed 16,784 kWh (Appendix A). To offset this consumption, Lincoln would need three tracking modules or 11 fixed modules. Three tracking modules would require 0.17 acres. Eleven fixed modules would require 0.057 acres.

Lincoln has seven municipal parcels (Figure 3). Possible development sites were identified by GIS analysis (suitable and unsuitable lands, Table 1), on-site observations, and energy coordinator suggestions. Two parcels are completely forested and one parcel is a cemetery. The other parcels, including the roof of the school, roof of the library, fire department, town office site, and land around the town garage, could host development.

The land around the garage seemed particularly appropriate for ground-mounted arrays because of its availability, minimal slope, and large area (Figure 4). The garage municipal parcel is 81.19 acres, but only 8.87 acres are suitable for development. The school roof is another potential location for development. Table 2 shows that the school has 5.5 acres suitable for development, but most of that is taken up by the school or the playground. Therefore any development would need to take place on the rooftop. They do have a large, south-facing roof that could host several panels.

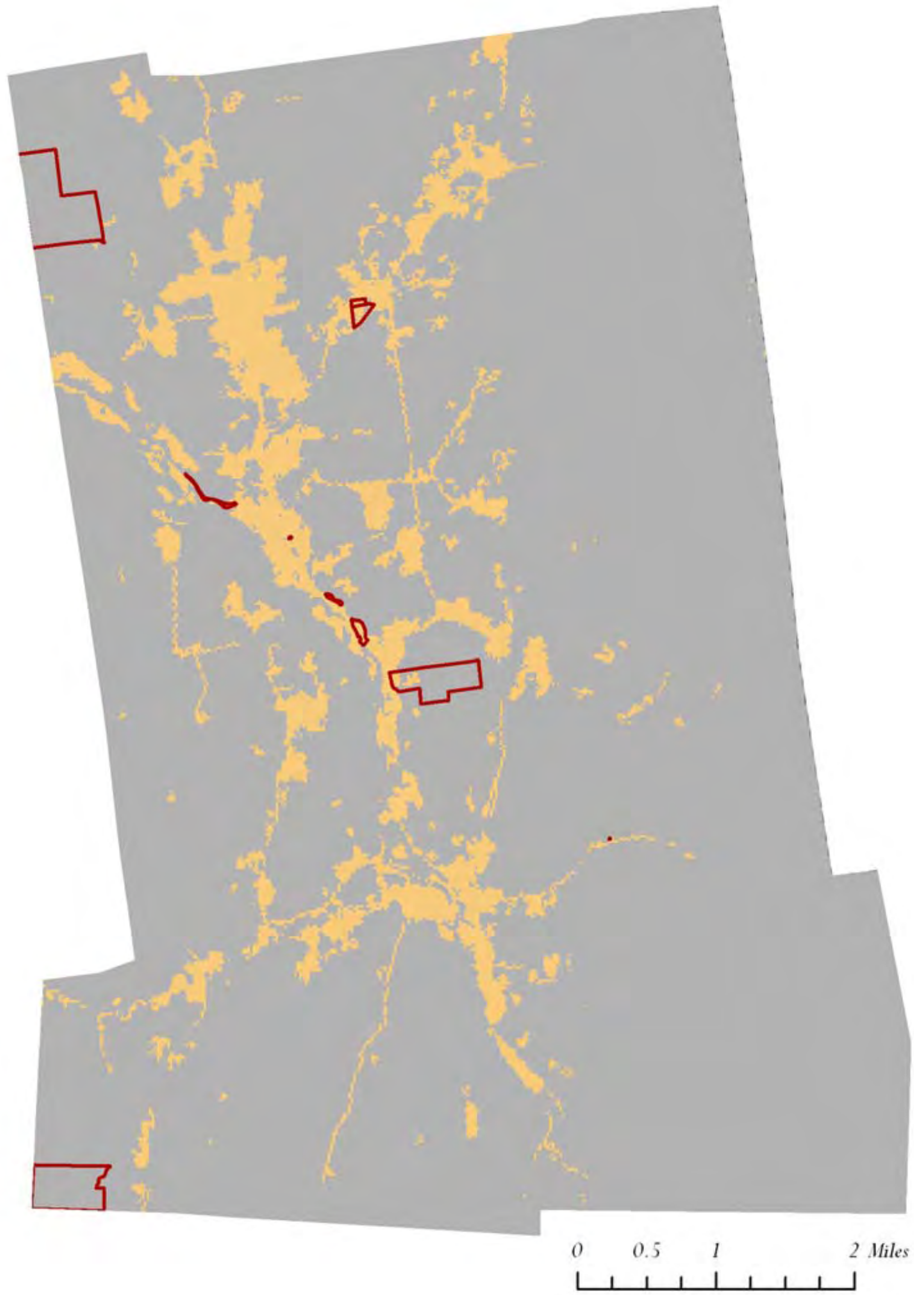

Figure 3. *Lands suitable for development given slope and land use (orange) and municipal parcels (red) of Lincoln, VT.*

Figure 4. *Town garage site in Lincoln, VT*

Table 2*. Land acreage for the municipal parcels of Lincoln, VT, and the maximum potential power produced from a 1.5 kW fixed and 4 kW tracking module that specific acreage can accommodate. Acreage is based on an aerial photograph and does not subtract any surface area taken up by development.*

Parcel Use	Total Area (Acres)	Suitable Area (Acres)	# Fixed Modules	Maximum Potential Production (MWh/yr)	# Tracking Modules	Maximum Potential Production (MWh/yr)
Forest	174.8	0	0	0	0	0
Forest	105.02	0	0	0	0	0
Town Garage	81.19	8.87	1717	2807.3	155	874.2
Recycling Center	9.4	7.11	1376	2249.8	124	699.36
School	6.54	5.49	1063	1738	96	541.44
Unknown	3.19	1.72	333	544.46	30	169.2
Recycling Center	2.87	2.21	428	699.78	39	219.96
Town Shed	1.36	0.54	105	171.68	9	50.76
Pope Cemetery	0.11	0.11	21	34.335	2	11.28
Unknown	0.05	0	0	0	0	0

Salisbury

Salisbury is a small town in west-central Vermont. The town was established in 1761 and is chiefly a rural community of farms, dairies, and tourist enterprises centered around Lake Dunmore. According to the 2000 Census, just under 1,100 people live in the township. The geography of Salisbury is similar to other towns in the Champlain Valley; it is generally flat with slight rolling hills. The spine of the Green Mountains rises to the east of the town's boundaries and open fields with good sun exposure dot the landscape. The energy coordinator for Salisbury is Ann Dittami. She also assumes the role of the Town Clerk. While Ms. Dittami expressed interest in the idea of local solar power production, she also expressed concerns about the unavailability of municipal land (Dittami pers. comm.). Many of the parcels are currently in use, such as the Fire Department or Landfill, but our initial analysis shows there are several feasible sites if the town wishes to pursue development.

CVPS supplies Salisbury's three municipal buildings with electricity. In 2009, the buildings consumed 20,135 kWh of electricity (Appendix A). To offset this consumption, 13 fixed modules or four tracking modules would be required. Four tracking modules would require 0.23 acres. Thirteen fixed modules would require 0.067 acres.

The town owns ten municipal parcels, eight of which have lands suitable for solar development (Figure 5). If they wish to pursue ground-mounted modules, there is land by the town clerk's office as well as near the Salisbury Community School. The clerk's office has 0.44 acres suitable for development while the school has 29.8 acres. The school also has very large south facing roofs, which would be ideal for a roof-top array (Figure 6).

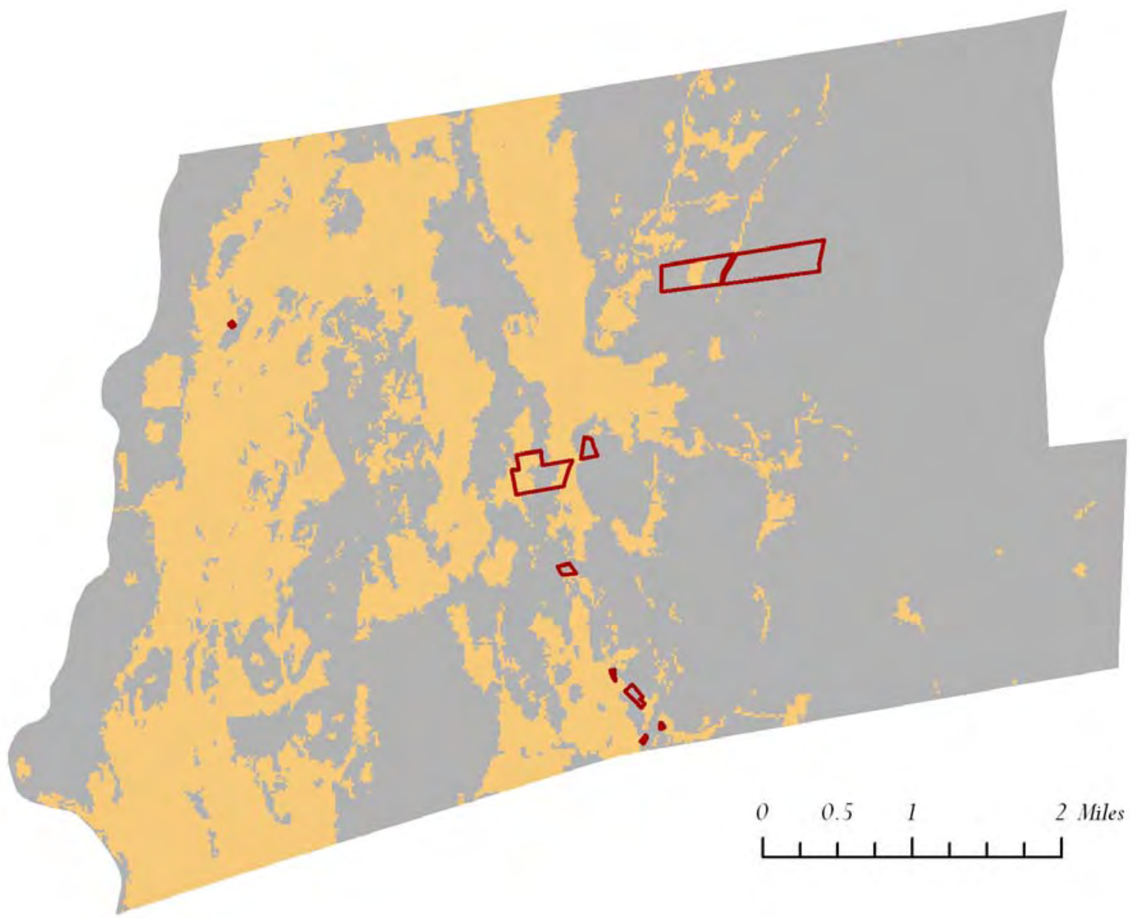

***Figure 5**. Lands suitable for development given slope and land use (orange) and municipal parcels (red) for Salisbury.*

