

Solar Resource and Infrastructure Assessment

for

the Town of Northfield



Photo Credit: Northfieldma.gov

May 19, 2023

Prepared by
John Carney

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

Table of Contents

| | |
|--|-----------|
| Executive Summary | 1 |
| Terminology | 2 |
| Terms | 2 |
| Abbreviations & Acronyms | 3 |
| 1. INTRODUCTION | 4 |
| 2. GRID INFRASTRUCTURE ASSESSMENT | 5 |
| 2.1 Introduction | 5 |
| 2.2 Grid Infrastructure Basics | 5 |
| 2.3 Existing Grid Infrastructure | 6 |
| 2.4 Existing Hosting Capacity | 7 |
| 3. MUNICIPAL PLANNING DOCUMENTS | 10 |
| 3.1 Planning Documents & Bylaw Review | 10 |
| 3.2 Master Plan | 10 |
| 3.3 Solar Zoning | 10 |
| 3.4 Open Space and Recreation Planning | 12 |
| 4. COMMUNITY INFRASTRUCTURE | 13 |
| 4.1 Introduction | 13 |
| 4.2 Existing Renewable Energy Infrastructure | 13 |
| 4.3 Potential Energy Storage Sites | 13 |
| 5. SOLAR RESOURCE ASSESSMENT | 15 |
| 5.1 Introduction | 15 |
| 5.2 Residential-Scale Resources | 15 |
| 5.3 Medium to Large-Scale Rooftops | 16 |
| 5.4 Parking Lots | 18 |
| 5.5 Landfills, Brownfields, and other Disturbed Sites | 18 |
| 5.6 Agricultural Resources | 20 |
| 5.7 Commercial-Scale Development Sites | 21 |
| 5.8 Summary | 23 |
| Appendix A – Maps of Solar Resources and Infrastructure | 25 |
| A.1 Roads and Property Lines | 25 |
| A.2 Land Cover | 26 |
| A.3 Agricultural Resources | 27 |

| | |
|--|-----------|
| A.4 Parcels available for Commercial-Scale Development | 28 |
| Appendix B – Medium & Large Building Roofs..... | 30 |

Executive Summary

This report is a Solar Resource and Infrastructure Assessment for the Town of Northfield, 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 Northfield. 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. In Northfield, there is one three-phase distribution line known as 21B8. This distribution line is the primary source of electricity for the town and has a voltage of 13.8 kV. Running along Route 63, this distribution line offers the opportunity for large-scale projects for Thomas Aquinas College and short sections of East Northfield Road and Upper Farms Road. Our analysis indicates that the current hosting capacity (i.e., the ability for the line to accommodate additional sizable generation projects) of this circuit is very low at about 200 kW (0.2 MW). Currently, any large- or medium-scale developments (over 200 kW) on circuit 21B8 would likely require significant upgrades to the grid infrastructure. Meanwhile, Northfield has an extensive network of single-phase lines and these lines could likely accommodate projects under 50 kW in size.

Readers should note that this description represents the local grid infrastructure in its current state. Planning for future scenarios of development could include recommendations for areas of grid infrastructure improvement to allow siting of distributed generation in preferred locations.

Northfield has significant potential for additional solar arrays on residential rooftops and properties, businesses, small parking lots, and farms. For example, at Pioneer Valley Regional High school, there is roughly 1,085 kW of estimated solar technical potential. At Five Point Farm, there is approximately 232 kW of estimated solar technical potential from barn and storage facility roofs. The South Moon Estate, a former youth center, has approximately 222 kW of available solar potential. With a wide variety of different building utilization, the possibility of solar potential development across the town is high – with the caveat that grid capacity may limit some project possibilities.

Our findings suggest that there are several large parcels in Northfield on the west side of the Connecticut River near Route 10 and along Route 63 that may be appropriate for large-scale commercial solar development. This land mainly consists of prime farmland and cultivated land. There are also smaller parcels consisting of forested wetland, deciduous/evergreen forest, etc. Due to the Massachusetts Wetland Protection Act, development near these areas is strictly regulated and must be reviewed. Aside from these restricted areas, Northfield features approximately 230 properties with a total of nearly 5000 acres.

A summary of solar technical potential for different types of sites is provided in Section 5.8 of this document.

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 in size
- **Medium** systems are 25-500 kW in size
- **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.

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

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 Northfield.

Northfield is located in Franklin County, on the northern border of Massachusetts. As of 2020, the town had around 1,278 households and a total population of 2,866.¹ Northfield spans approximately 35.4 square miles, much of which is forested; it is also home to streams, wetlands, and the Connecticut River, which runs through the town and forms a portion of its southwestern border. Northfield has been a designated Green Community since 2012.² Northfield hosts a mix of open land and forests, and features Northfield State Forest, Brush Mountain Conservation Area, and other conserved lands.³

The assessment was conducted through a joint collaboration between 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). The Toolkit consists of six steps designed to guide community residents and officials through a comprehensive solar planning process.

To support Northfield in the second step of 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

¹ US Census bureau, 2022. <https://data.census.gov/>

² MA DOER, 2022. <https://www.mass.gov/doc/map-of-280-gcs-and-grant-summaries/download>

³ MassGIS, www.mass.gov/info-details/massmapper-interactive-map

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 soon. 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 below). This line connects the Northfield Mountain pumped storage hydroelectric station with the Stonybrook Power Plant, an oil and natural gas facility located in Ludlow. This line continues north into Vermont, running roughly north-south along the eastern edge of town. A second 345 kV line runs west from the Northfield Mountain pumped storage hydroelectric station, 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](#).

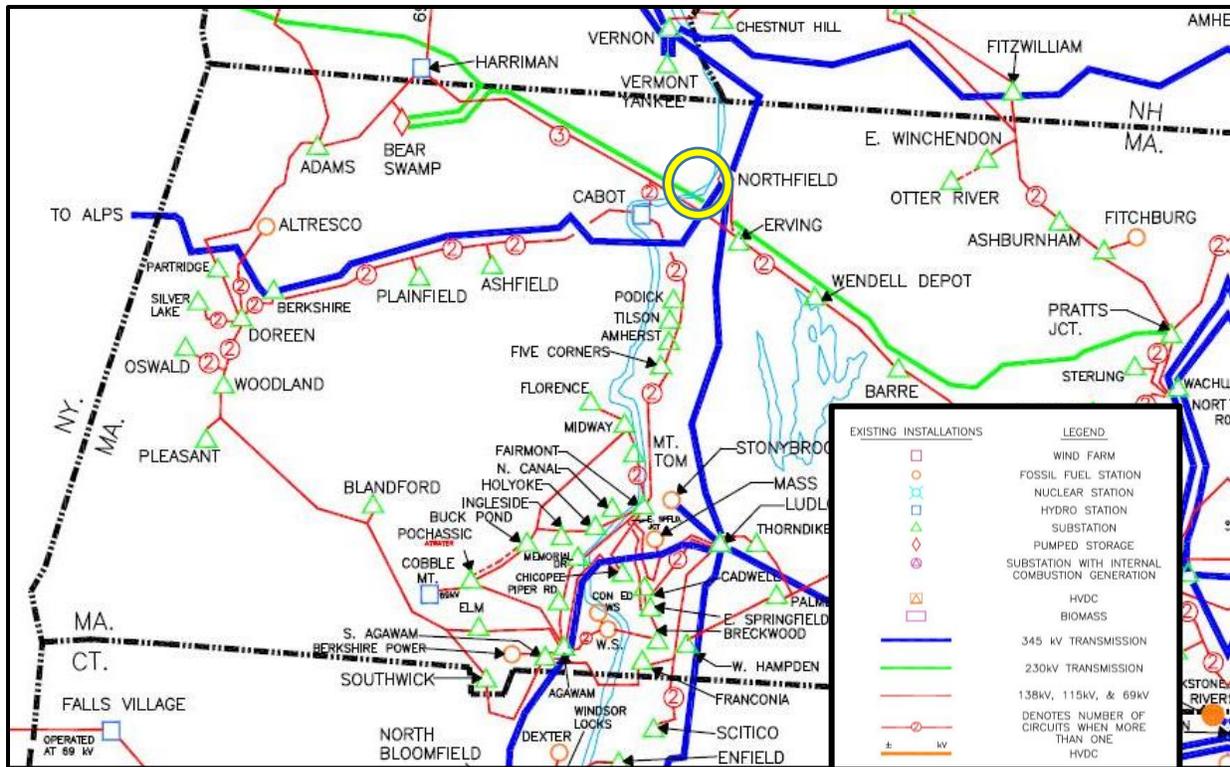


Figure 1 Major electricity transmission lines and substations in western Massachusetts. The location of Northfield is shown as a yellow circle. Source: ISO New England 2019.

