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Master's Project: Impacts to Natural Resources and the Natural Environment from Large-Scale Solar Facilities in Vermont: An Analysis of Public Utilities Commission Documents

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Impacts to Natural Resources and the Natural Environment from Large-Scale Solar Facilities in Vermont: An Analysis of Public Utilities Commission Documents

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Abstract:

Renewable energy deployment and conserving biodiversity are both related to mitigating and preventing the worst effects of climate change. These issues require careful consideration of land use and the consequences associated with land use choices. Large-scale ground-mounted photovoltaic solar energy is a promising clean energy technology, as it can be flexibly deployed, produces low lifecycle carbon emissions compared to other energy sources, and is cost competitive. However, questions remain about how large-scale solar will affect ecological functionality of the Vermont landscape. This report evaluates how the Vermont Public Utility Commission, the Vermont Agency of Natural Resources, and other parties to siting ground-mounted solar evaluate the ecological impacts from large-scale solar energy. It includes interviews with experts involved in solar siting issues, a review quantifying stipulations issued by regulators to avoid undue adverse impacts on protected natural resources, and an analysis reviewing common stipulations across all large-scale solar installations sited in Vermont. The analysis reveals a pattern of development favoring farmland and areas with no zoning designation near populated areas. Incentives to deploy 2.2 MW or smaller arrays appeared to have fewer natural resource concerns compared to larger installations. Impacts to grassland bird habitats, abutting forest blocks, soil erosion, and rare, threatened, or endangered species were commonly raised across developments. To improve solar siting and mitigate impacts to environmental resources, increased monitoring requirements and improved coordination between state and local governments solar should be considered by the state to facilitate low-impact developments at the local level.

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2. Introduction

2.1 Climate Change and the Energy Transition in Vermont

This section summarizes Vermont's approach to decarbonizing their energy sector as well as current trends related to energy generation and solar deployment. For an overview of basic energy policy concepts, see Appendix A: Basic Energy Concepts for Natural Resource Professionals. The Vermont State Legislature has implemented several mandates to decarbonize their energy mix. Energy use in Vermont continues to exceed production, and the state continues to be a small player in the larger New England ISO grid network. Solar development in the state peaked from 2016 to 2018 with incentives related to the standard offer program, however local resistance and constraints related to siting continue to limit further solar deployment.

2.1.1 State Decarbonization Goals

The state of Vermont has several decarbonization goals established by law and delegated to agencies overseeing a transition to renewable energy. Vermont Statute 10 V.S.A. § 578 lays out Vermont's greenhouse gas reduction requirements. It states, "Vermont shall reduce emissions of greenhouse gases from within the geographical boundaries of the state and those emissions outside the boundaries of the state that are caused by the use of energy in Vermont." These requirements target both energies generated in Vermont and energy sourced from outside the state. The statue provides targets, the final ones being carbon reductions "not less than 80 percent from 1990 greenhouse gas emissions by January 1, 2050 pursuant to the State's 2016 Comprehensive Energy Plan."

In addition to these carbon reduction goals, Vermont codified it's "25 by 25 State goal" to "by the year 2025, produce 25 percent of the energy consumed within the state through the use of renewable energy sources, particularly from Vermont's farms and forests." [1] The language in this section that strongly encourages proposed solutions to create renewable energy sources which include Vermont farmers or the forest industry. Additional renewable energy goals are found in 30 V.S.A § 8001, which prioritize renewable energy development, offer incentives for renewable energy contracts, and encourage development of viable renewable energy markets.

While not codified, the Climate Action Plan, produced by the Vermont Climate Council, contains further recommendations and pathways to decarbonizing the energy sector across Vermont. The 2022 Comprehensive Energy Plan (CEP)[2] sets a goal for the electric sector to be fully decarbonized and at least 75% renewable by 2032. This expands on 2011 goals related to meeting 90% of the state's energy needs through renewable sources by 2050,[3] and subsequent action steps for meeting these goals proposed in the 2016 CEP.[4] These goals seek to install over 400 MW of solar power generation and approximately 50 MW of solar-energy storage. The CEP also recommends continued improvements to net-metering programs that better reflect development costs and relative contribution to meeting target goals.