Figure 6. *South facing roof of Salisbury Community School.*

Table 3*. Land acreage for the municipal parcels of Salisbury, VT, and the maximum potential power produced from a 1.5 kW fixed and 4 kW tracking module that specific acreage can accommodate. Acreage is based on an aerial photograph and does not subtract any surface area taken up by development.*

Parcel Use	Total Area (Acres)	Suitable Area (Acres)	# Fixed Modules	Maximum Potential Production (MWh/yr)	# Tracking Modules	Maximum Potential Production (MWh/yr)
Town Hall	0.44	0	0	0	0	0
Town Clerk Office	4.89	0.44	86	140.61	8	45.12
Open Lot	1.33	0.67	129	210.92	12	67.68
Cemetery	3.34	0.44	86	140.61	8	45.12
School	47.81	29.8	5769	9432.3	519	2927.2
Cemetery	0.67	0.67	129	210.92	12	67.68
Cemetery	0.67	0.22	43	70.31	4	22.56
Fire Department	6.23	0	0	0	0	0
Landfill 1	48.7	11.79	2282	3731.1	205	1156.2
Landfill 2	77.17	0	0	0	0	0

Shoreham

Shoreham was established in 1761, and has a population of approximately 1,222 (Census 2000). The town's website describes it as a "thriving lakeshore town lying on the outskirts of the growing communities of Burlington, Middlebury, and Rutland" (Town of Shoreham 2010). Shoreham is primarily an agricultural community of farms and dairies, with some commercial development. The landscape is primarily flat with slight rolling hills. Fields dot the landscape and the town center is the only highly-developed area in the community. In January 2010, Shoreham created the Shoreham Energy Committee, which has the following mission statement:

> *"The Shoreham Energy Committee will help our fellow Shoreham residents identify, finance, and implement energy efficiency cost savings. In the long term, the committee will study the feasibility and spearhead the development of community scale energy generation projects within Shoreham"*
>
> *-cited by George Gross, energy coordinator of Shoreham, VT*

The committee is in the midst of conducting a community-wide energy audit and a study to gauge public interest in municipal renewable energy. Members of the community on the board have found that interest in local energy production is high. George Gross, the energy coordinator for Shoreham, is enthusiastic and very well-informed.

In 2009 CVPS provided Shoreham's five municipal buildings with 44,675 kWh of electricity (Appendix A). Twenty-eight fixed and eight tracking modules would be required to offset this electrical consumption. Twenty-eight fixed modules would require 0.14 acres, and eight tracking modules would require 0.46 acres.

The town owns only five municipal lots, but all are viable for development (Figure 7). Mr. Gross suggests that installing solar panels on the rooftops of municipal buildings would not be optimal, because there are few buildings and the rooftops are not very large. Ground-mounted modules would be preferable. Shoreham's largest municipal plot, situated just northwest of the Route 22A and Route 74 intersection, is the most suitable for the installation of a solar array. The parcel is 314 acres, but only 175 of those acres are suitable (Table 4). The land was purchased by the town roughly 10 years ago and is currently leased out to farmers. The Waste Water Treatment plant is surrounded by this lot, but development could take place around it on the open fields (Figure 8). While the parcel is in use, Mr. Gross noted that the community is open to development ideas. Almost half of the land is a cedar swamp, and it is not visible to the road, but it is extremely close to power lines and sizable. The area around the town green is also suitable for solar development, and perhaps the option the town wishes to pursue if they want a more publicly visible project.

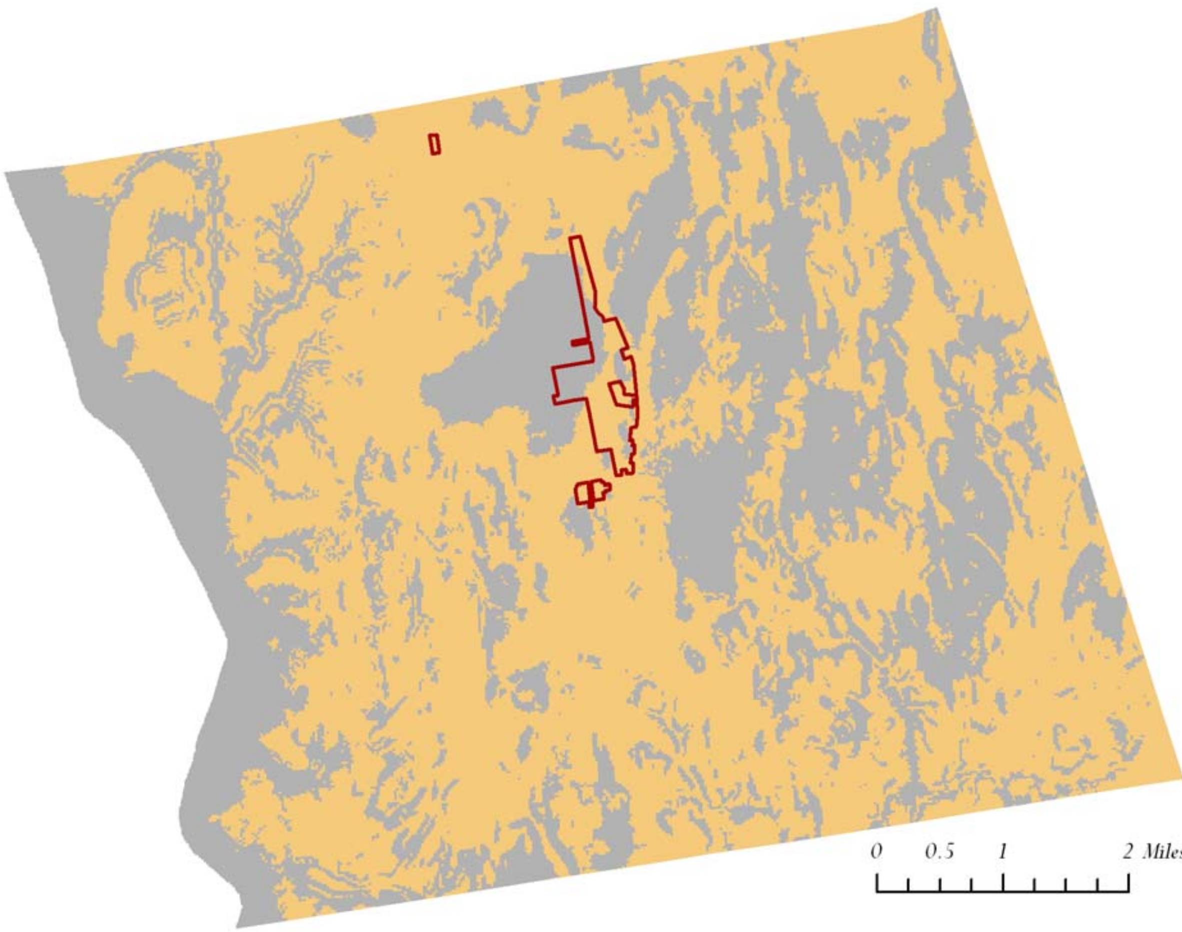

Figure 7. *Lands suitable for development given slope and land use (orange) and municipal parcels (red) for Shoreham.*

Figure 8. *Open lot and the waste water treatment plant northwest of Route 22A and Route 74 in Shoreham, VT.*

Table 4. *Land acreage for the municipal parcels of Shoreham, VT, and the maximum potential power produced from a 1.5 kW fixed and 4 kW tracking module that specific acreage can accommodate. Acreage is based on an aerial photograph and does not subtract any surface area taken up by development.*

Parcel Use	Total Area (Acres)	Suitable Area (Acres)	# Fixed Modules	Maximum Potential Production (MWh/yr)	# Tracking Modules	Maximum Potential Production (MWh/yr)
Water Treatment Plant	15.12	13.79	2669	4363.82	240	1353.6
Leased Field	314.01	175.46	33970	55541	3057	17241
Open Lot	5.34	5.34	1033	1688.96	93	524.52
Town Green	10.45	9.34	1808	2956.08	163	919.32
Town Green	9.56	9.12	1765	2885.78	159	896.76

PART VI: COSTS

Although many of the energy coordinators were interested in the potential for photovoltaic development in their towns, the cost of PV technology was a common concern.

> *"I think funding is almost always the hurdle for initiating projects of this type"*
> *-David Raphael, energy coordinator of Panton, VT*
>
> *"While the long term savings and the salutary effect on the climate are substantial, so is the current up front cost, especially for photovoltaic technology"*
> *–Henry Wilmer, energy coordinator of Lincoln, VT*

Indeed, the permitting process and costs of installation and hardware make photovoltaic installations the most expensive of the mainstream renewable energy technologies (Evans *et al.* 2009). The permitting process is currently costly and unwieldy, and of concern for many developers (Reviewed in ENVS401 2010*a*). Brian Waxler, principal at Pomerleau Real Estate, estimated that the cost of permitting for the 2.2 MW array in Ferrisburgh totaled near $300,000. This is due to the fact that the permitting process under Section 248 is the same for solar arrays over 240 kW as it is for any other large-scale power production plant such as a coal or nuclear plant (Talmage pers. comm.). Practically, this means that 65 4 kW modules producing 260 kW of power must follow the same permitting process as a massive nuclear power plant producing 50 times that quantity of electricity. Due to the current costs of permitting, even with various tax credits and incentives, developers are struggling to turn a profit (Waxler pers. comm.). Therefore, until this process is changed, municipalities should focus on arrays under 150 kW. Fortunately, the proposed H.781 Renewable Energy bill, seeks to streamline Section 248 and permitting.