2.3 Existing Grid Infrastructure

Electricity in Northfield is distributed by Eversource. According to the Eversource hosting capacity map shown in Figure 2 below, Northfield has one three-phase distribution line. This circuit, known as 21B8, has a voltage of 13.8 kV and is the primary source of electricity for the entire town. The 21B “French King” substation which serves the 21B8 circuit is located off of Northfield Mountain Main Access Road near the Northfield Mountain Recreation Center; this substation steps voltage down from the transmission line to the distribution line’s 13.8 kV. Beginning at the substation, the circuit follows Route 63 northwards. At the junction with Route 10 it splits, one section continuing north along Route 63, and one section heading west across the Connecticut River and into the neighboring town of Bernardston. On the western side of the Connecticut River, the three-phase line serves Old Bernardston Road, Route 142 as far as the Mount Hermon Station, and Bennet Brook Road as far as the Northeast Paving Plant. On the eastern side of the river, the three-phase distribution line continues north on Route 63 as far as its intersection with Ashuelot Road. Small branches off this line provide three-phase power to Thomas Aquinas College, and short (less than 0.5-mile) sections of East Northfield Road, Holton Street, Pentecost Road, School Street, Warwick Road, Maple Street, and Upper Farms Road. Other areas of town are served by single-phase distribution lines, shown in gray in Figure 2.

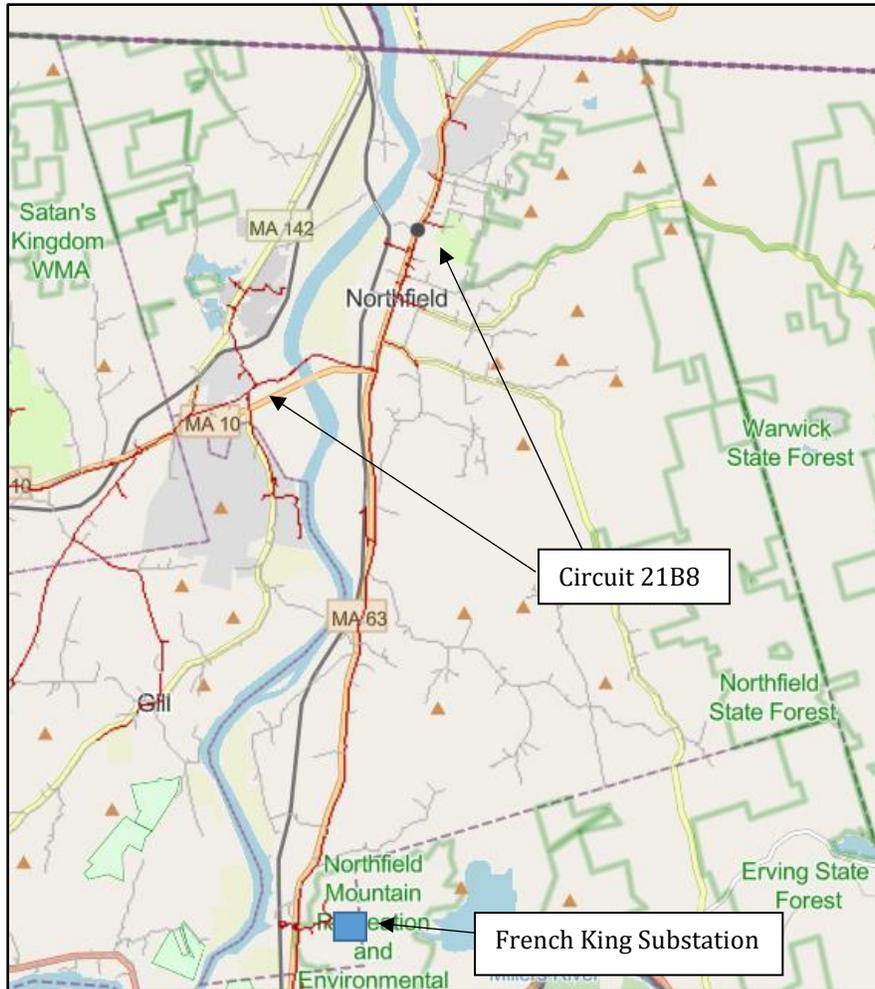


Figure 2 The 21B French King Substation (blue box) and the 21B8 three-phase distribution circuit (red lines) serving Northfield. Single-phase lines are shown in gray. Source: Eversource, DG Hosting Capacity Map, 2022.

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. 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 further distributed generation systems can be added to the circuit, but does suggest that upgrades are needed before additional large projects 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.

As described above, the three-phase distribution lines in Northfield are on circuit 21B8. The current hosting capacity of this circuit is 200 kW (0.2 MW). This means the circuit is currently very saturated. Currently, any large- or medium-scale developments (over 200 kW) on circuit 21B8 would likely require significant upgrades to the grid infrastructure. Meanwhile, most single-phase lines could likely accommodate projects under 50 kW in size.

The current saturation of 21B8 is likely due to large, distributed energy facilities proposed or connected to this circuit. As shown in Table 1 (next page), developers have proposed numerous solar projects (over 25 kW capacity) to Eversource for connection to the 21B8 circuit in Northfield. Of these facilities, one large facility (2,000 kW) is on-line. Several medium-sized projects have been cancelled, but a number of projects are in progress or on hold behind other applications for interconnection to the grid. For a number of projects, the status is not known from available data. (Note that some of the projects with a similar size and application date could be different versions of the same project submitted for review by Eversource.)

In addition to distributed generation facilities proposed in Northfield, projects proposed in neighboring towns that utilize the same circuit also affect the hosting capacity of the 21B8 circuit. Nine projects over 25 kW are currently proposed in Bernardston, and Gill, but only one project of 31 kW has been connected, which is unlikely to have a major impact on grid saturation. However, three large projects (990 kW; 1,250 kW; 1,990 kW) have received authorization to interconnect. It is not clear how quickly these projects will come on-line, or whether projects currently in progress or on hold will proceed.

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

distributed generation facilities to be sited in preferred locations. 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.

| Fuel Type | Design Capacity (kW) | Date Application Received | Authorization to Interconnect | Status |
|-----------|----------------------|---------------------------|-------------------------------|----------------|
| Solar | 25 | 9/20/2019 | | Status unknown |
| Solar | 40 | 2/16/2022 | 7/1/2022 | On line |
| Solar | 56 | 4/17/2015 | 2/3/2016 | In process |
| Solar | 65 | 4/21/2010 | | Cancelled |
| Solar | 300 | 8/26/2021 | | In process |
| Solar | 500 | 12/4/2017 | | Cancelled |
| Solar | 500 | 12/4/2017 | | Cancelled |
| Solar | 1,000 | 12/4/2017 | | In process |
| Solar | 1,000 | 2/20/2019 | | Status unknown |
| Solar | 1,000 | 3/29/2019 | | Status unknown |
| Solar | 1,500 | 3/26/2021 | | Status unknown |
| Solar | 2,000 | 4/7/2011 | 3/30/2012 | On line |
| Solar | 2,000 | 2/20/2019 | | Status unknown |
| Solar | 2,000 | 3/2/2020 | | Status unknown |
| Solar | 2,000 | 4/22/2020 | | Status unknown |
| Solar | 2,000 | 4/23/2020 | | Status unknown |
| Solar | 2,104 | 11/13/2018 | | Status unknown |
| Solar | 2,250 | 4/20/2020 | | Status unknown |
| Solar | 3,000 | 2/20/2019 | | Status unknown |
| Solar | 3,575 | 2/12/2018 | | On hold |
| Battery | 4,500 | 12/17/2020 | | Status unknown |
| Solar | 4,950 | 8/14/2018 | | On hold |
| Solar | 4,988 | 4/23/2018 | | On hold |
| Solar | 5,000 | 1/30/2018 | | On hold |

Table 1 Distributed generation projects authorized or in process in Northfield that utilize the 21B8 circuit. It is unknown how many of the projects currently “in process,” “on hold,” or with an unknown status will ultimately be built and connected to the grid. While all listed projects are in Northfield, the specific location of each project is not available. Source: MA DOER, 2022, www.mass.gov/info-details/utility-interconnection-in-massachusetts

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:

- Northfield's *Master Plan* was completed in 2014 and is described further in Section 3.2 *Master Plan*.
- Northfield does have a *Municipal Vulnerability Preparedness (MVP)* plan. In collaboration with the Town of Warwick and with assistance from the Franklin Regional Council of Governments (FRCOG), Northfield became designated as an MVP community through the MA Executive Office of Energy and Environmental Affairs' MVP Program.
- Northfield's zoning bylaw addresses (1) residential development "density bonuses" as they relate to Open Space Residential Development (OSRD) and solar installations, and (2) large-scale ground-mounted photovoltaic solar development under the Special District regulation section.
- Northfield does have an *Open Space and Recreation Plan (OSRP)*, which was prepared by the Northfield Open Space Committee and approved in 2005.
- Northfield does not currently have municipal wetlands bylaws. The Northfield Conservation Commission is the steward of wetlands in Northfield, and they administer the state wetland protection laws in cooperation with the Massachusetts Department of Environmental Protection.

3.2 Master Plan

Northfield's Master Plan was approved in 2014 and describes three overlay districts in Northfield: the Flood Plain District, the Water Supply Protection District, and the solar photovoltaic overlay district, located in West Northfield. The Solar Overlay District provides by-right solar installations as required by the Green Communities Act and allows large-scale ground-mounted photovoltaic solar installations to be constructed by-right on up to five acres, as required by the Massachusetts Green Communities Act.

Section 5.2.1 of the Master Plan suggests promotion of the Solar Overlay District as a key community opportunity that has the potential to attract companies in alternative energy and the "creative economy" in the form of solar and other alternative energy firms.