[1] 10 V.S.A. § 580
[2] Vermont Department of Public Service, 2022 Vermont Comprehensive Energy Plan – Executive Summary, 1-25 (2022)
[3] Vermont Department of Public Service, 2011 Vermont Comprehensive Energy Plan – Executive Summary (2011)
[4] Vermont Department of Public Service, 2016 Vermont Comprehensive Energy Plan – Executive Summary (2016)

2.1.2 Electrical Generation in Vermont

Although Vermont's overall energy consumption is low compared to the other 49 states in the United States, Vermont's population consumes more electricity than is produced in state.[5] Currently, electrical consumption primarily materializes in the residential sector, followed by the commercial sector. Consumption is likely to increase as Vermont pursues goals related to electrifying the transportation sector.[6]

Because Vermont's in state electrical generation cannot meet in-state electricity demand, Vermont sources most of its electricity from out-of-state sources like Canada's Hydro-Quebec electrical dam facility. Regionally, Vermont plays a relatively small role in the larger grid systems and energy production franchises. This regional component requires Vermont to look externally, as well as internally, on how to meet their energy needs, especially as ISO England state participants maintain different renewable energy portfolio requirements[7] and Canada seeks to further new energy technologies like small nuclear reactors.[8] In-state generating capacity, however, is growing.

In 2020, Vermont's in-state generation provided almost half of the electricity consumed in the state. More than half of this in-state electricity came from the burning of biomass, while a smaller portion came from carbon-free renewable energy like wind and

[5] U.S. EIA, State Energy Data System, Rankings: Total Energy Consumed per Capita, 2019. (https://www.eia.gov/state/analysis.php?sid=VT#15)

[6] Vermont Department of Public Service, 2022 Vermont Comprehensive Energy Plan – Executive Summary, 1-25 (2022)

[7] Schlichting, Kerry. Winne, Melissa. "ISO New England Overview and Regional Update." Presentation to the New Hampshire House Science, Technology & Energy Committee. January 19, 2023. Power Point Presentation.

[8] Honourable Jonathan Wilkinson, Minister of Natural Resources. *Canada's National Statement on Nuclear Energy*. Canada, Natural Resources Canada, October 26, 2022, https://www.canada.ca/en/natural-resources-canada/news/2022/10/canadas-national-statement-on-nuclear-energy--the-honourable-jonathan-wilkinson-minister-of-natural-resources--the-international-atomic-energy-agen.html. Accessed 2/25/2023.

solar.[9] Thermal biomass has growing support through legislative efforts like the Affordable Heat Act (S.5) which is currently under consideration.[10] Legislators will likely continue exploring methods of energy production in this and subsequent legislative sessions.

2.1.3 Solar Energy Across Vermont

Solar energy generation continues to increase in Vermont. Solar deployment in Vermont peaked between 2016 and 2018.[11] Most of the megawatts (MW) in this increase are found in the utility industry, with residential and commercial electricity following closely behind. Overall, 401 MW have been installed across Vermont. This includes utility, commercial, residential, and community solar installations. An additional 119 MW is predicted to follow over the next 5 years.[12]

In 2020, utility-scale (7% of the total in-state electrical generation) and small-scale solar installations (another 7% of the total in-state electrical generation) accounted for one-seventh of Vermont's total net generation.[13] By the end of June 2021, Vermont had about 266 megawatts of solar capacity installed at large and small-scale utility solar sites across the state,[14] compared to its 829 MW of total electrical generating capacity across the state.[15] This trend has been facilitated in part by the Clean Energy Development fund, which assists

[9] U.S. EIA, Vermont Electricity Profile 2019, Table 10, Supply and disposition of electricity, 1990 through 2019.
[10] An act relating to affordably meeting the mandated greenhouse gas reductions for the thermal sector through electrification, decarbonization, efficiency, and weatherization measures. S.5 2023 Vermont State Legislature. (2023), https://legislature.vermont.gov/bill/status/2024/S.5
[11] Solar Energy Industries Association, https://www.seia.org/state-solar-policy/vermont-solar (last visited July 31, 2022)
[12] Ibid
[13] U.S. Energy Information Association, https://www.eia.gov/state/analysis.php?sid=VT (Last visited July 31, 2022)
[14] Ibid
[15] Vermont Electricity Profile 2020, https://www.eia.gov/electricity/state/vermont/ (Last Visited 8/14/2022)

small-scale and community projects using environmentally sustainable electric generation and combined-heat-and-power (CHP) technologies. The 2015 Renewable Energy Standard also contributed to this trend by requiring all retail electricity suppliers in the state to obtain 75% of their annual electricity retail sales from eligible renewable sources by 2032 including 10% from new, in-state renewable generation at customer-site facilities with capacities of 5 megawatts or less.[16]