In addition to permitting, other factors affect the price of solar installation:

- Costs of **installations** depend on a site's proximity to three-phase power lines (Bowen pers. comm.., Ferrell pers. comm.).
- Costs of module **hardware** vary based on the developer and whether the arrays are tracking or fixed (Table 5).
- Electricity **prices** are variable.

- **Maintenance** costs are negligible (Elder pers. comm.).
- There are various sources of **funding**.

Table 5*. Costs of tracking and fixed photovoltaic module hardware (ENVS401 2010b). Cost per module and kW per module are based on AllSun Trackers' experimental tracking array in Hinesburg and The Central Vermont Public Service's fixed solar array in Rutland. Efficiency (kWh/year/W installed) is an average from various sources (ENVS401 2010b). Assumed lifetime is based on module warranties. These values do not include any incentives.*

	Tracking	**Fixed**
Cost per module	$31,000.00	$9,150.00
kW per module	4	1.4
kWh/year/W installed	1.41	1.09
Assumed lifetime (years)	25	25
Cost/kWh over assumed lifetime	$0.22	$0.22

To overcome these financial hurdles, municipalities may take advantage of several state and federal incentives, including:

- **Clean Energy Development Funds (CEDF) – Municipal Technical Assistance Grants**
  Municipal governments and public schools are eligible to apply for CEDF grants, which are intended to help them investigate their potential to install grid-connected renewable energy systems. Recipients of the grants must match 10% of the granted funds. The money may be used for site evaluations, permitting, project development, project proposals, and project bids in response to requests for proposals.

- **Renewable Energy Systems Sales Tax Exemption**
  This is a tax exemption for renewable-energy systems. These are defined generally as any system up to 250 kW that generates electricity from a "renewable energy" resource, including solar PV. Vermont's sales tax is 6%, and therefore 6% can be saved on the purchase of a PV array. This exemption includes on and off the grid systems.

- **Green Mountain Power – Solar GMP**
  Green Mountain Power, one of Vermont's electric utilities, provides electricity to at least some of the municipal lands in Addison, Ferrisburgh, Monkton, New Haven, Starksboro, Vergennes, and Waltham (Appendix B). In addition to the benefits of net metering, GMP pays its customers with PV installations $0.06 per kWh of electricity that is generated by the system. This incentive does not currently have a cap or an expiration date.

- **Vermont Standard Offer for Qualifying SPEED Resources**
  This program was established in May 2009 and is currently enrolled to capacity, but it is included in this report as an example of past success. SPEED established a feed-in-tariff as part of H.446. The feed-in-tariff incentivized renewable energy production by making it more financially feasible. This program provides qualifying renewable energy facilities with a long-term, fixed rate for the electricity they sell into the grid. It accomplishes this by mandating that the retail electricity providers such as CVPS purchase the power produced by these facilities. The total cap for the program was set at 50 MW, and individual installations were capped at 2.2 MW. The contracts were signed during the interim price period at $0.30 per kWh and are for 25 years. All of the renewable energy credits (RECs) generated are the property of the retail electricity provider. The VT state legislature is currently exploring the possibility of expanding it to dairy farms (ENVS401 2010*a*, H.518 2010).

For a more comprehensive summary of financial incentives for corporations, businesses, and private parties as well as for municipalities, please see the Database of State Incentives for Renewables and Efficiency (DSIRE), developed by the U.S. Department of Energy (2010).

PART VII: SUGGESTIONS FOR FURTHER RESEARCH

Despite geographical, social, and economic constraints, our research shows that there are several municipal lands suitable for solar development. With further research, ACRPC's goals of local energy production could be realized. However, there are some financial and organizational hurdles that must be overcome. The Planning Commission and the towns would be better suited to achieve their goals if the following suggestions were considered:

- **Digitize and increase the availability of maps.** Digitization allows for geographical analysis and facilitates data sharing. The creation of a single database – consolidated from the many different files that the town clerks provide to ACRPC separately, and updated as needed – will make the process more efficient. Our creation of a single municipal parcels map for Addison County is the first step, but this map will require maintenance (Appendix C). Other information, such as electrical usage and the location of power lines should also be included in this database.

- **Expansion of scope.** We specifically researched the potential for PV solar development on municipal lands, but we suggest broadening the scope of further projects to include:

    - <u>Solar hot water heaters</u>. Several energy coordinators mentioned that these are more financially feasible than photovoltaic technology.

> *"Solar hot water is so far more efficient [than PV technology] and has a shorter payback on initial investment"*
> *-Henry Wilmer, Lincoln*

    - <u>More than just municipal lands</u>. Municipal parcels are limited in size and suitability, so broadening the scope to include private lands would provide more options for development.
    - <u>Creation of tax-equity relationships</u>. In San Francisco, municipalities linked up with a third-party entity to take advantage of the 30% tax credits. Municipalities of Vermont should consider this option because it offers a promising incentive.
    - <u>Collaboration between towns</u>. Many towns, including Lincoln, Salisbury, and Shoreham, have the capacity to install a number of modules that could produce far more electricity than their municipal buildings would consume.

That "extra" electricity could be shared with a nearby town or used to offset private electrical bills.

- **Enhanced communication.** Currently, there seems to be a lack of clear communication between the towns and ACRPC. For example, several town clerks were surprised to learn that a map of municipal lands in Addison County simply did not exist. They thought that the ACRPC had created a digital data layer with all the necessary information from data they said they supplied to the ACRPC. A continuing dialogue among towns and the ACRPC about available databases will facilitate renewable energy development within the county.

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PERSONAL COMMUNICATIONS

Bowen, M. III, Customer generation program manager at Central Vermont Public Service.

Dittami, A., Salisbury energy coordinator and town clerk.

Elder, C., Customer support at AllEarth Renewables, Inc.

Ferrell, C., Owner of Encore Redevelopment.

Talmage Solar Engineering, Inc. – a representative.

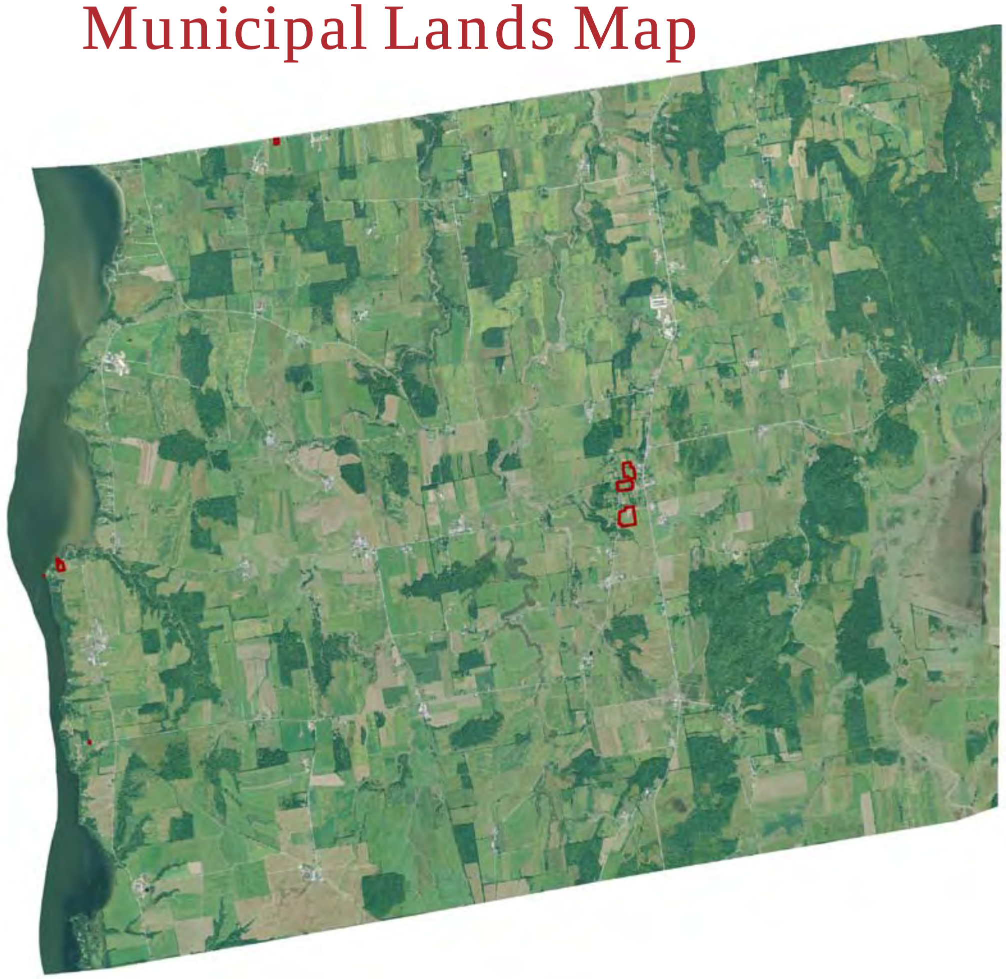
Waxler, B., Principal at Pomerleau Real Estate.

The Town of Bridport

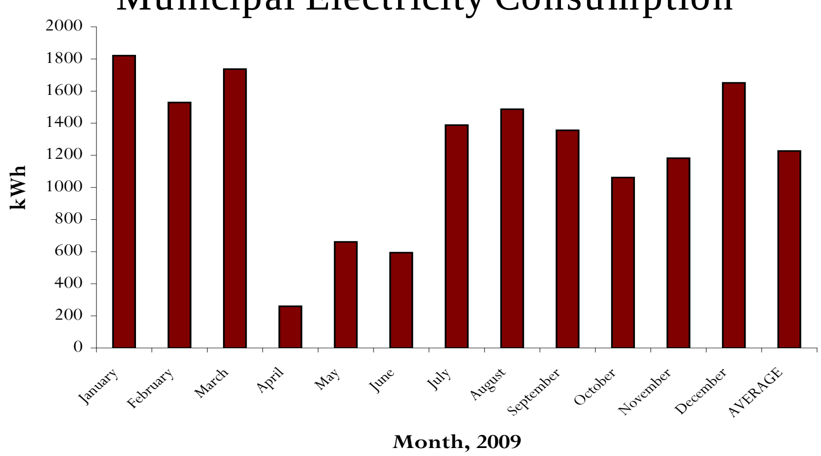
Town Clerk: Valeri Bourgeouis
(802) 758 - 2483

Energy Coordinator: Ed Payne
(fampayne@accessvt.com)

Municipal Lands Map



Municipal Electricity Consumption



Total: 14,728 kWh Peak Month: Januaray

Located on the shore of Lake Champlain, the town of Bridport has a population of just over 1,200. The town currently owns 7 municipal parcels, several of which are feasible sites for solar development, including the school, town dump and town shed. Other municipal lands, however, are not feasible. Those include the two cemeteries and the light house.