The Master Plan's *Open Space Residential Design* measure allows for the by-right development (after site plan review by the Planning Board) of parcels no less than 10 acres in size, in a manner that results in a reduction in frontage and minimum lot size requirements and the conveyance of at least 50 percent of the lot, excluding wetlands, to a home association to be used as common open space. Additional incentives include allowing increased housing density in return for (a) more reserved open space and/or or (b) providing grid-connected photovoltaic solar generation facilities on each unit.

3.3 Solar Zoning

Northfield's zoning bylaws were approved in 2018 and address solar photovoltaic development in two distinct areas: (1) residential development "density bonuses" as they relate to the OSRD and solar installations, and (2) the Solar Overlay District. These bylaw elements are further detailed in the sections below.

3.3.1 Open Space Residential Development

Section 9.3.5 of the bylaws describes residential development "density bonuses" as they relate to OSRD and solar installations. Specifically, housing developments that protect solar access and agree to provide solar-ready construction for the proposed dwellings may be eligible to increase development density by a

maximum of 25 percent. The phrase “protect solar access” indicates that streets and lots in the OSRD will be oriented to maximize the solar resource available to each lot or to as many lots as possible as determined by the Northfield Planning Board. The phrase “solar-ready construction” indicates that construction of homes in such a way that installing and connecting a solar energy system (whether PV or solar thermal) does not require additional wiring, plumbing, or building modification.

3.3.2 Solar Overlay District

Section 10.3 of the bylaw describe the purpose of the town’s Solar Overlay District is to promote the creation of new large-scale ground-mounted solar photovoltaic installations by providing standards for the placement, design, construction, operation, monitoring, modification and removal of such installations that address public safety, minimize impacts on scenic, natural and historic resources and to provide adequate financial assurance for the eventual decommissioning of such installations.

The Solar Overlay District – delineated on the overlay map entitled “Northfield Solar Overlay Zone Map,” dated 2011 and on file with the Town Clerk and shown in Figure 3 below – includes the following zones:

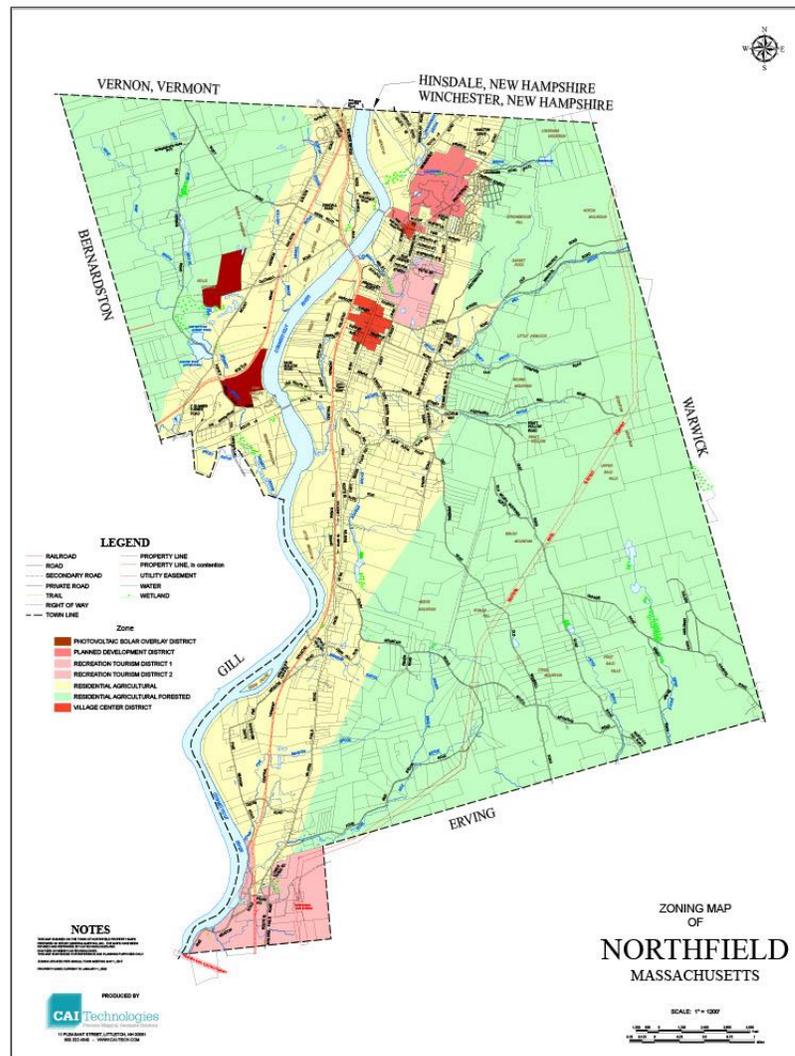


Figure 3 Northfield’s Solar Overlay District

1. Zone 1: The eastern end of town parcel 25-A-1, the western boundary being defined by the following three straight line segments: beginning at point (42° 42.332 N, 72° 29.069 W), then proceeding to point (42° 42.076 N, 72° 29.127 W), then proceeding to point (42° 42.030 N, 72° 29.301 W), and then proceeding to point (42° 41.933 N, 72° 29.285 W).
2. Zone 2: Entire town parcel 29-E-1, approximately 80 acres, bordered roughly by the Connecticut River on the east, the railroad on the north, and Bennett Brook Road on the west.

The bylaw defines Large-Scale Ground-Mounted Solar Photovoltaic Installations (LSGMSPi) as occupying no more than 5 acres of land on one or more adjacent parcels in common ownership (including those separated by a roadway). LSGMSPiS proposed to be constructed in the Solar Overlay District are permitted as-of-right and are subject to Site Plan Review. All other proposed LSGMSPiS require a Special Permit and Site Plan Review in accordance with the bylaw.

Setback and height requirements for LSGMSPiS are at least 100 feet from any property boundary; the minimum setback areas are not included in the calculation of the 5-acre maximum specified in the bylaw. The height of a LSGMSPi (or any related structure) shall not exceed 20 feet.

The bylaw outlines several requirements for all LSGMSPiS, including those related to building permits, fees, design and performance standards, reporting, decommissioning, and financial surety.

3.4 Open Space and Recreation Planning

Northfield's OSRP was prepared by the Northfield Open Space Committee and approved in 2005. The plan was developed based on solicitation of public comments, including a survey of town residents, public meetings, and involvement of town boards and committees.

The plan is a comprehensive inventory of Northfield's natural, agricultural, cultural and recreational resources and a plan for their stewardship and conservation. The plan emphasizes the remarkable importance of the town's land and natural resources, which help provide residents with clean air and water, jobs, and access to recreational activities. Relative to solar development, the plan describes the town's Solar Overlay District and solar photovoltaic development related to the Open Space Residential Development detailed in the sections above.

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

According to public information available from the MA DOER, there are 120 small-scale (less than 25 kW) solar facilities in Northfield.⁴ Cumulatively, these projects represent 903 kW of capacity, and the vast majority are residential installations. It is worth noting that among these installations is a small-scale (5.4 kW) municipal PV array at Northfield's Town Hall/Senior Center Pavilion.

There is a single medium-scale (64 kW) commercial facility in Northfield owned by Four Star Farms, and one large-scale (1,929 kW) commercial development in Northfield, owned by NFM Solar Power, LLC. This project is located at 100 Millers Fall Rd. In July 2022, the Northfield Planning Board granted approval for the construction of three additional large solar arrays totaling 10.9 MW DC capacity at Four Star Farms, but these projects have not yet been installed. The project is still in litigation.

As shown in Table 1 above, 16 additional large-scale (greater than 500 kW) solar PV projects have been proposed in Northfield, which would cumulatively represent 42,867 kW of capacity. It is unknown how many of these proposed projects are still in progress or will ultimately move forward to construction – although it is highly unlikely that all projects will proceed.

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 typically 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.

The following are town sites where considering energy storage may be of particular value:

⁴ MA DOER. 2022. <https://www.mass.gov/service-details/lists-of-qualified-generation-units>

4.3.1 Town Hall/Senior Center

Northfield Town Hall is located at 69 Main Street and houses town offices and the Northfield Senior Center. The Senior Center is the home base for senior-focused activities, meals, programs, and outreach. The Senior Center is located on the ground level of Town Hall and is handicapped accessible from the parking lot in the rear of the building. There is a small-scale (5.4 kW) municipal PV array at Northfield's Town Hall/Senior Center Pavilion. The proximity of Town Hall to the Northfield Police Department facility suggests that energy storage may provide significant value to these important community assets – and the community as a whole – during power outages and other emergencies.

4.3.2 Northfield's Public Schools

The Pioneer Valley Regional School is a public regional comprehensive secondary school located in Northfield. It offers grades seven through twelve for 400+ students and is the primary high school for the towns of Leyden, Northfield, and Bernardston. Northfield Elementary School currently welcomes approximately 190 students from preschool to sixth grade. Schools and libraries often constitute some of the largest energy loads in rural communities, and the use of energy storage may provide a cost-effective strategy for meeting these loads and managing energy costs. Energy storage may also provide significant value in these public, highly used facilities during power outages and other emergencies. Schools often have a public water supply, large kitchens, and, during the school year, reserves of food, which can be helpful during an emergency.

