Solar Resource and Infrastructure Assessment

for

the Town of Leverett

Photo Credit: *Town of Leverett*

May 9, 2023

Prepared by

UMass Clean Energy Extension

209 Agricultural Engineering
250 Natural Resources Way
Amherst, MA 01003-9295
413.545.8510

energyextension@umass.edu
https://ag.umass.edu/clean-energy

Completed using the *Community Planning for Solar* Toolkit available at
https://ag.umass.edu/solarplanning

UMassAmherst | Clean Energy Extension

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Executive Summary

This report is a Solar Resource and Infrastructure Assessment for the town of Leverett, Massachusetts. The assessment was conducted through a joint collaboration among the town, UMass undergraduate students, UMass Clean Energy Extension (CEE), and the UMass iCons program, using CEE's *Community Planning for Solar* toolkit (ag.umass.edu/solarplanning). As Step 2 in the planning process, this assessment details existing infrastructure, resources, and potential solar development opportunities in Leverett. This assessment is designed to describe relevant bylaws and infrastructure within the town, identify the types of solar facilities that could be developed, and quantify the total space available for each type of facility.

In this report, we review existing electricity grid infrastructure and the potential to interconnect additional solar facilities. Currently, the three-phase distribution lines which run through Leverett are largely saturated and could only accommodate additional small-to-medium scale projects (up to 200 kW); most single-phase lines could likely accommodate additional projects under 50 kW in size. Grid upgrades would likely be necessary before larger solar arrays could be connected to the grid. A potential alternative solution to grid updates would be the development of a local microgrid, which is a local electricity network with local source of supply and/or storage. Microgrids are typically interconnected to the larger electric grid but are also able to function independently. Development of a Leverett microgrid would likely involve the creation of a community Municipal Lighting Plant (MLP) and the installation of single- and three-phase power lines into Leverett neighborhoods. A possible pilot location for this concept would be on contiguous town-owned parcels of land in the Leverett Municipal Campus located on Montague Road, and which encompasses the Leverett Public Library, Leverett Elementary School, and the Leverett Public Safety Complex.

Leverett currently has 135 solar arrays totaling roughly 1.6 MW of solar capacity, located largely on residential rooftops. There is significant potential for additional solar arrays on residential rooftops and properties, non-profit organization rooftops and parking lots, municipal rooftops and parking lots, and barn roofs. Ground-mounted solar development could be a possibility on the closed municipal landfill, transmission line ROWs, and, depending on whether they are active, on sand and gravel operations located within Leverett or just over the town line in Sunderland. In addition, within Leverett, 33 parcels have at least 5 acres located near three-phase power that are not permanently protected, not wetlands, and not located on properties that are more than 50% BioMap2 habitat; potential land for solar development on these properties totals roughly 640 acres – but this does not take into consideration other competing land uses (such as residential buildings on the property).

It should be noted that – except for a small grid-tied solar installation at Leverett's Public Safety Complex – the Leverett Municipal Campus currently has no ability to share power between buildings or store power. This existing municipal solar installation offers no resiliency in emergencies since it lacks the ability to store power and is non-operational when the larger grid is non-operational.

In addition, Leverett's residential solar arrays are all privately owned and the majority are grid-tied and lack battery backup capabilities, which means that they offer no resiliency capabilities to the homeowners in the event of a sustained power outage. Residential backup power systems are typically powered by fossil fuels.

Leverett's solar resources are detailed in Section 5 of this report and summarized in subsection 5.8.

Terminology

The following terms, abbreviations, and acronyms are used in this report.

Terms

Photovoltaic, or "PV," systems are solar arrays composed of panels that generate electricity from sunlight. These panels are a different type of technology than the types of panels used in "solar hot water" or "solar thermal" systems.

Voltage of an electric power line can be thought of as the equivalent of pressure in a water line. The voltage of transmission and distribution power lines is typically measured in kilo-volts (kV). One kilo-volt is equivalent to 1000 volts (V). In residential use in the United States, electrical wires within a household carry electricity at 120 V.

Capacity of a solar array is a description of the instantaneous power output of the panels at top production (i.e, in full sun). It is typically measured in kilowatts (kW) or megawatts (MW). A residential-size solar system is typically 5-10 kW in capacity. Commercial-scale solar arrays are typically 1 MW or greater in size. An average 1 MW array would cover approximately 4-5 acres of land.

Annual generation of a solar array is a measure of the yearly energy output produced by the panels. It is typically measured in kilowatt-hours (kWh) or megawatt-hours (MWh). In New England, annual generation is approximately equal to the array's capacity (in DC) *14% * 8760 hours per year.

DC is the abbreviation for direct current, the type of electricity produced by solar panels. The DC capacity of a solar array is a good indication of its size, and footprint on the landscape.

AC is the abbreviation for alternating current, the type of electricity flowing into the grid from a solar array, after it has gone through a transformer. In the absence of energy storage, a typical DC to AC ratio for solar array capacity is about 1.25:1. However, with energy storage, that ratio can be significantly higher (close to 2:1), since excess electricity can be stored in batteries during the day, and released into the grid during the night, when the panels are not generating electricity.

Solar facility size terms used in this report are in line with current state solar incentive program categories (not with municipal bylaws). That is:

- **Small** systems are 25 kW or less.
- **Medium** systems are 25-500 kW.
- **Large** systems are over 500 kW (0.5 MW) in size.

SMART is the abbreviation for the current state solar energy incentive program (the Solar Massachusetts Renewable Target program). This program replaced earlier solar incentive programs, commonly known as "SREC" programs, in November of 2018, and was further updated through an emergency regulation in April 2020. The SMART regulation includes incentives for projects up to 5 MW AC in size. Additional incentives are available for projects located on buildings, parking lot canopies, landfills, brownfields, and "dual-use" solar and agriculture projects, as well as certain types of projects that benefit public entities, like municipalities. The updated regulation places restrictions on what types of large, ground-mounted projects can receive incentives, if they are sited on undeveloped land designated as BioMap2 Critical Natural Landscapes or Core Habitat, by the state MassWildlife Natural Heritage and Endangered Species Program.

Microgrids are local electricity networks with a local source of supply (e.g., solar PV) and/or storage, and are typically attached to the larger electric grid but are also able to function independently.

Abbreviations & Acronyms

CEE - UMass Clean Energy Extension
DOER - Massachusetts Department of Energy Resources
FRCOG - Franklin County Regional Council of Governments, the regional planning authority for Franklin County, MA
kV - kilo-volt
kW - kilowatt
kWh - kilowatt-hour
MDAR - Massachusetts Department of Agricultural Resources
MLP - Municipal Lighting Plant
MVP - Municipal Vulnerability Preparedness plan, a municipal planning document
MW - megawatt
MWh - megawatt-hour
OSRP - Open Space and Recreation Plan, a municipal planning document
PV – photovoltaic, the type of solar panels that generate electricity from sunlight
PVPC - Pioneer Valley Planning Commission, the regional planning authority for Hampden and Hampshire Counties, MA
sf - square feet

1. INTRODUCTION

This report is a Solar Resource and Infrastructure Assessment for the town of Leverett, MA. Situated in Franklin County in western Massachusetts, Leverett is a rural town of 23 square miles in area[1]. It is rich in natural beauty, with many forests, brooks, and scenic views. Leverett is adjacent to the Five College area, which includes Amherst, Hampshire, Smith, and Mt. Holyoke Colleges and the University of Massachusetts. Its population of roughly 1,850[2] residents (710 households[3]) includes teachers, students, farmers, lumbermen, gardeners, artists, and professionals in the areas of medicine, law, and telecommunications.[4] Leverett has been a designated Green Community since 2011.[5]

The assessment was conducted through a joint collaboration among the town, UMass undergraduate students, UMass Clean Energy Extension (CEE), and the UMass iCons program, using CEE's *Community Planning for Solar* toolkit (ag.umass.edu/solarplanning).

As the second step in the *Community Planning for Solar* process, UMass team members prepared this assessment of existing infrastructure, resources, and potential solar development opportunities. This assessment is designed to describe relevant bylaws and infrastructure within the town, identify the types of solar facilities that could be developed, and quantify the total space available for each type of facility.

In this report, we review and describe:

- Existing electricity grid infrastructure, and the potential to interconnect additional solar facilities
- Current municipal solar zoning bylaws
- Town conservation priorities and conservation land
- Existing renewable energy facilities
- Priority energy storage sites
- Businesses and institutions with potentially moderate to heavy electricity use
- Areas available for development on:
    - Residential rooftops and properties
    - Medium to large-scale rooftops
    - Parking lots
    - Landfills, brownfields, and other previously disturbed sites
    - Farms
    - Undeveloped land where large-scale commercial development could be viable

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[1] Town of Leverett, MA. 2023. https://www.leverett.ma.us/p/7/About-Us
[2] U.S. Census, 2020. From MA state legislature site: https://malegislature.gov/Redistricting/MassachusettsCensusData/CityTown
[3] U.S. Census. American Communities Survey 2021: 5-year estimates. https://data.census.gov/table?q=leverett+ma&tid=ACSST5Y2021.S1101
[4] Town of Leverett, MA. 2023. https://www.leverett.ma.us/
[5] MA DOER. 2022. https://www.mass.gov/doc/map-of-280-gcs-and-grant-summaries/download

2. GRID INFRASTRUCTURE ASSESSMENT

2.1 Introduction

In this section, we provide a description of the existing electricity grid infrastructure serving the town, and the potential for new solar arrays to connect to existing circuits. Through this description, we hope to provide a general understanding of how the electricity grid functions, as well as to provide a snapshot of current conditions. Existing grid infrastructure plays a major role in where large solar arrays are built. The cost of connecting large solar facilities to the grid varies widely in different locations, and hence is a primary decision-making factor in where solar developers propose to site projects.

While existing grid infrastructure may currently financially constrain the types of solar projects that can be developed in some locations, the electricity grid is in a constant state of change, and grid components are constantly being upgraded. This description of the current state of the grid may be most relevant to situations in which the town or community members have an interest in the development of a particular site for medium- to large-scale solar in the near future. The current state of grid infrastructure within the town may be less relevant to long-term planning. In fact, we suggest that significant town-level planning around solar energy could potentially drive the location of electric grid upgrades to allow development in places where community members would prefer to see solar facilities sited.

2.2 Grid Infrastructure Basics

The New England electricity grid is overseen by ISO New England, the regional transmission organization that serves the states of Massachusetts, Maine, New Hampshire, Vermont, Connecticut, and Rhode Island. This non-profit organization is charged with ensuring grid reliability – that is, to continuously balance electricity supply and demand, in Massachusetts and throughout the region. The electricity grid consists of transmission lines, high-voltage lines which carry electricity over long distances, and distribution lines, lower voltage lines which distribute power to individual communities and households. Most transmission lines in Massachusetts are owned by the two major electricity utilities which operate in the state - Eversource (formerly NSTAR and WMECO) and National Grid. Distribution lines are typically owned by the local electricity provider, which could be Eversource, National Grid, Unitil, or a municipal utility. Transmission lines range in voltage from 69-345 kV. When these lines reach a substation, electricity is "stepped down" to a lower voltage and distributed along 13-34 kV distribution lines.