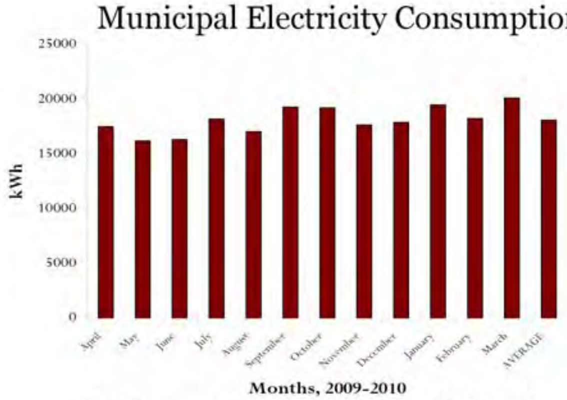
The Town of Bristol

Town Administrator: Bill Bryant
(802) 453 - 2410

Energy Coordinator: Brendan Gallivan
(802) 453-0633 *brendangallivan@gmail.com*

Municipal Lands Map

Municipal Electricity Consumption



Total: 217,143 Peak Month: March

The town of Bristol, located in the Green Mountains, already is involved in renewable energy projects with a hydroplant nearby in Lincoln. While they have multiple municipal lands, most are currently in use or unsuitable for solar development. The relatively large consumption of electricity in their municipal buildings makes them a candidate for development, but the lack of land prohibits reason to move forward with the process.

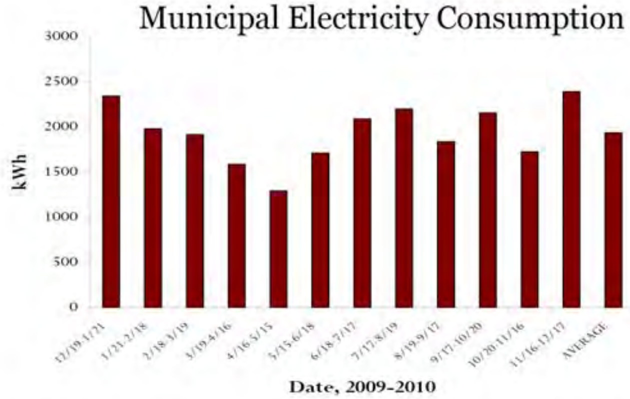
The Town of Cornwall

Town Clerk: Nancy Ertle
(802) 439-5850

Energy Coordinator: Gary
Barnett (802)462-3669

Municipal Lands Map

Municipal Electricity Consumption



Total: 25,942 kWh

Peak Month: November-December

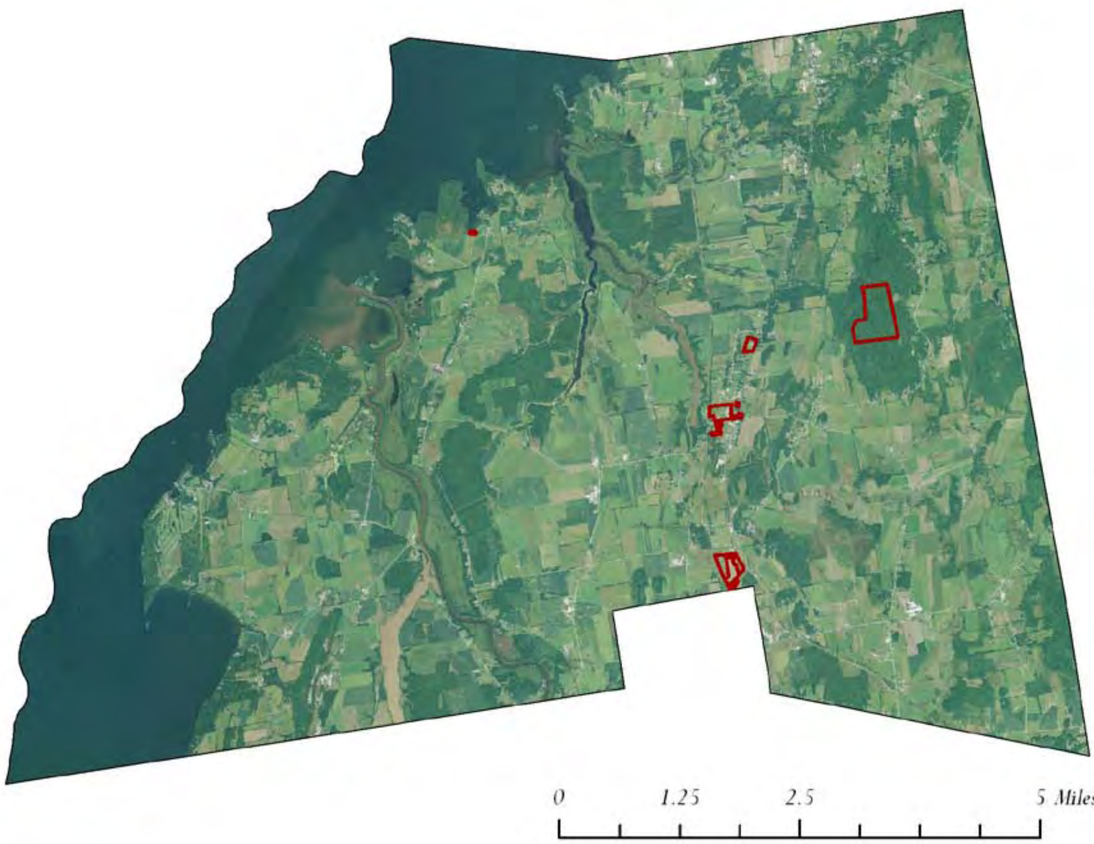
With a population of 1,210, Cornwall is a small town in the center of the Champlain Valley. There are 8 municipal lands, all of which fairly small in size. The energy coordinator seemed hesitant to pursue solar development because of their lack of land. A small scale project, located at the town hall or park, however, could be feasible.

The Town of Ferrisburgh

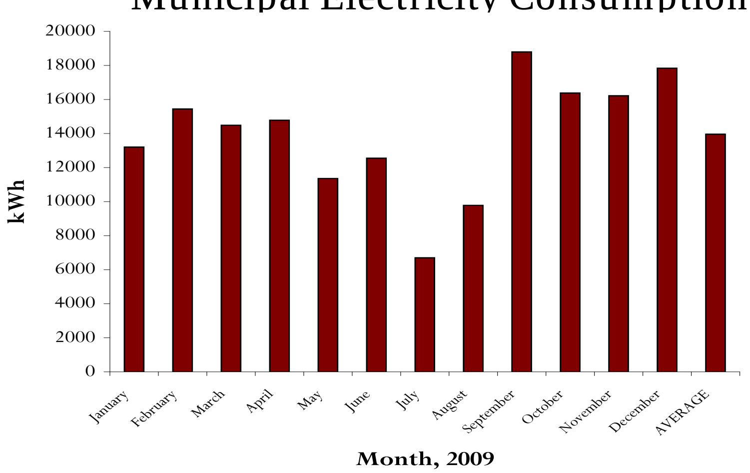
Town Clerk: Chester Hawkins
(802) 877-3429
ferrisburghclerk@comcast.net

Energy Coordinator: Larry Keyes
lhkeyes@yahoo.com

Municipal Lands Map



Municipal Electricity Consumption



Total: 167,557 Peak Month: September

At the beginning of 2010, the town of Ferrisburgh propsed a 1 MW solar farm along route 7 in Ferrisburgh (see www.ferrisburghsolarfarm.ncom for more information). As one of the few towns already involved in solar development, Ferrisburgh is well ahead of the curve. Their available municipal lands are sparse, but their interest in renewable energies make them appropriate candidates for further projects.

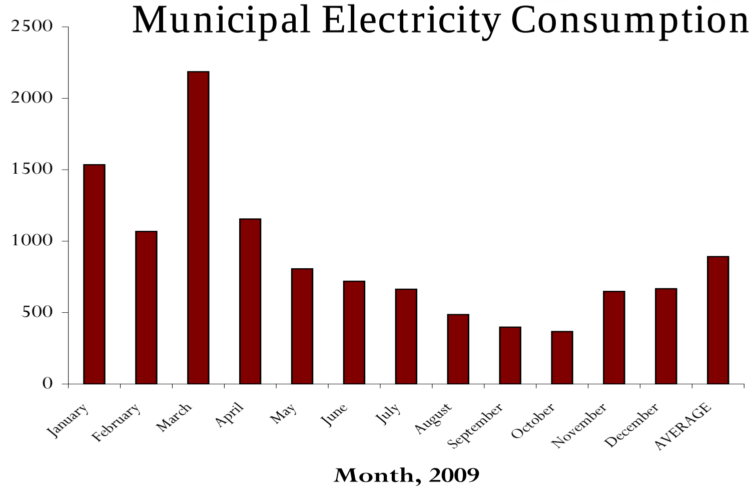
The Town of Goshen

Town Clerk: Rosemary McKinnon
(802) 247-6455

Energy Coordinator: Bruce Webster
(802) 353-6470

Municipal Lands Map

Municipal Electricity Consumption



Total: 10,698 kWh   Peak Month: March

The town of Goshen is located at the southeast corner of Addison County with a population just over 200. The municipality owns 4 small parcels of land, most of which is viable for solar development based on slope and land use criteria.