4.3.3 Northfield Fire Department and Safety Center

The Northfield Fire Department, located at 93 Main Street, is a call/volunteer department made up of 35 on-call members. The department serves the town 24 hours a day, 7 days a week, 365 days a year and represents a critical emergency facility in times of power outages and other emergencies to help ensure public health and safety. This facility is also located in the center of town, making it a central and practical location for an energy storage site. The Emergency Services Facility Committee has agreed to expand the current building's infrastructure to a safety complex design (aka the Safety Center). The final design includes three distinct sections of the building – one for the one for police, one for fire and one for EMS — with an area in the middle featuring conference rooms and other multi-purpose rooms to be shared by the three departments. The original design proposal included 20 parking spaces for the public. This was reduced to nine spots in the new design, with a side containing grass or gravel to accommodate overflow parking.

Town officials have noted that solar installations may be challenging at the Safety Center site due to tree shading but hope to conduct an initial review of the facility's design for the possibility of both solar and storage in the future. Further, the current fire station is likely to be retained by the town and could potentially host solar generating and storage. The current EMT site is leased and may not stay in town control.

4.3.4 Squakheag Village

Squakheag Village, located in the town center of Northfield, provides public housing for seniors and persons with disabilities. The property contains 20 one-bedroom units in three connected buildings, including two units for persons with mobility impairments. Due to the vulnerable population served at this facility, it may be an important location to consider siting energy storage.

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 Northfield. 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 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 appear to 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 (National Renewable Energy Laboratory) 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. NREL provides additional data and estimates regarding small building roof space in western Massachusetts²

Based on MassGIS Structures data, the town of Northfield has a total of 2,464 small buildings, totaling 3,438,109 sf in roof area. Most of these buildings are residential structures, including houses, garages, and sheds, although some small businesses and farm outbuildings are included in this total. NREL estimates that nation-wide, an average of 26% of the roof area of small buildings is suitable for solar⁵. Therefore, we could project a total technical solar resource of 893,908 sf available, equivalent to 13,283 kW (13.3 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.

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. Northfield has a total of about 1,278 households. In Northfield, approximately 75.2% 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 75.2% of households could install solar at their residences, either on a rooftop, or as a ground-mounted system, the town could ultimately have 961 residential systems. The average size of a residential solar system in Northfield is currently 7.53 kW. By this method, we can estimate a potential residential solar capacity of 7,232 kW (7.2 MW).

⁵ 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).

5.3 Medium to Large-Scale Rooftops

Northfield has 80 buildings with roofs over 5,000 sf, totaling 899,971 sf of roof space. NREL's analysis suggests that virtually all medium and large-scale buildings have a roof plane suitable for solar; on average, approximately 49% of area on medium-scale roofs (5,000-25,000 sf) is available and 66% of area on large-scale roofs (25,000+ sf). These NREL values are based on nationwide data and are not town-specific. Excluding greenhouses and Quonset buildings, we estimate 424,096 sf are available for solar. Our estimate of total technical potential on medium to large-scale roofs is 6,234 kW (6.2 MW). Again, this is the *technical* resource available, and does not reflect structural or financial considerations.

Table 2 (next page) provides a list of the property owners in Northfield with the largest roofs, or multiple large roofs spread across one or more properties. The numbers provided in the Table 2 reflect a rough estimate of technical potential, based on nationwide data from NREL. 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.

See a complete list of all 80 roofs over 5,000 sf in **Appendix B**. The complete list includes farm facilities, commercial and industrial establishments, campus buildings, a former youth center, storage facilities, large residences, and houses with attached barns.

| Owner | Structure | Street Address | Roof Area (sf) | Estimated Solar Technical Potential (kW) |
|-------------------------|-----------------------|--------------------------|----------------|--|
| Thomas Aquinas College | Campus Building | 0 MAIN ST | 32,505 | 319 |
| | | | 23,601 | 172 |
| | | | 19,333 | 141 |
| | | | 12,162 | 89 |
| | | | 9,022 | 66 |
| | | | 8,530 | 62 |
| | | | 7,902 | 58 |
| | | | 7,495 | 55 |
| | | | 7,397 | 54 |
| | | | 7,336 | 53 |
| | | | 6,466 | 47 |
| | | | 5,974 | 43 |
| | | | 5,692 | 41 |
| 5,231 | 38 | | | |
| Pioneer Valley Regional | High School | 97 F SUMNER TURNER RD | 110,580 | 1,085 |
| Nourse Realty, LLC | Plant Nursery | 118 HINSDALE RD | 13,614 | 99 |
| | Greenhouses | 118 HINSDALE RD | 29,535 | TBD |
| | Greenhouses | 118 HINSDALE RD | 28,437 | TBD |
| | Greenhouses | 118 HINSDALE RD | 19,320 | TBD |
| | Greenhouses | 118 HINSDALE RD | 16,885 | TBD |
| | Storage Facility | 92 CALDWELL RD | 29,013 | 285 |
| Moody Center, LLC | Dormitory | 36 WINCHESTER RD | 7,183 | 52 |
| | Dormitory | 206 MAIN ST | 5,427 | 40 |
| | Dormitory | 65 WINCHESTER RD | 20,515 | 149 |
| | Dormitory | 0 WINCHESTER RD | 17,434 | 127 |
| Whitney Trucking | Barn | 578 PINE MEADOW RD | 14,468 | 105 |
| | Barn | 383 PINE MEADOW RD | 10,184 | 74 |
| | Quonset Building | 578 PINE MEADOW RD | 9,286 | n/a - rounded roof |
| South Moon Estate | Youth Center | 154 SO MOUNTAIN RD | 10,345 | 75 |
| | | | 8,341 | 61 |
| | | | 5,907 | 43 |
| | | | 5,847 | 43 |
| Five Point Farm | Barn | 76 UPPER FARMS RD | 9,105 | 66 |
| | Barn | | 6,179 | 45 |
| | Barn | | 5,274 | 38 |
| | Barn/Storage Facility | | 9,967 | 73 |
| O'Shea's Repair | Auto Repair Shop | 531 MT HERMON STATION RD | 12,760 | 93 |
| | Barn | | 6,234 | 45 |
| Northeast Paving | Petroleum (Asphalt) | 216 MT HERMON STATION RD | 10,739 | 78 |
| | Mixing Plant | | | |
| | Office | | 6,527 | 48 |
| Eversource | Substation Building | REAR MILLERS FALLS RD | 7,119 | 52 |
| | | | 6,126 | 45 |

Table 2 List property owners with large roofs in Northfield. See **Appendix B** for a complete list of large roofs. (Please note that the South Moon Estate no longer serves as a youth center.)

5.4 Parking Lots

We identified a number of sites with at least 0.25 acres of parking lot or paved area in Northfield. Potential sites for parking canopies are summarized in Table 3. Technical estimates are based on a packing density of 263 kW per acre.⁶ Note that these estimates are in many cases likely to be higher than the actual potential solar capacity, since they may include paved areas that serve as driveways or vehicle turn-arounds. In addition, some paved areas may not be appropriate for solar – for example, due to site use (e.g., use of tall equipment for loading logging trucks, or aesthetic considerations at or near historic properties). Our estimate of total technical potential on the listed sites is 4,670 kW (4.7 MW). In addition to these sites, there are a number of small parking lots along Main Street in downtown Northfield, and along adjacent side streets. These smaller lots, as well as other small commercial and residential parking areas, could be appropriate for small carport solar arrays.

| Location | Street Address | Approximate Area (acres) | Estimated Solar Technical Potential (kW) |
|---|----------------------|--------------------------|--|
| Pioneer Valley Regional High School | 97 Sumner Turner Rd | (two lots) 3.00 | 789 |
| Whitney Trucking | 578 Pine Meadow Rd | (dirt lot) 2.50 | 658 |
| Samuel Browning, Jr. Trucking | 20 Orange Rd | 1.50 | 395 |
| Daniel Browning | 849 Millers Falls Rd | 1.50 | 395 |
| Northfield Transfer Station (& Highway Garage?) | 49 Caldwell Rd | (two lots) 1.35 | 355 |
| Northfield Elementary School | 104 Main St | 1.2 | 316 |
| Four Star Farms | 496 Pine Meadow Rd | 2.00 | 526 |
| Farm – Nourse | 118 Hinsdale Rd | 0.75 | 197 |
| Community Bible Church | 105 Main St | 0.75 | 197 |
| Northwoods Forest Products | Gulf Rd | 0.70 | 184 |
| Green Pastures Study Center | Moody St | (two lots) 0.60 | 158 |
| Northfield Town Hall | 69 Main St | 0.35 | 92 |
| Golf Course | 31 Holton St | 0.35 | 92 |
| Residence (?) | 330 Old Wendell Rd | 0.35 | 92 |
| Residence | 665 Millers Falls Rd | 0.35 | 92 |
| Thomas Aquinas College | 0 Main St | 0.25 | 66 |
| [Multiple businesses] | 190-198 Main St | 0.25 | 66 |
| TOTAL | | 17.75 | 4,670 |

Table 3 Parking lots and paved surfaces identified in Northfield.