The "interstate highways" of the electrical grid are 345 kV transmission lines. In western Massachusetts, one 345 kV line runs north-south, east of, but approximately paralleling, the Connecticut River (see dark blue lines **Figure 1**, next page). This line connects the pumped storage facility in Northfield with the Stonybrook Power Plant, an oil and natural gas facility, in Ludlow. A second 345 kV line runs west from the Northfield pumped storage facility, through Ashfield, Plainfield, and Pittsfield, and ultimately across the state line into New York.

For a more complete introduction to the electricity grid, please see CEE's Fact Sheet: The Electric Grid, Distributed Generation, and Grid Interconnection.

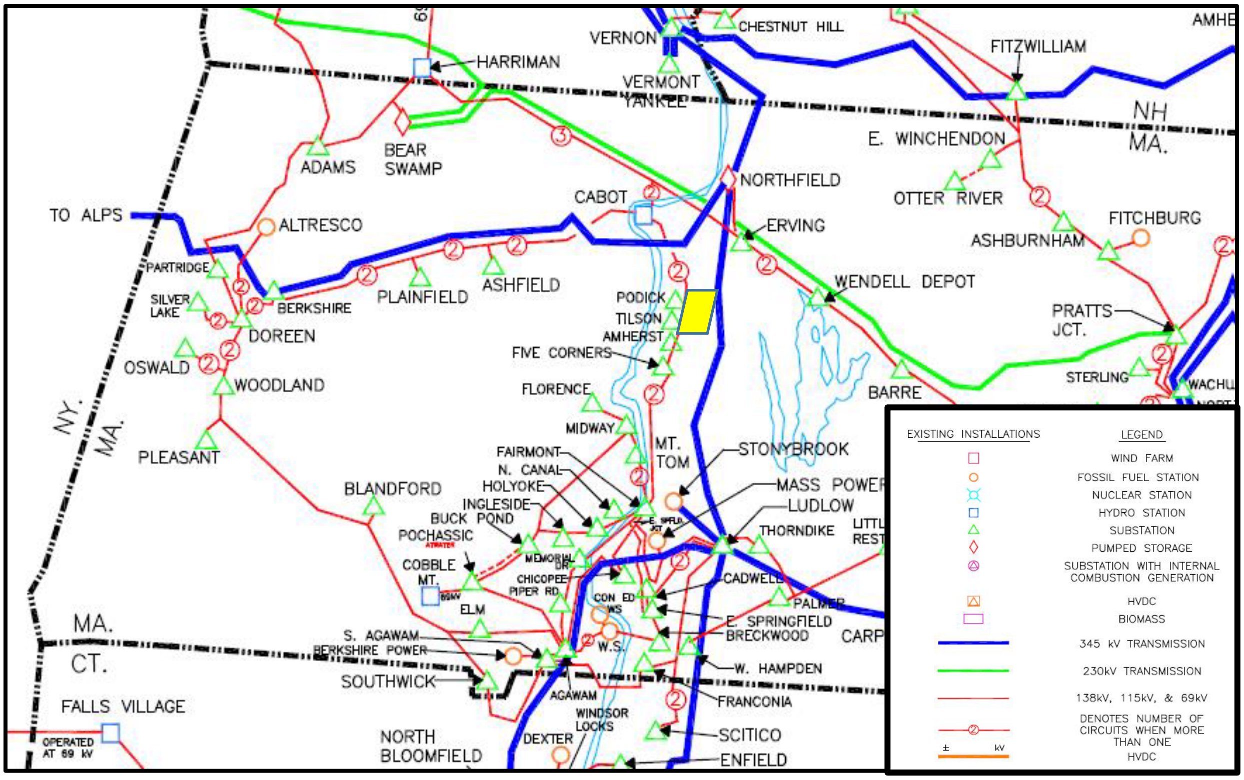


Figure 1 Major electricity transmission lines and substations in western Massachusetts. The location of Leverett is shown in yellow. Source: ISO New England. 2019. https://www.iso-ne.com/about/key-stats/maps-and-diagrams/

2.3 Existing Grid Infrastructure

Leverett is traversed by three electricity transmission lines – two lines with voltages between 115-138 kV which run roughly north-south through the western portion of town, and one 345 kV line which runs roughly north-south through the eastern portion of town. These transmission lines do not provide electricity directly to Leverett, but power from one of the 115-138 kV transmission lines is "stepped down" at the Podick 18G substation. This substation is located across from the Podick Conservation Area in North Amherst. From the Podick substation, electricity is transmitted along three-phase distribution lines into Leverett. Within Leverett, there is one three-phase distribution line, 18G7, running south to north the full length of the town along Route 63 (Long Plain Rd). This line also branches at Depot Road to continue roughly 1.6 miles towards the center of town, terminating at the intersection of Shutesbury and Montague Roads. A separate small three-phase section of 18G7 enters the town from the southern border and runs roughly 0.30 miles north along Amherst Road.

In addition to 18G7, there is a second three-phase circuit, 21C7, which enters the town from its northern border and runs roughly 0.6 miles along North Leverett Road to its intersection with Cave Hill Road. Circuit 21C7 is connected to the 21C Montague substation in Turners Falls.

Both three-phase lines (18G7 and 21C7) have an operating voltage of 13.8 kV.

The remainder of Leverett is served by single-phase distribution lines connected to these three-phase lines.

One challenge to Leverett's resilience goals noted by the Solar Planning Committee is that town is currently divided between the 18G7 and the 21C7 three phase transmission lines as described above, and there is currently no option for switching (or ability to isolate) in the event that one or the other feeder fails. This prevents electric redundancy in the event of a grid failure. A possible solution to this challenge involves the development of a MLP-owned town grid that could tie to both 18G7 and 21C7 and, with some transformer capacity and switching capability, provide power to Leverett's commercial and residential sector. Another solution would entail the development of a series of microgrids tied together to accomplish the mission of a town-wide distribution grid with storage and generation capacity.

See **Figures 2 and 3** on the next two pages for maps of the 18G7 and 21C7 three-phase distribution lines in Leverett.

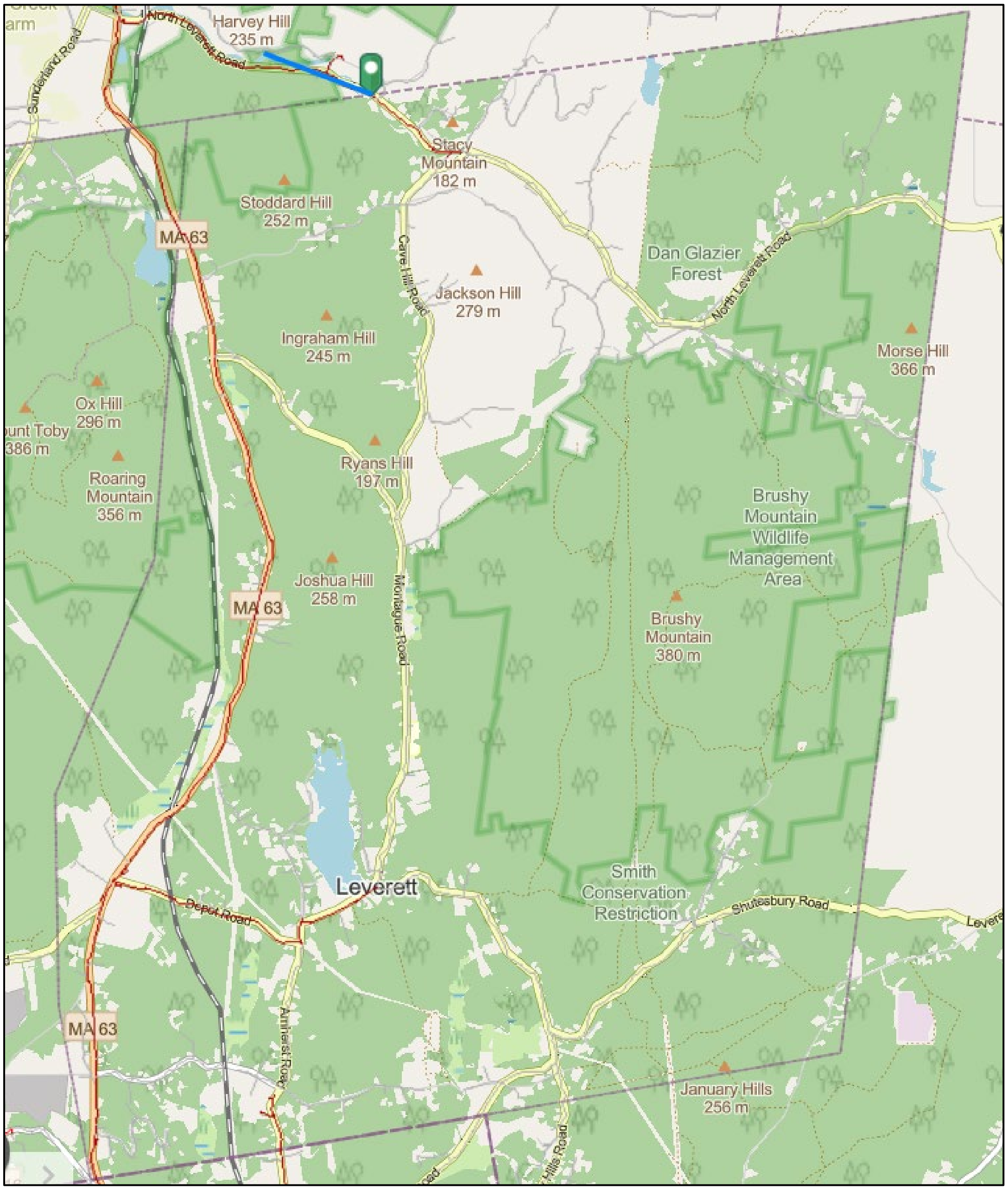


Figure 2 The major three-phase distribution lines (red lines) serving Leverett. Single-phase lines are shown lightly in gray. Source: Eversource DG Hosting Capacity Map. 2023, https://eversource.maps.arcgis.com

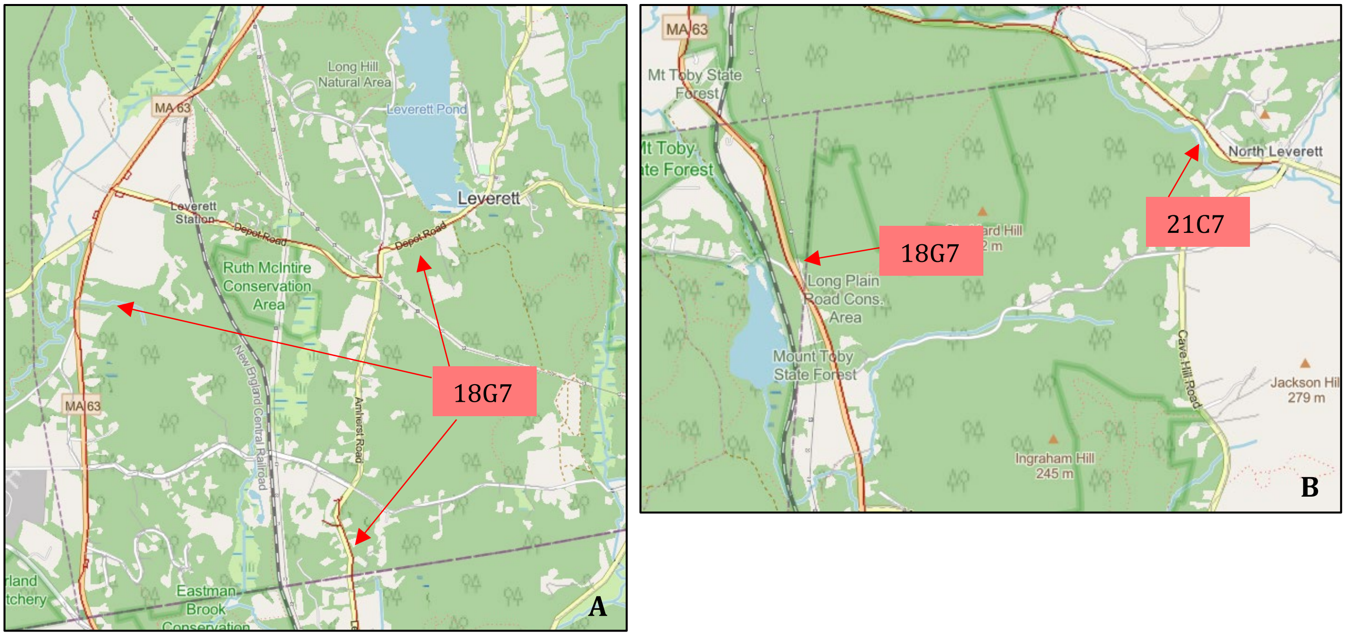


Figure 3 Details of the A) southwest and B) northern sections of Leverett showing details of three-phase distribution lines. Three-phase lines are shown in red and single-phase lines in gray.
Source: Eversource DG Hosting Capacity map. 2023, https://eversource.maps.arcgis.com