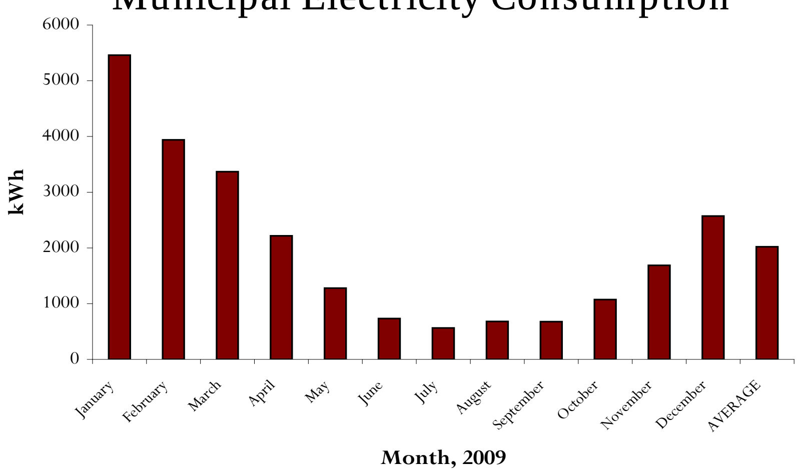
The Town of Leicester

Town Clerk: Julie Delphia
(802) 247 - 5961

Energy Coordinator:
Raymond Lalumiere, *lalumiere.ray@gmail.com*

Municipal Lands Map

Municipal Electricity Consumption



Total: 24,251 kWh Peak Month: January

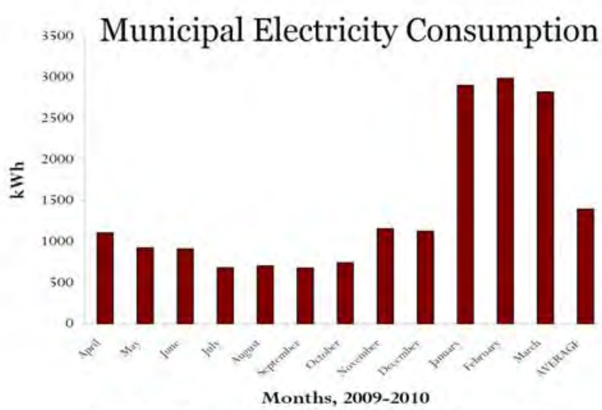
Leicester is a small town with a population of about 1,000. The energy coordinator is unsure of how much interest people have in solar electricity generation, but he is quite responsive and has suggested conducting a survey. There are few municipal lands, and the energy coordinator suggested that roof installations might be more appropriate than ground-mounted arrays. He is concerned with solar's low cost effectiveness.

The Town of Lincoln

Town Clerk: Sally Ober
(802) 453 - 2980

Energy Coordinators:
Henry Wilmar *hwilmer@andover.edu*
Stephen Taylor *vhw@gmavt.net*

Municipal Lands Map



Total: 16,784 Peak Month: February

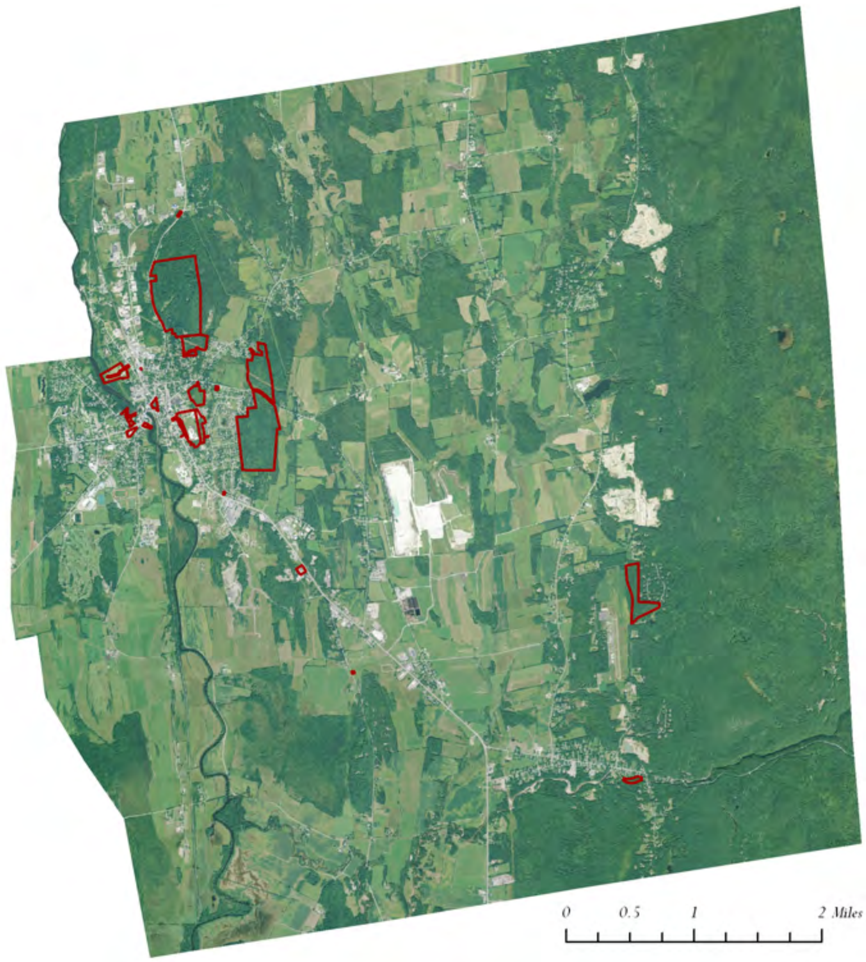
Lincoln is a mountain town with a population of approximately 1,200. Both of its energy coordinators are enthusiastic about solar development prospects, as well as prospects for the development of other alternative energies. They are well-organized, knowledgeable, and mobilize quickly and efficiently. They are in close contact with other leaders in the town, such as the school principal.

The Town of Middlebury

Town Clerk: Ann Webster
(802) 388-8100 x211
awebster@townofmiddlebury.org

Energy Coordinator: Laura Asermily
(802) 388-9478
lasermily@yahoo.com

Municipal Lands Map



Municipal Electricity Consumption

Consumption Information Not Compiled

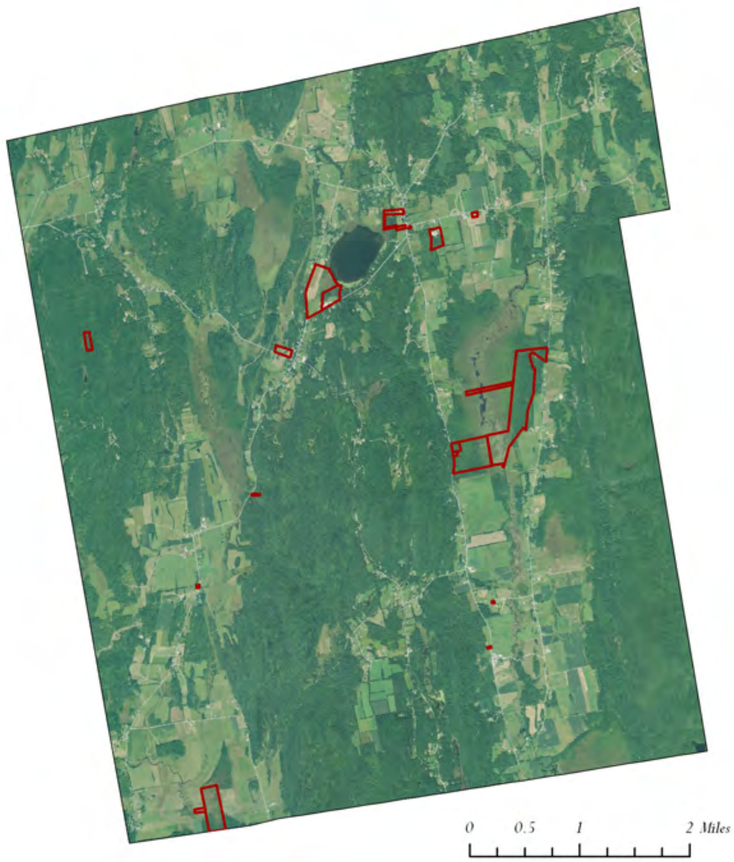
Located along Otter Creek in the valley of Addison County, the town is home to about 6,200 residents. Middlebury has extensive municipal lands viable for solar development, including the wastewater plant, police department, and four water well sites. The town has recently submitted a grant proposal to the state for a solar PV project feasibility study.

The Town of Monkton

Town Clerk: Carmelita Burritt
(802) 453-3800
monktontc@comcast.net

Energy Coordinator: Carlie Huizenga
huijack@gmwireless.net

Municipal Lands Map



Municipal Electricity Consumption

Consumption Information Not Compiled

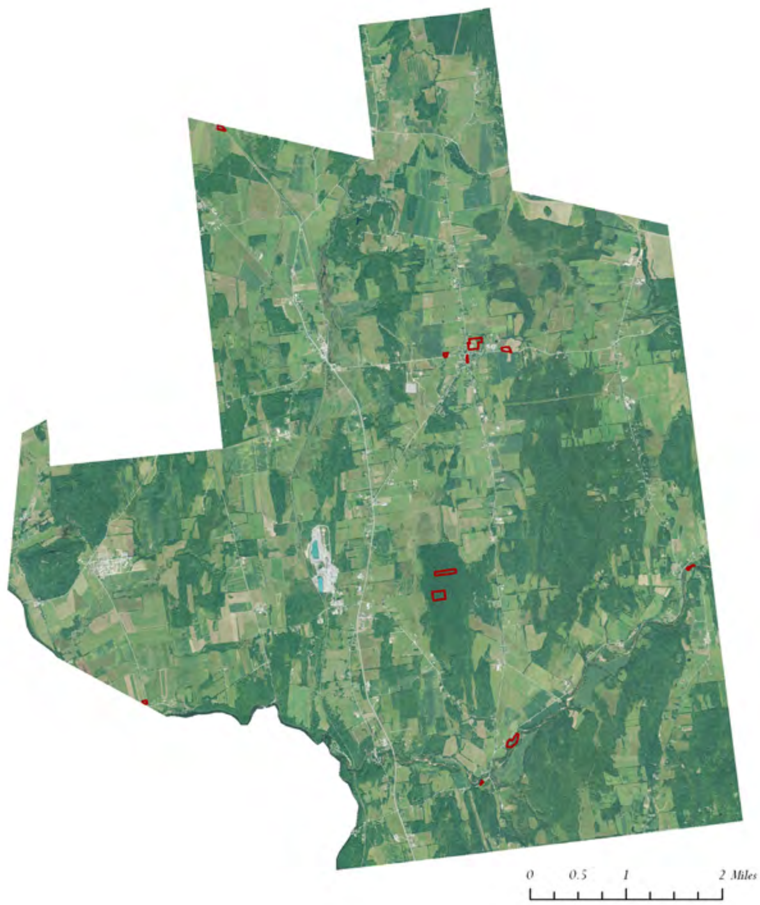
Monkton a town with a population of 1759. They have several municipal lands, yet seemed most interested in roof-top installments. The energy coordinator, Mr. Huizenga, sent us a rendered building design for a new town hall that includes roof mounted PV arrays. They are planning on applying for a grant if they can get a majority vote. Conversations were brief, and he did not mention other projects or interest.