5.5 Landfills, Brownfields, and other Disturbed Sites

Northfield contains no MassDEP-identified brownfields. Northfield has several sand and gravel operations, all located in close proximity to the Northeast Paving facility. Most of these properties are owned by Northeast Paving’s parent company, Eurovia Atlantic Coast, LLC. These properties total 478 acres,

⁶ Krishnan, Ram. 2016. *Technical solar photovoltaic potential of large scale parking lot canopies*. Dissertation, Michigan Technological University.
UMass Amherst Clean Energy Extension *Solar Infrastructure and Resource Assessment for Northfield, MA* 18

although at present, roughly 193 acres appear to be disturbed. Mitchell Materials, LLC of Sunderland owns a 44-acre lot also on the Mount Hermon Station Road, the majority of which (roughly 40 acres) has been excavated. Another nearby property at 122 Old Bernardston Road, owned by Connecticut River Realty, LLC of Shelburne, consists of 79 acres, out of which roughly 9 acres are currently disturbed. Most of these sites appear to be active operations and are likely not suitable for solar currently. However, should mining/quarrying operations at these properties, or portions of these properties, become discontinued, they could be suitable sites for solar. Based on an estimated 1 MW per acre, if the entire areas currently disturbed were to be developed for solar, the total potential capacity would be 48 MW. If all portions of these properties were to be developed (including currently undisturbed areas), the total potential capacity would be 120 MW. Disturbed sites in the vicinity of the Northeast Paving facility in northwest Northfield are shown in Figure 4 below.



Figure 4 Disturbed sites in the vicinity of the Northeast Paving facility in northwest Northfield, with property owners labeled.

In addition, as noted in the grid infrastructure section of this report, there is an electricity transmission line which runs through Northfield. The right-of-way (ROW) associated with this line is maintained as open land by the utility. While not as disturbed as the other types of sites mentioned above, the ROW is partially developed, and includes large areas of land. The ROW, on the eastern side of town, is cleared to roughly 150 ft wide and runs 8 miles through Northfield, for a total area of roughly 146 acres. Much of this area would not be suitable for solar, due to the proximity of protected land, steep slopes, portions crossing through or near private property, watershed considerations in high-elevation portions of the ROWs, and bordering

trees providing too much shade on the edges of the ROW, the ROW could potentially 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. However, this type of land area represents a potential untapped resource for solar across Massachusetts.

5.6 Agricultural Resources

According to the town's website, Northfield was an early attraction for colonial settlers due to its rich and fertile plains along the Connecticut River. Europeans began farming in the area in 1673, and there are still many farms located in the community, especially in proximity to the Connecticut River. Based on MassGIS Land Cover data, 2,136 acres are dedicated to agriculture in Northfield, including 676 acres in hay/pasture and 1,460 cultivated acres. Northfield has large areas of prime farmland soils, concentrated along the Connecticut River, but also scattered in smaller patches throughout the town on both sides of the river.

Northfield has roughly 522 acres of APR land, protected from development in perpetuity by Agricultural Preservation Restrictions. These properties are located mainly along the west side of the Connecticut River bordering Mount Hermon Station Road and Caldwell Road. Three adjacent parcels are protected along Maple Street and St. Mary's Street near the center of town. In addition, 105 properties are currently (2022) enrolled in the Chapter 61A program for the purposes of agricultural production, totaling 1,360 acres. There are also a number of mixed-use properties which include land enrolled in Chapter 61A. The Chapter 61A program acts as a financial disincentive for solar development but does not preclude development of these parcels.

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

- Apple Creek Farm – 850 Old Wendell Road
- Cider Crossing – 166 Maple Street
- Five Point Farm – 76 Upper Farms Road
- Four Star Farms/Farm Brewery – 508 Pine Meadow Road
- Mondego Acres – 25 Lower Farms Road
- Nourse Farms – (Based in Whately/South Deerfield, but owns farmland in Northfield)
- Patterson Farm – Caldwell Road
- Rock Ridge Farm – 2 Main Street
- Severance's Maple Products – 48 Pierson Road
- Trillium Farm – 82 Gulf Road
- Wild Bramble Farm – 570 Millers Falls Road

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.

As noted in Section 4.2, there is already a single medium-scale (64 kW) commercial facility in Northfield owned by Four Star Farms. In July 2022, the Northfield Planning Board granted approval for the construction of three additional large solar arrays totaling 10.9 MW DC capacity at Four Star Farms, but these projects have not yet been installed. These three additional large solar arrays are currently in

litigation. At least 25 barns and farm facilities were identified with large roofs in Northfield (Section 5.3), including those associated with farm businesses as well as residential properties. There are also a number of large greenhouses.

5.7 Commercial-Scale Development Sites

As a final step in the assessment, we explored the potential for large-scale commercial solar development on currently undeveloped land within Northfield. 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 analysis from Mass Audubon⁷, Northfield has 18,803 acres of natural land, composing 79% of the town. There are 3,116 acres of open land, composing an additional 14% of the town. Only 6% of Northfield is developed, totaling 1,351 acres. From 2012 to 2017, 65 acres were developed in Northfield; it ranks 141st out of 351 towns and cities in MA in this category, or 234th when adjusted for land area. Northfield has 6,161 acres (27%) of permanently conserved land, ranking 67th in the state based on conserved area and 131st conserved percentage. A total of 2,185 acres were newly conserved between 2012 and 2019, of which 935 are BioMap2 Core Habitat, 1,561 are BioMap2 Critical Natural Landscape, and 161 are classified by The Natural Conservancy as resilient lands.

Because the vast majority of Northfield 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 areas which are unsuitable for solar, either because they are legally protected from solar development or because they may be important areas for recreation or wildlife conservation. Northfield highly values its natural resources, as discussed in its *Open Space and Recreation Plan*.

In Northfield, there are large, permanently protected properties which are not available for development. These include Northfield State Forest, Satan's Kingdom WMA, Pachaug Brook WMA, and the Brush Mountain Conservation Area. In addition, there are a number of privately owned properties permanently protected through Conservation Restrictions or Agricultural Preservation Restrictions.

In addition to the Chapter 61A agricultural properties noted above. Northfield also has a number of properties which are currently enrolled in the Chapter 61, Chapter 61A, or Chapter 61B programs, for the purposes of providing timber products, recreation, wildlife habitat, or open space value. Chapter 61 programs act as a financial disincentive for solar development but do not preclude development of these parcels. As of 2022, 101 properties are currently enrolled in one of these programs for the purposes noted above, totaling 2,485 acres. In addition, there are some mixed-use properties which include land enrolled in these programs.

Northfield's geography is strongly influenced by the Connecticut River, which cuts through the town. The town is also home to many brooks, large and small, associated wetlands, and scattered small water bodies, including Wanamaker Lake, Lily Pond, Sawyer Ponds, and the Grandin Reservoir. While many wetlands

⁷ 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.

and water bodies are located on protected land, many are located on, or flow through, privately owned properties. Under the Massachusetts Wetland Protection Act, development in wetlands, lakes, rivers, 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.

Nearly three-quarters of Northfield is mapped as BioMap2 habitat, which represents 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 found along the Connecticut River, in the northwest corner of Northfield, and across much of the eastern portion of Northfield, starting 0.5-1.5 miles east of Main Street.

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 Northfield, 268 properties meet these criteria, but 19 properties are largely comprised of permanently protected land. This leaves 249 properties with the potential for commercial-scale solar development, totaling some 5,113 acres. However, wetlands comprise a considerable portion of these properties, and are not available for development. Removing wetland areas leaves approximately 4,692 acres available for development across these 230 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, 155 properties remain with the potential for large-scale solar development, totaling roughly 2,729 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 farmland, other commercial enterprises, 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). Much of Northfield is mapped as BioMap2 habitat, but the central portion of town along Main Street is located near three-phase power and is not mapped as BioMap2 habitat. There are many parcels in this part of town that are not permanently protected, do not have large wetlands, and do not consist largely of BioMap2 habitat. Many of these parcels have private residences on them which could represent a competing land use, but a significant fraction do not.

5.8 Summary

Table 4 below provides a summary of solar resources identified in this assessment.

| Resource Type | Resources Available | Estimated Technical Potential |
|--|---|---|
| Residential-Scale Solar | <ul style="list-style-type: none"> - 2,464 small roofs totaling 3.4 million sf; estimated 893,908 sf available - 1,278 households, of which 75.2% are estimated to support some solar - Average size of a residential solar array in Northfield is 7.53 kW | <ul style="list-style-type: none"> - 13.3 MW if all small roofs were developed - At least 7.2 MW, assuming that 75.2% of households can install a roof or ground-mounted system |
| Medium to Large Scale Roofs | <ul style="list-style-type: none"> - 80 large roofs totaling 899,917 sf; estimated 424,096 sf suitable for solar | Estimated at 6.2 MW |
| Parking Lots | Roughly 17.75 acres, including: <ul style="list-style-type: none"> - 3 acres at Pioneer Valley Regional High School - 2.90 acres combined between Northfield Elementary School, Northfield Transfer Station, and Northfield Town Hall - 5.5 acres combined across several trucking company sites | 4.7 MW, if all sites listed were to be developed |
| Landfills, Brownfields, and other Previously Disturbed Sites | <ul style="list-style-type: none"> - 600 acres across 14 properties identified as sand/gravel sites; roughly 242 acres disturbed at these sites; some sites likely still in active operation - Roughly 8 miles of utility transmission line ROW | <ul style="list-style-type: none"> - Maximum of 120 MW if entire 14 sand/gravel properties were developed for solar; 48 MW if all disturbed areas were developed for solar - Practicality of developing ROWs is still to be determined |
| Agricultural Resources | <ul style="list-style-type: none"> - At least 25 farms and private residences with large barn roofs or other farm facilities - Many greenhouses associated with Nourse - Estimated 2,136 acres in agricultural production | <ul style="list-style-type: none"> - Roughly 1,533 kW (1.5 MW) farm facilities and other barn roofs - 10.9 MW agrivoltaic facility planned at Four Star Farms (still in litigation). - Other capacity dependent on project type (e.g., solar |