2.4 Existing Hosting Capacity

Historically, distribution lines in the electricity grid were designed as somewhat akin to one-way streets, supplying power to homes and businesses from large power plants connected to high-voltage transmission lines. With the addition of solar and wind resources, there are now many energy-generating facilities that seek to interconnect to the grid via distribution lines. These "distributed generation" electricity sources require that distribution lines act as two-way streets instead, allowing for energy to flow into the grid via distribution lines, while still allowing energy to continue to flow outward into individual homes and businesses. Balancing this two-way flow can represent a challenge for ensuring reliability and safety of the grid. This is especially true where distributed generation electricity sources are renewable sources, such as wind and solar energy, which supply electricity to the grid in an intermittent and variable manner. In order to ensure that generation facilities can be connected safely, developers are required to obtain written permission from the local utility company before interconnecting these systems to the electricity grid.

The "hosting capacity" of an electric power line identifies its ability to incorporate distributed generation electricity sources, such as wind and solar. In most places, including those served by single-phase distribution lines, small solar systems of up to 50 kW can be incorporated without adverse impacts on the grid's reliability. In areas served by three-phase power lines, solar systems of up to 200 kW can typically be interconnected without significant challenges. However, for larger systems, it is necessary to ensure there is sufficient capacity available on the distribution line before these facilities can be built and interconnected. Otherwise, power lines or substations may require upgrades before additional distributed generation sources can be interconnected without compromising reliability. While not true across the board, an industry 'rule-of-thumb' is that 6 MW can be connected safely for every 13.8 kV distribution line. In western Massachusetts, where many towns are served by one or a few low-voltage feeder circuits, the local grid can quickly become "saturated," such that there is not sufficient hosting capacity to incorporate additional medium to large solar arrays.

The state of Massachusetts now requires that utilities provide publicly available maps and data regarding the available hosting capacity of distribution lines, and the level of saturation of individual feeder circuits. This public information lists all projects greater than 25 kW in capacity connected to three-phase lines, and all projects greater than 10 kW connected to single-phase lines. If circuits are currently saturated, it does not mean that no more distributed generation system can be interconnected. Upgrades may involve significant costs, which the energy facility developer is typically expected to pay for, as a condition of interconnection. Previously, interconnection applications were considered on a project-by-project basis, but recently, ISO New England has determined that multiple projects may be considered together as one group for the purposes of interconnection, in what are known as "Affected System Operator," or Group, studies. This change is anticipated to streamline the review of interconnection requests for projects "queued" up to connect to each circuit. Even if areas currently appear saturated on the map, they may not remain so. Companies developing large, more lucrative solar projects may be able and willing to support significant upgrades to these circuits (either individually or in groups with cost sharing). New upgrades may then open up new hosting capacity.

Table 1 provides a listing of distributed generation projects over 25 kW proposed in Leverett or located in adjacent towns which use the same circuits**.** One medium-sized facility of roughly 366 kW has been authorized to interconnect in Leverett, and an additional large 3,120 kW system has been proposed. Several medium-sized arrays have been connected to the 21C7 circuit in neighboring Montague. As least one large solar facility (5,000 kW) has been connected to the 18G7 circuit in Amherst. It is not known whether projects currently "in process" will ultimately be built and connected to the grid.

Town	**Capacity** (kW AC)	**Circuit**	**Authorization to Interconnect**
Amherst	25	18G7	Authorized to Interconnect - 5/26/2022
Montague	36	21C7	Authorized to Interconnect - 11/10/2017
Montague	56	21C7	Authorized to Interconnect - 1/26/2017
Leverett	366	18G7	Authorized to Interconnect - 2/14/2019
Amherst	996	18G7	Cancelled
Amherst	996	18G7	Cancelled
Amherst	2,000	18G7	In Process
Amherst	3,000	18G7	Cancelled
Leverett	3,120	18G7	In Process
Amherst	3,182	18G7	Unknown
Amherst	4,980	18G7	Authorized to Interconnect - 7/30/2019

Table 1 Distributed generation projects over 25 kW proposed in Leverett or in adjacent towns which utilize the same circuits (Amherst, Montague). Note that several large projects have been cancelled, but several may be in process, and one large project in Amherst has been approved for interconnection. **Source:** MA DOER. 2022. Distributed Generation Facilities Raw Data. https://www.mass.gov/info-details/utility-interconnection-in-massachusetts#utility-interconnection-reports-

Both three-phase lines (18G7 and 21C7) currently have a hosting capacity of 0.2 MW. This indicates they could currently accommodate additional small-to-medium scale projects (up to 200 kW) and suggests grid upgrades are needed before additional large projects can be interconnected. Meanwhile, most single-phase lines can be expected to accommodate additional projects under 50 kW in size.

This description represents the local grid infrastructure as it is – planning for future scenarios of development could include recommendations for areas of grid infrastructure improvement to allow siting of distributed generation in preferred locations. Companies developing large, more lucrative solar projects may be able and willing to support significant upgrades to these circuits (either individually or in groups with cost sharing). New upgrades may then open up new hosting capacity. Future scenarios may also include the addition of what are known as "non-wires alternatives," which can reduce the needs for grid upgrades. These are technologies like energy storage, energy efficiency, demand-response, and grid software, which reduce the need for additional power lines to be added to the grid.

While the above description addresses hosting capacity, the Solar Planning Committee is also focused on improving local power distribution and energy resilience measures through the development of local power infrastructure that can respond to the hazards of global climate change. To this end, Leverett is exploring the possibilities of developing a MLP-owned three phase distribution system, located on either on town-owned land (e.g., the Leverett Municipal Campus located on Montague Road) or on leased land with access to existing utility poles owned jointly by Verizon and Eversource, and on MLP-owned poles elsewhere in town. This system could be structured similarly to the way the Leverett fiberoptic MLP cables are distributed for the LeverettNet Broadband Network.

The Solar Planning Committee views the Leverett Municipal Campus as a preferred site for a pilot municipal microgrid because this location would not involve the utility company's utility poles and could be constructed entirely underground between the buildings that host the solar arrays and a battery storage facility. Further, the microgrid could be constructed as a three-phase system with a single demarcation point with the Eversource single-phase 13.8 kV distribution to 21C7 that runs along Montague Road with the capability of connecting three-phase 13.8 kV power if Eversource agrees to extend three-phase power farther along Montague Road from the junction of Montague Road, Depot Street, and Shutesbury Road.

3. MUNICIPAL PLANNING DOCUMENTS

3.1 Planning Documents & Bylaw Review

We conducted a brief review of relevant planning documents and municipal bylaws, and identified the following:

- Leverett does not currently have a Master Plan but is currently engaged in a two-phase process to develop a new Master Plan. Phase 1 involves comprehensive planning process to compile and understand the Town's data and reports and assess whether it is appropriate or sufficient for the comprehensive planning process. This Phase 1 process also includes development of a plan for community engagement during the main planning effort and submission of an application to the Community One Stop for Growth grant program to fund Phase 2 of the planning process. Phase 2 of the planning process is underway, and the *Community Planning for Solar* process could help inform comprehensive planning efforts.
- Leverett has a Municipality Vulnerability Preparedness (MVP) plan, drafted in 2020 and referenced in *Potential Energy Storage Sites*.
- Leverett's zoning bylaws include a section (4970) specifically addressing ground-mounted solar development. The content of these bylaws is addressed in Section 3.2 *Solar Zoning Bylaws*.
- Leverett does not have a municipal wetlands bylaw. Any work in proximity to wetlands or waterbodies is regulated by state and federal laws. It should be noted that the current lack of a municipal wetlands bylaw is likely to change soon because of the need for passage of a Massachusetts Model Flood Plain Bylaw that will enable town property owners to remain eligible for FEMA flood insurance.
- Leverett has an Open Space and Recreation Plan (OSRP) completed in 2019. A summary of town conservation priorities from the plan is briefly outlined in Section 3.3 *Open Space and Recreation Planning.*

3.2 Solar Zoning

Leverett's zoning bylaws were amended in April 2020. Bylaws regarding solar development are included as part of the general zoning bylaw under Section 4970.

Purpose: The purpose of the solar bylaw is to facilitate the creation of new medium scale and large-scale ground-mounted solar electric installations by providing standards for the placement, design, construction, operation, monitoring, modification and removal of such installations that address public safety, minimize impacts on environmental, scenic, natural and historic resources and to provide adequate financial assurance for the eventual decommissioning of such installations.

Definitions: Solar facilities within Leverett are regulated based on their location and total panel area:

- **Roof-Mounted Solar Electric Installations** are mounted on a building and are not limited in size.
- **Small-Scale Ground Mounted Solar Electric Installations** are mounted on the ground and include small systems with up to 1,750 sf of panel area.
- **Medium-Scale Ground-Mounted Solar Electric Installation**s are mounted on the ground and include systems with between 1,750-40,000 sf of panels.
- **Large-Scale Ground-Mounted Solar Electric Installations** are mounted on the ground and include systems with between 40,000-200,000 sf of panels.

- Systems larger than 200,000 sf in panel area are not addressed and therefore do not appear to be permitted in Leverett. In addition, systems taller than 35 ft in height are not permitted.

Zoning Districts:

Leverett has 5 zoning districts and 7 overlay districts. The zoning districts are:

- Residential/Village .... RV
- Residence/Rural .... RR
- Rural Outlying Residential ...... RO
- General Business .... GB
- Commercial .... COM

The overlay districts are:

- Aquifer Protection District (pursuant to Section 4300)
- Flood Hazard District (pursuant to Section 4400)
- Stream and Lake Protection District (pursuant to Section 4500)
- Scenic Road Protection District (pursuant to Section 4600)
- Rattlesnake Gutter Overlay District (pursuant to Section 4700)
- Upper Elevation Site Plan Review Overlay District (pursuant to Section 4960)
- Wireless Telecommunications Overlay District (pursuant to Section 4900)

A map of the zoning districts and overlay districts is provided in **Figure 4** on the next page.