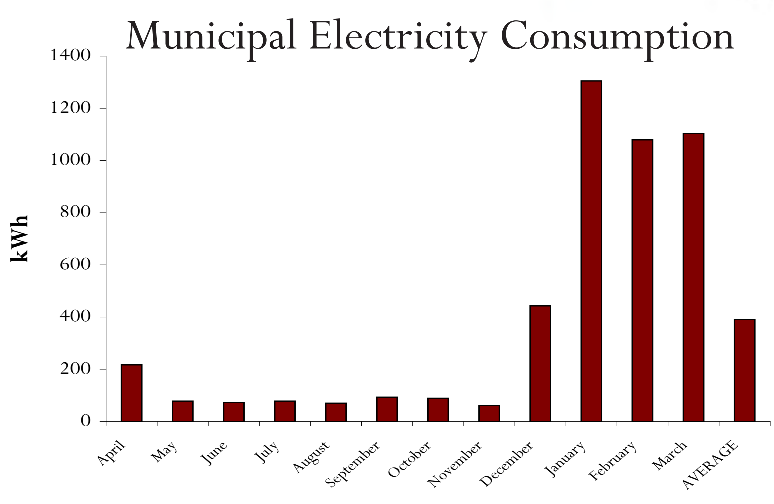
The Town of New Haven

Town Clerk: Pam Kingman
(802) 453-3516 or *pkingman@gmavt.net*

Energy Coordinator: Harvey Smith
smith45@together.net

Municipal Lands Map





Total: 4,689 kWh   Peak Month: January

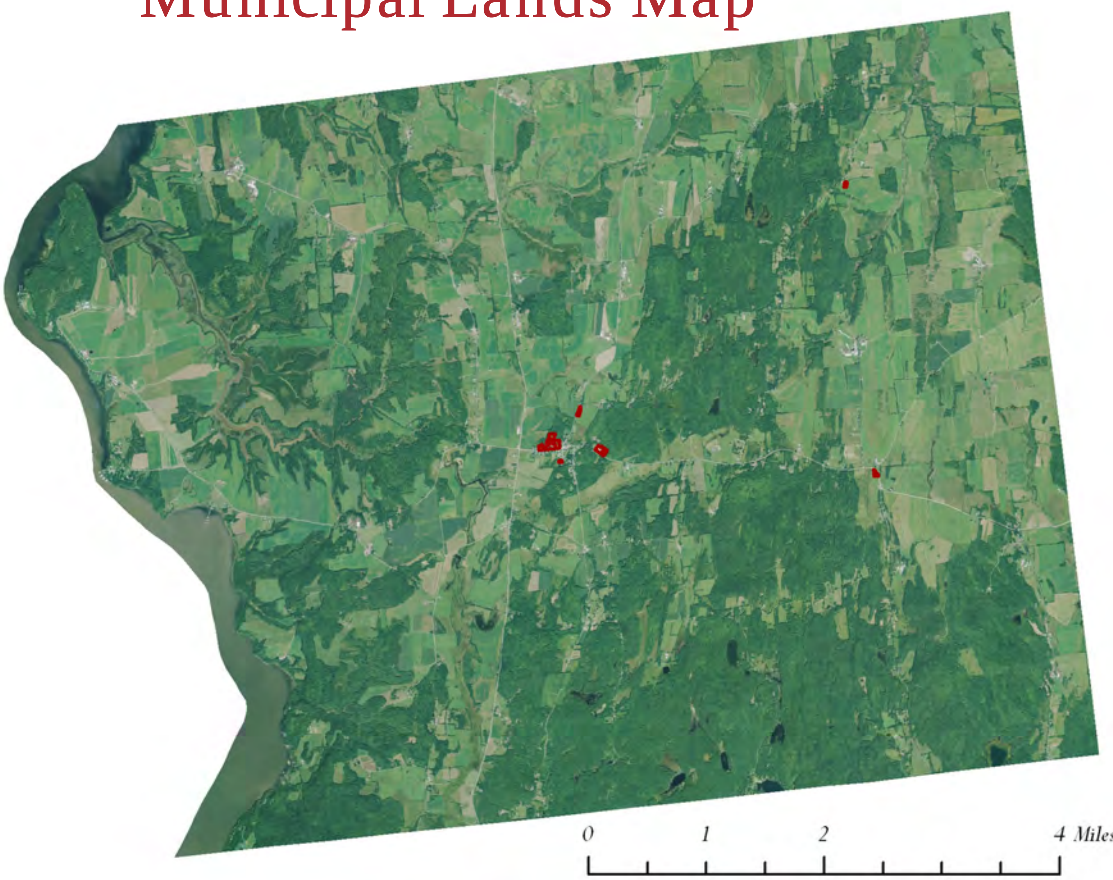
New Haven is a town with a population of 1666. There are currently 12 municipal parcels, yet many are unsuitable for development because they are either forested or because of their use (like the cemetery). They would, however, need very little infrastructure to offset their municipal building's electrical consumption. The energy coordinator said that they were interested in solar but had no current plans.

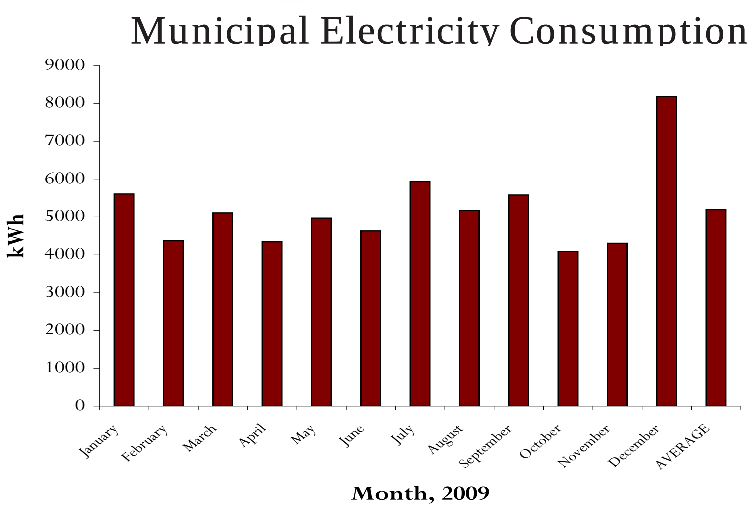
The Town of Orwell

Town Clerk: Susan Ann Arnebold
(802) 948-2032
tckorwel@sover.net

Energy Coordinator:
Susan Ann Arnebold
(802) 948-2032

Municipal Lands Map





Total: 62,296 Peak Month: December

Orwell, a town with 1185 residents, is located along the shore of Lake Champlain. They currently have eight municipal lands, all under 5 acres in size. Most of that land is developed or in use, and includes sites like the school and the town garage. Due to their lack of available and open municipal land, any type of renewable development would be difficult to rationalize.

The Town of Panton

Town Clerk: Susan Torrey
(802) 475-2333
panton@gmavt.net

Energy Coordinator: David Raphael
(802) 388-3011
davidr@landworksvt.com

Municipal Lands Map

Municipal Electricity Consumption

Consumption
Information Not Compiled

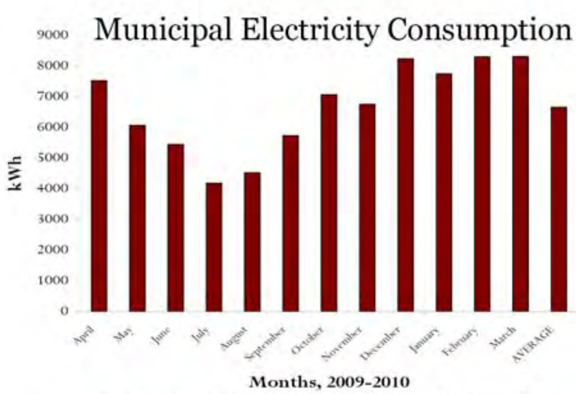
Panton is small town with a population of 682. There are six municipal lands in the town. Although the town does not have extensive municipal lands, the energy coordinator, Mr. Raphael, thought some of the towns people might be interested in leasing their land for solar. He also suggested looking at the roof of the waste treatment facility.

The Town of Ripton

Town Clerk: Sally Hoyler
(802) 388-2266
townoffice@riptonvt.org

Energy Coordinator: Warren King
kinglet@togeter.net

Municipal Lands Map



Total: 79,995 kWh   Peak Month: March

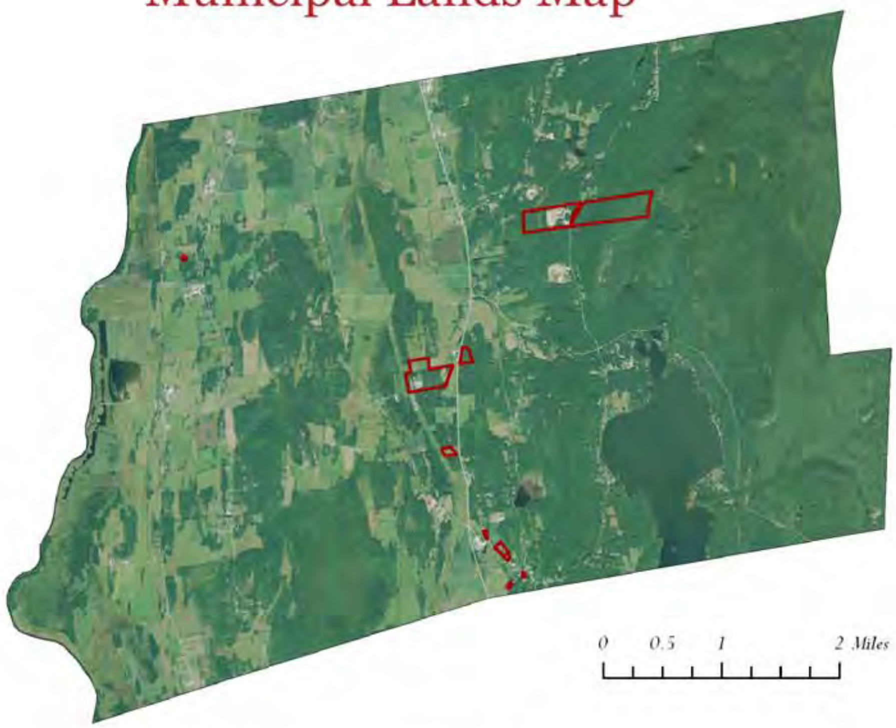
Ripton is a small mountainous town with a population of approximately 550. The energy coordinator suggests that there is considerable interest in solar among Ripton residents, but that the town has no unused fields that would be appropriate for solar development. The school, however, has a huge south-facing roof that is currently "going to waste." The school is currently suffering economically due to decreasing enrollment issues.