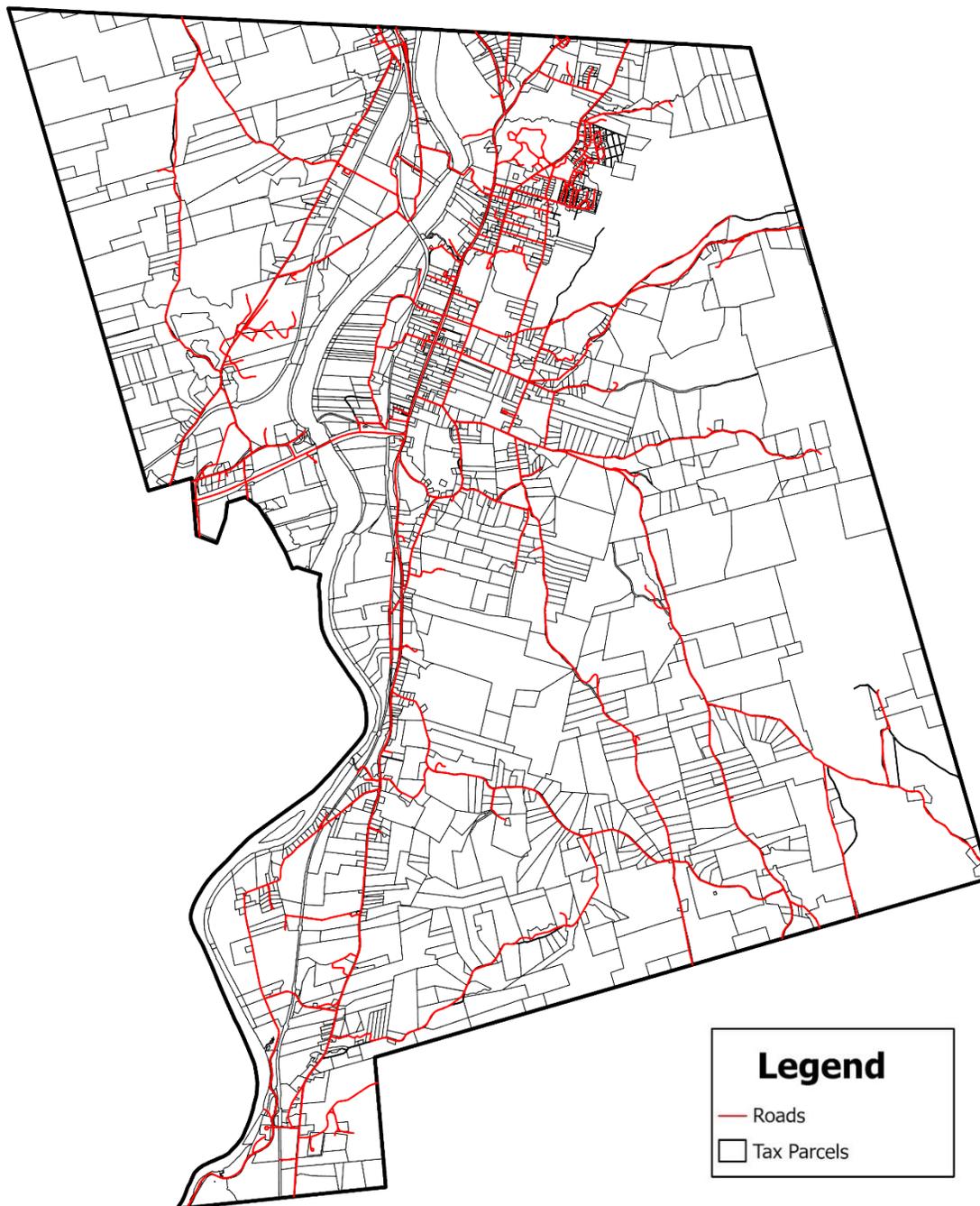
| Resource Type | Resources Available | Estimated Technical Potential |
|------------------|--|---|
| | - At least 1,360 acres in Chapter 61A program for agriculture | greenhouses, parking canopies for farm equipment, agrivoltaic arrays, solar arrays at field margins) |
| Undeveloped Land | <p>-230 large land parcels located near three-phase power have at least 5 acres that are not permanently protected, not wetlands, and are near three-phase power = 4,692 acres of non-wetland land</p> <p>-155 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 = 2,729 acres</p> | <p>Approximately 1 MW per 5 acres: 4,692 acres = 938 MW 2,729 acres = 546 MW</p> <p><i>It is not expected that all undeveloped land available would be built out for solar development.</i></p> |

Table 4: Summary of Northfield’s solar resources identified in this assessment.

Appendix A – Maps of Solar Resources and Infrastructure

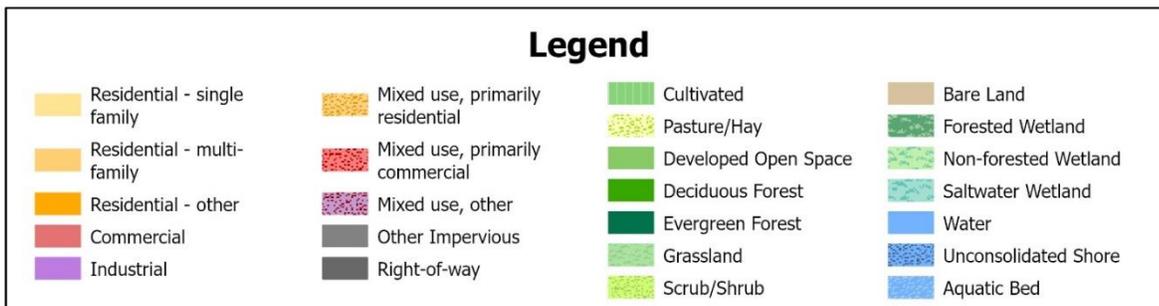
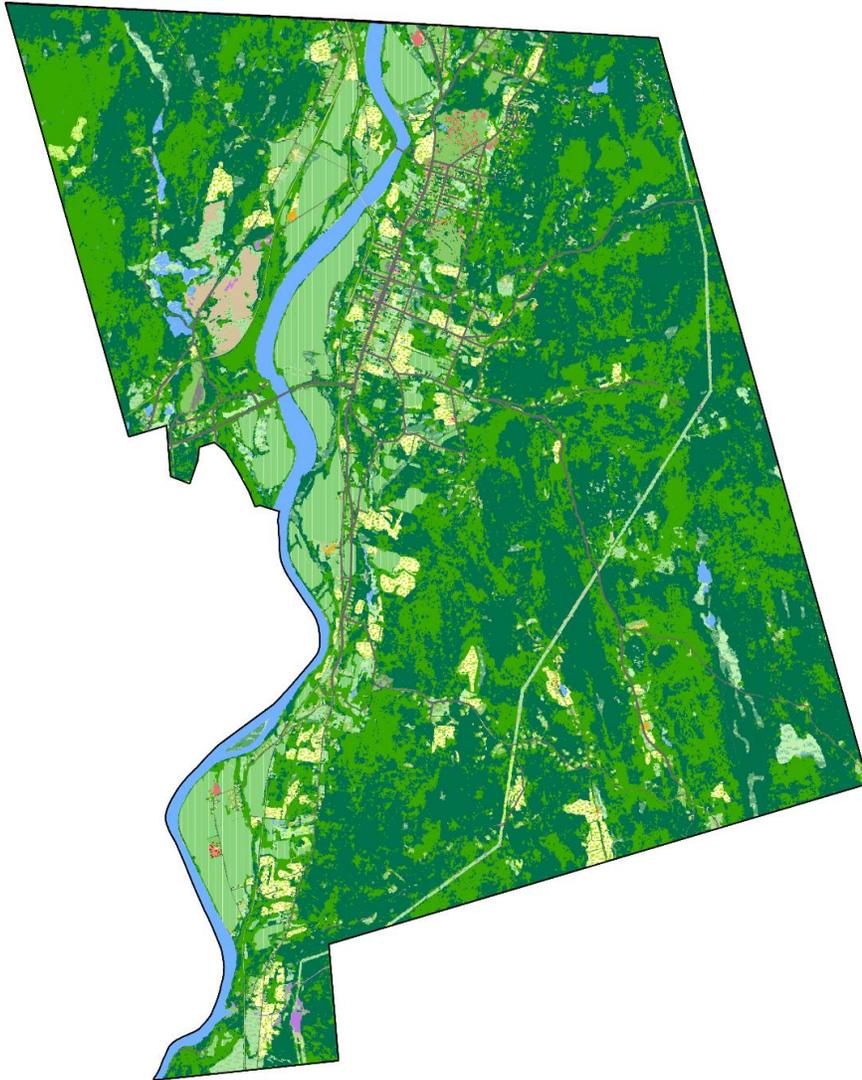
A.1 Roads and Property Lines

Data from MassGIS Tax Parcel data (<https://www.mass.gov/info-details/massgis-data-property-tax-parcels>) and MassDOT roads (<https://www.mass.gov/info-details/massgis-data-massachusetts-department-of-transportation-massdot-roads>).