Permitting requirements differ by project size, location, and zoning district:

- **Roof-mounted systems** are allowed as of right in all zoning districts. They require a building permit and must comply with the other provisions of Leverett's zoning bylaws.
- **Small-scale ground-mounted systems** which are an accessory structure to an existing residential or non-residential use are generally allowed as of right in all zoning districts. They require a building permit and must comply with the other provisions of Leverett's zoning bylaws such as setback requirements. Systems greater than 9 feet in height are allowed as of right but subject to Site Plan Review. Systems greater than 20 feet in height require a Special Permit. Systems larger than 35 feet in height are not permitted.
- **Medium-scale ground-mounted systems** are permitted as of right with Site Plan Review in most districts, but require a Special Permit if over 9 feet in height or located in the RV district or in the following overlay districts: (i) the Stream and Lake Protection District, (ii) Rattlesnake Gutter Overlay District and (iii) Upper Elevation Site Plan Review Overlay District.
- **Large-scale ground-mounted systems** require a Special Permit, and are not permitted in the RV district and the following overlay districts: (i) the Stream and Lake Protection District, (ii) Rattlesnake Gutter Overlay District and (iii) Upper Elevation Site Plan Review Overlay District.

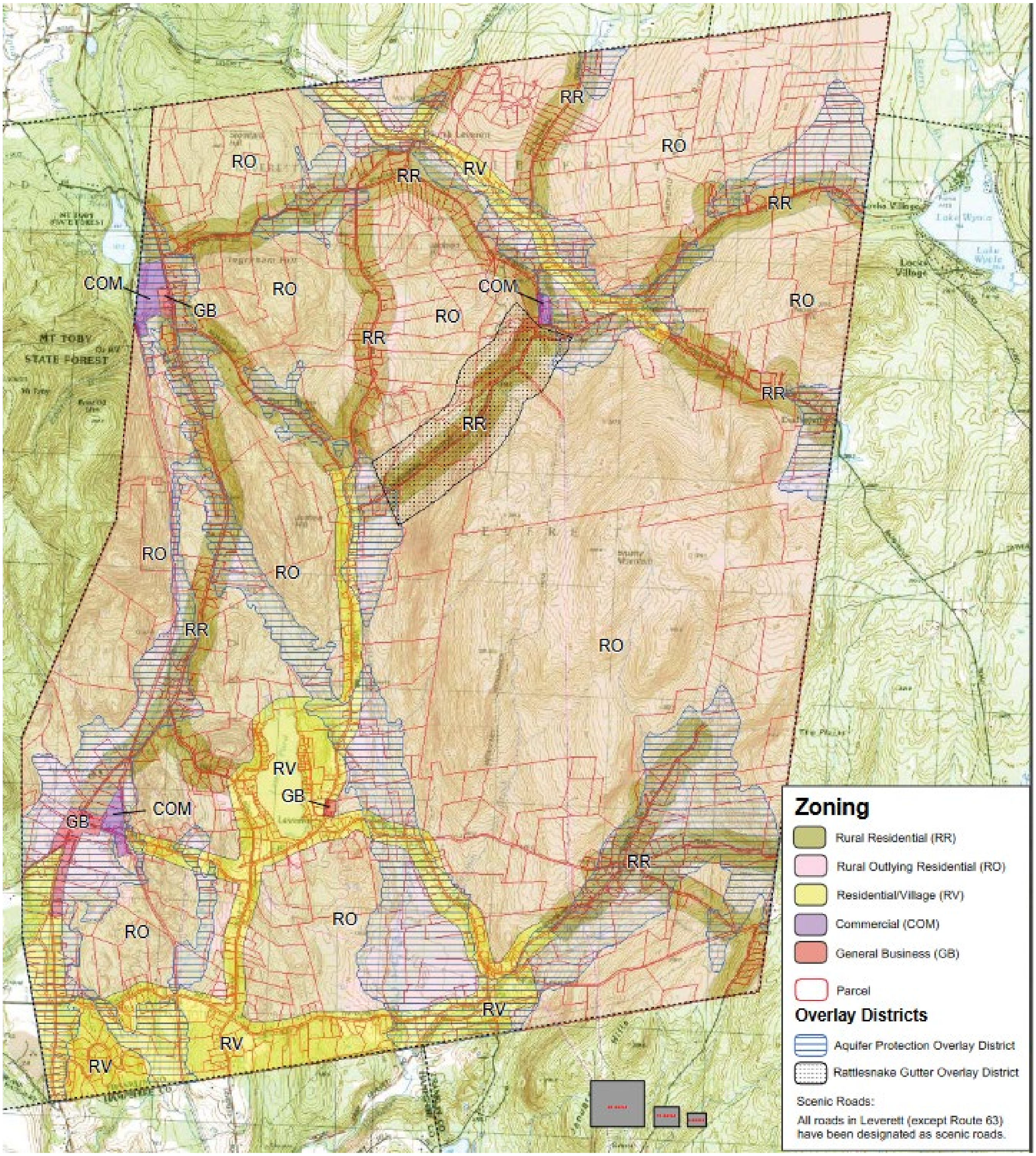


Figure 4 Zoning and overlay districts within Leverett. Note that some overlay districts are not shown. Source: FRCOG. 2008. https://www.leverett.ma.us/files/Zoning_11x17.pdf

Basic requirements associated with project design and site plan review of medium or large solar arrays include:

- Site plans submitted for review are required to include, among other items, locations of roads, topography, wetlands, proposed grading changes, NHESP Priority Habitat areas, floodplains, Priority Heritage landscapes and local or National Historic Districts, as well administrative information (e.g., contact information, liability insurance, financial surety).
- The project proponent must submit a plan for the operation and maintenance of the system which includes measures for maintaining safe access to the installation, storm water and vegetation controls, as well as general procedures for operational maintenance of the installation. Herbicides may not be used to control vegetation.
- The facility setback from the property line must be 100 feet on all sides. The height of structures may not exceed 35 feet.
- Whenever reasonable, associated structures should be screened from view by vegetation and/or joined or clustered to avoid adverse visual impacts.

3.3 Open Space and Recreation Planning

Leverett completed its OSRP in August 2019. The plan focuses primarily on preserving and maintaining the town's recreational, natural, and historic resources. The plan aims to provide a balance between conservation and economic development to ensure the town's long-term prosperity and improve the overall well-being of the community. The OSRP also provides a framework for how to make decisions that have the potential of affecting the town's natural wildlife, recreational areas, historic lands, and scenic roads. A town-wide survey conducted as part of the OSRP process concluded that the most important factors that draw residents into the community are Leverett's abundance of beautiful landscapes, freshwater sources, and diverse wildlife.

To preserve Leverett's natural resources and address climate change, a main goal coming out of the planning process was to educate residents about land use practices and recreational opportunities in town. Leverett seeks to protect land of conservation value by promoting growth management strategies which include active land conservation and zoning measures. Assessing important wildlife core habitats, riparian corridors, significant soil types, scenic vistas, and critical water resources will help to determine priority areas to protect and enhance. Preserving historic and cultural resources is also an important goal coming out of the OSRP. The town is interested in expanding trail networks to expand access to both natural and historic resources.

4. COMMUNITY INFRASTRUCTURE

4.1 Introduction

In this section, we briefly review community infrastructure of relevance to solar energy development and energy storage. Information included in this section was drawn from a variety of sources, including:

- Municipal representatives participating in this planning process
- Municipal planning documents
- Department of Energy Resources (DOER) databases of renewable energy generation facilities
- Community Involved in Sustaining Agriculture Farm Finder
- MassGIS geospatial data layers

Associated maps are provided in Appendix A of this document.

4.2 Existing Renewable Energy Infrastructure

Leverett has 134 small-scale solar facilities with individual capacities of less than 25 kW per system, totaling 1,074 kW (1.1 MW) altogether. Most of these systems are associated with individual residences, although there is one 15 kW municipal solar facility adjacent to the town's Public Safety Complex. There are also several associated with town non-profits (e.g., a 9 kW system at the Mt. Toby Friends Meetinghouse, a 19 kW system owned by the Dakin Humane Society). In addition to these smaller-scale solar arrays, there is one 480 kW roof-mounted system owned by the Kittredge Trust which came online in 2019. The total capacity of all solar facilities currently located in Leverett is therefore roughly 1,553 kW (1.6 MW).

One much larger solar facility (capacity of 3,120 kW) was proposed in Leverett in 2018 (see Section 2.4) and received an interconnection agreement response from Eversource at that time. However, final interconnection authorization was never granted and the project idea was abandoned to costs of bringing three-phase power to the site making it economically infeasible.

4.3 Potential Energy Storage Sites

Energy storage systems help to balance differences between electricity demand and generation, and are especially valuable components for intermittent energy sources like wind and solar, which do not produce energy 24 hours a day, and may not be producing during times of peak demand.

Energy storage systems have the potential to allow larger solar facilities to be built in areas where interconnecting a medium or large solar array could otherwise exceed the ability of the local distribution lines to accommodate additional renewable energy capacity. Prices of battery storage are dropping quickly, but energy storage is still a relatively expensive technology. At present, these types of systems often require loads larger than residential-scale to be cost-effective where cost is the sole consideration, but these systems can provide energy reliability during outages, which means that they also provide additional value in terms of public health and safety.

In Leverett's *Municipal Vulnerability Plan* and *Hazards Mitigation Plan*, there is much discussion of the challenges associated with the town's relatively vulnerable electricity grid. MVP workshop participants noted that widespread outages can occur if as little as one line or pole is knocked down; for example, if the system is damaged on Bull Hill Road, roughly two-thirds of the town can lose power. Loss of power can also mean loss of communications for areas with limited cell phone coverage, as it leads to the loss of internet and phone over internet, as well as the potential for the loss of landline communications if damaged poles are also carrying telephone lines. Because Leverett residents rely on private wells typically powered by electricity-driven water pumps, loss of power can also result in a loss of access to potable water.

With these concerns in mind, Leverett's planning efforts regarding emergency situations has involved much discussion of potential shelter sites, which could provide heated spaces, cooling, food, potable water, communications, and/or electricity during a power outage. The subsequent subsections focus on specific locations which could serve as potential community shelter sites and which could benefit from the addition of solar plus energy storage. Please note that vulnerable residents, including senior citizens or those with disabilities, could also benefit from energy storage systems installed in their individual residences. However, we did not identify any specific sites in Leverett, such as a hospital, urgent care facility, nursing home, senior housing, or group home, where vulnerable residents would be expected to be congregated during an emergency.

According to the MVP, outside of Leverett, the regional sheltering location alternates between Turner Falls High School and Greenfield Middle School, which take turns providing emergency shelter during events that impact the broader region. Greenfield Middle School has backup power and a limited inventory of emergency supplies. A regional sheltering plan that identifies regional shelter sites was completed for Franklin County with funds from the Western Region Homeland Security Advisory Council (WRHSAC). The Franklin County REPC is now working on operationalizing the plan by creating Shelter Management Teams and cost sharing agreements between towns. Leverett has assembled and trained a Sheltering Team.