Ground-mounted solar is divided into two categories based on size: standard offer and large-scale solar.[17] Vermont's Standard Offer program began in 2009 when the Vermont legislature included provisions in Vermont's Sustainably Priced Energy for Economic Development (SPEED) program. The program awards renewable energy developers long-term, fixed-price contracts for qualifying facilities up to 2.2 MW in size.[18] Solar facilities above the 2.2 MW size are defined as large-scale solar by the Public Utilities Commission. These definitions will be used throughout this analysis, and both standard offer projects above 1 MW in generating capacity and projects exceeding 2.2 MW are the subjects of this analysis. In 2012, the program's capacity increased from 50 MW to 127.5 MW, granting more facilities access to the program. Projects eligible for the program are selected through a lottery system, and contract prices are based on tech-specific avoided costs.[19] These incentives lead many solar developers to cap their facilities to 2.2 MW so they qualify for the benefits of the program.

[16] Ibid
[17] For clarification, both standard offer solar and large-scale solar fall into the category of Utility-grade solar, as they are above 1 MW in size.
[18] Department of Public Service – Standard Offer Program, https://publicservice.vermont.gov/renewable_energy/standardoffer, (last visited July 31, 2022)
[19] State of Vermont Public Utility Commission – Standard Offer, https://puc.vermont.gov/electric/standard-offer, (last visited July 31, 2022)

While Vermont remains a renewable friendly state, ground-mounted solar has faced resistance from individual citizens, municipalities, and coalition groups like homeowners associations or activist coalitions. Citing impacts to the natural environment, aesthetics, and orderly development, among other arguments, citizens have submitted public comment or became involved in PUC proceedings to formally oppose these projects. Significant pressure exists on municipalities from citizen groups to avoid developing solar in their communities. This pressure is not unwarranted, as changes to the landscape are often visible when solar is developed. Additionally, some large-scale solar companies have already violated certain CPG provisions,[20] and historic environmental injustices related to new energy systems[21] leave both informed and naïve citizens skeptical of perceived benefits. These benefits may be especially hard for individuals unfamiliar with energy systems to understand when they are construed as global in nature, rather than materializing at the local level.

2.2 Laws Controlling Solar Siting in Vermont

This section reviews the laws governing solar siting in Vermont. Definitions for renewable energy center around a resource's harvest rate when compared to its natural regeneration rate, they also restrict the expansion of the definition to include carbon polluting fuels. Criteria for solar siting is found under 30 V.S.A. § 248, which details the process by which new electrical generating sources acquire a certificate of public good.

[20] Jasper Goodman. "State fines energy company $57,500 for violations at Ludlow solar project." *Vermont Digger*, Jul 29 2020. https://vtdigger.org/2020/07/29/state-fines-energy-company-57500-for-violations-at-ludlow-solar-project/. Accessed 2/18/2023.

[21] A.M. Levenda, I. Behrsin, F. Disano. "Renewable energy for whom? A global systematic review of the environmental justice implication." *Energy Research & Social Science*, Volume 71, 2021, https://doi.org/10.1016/j.erss.2020.101837

This process intersects with Act 250 in key areas related to considering the impact new generating sources have on natural resources. Act 174 of 2016 incentivized local energy planning and created statewide approaches to locating ideal locations for solar projects.

2.2.1 Definitions for Renewable Energy

According to Title 30, Chapter 089, Subchapter 001 definitions section,[22] "renewable energy" is created by technology that "relies on a resource that is being consumed at a harvest rate at or below its natural regeneration rate."[23] Neither harvest rate nor natural regeneration rate are defined by Vermont statute, however it is stated that renewable energy cannot include nuclear fuel and the definition cannot be updated to include coal, oil, propane, or natural gas. The definition does include "methane gas and other flammable gasses produced by the decay of sewage treatment plant wastes or landfill wastes and anaerobic digestion of agricultural products, byproducts, or wastes…or of food [and] silvicultural waste."[24]