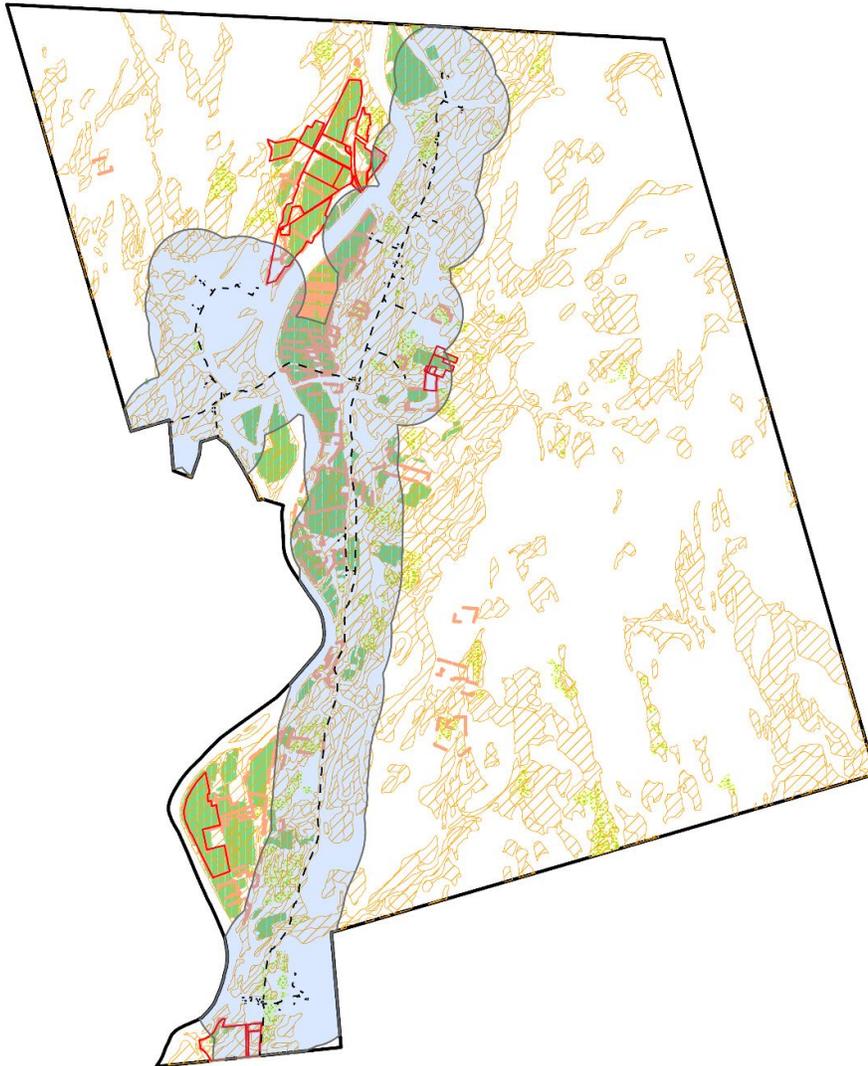
A.2 Land Cover

Land cover data from the MassGIS Land Cover/Land Use data layer, updated in 2016 (<https://www.mass.gov/info-details/massgis-data-2016-land-coverland-use>).



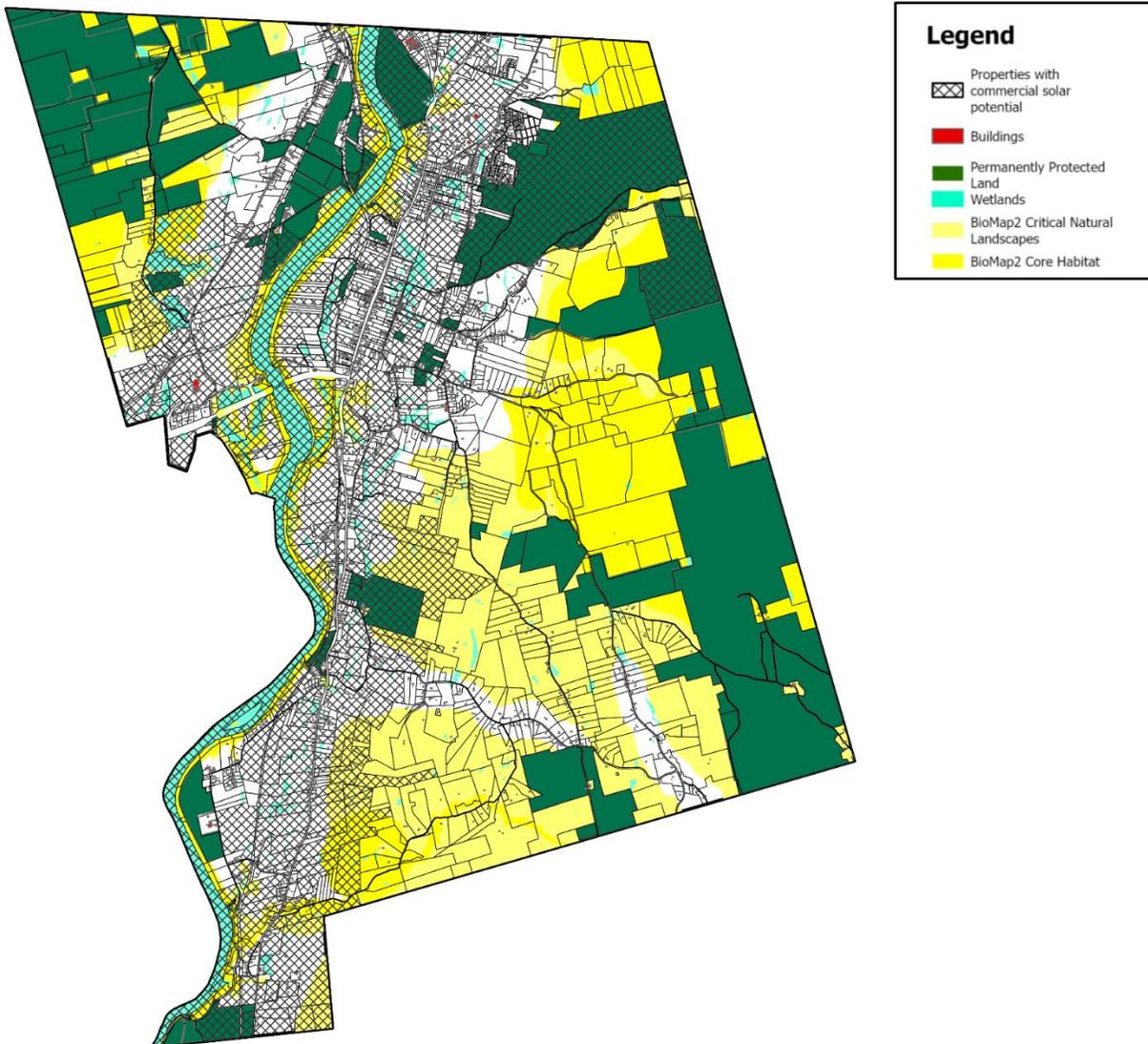
A.3 Agricultural Resources

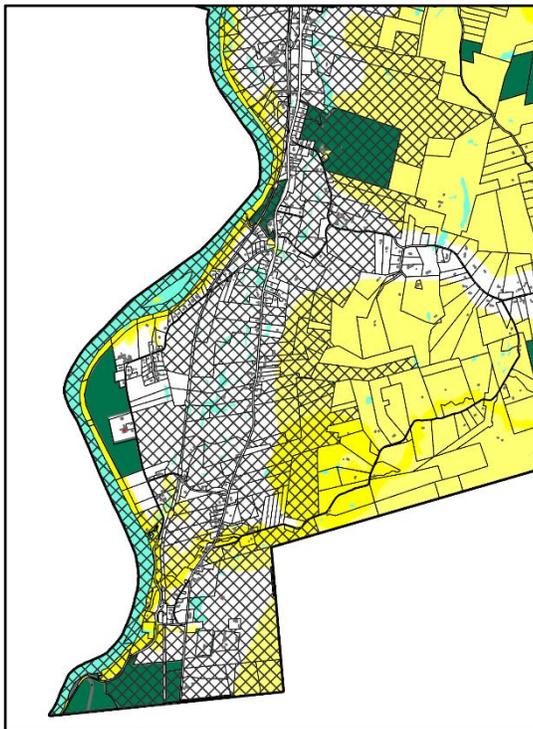
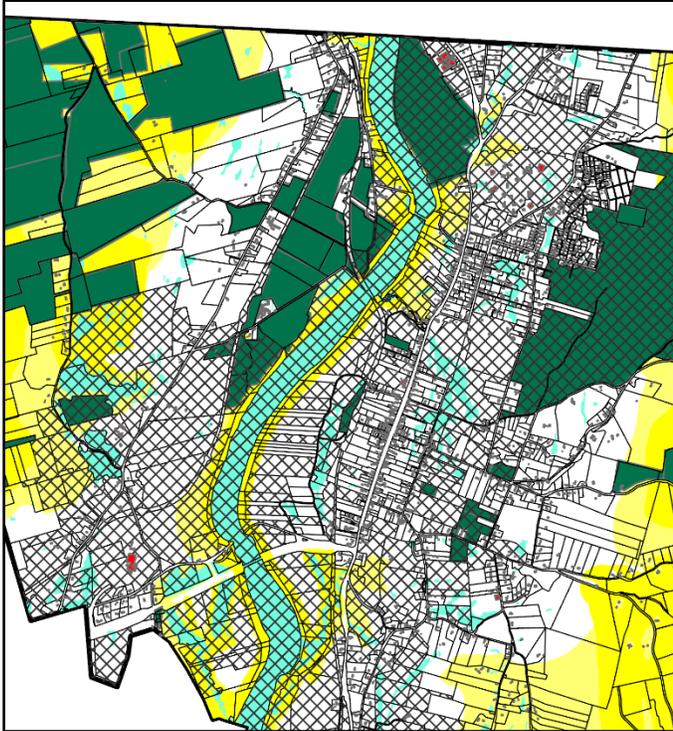
Data from MassGIS Tax Parcel data (<https://www.mass.gov/info-details/massgis-data-property-tax-parcels>), MassGIS Land Cover/Land Use data layer (<https://www.mass.gov/info-details/massgis-data-2016-land-coverland-use>), and NRCS SSURGO-Certified Soils (<https://www.mass.gov/info-details/massgis-data-soils-ssurgo-certified-nrcs>).