4.3.2 Leverett Municipal Campus

The Solar Planning Committee is interested in exploring the development of a local microgrid and the creation of a MLP that could potentially install single- and three-phase power distributed into Leverett neighborhoods. A potential pilot location for this concept is on contiguous town-owned parcels of land in the Leverett Municipal Campus located on Montague Road, encompassing the Leverett Public Library, Leverett Elementary School, and the Leverett Public Safety Complex. These large municipal buildings can continue to provide emergency sheltering, municipal coordination, and supportive municipal functions during emergencies by integrating additional solar PV and battery storage systems that could be sized to meet the power needs of municipal buildings. The Leverett Municipal Campus is also the home one of Leverett's points of presence (POP) nodes for the town broadband land line fiber optic Gigabyte speed ethernet internet system and Voice over Internet Protocol land line telephone network critical for town communications.

4.3.2 Leverett Elementary School

Leverett's primary designated shelter is the Leverett Elementary School. The school is equipped with a life safety generator, a water supply, a kitchen, and showers. The town's solar facility and Public Safety Complex are located adjacent to the school and there has been some interest and discussion regarding establishing a microgrid to serve both buildings. Handicap-accessible cots and other resources are available at the school and the Town is currently working on a transition plan to repair any features that are not compliant with ADA regulations. Food supplies at the school would be adequate for several days of sheltering during the school year. New food access planning and procurement would be needed for sheltering at the school long-term and/or outside of the school year. The school shelter has been successfully activated in recent years. Using the school as a shelter during the academic year could lead to some logistical challenges, if classes were to resume before an emergency situation was completely resolved. The school's generator currently has very limited fuel, and there is no redundancy in the system. A possible solution to this is the installation of a photovoltaic power generator and battery storage. Both installations would require proper construction to withstand severe weather and emergency conditions.

There is considerable interest on the part of the Leverett Energy Committee and the Leverett School Committee in exploring the possibility of installation of solar PV on the Leverett Elementary School's parking lots and roofs.

4.3.3 Public Safety Complex

The town's Public Safety Complex is, as aforementioned, located adjacent to Leverett Elementary School and the town's solar array, and has been considered for a microgrid serving both municipal buildings. This Complex houses the Emergency Operations Center, Police Department, Fire Department, and the Highway Department, and ideally serves as a communication center in case of emergency. There are two older diesel life safety generators in this complex. Both are able to produce electricity to maintain emergency lighting, but are not able to maintain normal business operations during extended commercial power outages. The Town keeps a trailer at the Safety Complex, which it purchased to store emergency supplies. Like the elementary school, the Public Safety Complex has showers and a public water supply.

4.3.4 Town Hall

The secondary official sheltering location in Leverett is the Town Hall, which has also been successfully used as a shelter in recent years. The Town Hall has back-up power, a water supply, and access to a kitchen. The back-up power of these generators are set up for a single phase powerline, and are therefore limited. It is not capable of generating enough power to sustain normal building operations during extended power outages. It is located less than one mile from the Elementary School and Public Safety Complex.

4.3.5 Leverett Village Coop

The Leverett Village Coop is able to serve as a designated heating and cooling shelter for residents in North Leverett. The Coop is working on obtaining a backup generator to preserve food stock and help residents during an emergency. A photovoltaic power generator and battery storage would work well in place of a traditional backup generator so that the Leverett Village Coop is able to function during emergencies. A significant photovoltaic array and battery storage in Moores Corner could provide the basis for a microgrid in this part of the town.

4.3.6 Religious Establishments

Churches and meetinghouses within Leverett have been considered as potential localized shelter sites. Several of the Town's church leaders have mentioned that they are interested in offering their facilities as shelters, but they have not been officially designated as such. The Mount Toby Quaker Meetinghouse has been identified as a potential cooling shelter. The meetinghouse has a solar array located adjacent to the building. The meetinghouse's septic system could be overwhelmed in case of high usage during an extended emergency. The North Leverett Baptist Church is a willing partner. The church has a water supply, but the building lacks backup power.

4.3.7 Dakin Humane Society

The Dakin Animal Shelter has been previously identified as a potential shelter site, at least for farm animals and pets, in case of emergency. However, this facility has permanently closed and the building is being sold. This building has solar panels on its roof.

4.3.8 Individual Residences

Given the scattered distribution of Leverett's population, the potential for road closures, and noted communication challenges, there has been discussion of developing self-organized warming shelters within neighborhoods so residents would not have to travel far during emergencies. Ideally, these sites would be organized in parts of town without easy access to the public facilities (municipal, non-profit) noted above.

Strategic sites would be those with artesian wells that do not require electricity and/or sites with new or existing solar arrays that could be connected to an energy storage system

The Solar Planning Committee has noted that individual residences offer a significant opportunity for the generation of distributed PV power and hosting battery storage. Private homes also offer the opportunity for distribution to local microgrids, should those be developed. One possible strategy for pursing these opportunities involves Leverett developing a MLP that builds and manages town-owned microgrids that distribute power within various areas of the town and are tied together to distribute power between area of surplus supply and surplus demand.

5. SOLAR RESOURCE ASSESSMENT

5.1 Introduction

In this section, we identify, summarize, and attempt to quantify the available solar resources in the town of Leveret. We identify a number of different types of potential resources in this assessment, including:

- Residential-scale solar resources (roof-mounted and small ground-mounted systems)
- Medium to large-scale roofs (greater than 5,000 sf)
- Parking lots
- Landfills and brownfields
- Other previously developed/disturbed land
- Undeveloped land with the potential for large, commercial-scale solar development

This analysis was a desktop analysis, incorporating publicly available geospatial data layers downloaded from MassGIS, the state's Bureau of Geographic Information. It is important to recognize that some information contained within these data layers may be out-of-date, inaccurate, or include irregularities that reduce the accuracy of this analysis. For example, boundaries of conserved land outlined in the MassGIS Protected and Recreational Open Space data layer do not always line up perfectly with tax parcel boundaries. This should be considered as a preliminary analysis, providing direction regarding where more in-depth site assessments can be conducted.

5.2 Residential-Scale Resources

In this analysis, we will provide several rough estimates of solar potential, based on MassGIS structures data, and NREL solar potential estimates for small buildings. For this analysis, we follow NREL's definition of a "small building" as one with a roof area of 5,000 sf or less.

Based on MassGIS Structures data, the town of Leverett has a total of 1,396 small buildings, totaling 2,017,843 sf in roof area. The majority of these buildings are residential structures, including houses, garages, and sheds, although some small businesses and outbuildings are included in this total. In addition, there are 6 slightly larger residences with rooftops in the 5,000-6,300 sf range which we grouped in this category. These 6 residences totaled 33,170 sf, for a total of 2,051,013 sf overall. The National Renewable Energy Laboratory (NREL) estimates that nation-wide, an average of 26% of the roof area of small buildings is suitable for solar[6]. Therefore, we could project a total technical solar resource of 533,263 sf available, equivalent to 7,924 kW (7.9 MW) of solar. Of course, this is the *technical* resource available. It is not feasible to connect solar panels to electric lines at all locations, some roofs may not have the structural integrity necessary to support solar panels, and it is not cost-effective to install panels in locations where the available space is small.

NREL provides additional data and estimates regarding small building roof space in western Massachusetts[2]. A second, and perhaps more practical, estimate of residential-scale solar potential can be derived by considering the potential for roof-mounted OR small-scale ground-mounted arrays to support residential use. Leverett has a total of about 708 households. In Leverett, approximately 67% of small buildings have some roof space suitable for solar, with the most common impediment to development being tree shading on the property. If we assume 67% of households could install solar at their residences, either on a rooftop, or as a ground-mounted system, the town could ultimately have 474 residential

[6] Gagnon, P., Margolis, R., Melius, J., Phillips, C. and Elmore, R., 2016. *Rooftop solar photovoltaic technical potential in the United States. A detailed assessment* (No. NREL/TP-6A20-65298). National Renewable Energy Lab.(NREL), Golden, CO (United States).

systems. The average size of a residential solar system in Leverett is currently 8.02 kW. By this method, we can estimate a potential residential solar capacity of 3,801 kW (3.8 MW).

5.3 Medium to Large-Scale Rooftops

Table 2 (next page) provides a list of the 20 largest roofs in Leverett. This list includes barns, municipal buildings, several businesses and non-profit organizations, and buildings associated with the Kittredge estate. The numbers provided in the table reflect a rough estimate of technical potential, based on nationwide data from NREL. NREL's analysis suggests that virtually all medium and large-scale buildings have a roof plane suitable for solar, and that on average, approximately 49% of area on medium-scale roofs is available[2]. Our technical estimates are based on this statistic. As described above, this technical potential is not reflective of roof structural integrity or economic viability, and on-the-ground assessments would need to be conducted.

Leverett has 20 buildings with roofs over 5,000 sf, totaling 215,912 sf of roof space. (Note that this value excludes the 6 residences slightly over 5,000 sf included above in Section 5.2). Excluding the Peace Pagoda roof, which is not appropriate for a solar installation, an estimated 102,975 sf are suitable for solar. Our estimate of total technical potential on medium to large-scale roofs is 1,530 kW (1.5 MW). Again, this is the *technical* resource available, and does not reflect structural or financial considerations.

Structure/Ownership Status	Street Address	Total Roof Area (sf)	Estimated Technical Solar Potential (kW)
Private Residence (Kittredge)	6 AMHERST RD	5 buildings: 43,384; 14,903; 11,905; 6,643; 5,020	5 buildings: 316, 109, 87, 48, 37 = **total of 597**
Leverett Elementary School	85 MONTAGUE RD	35,058	255
Leverett Public Safety Complex	85 MONTAGUE RD	11,099	81
Barn - Craig Memorial Equestrian Center	470 LONG PLAIN RD	10,091	73
Barn	360 NORTH LEVERETT RD	8,315	61
Business - Ecoshel Cedar Shingles	177 CAVE HILL RD	7,909	58
Leverett Crafts & Arts Building	13 MONTAGUE RD	7,283	53
House + Barn Complex - Stone Pony Farm	147 LONG PLAIN RD	7,257	53
Barn - Stone Pony Farm	147 LONG PLAIN RD	6,997	51
Business - Warehouse	0 HEMENWAY RD	6,663	49
Mount Toby Friends Meetinghouse	194 LONG PLAIN RD	6,235	45
Peace Pagoda	100 CAVE HILL RD	5,760	*
Barn - Stone Pony Farm	147 LONG PLAIN RD	5,662	41
Business - Clark's Auto Wrecking	161 PRATT CORNER RD SHUTESBURY	5,500	40
Barn Complex - Residential	180 LONG PLAIN RD	5,146	37
Baptist Church	72 NORTH LEVERETT RD	5,083	37

Table 2 A list of the 20 largest roofs identified in Leverett. Note that no solar potential is listed for the Peace Pagoda because the addition of solar panels is not anticipated, and that Clark's Auto Wrecking is on the Leverett-Shutesbury line, with the majority of the building located in Shutesbury.

5.4 Parking Lots

There are few large parking lots or large paved areas in Leverett. The largest parking lots are primarily associated with municipal facilities, although a few smaller parking lots are located adjacent to sites accessible to the public (e.g., Mt. Toby Friends Meetinghouse, Baptist Church, Peace Pagoda). Potential sites with at least 0.25 acres available for parking canopies are summarized in **Table 3** (next page). Of these, the Leverett Municipal Campus offers access to large publicly owned parking lots in town. Technical estimates are based on a packing density of 263 kW per acre[7]. Our estimate of total technical potential on the listed parking lots is 1,710 kW (1.7 MW).