Renewable energy is further divided into two definitions: existing renewable energy and new renewable energy. Any renewable energy plant that came into service before or on June 30, 2015, is considered "existing"[25] while anything after that date is considered "new."[26] The section goes on to define "New renewable energy" to include "additional energy from an existing renewable energy plant retrofitted with advanced technologies…to increase the kWh output of the plant…" when compared to a 10-year baseline ending on June 30, 2015. For the purposes of this project, I focus on electricity

[22] 30 V.S.A. § 8002
[23] 30 V.S.A. § 8002(21)
[24] 30 V.S.A. § 8002(21)(A)
[25] 30 V.S.A. § 8002(8)
[26] 30 V.S.A. § 8002(17)

produced with photovoltaic cells mounted on the ground, also known as ground-mounted solar power.

2.2.2 Certificates of Public Good in Section 248 Solar Siting

New electrical facilities and transmission, including solar power, must obtain a Certificate of Public Good (CPG) in accordance with provisions outline in 30 V.S.A. § 248. A CPG certifies that an electrical provider wishing to operate a renewable energy installation, "over which the Public Utility Commission has jurisdiction," must be found to "serve the general good of the state." Criteria to acquire a CPG include several provisions for ground-mounted solar, which are maintaining compliance with municipal bylaw screening requirements[27] and any municipal ordinances recommended to the Public Utility Commission applying to the generating plant in question.[28] These criteria must not interfere with its intended "functional use" and are not more restrictive than screening requirements applied to commercial developments in the municipality under chapter 117. Additional criteria for CPGs include considerations related to ecology and natural resources, including an assessment of the "environmental and economic costs of the purchase, investment, or construction,"[29] as well as a statement that the in-state facility will not have undue adverse effects on the "natural environment."[30] The Agency of Natural Resources focuses most of its assessment on environmental consideration criteria found in Act 250, but their broad mandate to protect the "natural environment" of Vermont allows them some flexibility when considering natural resource issues under their mandate.

[27] 24 V.S.A. § 4414(15)
[28] 24 V.S.A. § 2291(28)
[29] 30 V.S.A. § 248(b)(2)
[30] 30 V.S.A. § 248(b)(5)

Act 250, a land use and development law, provides a quasi-judicial process for reviewing and managing the environmental, social, and fiscal consequences of major subdivisions and developments in Vermont.[31] Act 250's most significant natural resource consideration occurs in its permit process as the law require projects to evaluate their impacts on select natural resources found in Vermont. Impacts on resources such as significant wetlands,[32] irreplaceable natural areas like necessary wildlife habitat or endangered species[33] are evaluated for "undue, adverse effects" before any development can occur.

Act 250 interfaces with solar siting through Section 248. In 30 V.S.A. § 248(a)(4)(E); the Agency of Natural Resources is directed to provide evidence and recommendations concerning findings made under § 248(b)(5) of the same title. These findings made under § 248(b)(5) reference conditions and criteria related to an issuance of permit under 10 V.S.A. § 6086, which include considerations related to water, soil, and several other natural resources of interest to the State of Vermont. The standard for review evaluating impacts to each natural resource differs from resource to resource. For example, the burden of proof to show no "unreasonable or adverse effect" lies on the applicant for issues related to significant wetlands and productive forest soils,[34] while burden of proof for no unreasonable or adverse effect lies on "any party opposing the applicant" with respect to irreplaceable natural areas.[35]

[31] Vermont Natural Resources Board, Act 250 Program, https://nrb.vermont.gov/act250-program Accessed February 23rd, 2022
[32] 10 V.S.A. § 6086(a)(1)(G)
[33] 10 V.S.A. § 6086(a)(8)(A)
[34] 10 V.S.A. § 6088 (a)
[35] 10 V.S.A. § 6088 (b)

2.2.3 The Public Utilities Commission Siting Process – 30 V.S.A. § 248

The Vermont Public Utilities Commission follows 30 V.S.A. § 248 to consider approvals of a CPG for new electric generation in the state. For a visualization of this process, see Appendix B at the end of this document. Parties may participate in this process either as a formal party to the case, with the abilities to join evidentiary hearings and provide testimony, or as a member of the public speaking at public hearings and submitting public comments during comment periods. Agency documents detail this process,[36] which begins when the applicant submits advanced notice at least 45 days prior to a Section 248 petition. This advanced notice allows for municipal and regional planning commissions to issue pre-permitting comments or suggestions based on issues found in the development plan.