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://www.mass.gov/info-details/massgis-data-protected-and-recreational-openspace>), and MassGIS OLIVER DEP wetlands data layer (<https://www.mass.gov/info-details/massgis-data-massdep-wetlands-2005>). Note that the BioMap2 wildlife data layer has recently been updated with a new BioMap datalayer (<https://www.mass.gov/info-details/massgis-data-biomap-the-future-of-conservation>).





Close-ups of the northern (above) and southern (left) portions of town. Note that some large parcels on the west side of the Connecticut River near Route 10 and also along Main St (Route 63) 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 some of these properties, which could preclude development for solar.

Appendix B – Medium & Large Building Roofs

| Structure | Street Address | Roof Area (sf) | Estimated Solar Technical Potential (kW) |
|---|--------------------------|----------------|--|
| Pioneer Valley Regional School | 97 F SUMNER TURNER RD | 110,580 | 1,085 |
| Thomas Aquinas College | 0 MAIN ST | 32,505 | 319 |
| Greenhouses - Nourse | 118 HINSDALE RD | 29,535 | TBD |
| Storage Facility - Nourse | 92 CALDWELL RD | 29,013 | 285 |
| Greenhouses - Nourse | 118 HINSDALE RD | 28,437 | TBD |
| Thomas Aquinas College | 0 MAIN ST | 23,601 | 172 |
| Northfield Elementary School | 104 MAIN STREET | 23,575 | 172 |
| Dormitory - The Moody Center | 65 WINCHESTER RD | 20,515 | 149 |
| Thomas Aquinas College | 0 MAIN ST | 19,333 | 141 |
| Greenhouses - Nourse | 118 HINSDALE RD | 19,320 | TBD |
| Brewery/Farm Business - Four Star Farms | 496 PINE MEADOW RD | 18,932 | 138 |
| Dormitory - The Moody Center | 0 WINCHESTER RD | 17,434 | 127 |
| Greenhouses - Nourse | 118 HINSDALE RD | 16,885 | TBD |
| Barn - Apple Creek Farm | 848 OLD WENDELL RD | 16,313 | 119 |
| Barn - Whitney Trucking | 578 PINE MEADOW RD | 14,468 | 105 |
| Plant Nursery - Nourse Farms | 118 HINSDALE RD | 13,614 | 99 |
| Auto Repair Shop | 531 MT HERMON STATION RD | 12,760 | 93 |
| Thomas Aquinas College | 0 MAIN ST | 12,162 | 89 |
| Petroleum (Asphalt) Mixing Plant - Northeast Paving | 216 MT HERMON STATION RD | 10,739 | 78 |
| Youth Center - South Moon Estate | 154 SO MOUNTAIN RD | 10,345 | 75 |
| Barn - Whitney Trucking | 383 PINE MEADOW RD | 10,184 | 74 |
| Barn/Storage Facility | 79 RANDALL RD | 10,003 | 73 |
| Barn/Storage Facility - Five Point Farm | 76 UPPER FARMS RD | 9,967 | 73 |
| FCHA Housing | 88 MAIN ST | 9,464 | 69 |
| Business Facility - Golf Course | 31 HOLTON ST | 9,348 | 68 |
| Quonset Building - Whitney Trucking | 578 PINE MEADOW RD | 9,286 | n/a - rounded roof |
| Residence | 1 ASHUELOT RD | 9,219 | 67 |
| Barn - Five Point Farm | 76 UPPER FARMS RD | 9,105 | 66 |
| Thomas Aquinas College | 0 MAIN ST | 9,022 | 66 |
| Thomas Aquinas College | 0 MAIN ST | 8,530 | 62 |
| Former Youth Center | 154 SO MOUNTAIN RD | 8,341 | 61 |
| Industrial Building - Northfield Mountain LLC | 0 MILLERS FALLS RD | 8,271 | 60 |
| House+Barn Complex | 330 OLD WENDELL RD | 8,251 | 60 |

| Structure | Street Address | Roof Area (sf) | Estimated Solar Technical Potential (kW) |
|---|--------------------------|----------------|--|
| Garage | 20 ORANGE RD | 8,041 | 59 |
| Thomas Aquinas College | 0 MAIN ST | 7,902 | 58 |
| Industrial Building - Northfield Mountain LLC | 99 MILLERS FALLS RD | 7,689 | 56 |
| Barn | 45 MAPLE ST | 7,625 | 56 |
| Garage - Trucking Terminal | 847 MILLERS FALLS RD | 7,596 | 55 |
| Church Community Bible | 105 MAIN ST | 7,557 | 55 |
| Thomas Aquinas College | 0 MAIN ST | 7,495 | 55 |
| Church - Trinitarian Congregational | 147 MAIN ST | 7,487 | 55 |
| Thomas Aquinas College | 0 MAIN ST | 7,397 | 54 |
| Thomas Aquinas College | 0 MAIN ST | 7,336 | 53 |
| House+Barn Complex | 15 MAIN ST | 7,300 | 53 |
| Dormitory - Moody Center, Inc. | 36 WINCHESTER RD | 7,183 | 52 |
| Substation Building - Eversource | REAR MILLERS FALLS RD | 7,119 | 52 |
| House+Barn Complex | 229 MAPLE ST | 7,081 | 52 |
| House+Barn Complex | 61 MAIN ST | 7,014 | 51 |
| Warehouse - Northfield Mountain LLC | 0 MILLERS FALLS RD | 6,909 | 50 |
| House+Barn Complex | 87 OLD WENDELL RD | 6,654 | 48 |
| Barn | 92 CALDWELL RD | 6,581 | 48 |
| Barn (in disrepair)/Concrete Ramp | 92 CALDWELL RD | 6,532 | 48 |
| Office - Northeast Paving | 216 MT HERMON STATION RD | 6,527 | 48 |
| Office Building | 168 MAIN ST | 6,522 | 47 |
| Garage - Town of Northfield | 49 CALDWELL RD | 6,494 | 47 |
| Thomas Aquinas College | 0 MAIN ST | 6,466 | 47 |
| Barn | 531 MT HERMON STATION RD | 6,234 | 45 |
| Barn - Five Point Farm | 76 UPPER FARMS RD | 6,179 | 45 |
| Substation Building - Eversource | REAR MILLERS FALLS RD | 6,126 | 45 |
| Church - Northfield Bible Conference | 56 WANAMAKER RD | 5,996 | 44 |
| Church - Northfield Baptist | 85 MAIN ST | 5,993 | 44 |
| Thomas Aquinas College | 0 MAIN ST | 5,974 | 43 |
| Youth Center - South Moon Estate | 154 SO MOUNTAIN RD | 5,907 | 43 |
| Barn - Residential | 141 WARWICK RD | 5,872 | 43 |
| House+Barn Complex | 531 MT HERMON STATION RD | 5,851 | 43 |
| Youth Center - South Moon Estate | 154 SO MOUNTAIN RD | 5,847 | 43 |
| Large Residence | 30 MAIN ST | 5,825 | 42 |
| Residence | 436 MILLERS FALLS RD | 5,718 | 42 |
| Thomas Aquinas College | 0 MAIN ST | 5,692 | 41 |
| Barn - Residential | 664 MILLERS FALLS RD | 5,652 | 41 |

| Structure | Street Address | Roof Area (sf) | Estimated Solar Technical Potential (kW) |
|---|-----------------------|-----------------------|---|
| Not clear if a building @ Northfield Water District | 0 OLD TURNPIKE RD | 5,626 | 41 |
| Barns - Northfield Mountain LLC | 153 MILLERS FALLS RD | 5,476 | 40 |
| Large Residence | 31 MAIN ST | 5,446 | 40 |
| Dormitory - Moody Center, Inc. | 206 MAIN ST | 5,427 | 40 |
| Large Contemporary Building (Residence?) | 796 PINE MEADOW RD | 5,376 | 39 |
| Northfield Food Mart | 74 MAIN ST | 5,363 | 39 |
| Barn - Residential | 5 EAST ST | 5,316 | 39 |
| Barn - Five Point Farm | 76 UPPER FARMS RD | 5,274 | 38 |
| Thomas Aquinas College | 0 MAIN ST | 5,231 | 38 |
| Barn - Residential | 122 WARWICK RD | 5,006 | 36 |