There are also some paved areas associated with some of the larger establishments in town, including the Kittredge Estate and Stone Pony Farm. However, these areas include driveways and vehicle turn-arounds, so it is difficult to determine how much, if any, solar would be feasible at these locations. These sites are not included in the table.

[7] Krishnan, Ram. 2016. *Technical solar photovoltaic potential of large scale parking lot canopies*. Dissertation, Michigan Technological University.

Location/Ownership Status	Approximate Area (acres)	Estimated Solar Technical Potential (kW)
Leverett Elementary School and Public Safety Complex	4	1,052
Leverett Transfer Station	0.8	210
Leverett Town Hall – behind and across the street from the building	0.5 (total across 3 small lots)	132
Leverett Town Library	0.25	66
Baptist Church	0.4	105
Peace Pagoda	0.3	79
Mt. Toby Meetinghouse	0.25	66

Table 3 Parking lots identified in Leverett.

5.5 Landfills, Brownfields, and other Disturbed Sites

Leverett has relatively few previously disturbed sites. Based on MassDEP's list, the town does not have any documented brownfields.[8] Adjacent to the Leverett Transfer Station is a roughly 3-acre site which appears to be a capped landfill. This area could be suitable for solar development and might accommodate as much as 600 kW of solar capacity. The current cost to developing solar on this landfill through the installation of a three-phase power line is currently uneconomical for the town. An alternative solution to this power line installation would be the development of a local microgrid

There are no tax parcels associated with a land use code that would indicate the primary land use is mining or quarrying on Leverett properties. However, there are several sites that appear to be active or former sand and gravel operations. These include:

- 3.5 acres located west of Long Plain Road, opposite the intersection with Jackson Hill Road, which appear to constitute to a current sand and gravel operation. This property is part of the Craig Memorial Equestrian Center and is currently being operated by RL Roberts Excavating; (3.5 acres = roughly 0.7 MW)
- A 2-acre gravel pit located off the Number 6 Road adjacent to the major bend in the road; (2 acres = roughly 0.4 MW).

These sites would not be appropriate for solar if currently active, but could potentially accommodate solar development in the future if they fall into disuse.

In addition, in the southwestern corner of town, located primarily over the town line in Sunderland, are two very large areas of bare soil which appear to constitute a very large sand and gravel or other quarrying/mining operation. These sites may be currently active and not suitable for solar development at present. However, they are worth noting because they are quite large in area. The two areas are 90 and 70 acres, representing potential solar capacities of 18 MW and 14 MW respectively.

Other large areas of bare soil include a roughly 1-acre dirt or gravel parking lot and storage area at 60 Hemenway Road. There appears to be a solar array on the roof of one of the buildings located on this

[8] MassDEP. 2018. https://www.mass.gov/service-details/find-brownfields-sites

property already. This site could potentially accommodate a ground-mounted or parking canopy solar array of 200-250 kW.

Finally, as noted in the grid infrastructure section of this report, there are three electricity transmission lines which run through Leverett. The right-of-ways (ROWs) associated with these lines are maintained as open land by the utility. While not as disturbed as the other types of sites mentioned above, these sites are partially developed, and include large areas of land. The two ROWs in the western portion of town are roughly 100 feet wide and 4 and 4.5 miles long respectively, representing areas of roughly 48 and 55 acres. The ROW on the eastern side of town is cleared to roughly 150 ft wide and runs 6 miles through Leverett, for a total area of roughly 109 acres. While it is likely that much of these areas would not be suitable for solar, due to steep slopes, portions crossing through or near private property, viewshed considerations in high-elevation portions of the ROWs, and bordering trees providing too much shade on the edges of the ROWs, the ROWs could provide significant space for ground-mounted solar development. A major challenge in developing ROWs is that there is not a common practice of developing electricity transmission ROWs for solar. Utility companies typically prefer to keep these areas clear to allow for easy maintenance of transmission lines as well as underlying vegetation. For these reasons, the Solar Planning Committee has noted that this type of development is unlikely to occur in Leverett. However, this type of land area represents a potential untapped resource for solar across Massachusetts.

5.6 Agricultural Resources

Historically, Leverett had a number of small, self-sufficient farms and homesteads. Today, much former pastureland is now forest as abandoned farms quickly revert to woodlands. Perhaps due in part to the low percentage of prime farmland in Leverett, farming does not currently constitute a large portion of the town's economy, though many residents care for home gardens. According to a community survey conducted as part of the town's Open Space & Recreation Planning process, 32% of respondents said they valued protection of farmland and encouragement of agriculture among their highest open space priorities.

According to the town's OSRP, approximately 1,494 acres of prime farmland soils are located within Leverett, consisting of roughly 10% of the town's area. These prime farmland soils are primarily located along the town's brooks and streams. In northern Leverett, they occur along Jackson Hill Road, North Leverett Road, Cave Hill Road, Dudleyville Road and along the Sawmill River. In central Leverett. prime farmland soils can be found along Doolittle Brook east of Joshua Hill. In the southern part of town, they are located on both sides of Route 63 south of the intersection with Long Hill Road, along Teawaddle Hill from Amherst Road to Shutesbury Road, and continuing on both sides of Shutesbury Road to the town line.

Based on MassGIS Land Cover data, 323 acres are dedicated to agriculture in Leverett, including 321 acres in hay/pasture and only 2 cultivated acres.

Four properties are currently (2022) enrolled in the Chapter 61A program for the purposes of agricultural production, totaling 30 acres. In addition, there are a number of mixed-use properties which include land enrolled in Chapter 61A. There is no farmland permanently protected through an Agricultural Preservation Restriction in Leverett.

Several large barn roofs were identified as potential solar sites as part of the analysis of rooftops.

The following farms were identified in Leverett which could be approached regarding their interest in agriculturally related energy projects:

- Stone Pony Farm (equestrian) – 147 Long Plain Road
- Craig Memorial Equestrian Center – 470 Long Plain Road
- Field Family Sugar House – 264 Long Plain Road

- Still Wagon Farm Stand – Teawaddle Hill Road

The Solar Planning Committee has noted that the costs associated with bringing three-phase power to these sites may make these locations uneconomical to develop. However, if municipal microgrids can be developed under a municipal microgrid model, it is possible that these cost barriers could be overcome.

Roof-mounted systems designed to support on-farm electricity use, solar parking canopies to protect farm equipment, dual-use systems developed to allow continued use of the land underneath the panels for agriculture, or other types of solar facilities may be appropriate for some of the sites. On-farm solar potential can be further explored in conjunction with the Massachusetts Department of Agricultural Resources, which provides agricultural energy grants to farms across the state.

5.7 Commercial-Scale Development Sites

As a final step in the assessment we explored the potential for large-scale solar development within Leverett. When looking for a location to install a solar facility, solar developers typically look for a location near (within 2,000 ft of) a three-phase distribution line because the expense of upgrading single-phase lines to allow interconnection of a solar facility can be cost-prohibitive. In addition, commercial developers typically look for a site where it is possible to install a large facility. For this analysis, we considered a minimum lot size of 5 acres, which could accommodate a solar facility of at least 1 MW.

Based on Mass Audubon's analysis[9], 89% (13,403 acres) of Leverett's land area is in a "natural" condition and an additional 5% (755 acres) is open land; only 3% (450 acres) is developed. Forty acres were developed between 2012 and 2017, placing the town at 209th in the state in terms of most area developed over that time period (239th if ranked relative to land area). Overall, 36% (5,251 acres) of Leverett is permanently protected, placing the town 85th in the state for the most conserved land (or 56th relative to land area). Between 2012 and 2019, 656 acres were newly conserved, including 443 acres identified as BioMap2 Core Habitat, 498 acres identified as BioMap2 Critical Natural Landscape, and 48 acres ranked by The Nature Conservancy as "resilient" lands.

Because the vast majority of Leverett is undeveloped, properties of a size appropriate for commercial-scale solar development sites are most likely to consist largely of undeveloped land. When evaluating the potential for commercial-scale solar development, it is important to consider what undeveloped areas may be unsuitable for solar, either because they are legally protected from solar development or because they may be important areas for recreation or wildlife conservation. Based on Leverett's OSRP, community residents highly value Leverett's scenic landscapes, freshwater resources, and diversity of wildlife.

In Leverett, there are a number of large, permanently protected properties which are not legally available for development. These include portions of Mt. Toby State Forest, the Mt. Toby, Brushy Mountain, and Montague Wildlife Management Areas, the Paul C. Jones Working Forest, the Cave Hill Conservation Area, the Ruth McIntre Conservation Area, and other areas owned by the town of Leverett or otherwise protected through Conservation Restrictions.

Leverett also has a number of properties which are currently enrolled in the Chapter 61 and Chapter 61B programs, providing timber products, recreation, wildlife habitat, or open space value. Chapter 61 and 61B programs act as a financial disincentive for solar development but do not provide permanent protection or preclude development of these parcels. Twenty-one properties are currently (2022) fully enrolled in one

[9] Ricci, E.H., J. Collins, J. Clarke, P. Dolci, and L. de la Parra. 2020. Losing Ground: Nature's Value in a Changing Climate. Massachusetts Audubon Society, Inc., Lincoln, Massachusetts, 33 pp.

of these programs, totaling 413 acres. In addition, there are some mixed-use properties which include land enrolled in these programs.

A number of freshwater resources are found in Leverett. These include Leverett Pond, the North Leverett mill pond, the Sawmill River, and a number of smaller streams and brooks, including Chestnut Hill Brook, Cranberry Pond Brook, Doolittle Brook, Dudleyville Brook, Gardner Brook, Mountain Brook, Red Brook, Roaring Brook, Russellville Brook, and Williams Brook. Under the Massachusetts Wetland Protection Act, development in wetlands, lakes, rivers, and perennial streams is prohibited. The Conservation Commission must be consulted regarding any projects proposed within 200 ft of a river or stream or 100 ft of a wetland. Water resources in Leverett are also protected through zoning overlay districts associated with water bodies.

The town also has large areas of BioMap2 habitat, which represent valuable habitat for wildlife. Solar development is not prohibited in these areas, but may require review by the state Natural Heritage and Endangered Species Program. In addition, these areas are not currently eligible for state incentives for solar development, due to the values they offer as open land maintained in its natural condition. BioMap2 habitats are located throughout Leverett, with only small pockets of town not designated as Core Habitat or Critical Natural Landscape.

As noted above, for this analysis of potential sites for commercial-scale development, we considered properties with a minimum lot size of 5 acres – equivalent to approximately 1 MW of solar development – located within 2,000 feet of an existing three-phase distribution line. Within Leverett, 155 properties meet these criteria, but 12 properties are largely comprised of permanently protected land. This leaves 143 properties with the potential for commercial-scale solar development, totaling some 3,244 acres. However, wetlands comprise a considerable portion of these properties, and are not available for development. Removing wetland areas leaves approximately 2,950 acres available for development across these 143 properties.

The current state solar incentive program does not provide incentives for solar development on land identified in state databases as important habitat conservation land – designated either as BioMap2 Core Habitat or Critical Natural Landscapes – or for development on parcels on which more than half of property receives this designation. Further excluding these parcels, as well as the BioMap2 habitat on developable parcels, 33 properties remain with the potential for large-scale solar development, totaling roughly 640 acres of land that is not comprised of permanently protected land, wetlands, or BioMap2 habitat. Note that this estimate does not take into consideration the current land use at the property, and some of these properties may include single-family homes and residential yards.