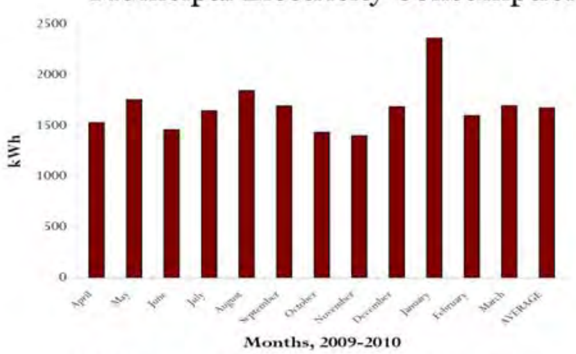
The Town of Salisbury

Town Clerk: Ann Dittami
(802) 352-4288 or
town.clerk@comcast.net

Energy Coordinator: Ann Dittami
(802) 352-4288 or
town.clerk@comcast.net

Municipal Lands Map





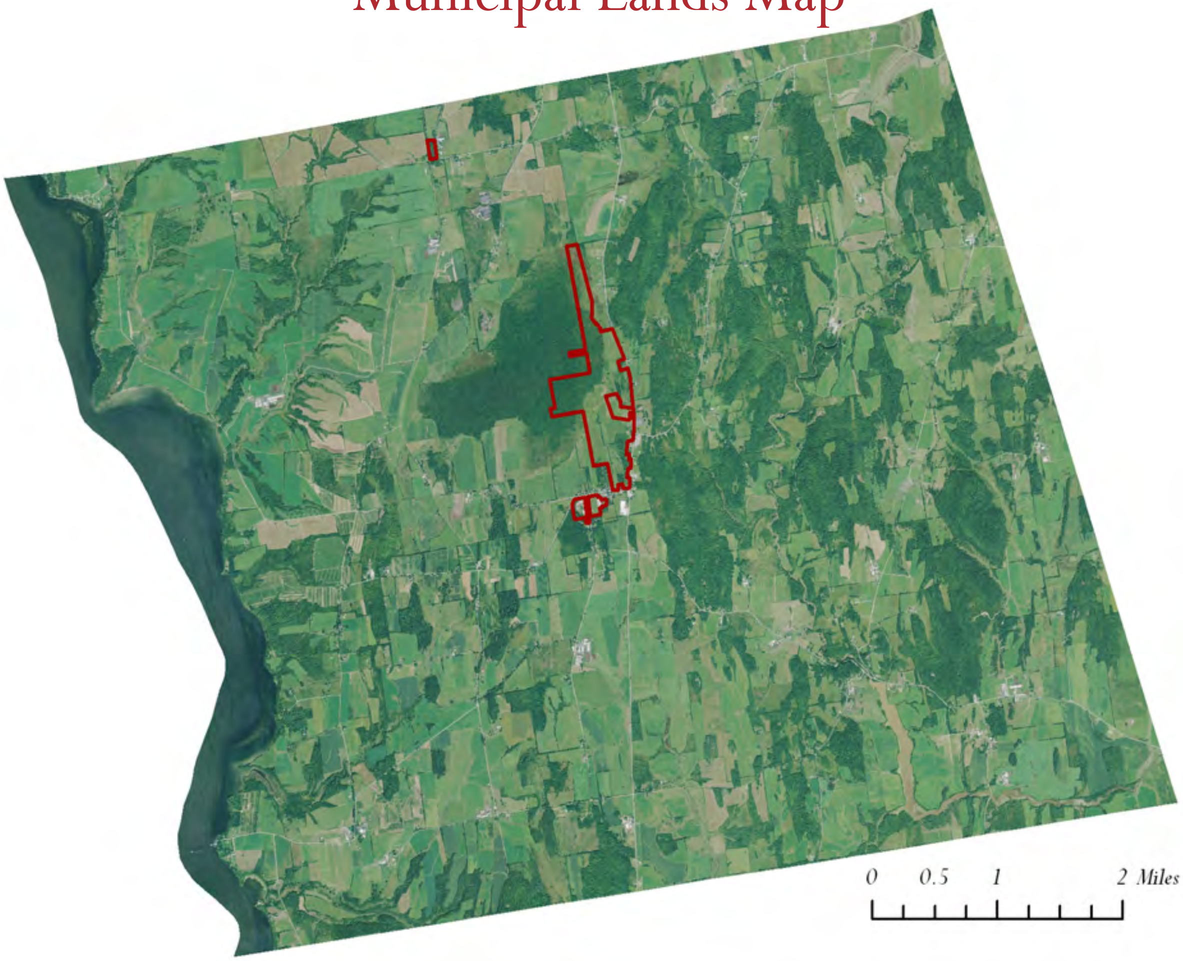
Total: 20,135 kWh   Peak Month: August

Salisbury is located in the southern portion of Addison County with a population of just over 1,000. The town owns ten parcels of land throughout its boundary, some of which is viable for solar PV development. Particular attention should be paid to the landfill as a potential development site.

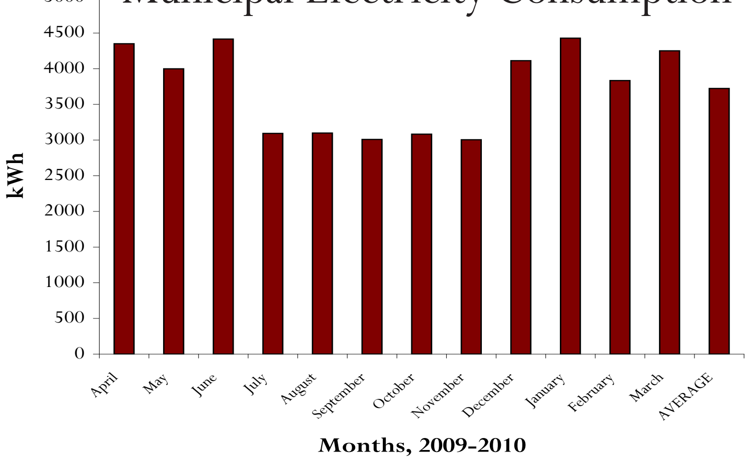
The Town of Shoreham

Town Clerk: Amy Douglas (802) 897 - 5841	Energy Coordinators: George Gross *gmgross@greenbuildscience.com*

Municipal Lands Map



Municipal Electricity Consumption



Total: 44,675 kWh   Peak Month: April

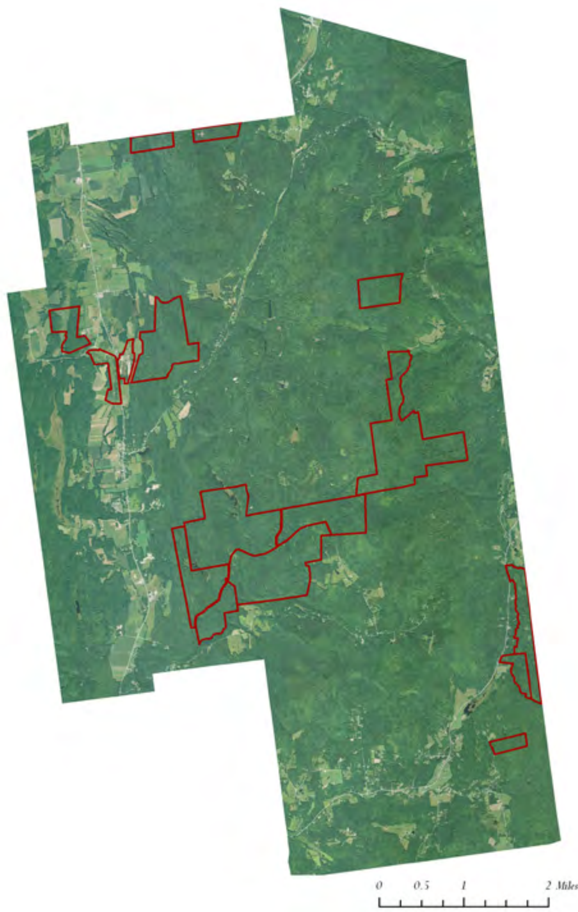
Shoreham is a town of about 1,200 located on the shore of Lake Champlain. The energy coordinator is knowledgeable about alternative energies (he lives in a net-zero house), responsive, and enthusiastic about solar development. Shoreham has a newly-chartered Energy Committee that has recently conducted a study to gauge public opinion re. municipal renewable energy. Preliminary results show high support for research.

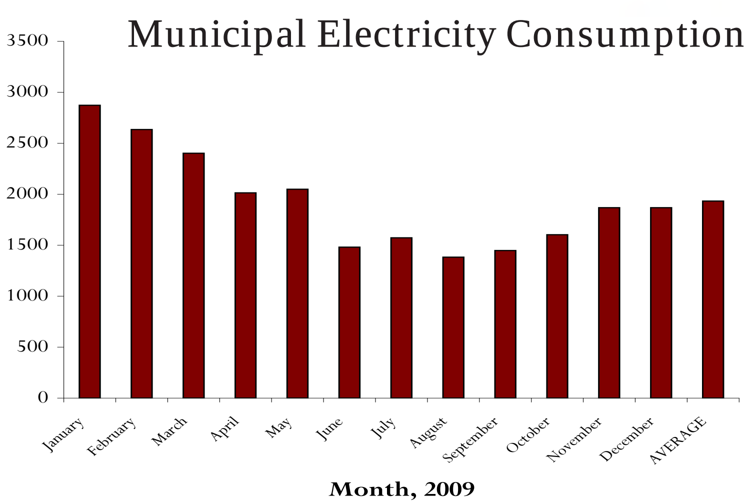
The Town of Starksboro

Town Clerk: Karen Brisson
(802) 545-2450

Energy Coordinator: Dean Ouellette
(802) 545-2252 or *douellet@middlebury.edu*

Municipal Lands Map





Total: 23,197 kWh Peak Month: January

Starksboro is a town at the base of the Green Mountains with a population of about 1,900 people. The energy coordinator of Starksboro was unresponsive even though as of recent the town is looking seriously at installing a 150 kW array. The town owns a good deal of land and is hoping to take advantage of the state and federal tax credits that will expire shortly.