See **Map A4** in Appendix A for a map of properties with the potential for large-scale solar development overlaid with constraints on development (i.e., permanently protected lands, wetlands, BioMap2 habitat). Most large properties in Leverett in the vicinity of three-phase power are permanently protected, have large wetlands, or consist largely of BioMap2 habitat. However, it is evident that some parcels in the northwest and southwest corners of Leverett are not constrained by those features.

5.8 Summary

Table 5 below provides a summary of solar resources identified in this assessment.

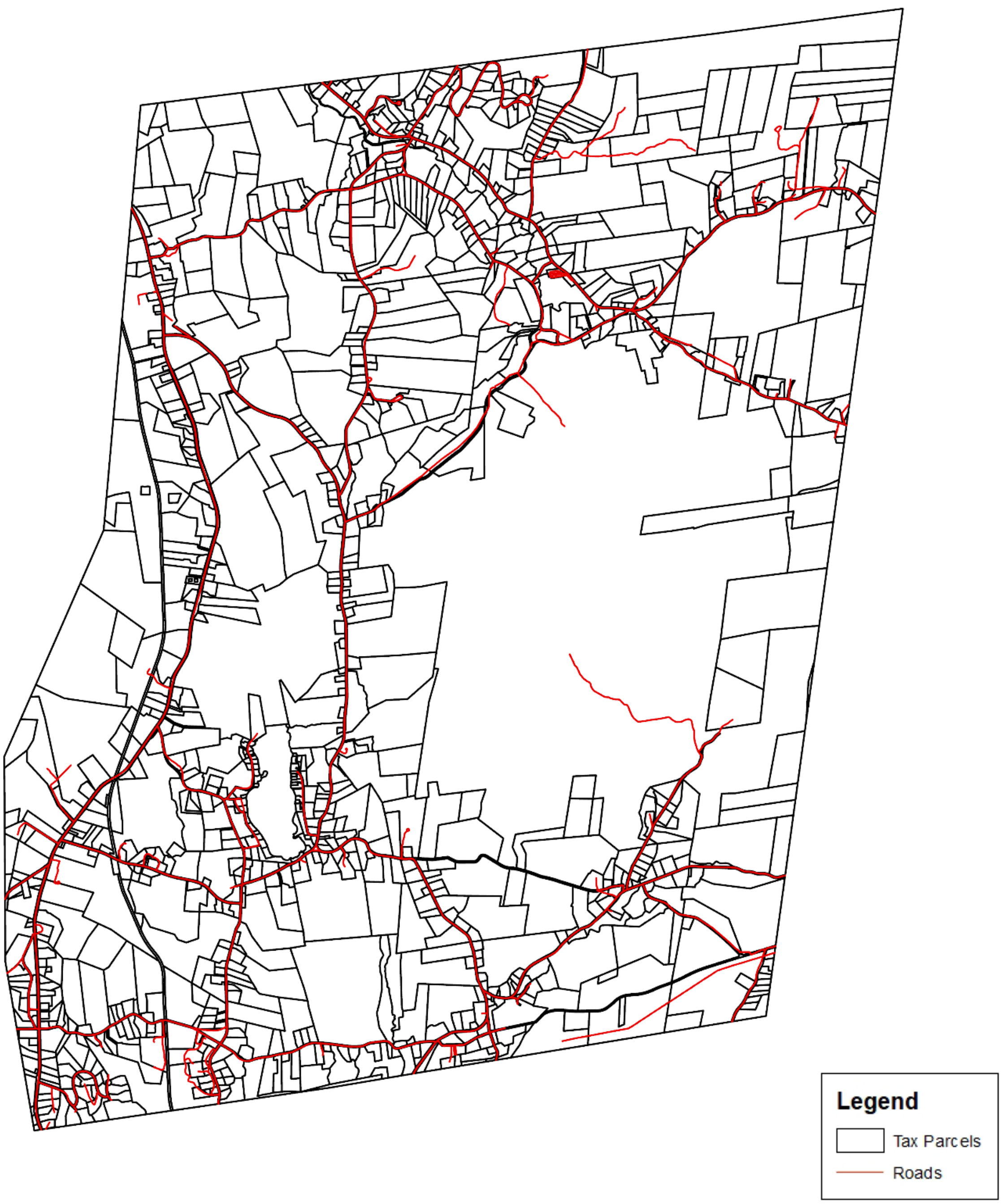
Resource Type	Resources Available	Estimated Technical Potential
Residential-Scale Solar	- Estimated 533,263 sf of small building roof space suitable for solar - Total of 708 residential households; estimated 474 households (67%) could support some solar -Average size of an average residential solar array in Leverett is 8.02 kW	-At least 3.8 MW, assuming that 67% of households can install a roof or ground-mounted system -Estimated 7.9 MW if all small building roofs were fully developed
Medium to Large Scale Roofs	-Estimated 102,975 sf suitable for solar across 19 large building roofs	Estimated 1.5 MW
Parking Lots	- 4 acres at Leverett Elementary School & Public Safety Complex - Total of ~1.5 acres across other municipal sites (Transfer Station, Town Hall, Library) - Total of ~1 acre across other publicly accessible spiritual institutions (Friends Meetinghouse, Baptist Church, Peace Pagoda)	Estimated 1.7 MW, if all sites listed were to be developed
Landfills, Brownfields, and other Previously Disturbed Sites	- 3 acres at closed municipal landfill -5.5 acres of gravel pits within Leverett -160 acres of gravel pit/mining operation largely across town line in Sunderland -2 dirt/gravel parking areas totaling 4 acres -14.5 miles of electricity transmission line ROWs	-TBD, depends on compatibility of solar with current uses -Closed landfill could accommodate 0.6 MW -Sunderland sites (if inactive) could accommodate ~32 MW of solar
Agricultural Resources	- 6 large barn roofs identified - Estimated 323 acres in agricultural production -Pastureland along Route 63 could support agrivoltaic array - At least 30 acres in Chapter 61A program for agriculture	-Dependent on project type (e.g., solar greenhouses, parking canopies for farm equipment, agrivoltaic arrays, solar arrays at field margins) -Barn roofs total 317 kW

Resource Type	Resources Available	Estimated Technical Potential
Undeveloped Land	-143 large land parcels located near three-phase power have at least 5 acres that are not permanently protected and not wetlands, totaling 2,950 acres of non-wetland land -33 large land parcels have at least 5 acres located near three-phase power that are not permanently protected, not wetlands, and not located on properties that are more than 50% BioMap2 habitat, eligible land on these properties totals roughly 640 acres	Approximately 1 MW per 5 acres: 2,950 acres = [590] MW 640 acres = 128 MW *It is not expected that all undeveloped land available would be built out for solar development.*

Appendix A – Maps of Solar Resources and Infrastructure

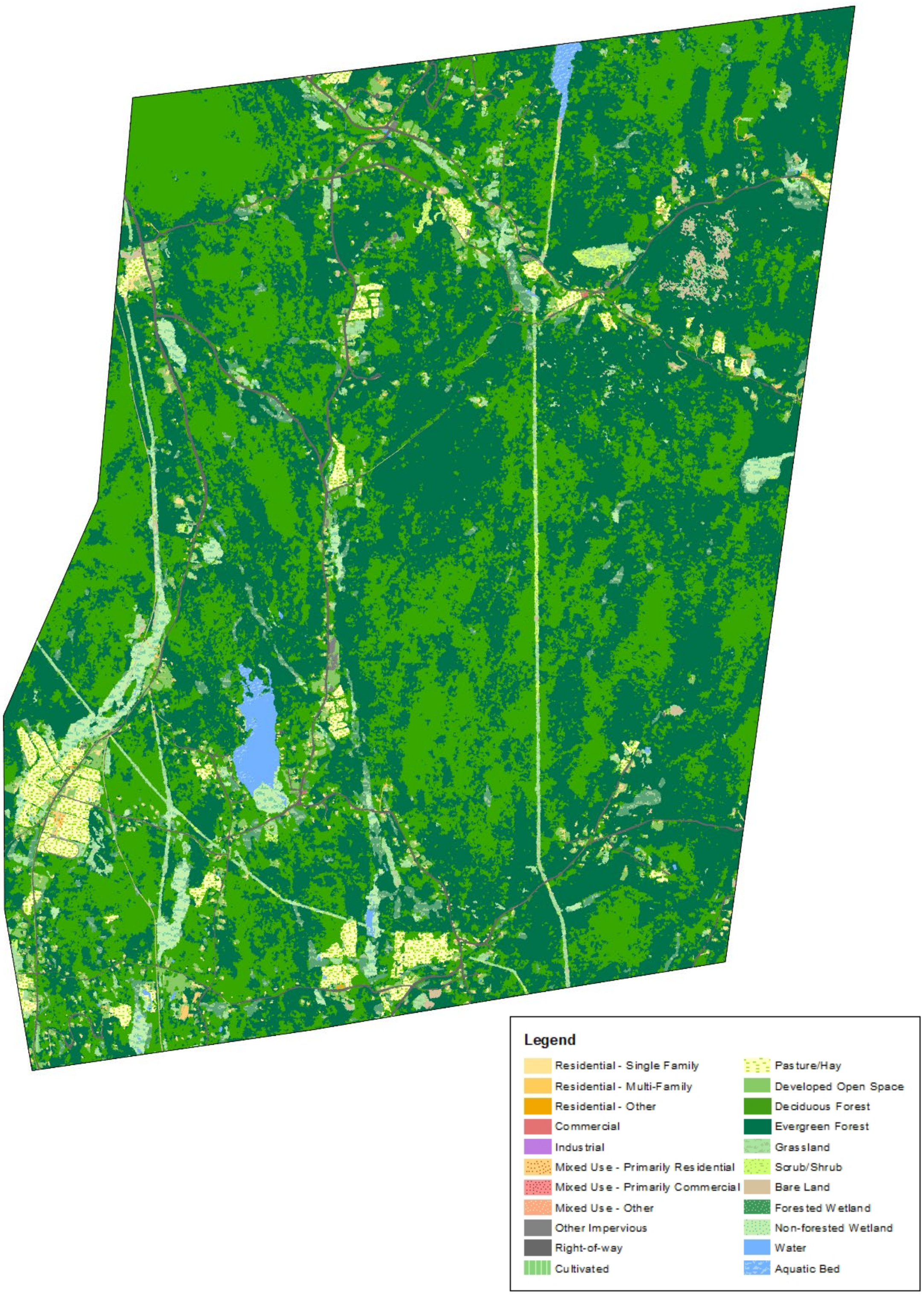
A.1 Roads and Property Lines

Data from MassGIS Tax Parcel data (https://docs.digital.mass.gov/dataset/massgis-data-standardized-assessors-parcels) and MassDOT roads (https://docs.digital.mass.gov/dataset/massgis-data-massachusetts-department-transportation-massdot-roads).



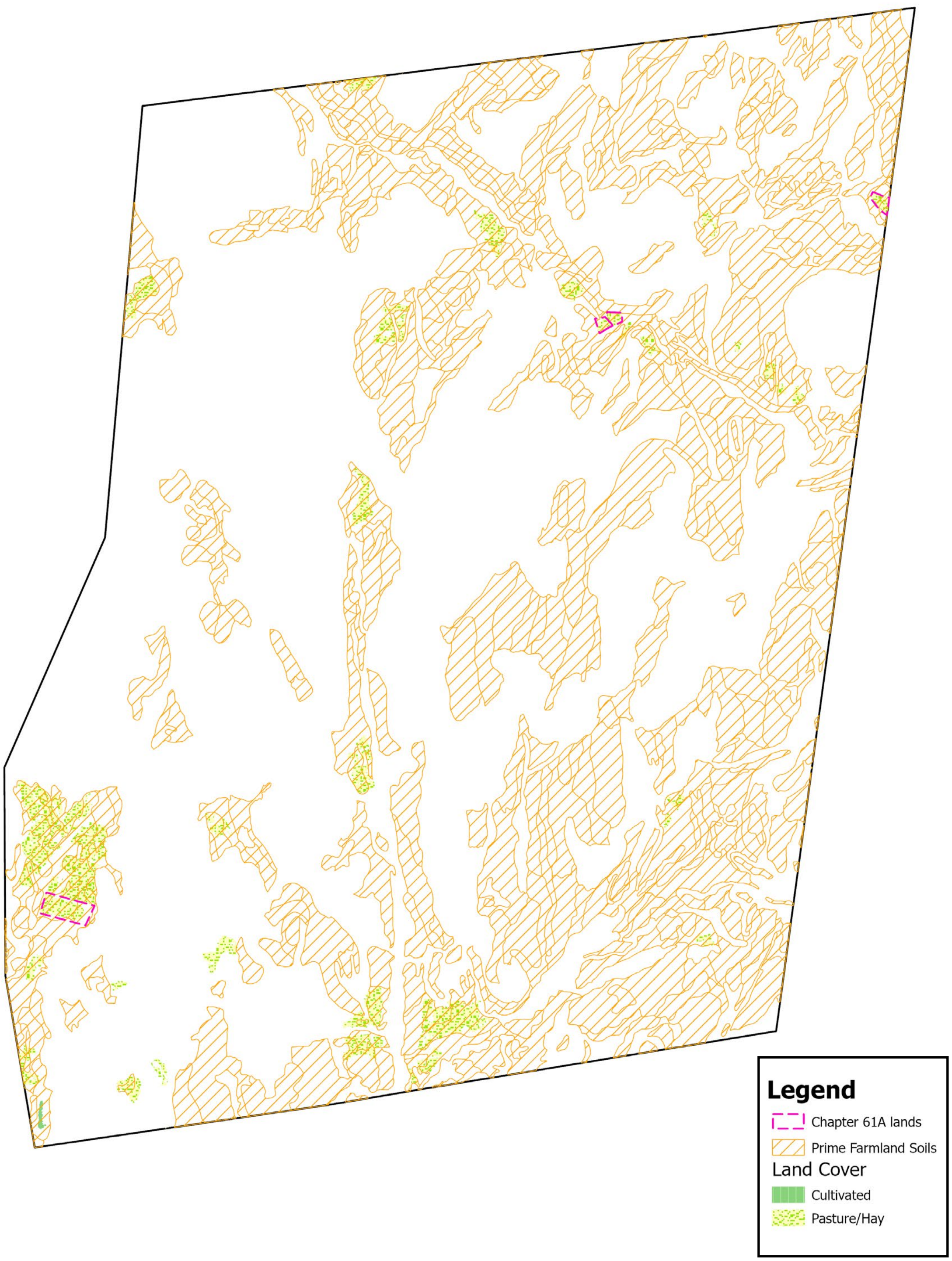
A.2 Land Cover

Land cover data from the MassGIS Land Cover/Land Use data layer, updated in 2016 (https://docs.digital.mass.gov/dataset/massgis-data-2016-land-coverland-use).



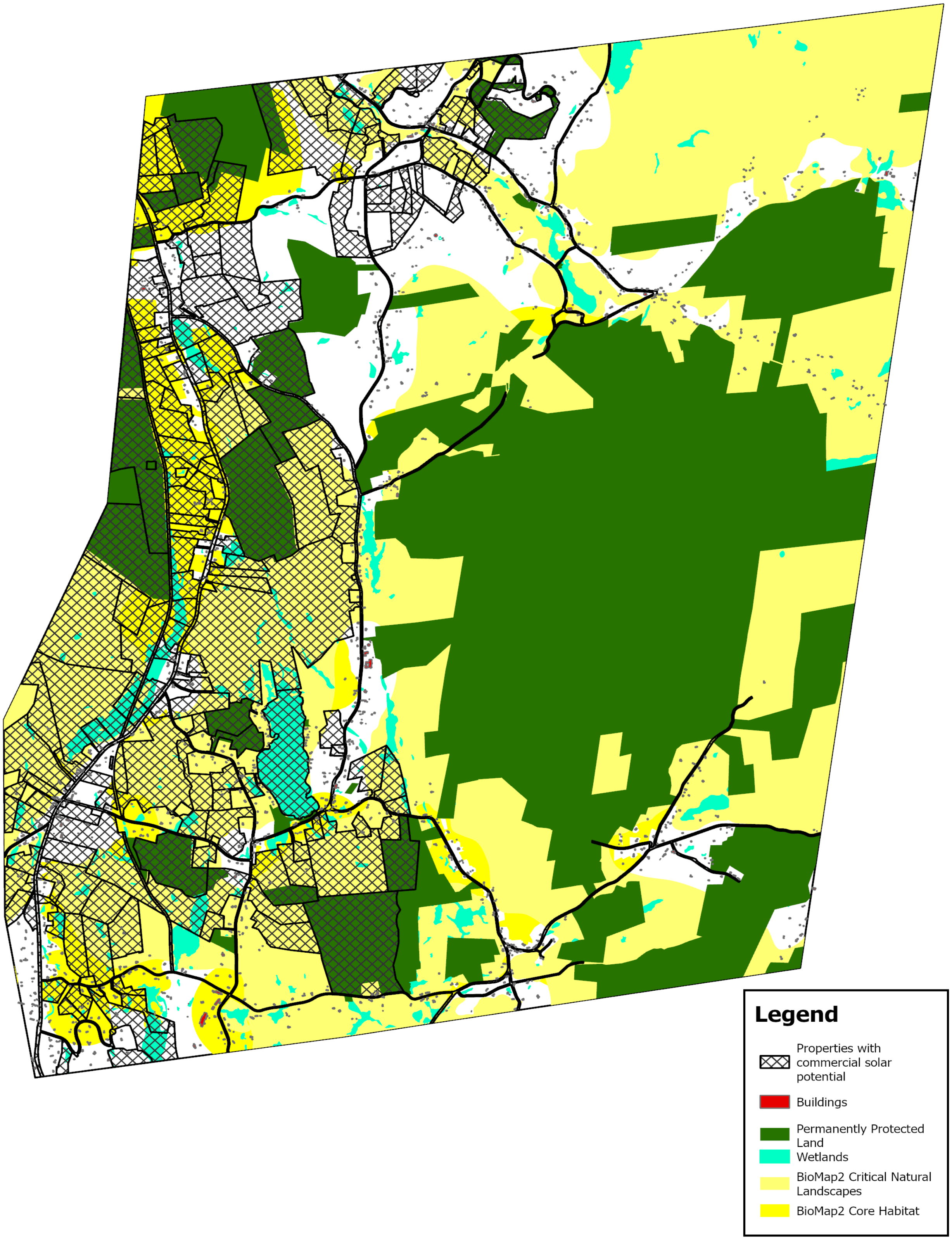
A.3 Agricultural Resources

Data from MassGIS Tax Parcel data (https://docs.digital.mass.gov/dataset/massgis-data-standardized-assessors-parcels), MassGIS Land Cover/Land Use data layer (https://docs.digital.mass.gov/dataset/massgis-data-2016-land-coverland-use), and NRCS SSURGO-Certified Soils (https://docs.digital.mass.gov/dataset/massgis-data-nrcs-ssurgo-certified-soils).

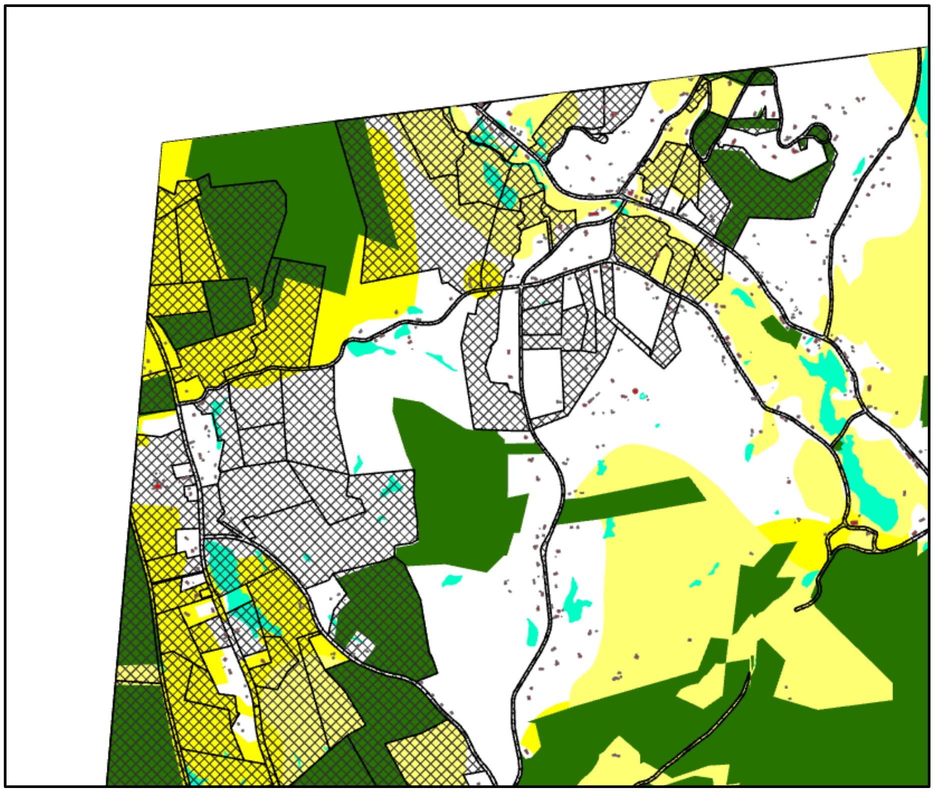


A.4 Parcels available for Commercial-Scale Development

This map depicts parcels suitable for solar development due to large size (5 acres or more) and proximity to three-phase distribution lines (within 2,000 ft), as well as several constraints on development, including permanent conservation protections, presence of wetlands, and extent of BioMap2 wildlife habitat. Buildings present on the property could also indicate a competing land use. Data from MassGIS BioMap2 repository (https://docs.digital.mass.gov/dataset/massgis-data-biomap2), MassGIS Protected Land and Recreational Open Space (https://docs.digital.mass.gov/dataset/massgis-data-protected-and-recreational-openspace), and MassGIS OLIVER DEP wetlands data layer (http://maps.massgis.state.ma.us/map_ol/oliver.php).



Legend
Properties with commercial solar potential
Buildings
Permanently Protected Land
Wetlands
BioMap2 Critical Natural Landscapes
BioMap2 Core Habitat



Note that some large parcels along Long Plain Road in the northwest (above) and southwest (below) portions of Leverett are near three-phase power and include large areas not mapped as priority wildlife habitat or wetlands, and not permanently protected, which means they could be suitable for solar development. However, competing land uses (such as residential or agricultural use) are already occurring on a number of these properties, which took preclude development for solar.