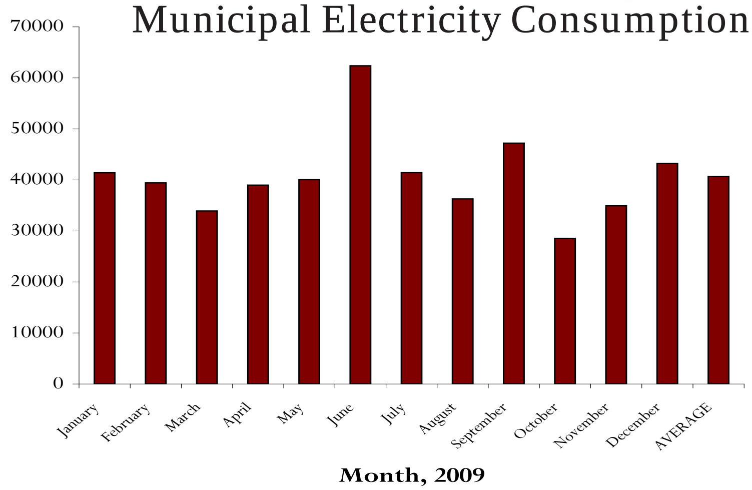
The Town of Vergennes

Town Clerk: Renny Perry
(802) 877-3637

Energy Coordinator: Diane Lanpher
(802) 877-2230 or (802) 651-1569

Municipal Lands Map

Municipal Electricity Consumption



Total: 487,821 kWh Peak Month: June

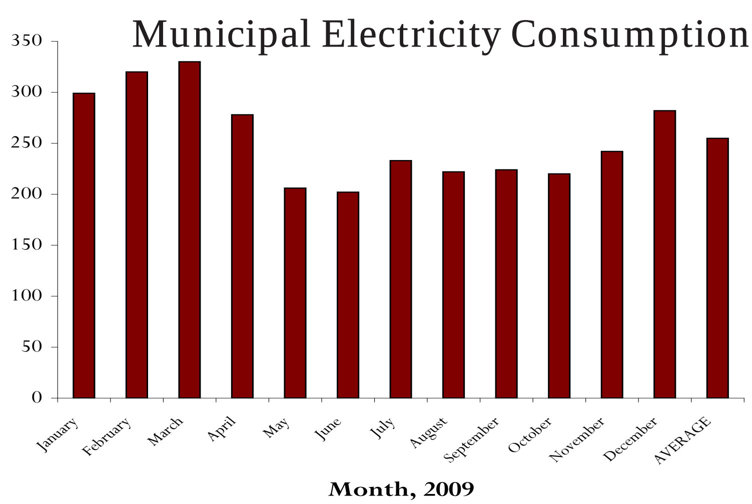
Vergennes is the smallest of Vermont's nine cities with only 2,741 inhabitants. The village is nestled in the Champlain Valley on the shores of Otter Creek. We did not hear back from the energy coordinator of the town, however Vergennes's high municipal energy usage would make it a suitable candidate for a solar development on public lands.

The Town of Waltham

Town Clerk: Mary Kensen
(802) 877-3641

Energy Coordinator: Mary Kensen
(802) 877-3641

Municipal Lands Map



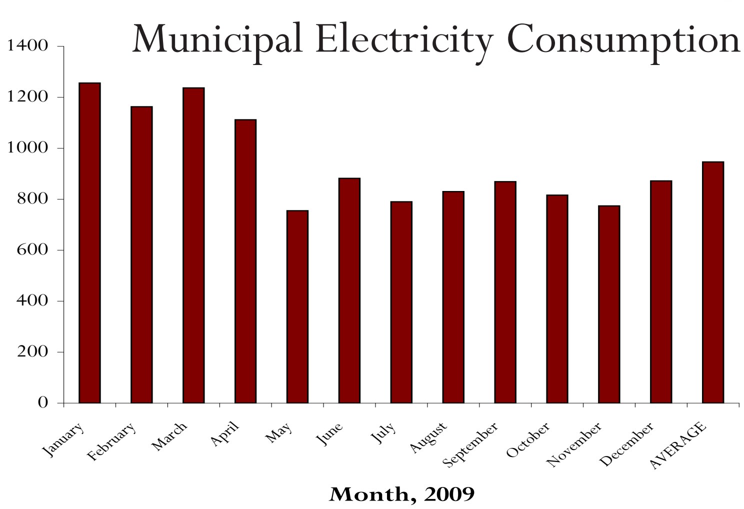
Total: 3,058 kWh Peak Month: March

The town of Waltham is located directly south of Vergennes and has a population of just under 500 people. The total area of the town takes up only 8.9 square miles and there is only one municipal lot, the town clerk's office. Mary Kinson, the energy coordinator did not foresee any solar developments for the municipal building pointing out that the site uses so little energy.

The Town of Weybridge

Town Clerk: Karen Brisson (802) 545-2450	Energy Coordinator: Dean Ouelette (802) 545-2252 or *douellet@middlebury.edu*

Municipal Lands Map



Total: 11,356 kWh   Peak Month: January

The town of Weybridge is located at the heart of Addison County. Its population of approximately 824 people is interested in the possibility of solar electricity generation, but when presented with an opportunity to put solar panels on the school, the funds could not be found. Dean Ouellette is the energy coordinator for the town and runs his own solar development business.

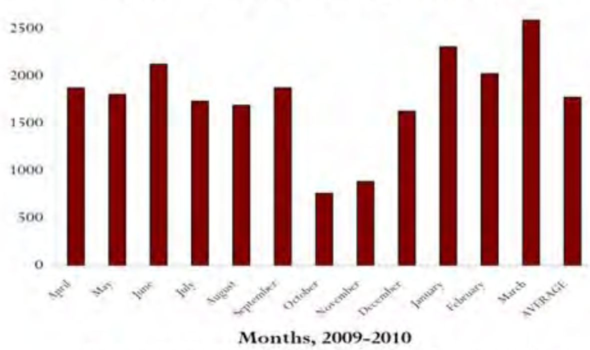
The Town of Whiting

Town Clerk: Grace Simonds
(802) 632-7813

Energy Coordinator: Larry Wilbur
(802) 623-7862

Municipal Lands Map

Municipal Electricity Consumption



Total: 21,300 kWh   Peak Month: December

Whiting is a tiny town in the southern part of Addison County along Route 7. The energy coordinator for the municipality was unresponsive. The town owns several parcels, yet the larger ones are occupied by town forests. There are few municipal buildings, keeping consumption rates low so it is unlikely that a solar development would be an efficient use of funds to offset municipal electrical use.

Appendix B: Detailed Information on the Towns of Addison County

	Population (2008)	Energy Provider for Town	Electricity Provider for Town Center	Municipal Electricity Consumption (Year) KWH	Municipal Electricity Consumption Peak KWH	Municipal Electricity Consumption (Avg/Mo) kWH	General Interest in Solar
Addison	1,393	GMP &CVPS	CVPS & GMP @ Town Garage	No information available			Cannot get a hold of Energy Coordinator
Bridport	1,235	CVPS	CVPS	14,728	1,821 (Jan)	1,227.30	High interest from Energy Coordinator, and none from Town Clerk
Bristol	3,788	CVPS	CVPS	217,143	20107 (Mar)	18,095.25	Weak interest due to lack of land; municipal lands currently in use; hydroplant usage
Cornwall	1,136	CVPS	CVPS	25,943	2,390 (11/16/09-12/17/09)	1,996	Lack of land and divided interest in solar, but looking small scale other renewable energies
Ferrisburgh	2,657	GMP &CVPS	GMP	167,485	18795 (Sept)	13,957	Very interested in solar development; large scale project currently being constructed
Goshen	227	CVPS	CVPS	24,251	5,460 (Jan)	2,020.90	Cannot get a hold of Energy Coordinator
Leicester	974	CVPS	CVPS	1,245	442 (Jan)	103.75	Unsure
Lincoln	1,214	CVPS	CVPS	16,784	2990 (Feb)	1398.67	Very interested
Middlebury	6,252	CVPS	CVPS	No information available			Very interested; grant proposal submitted
Monkton	1,759	GMP &CVPS	CVPS & GMP	No information available			Not much public interest
New Haven	1,666	GMP &CVPS	CVPS	4689	1305 (Jan)	391	Interest but no current plans; funding could get the ball rolling
Orwell	1,185	CVPS	CVPS	62296	8183 (Dec)	5191	No energy coordinator, interest unclear
Panton	682	GMP &CVPS	GMP	No information available			Not much public land, perhaps opening up to private owners? Attitudes being determined about potential
Ripton	556	CVPS	CVPS	79,995	8322 (Mar)	6,666.25	Some interest
Salisbury	1,090	CVPS	CVPS	20,135	1848 (Aug)	1,677.90	Interested
Shoreham	1,222	CVPS	CVPS	44,675	4,350 (apr)	3,722.90	Very interested
Starksboro	1,898	GMP, CVPS, & Vermont Electric	GMP	23,197	2873 (Jan)	1,993	No response
Vergennes	2,741	GMP	GMP	487821	62381 (Jan)	40651	No response

Waltham	479	GMP	GMP	3058	330 (Mar)	254	So little electricity use in the town makes solar not appropriate
Weybridge	824	CVPS	CVPS	11,356	1,256 (Jan)	946.33	Conservation fund available, but disagreements over how to use the money; interest if the technology was free, but otherwise probably not - divided town support
Whiting	380	CVPS	CVPS	21,330	2,592 (Jan)	1,777.50	No response

Appendix C: Municipal Lands in Addison County