After the 45-day period is complete and a petition is filed, the Commission schedules a conference to "discuss procedural details and set schedule leading to an evidentiary hearing and briefing" for each 248 case.[37] Site visits by the Commission and public comment periods are then held to assess site impacts and the public's reaction to the development. Public hearings may also be held by the Commission, or a hearing officer assigned to the case, in the town where the development is occurring. This provides the public another opportunity to raise issues related to the development.

[36] Vermont Public Utilities Commission, Section 248 https://puc.vermont.gov/sites/psbnew/files/doc_library/Siting-Cases-Section%20248-v11_0.pdf, (last visited July 31, 2022)
[37] Ibid

2.2.4 The Act 174 Process, Energy Planning, and Substantial Deference

In 2016, the Vermont Legislature passed the Energy Development Improvement Act, also known as Act 174, which facilitated municipal and regional energy planning standards pursuant to 24 V.S.A. §4352. These voluntary standards were designed to allow local and regional planning bodies to achieve goals related to "identifying areas suitable for renewable energy generation" in addition to other sustainability goals.[38] Updated energy planning standards for regions and municipalities can be found in the Department of Public Service's 2022 Comprehensive Energy Plan. All 11 regional planning commissions have adopted these plans. In contrast, only 69 of the 237 towns across Vermont have created plans under this legislation.[39]

Ground-mounted solar planning and development is further controlled through municipal and regional energy planning. Municipal and regional energy planning is implemented by Municipal and Regional Planning Commissions.[40] Regional plans may include an energy element,[41] which may include "an analysis of resources, needs, scarcities, costs, and problems within the region across all energy sectors, including electric…". This energy element also may identify sites suitable and unsuitable for potential renewable energy development. Municipal plans constitute enhanced energy planning specific to the municipality and may be confirmed by the regional planning commission if said municipal plan meets requirements detailed in 24 V.S.A. § 4352(c). These plans guide regional planners, inform local energy development, and government

[38] 24 V.S.A. § 4302(c)(7)(A)
[39] Vermont Department of Public Service – Act 174 Recommendations and Determination Standards, https://publicservice.vermont.gov/content/act-174-recommendations-and-determination-standards (last visited July 31, 2022)
[40] 24 V.S.A. § 4352
[41] 24 V.S.A. § 4348(a)(3)

oversight to ensure there is orderly development based on needs and availability of energy resources. The Department of Public Service oversees this planning process, approving regional plans as they are submitted to the department.[42]

Energy planning considers ecological preservation across several provisions in 30 V.S.A. § 202. When preparing the 20-year Electrical Energy Plan for the State, the Department of Public Service must assess all "energy resources available" and include "strategies for minimizing the economic and environmental costs" related to the energy supply, its pollutants, and any means related to emission improvements or fuel shifting.[43] This plan must also make efforts to consider "preservation of environmental quality" through consultation with the public, environmental advocacy groups, planning commissions and utilities, and other interested State agencies.[44] After municipalities or regional planning commissions construct a local energy plan, the plans themselves gain "substantial deference" in the Section 248 siting process. Substantial deference means "a land conservation measure or specific policy shall be applied in accordance with its terms unless there is a clear and convincing demonstration that other factors affecting the general good of the State outweigh the application of the measure or policy."[45] While this measure has yet to be tested through litigation, it remains as an important factor allotting greater consideration to those who participate in the energy planning process. This serves as a potential avenue to contest energy projects for which developers have ignored plans created under this process.

[42] 30 V.S.A. § 202
[43] 30 V.S.A. § 202(b)(2)
[44] 30 V.S.A. § 202(c)
[45] 30 V.S.A. § 248 (b)(1)(C)

2.3 Biodiversity and Natural Resource Considerations in Vermont

This section addresses Vermont's ecological resources and the ways agency oversight approach reducing current threats to biodiversity across the state. Vermont prides itself on its rich natural diversity. The Vermont State legislature and the Vermont Climate Council have made efforts to enshrine permanent conservation protections into law, however these efforts have had mixed success. The Agency of Natural Resources (ANR) approaches threat mitigation through the conservation design initiative, which mapped biophysical regions of Vermont and identified methods to preserve priority and high priority conservation areas. ANR address development impacts on natural systems through a review process, in which agency staff flag potential problems for developers so the project can maintain compliance with statutory protections on natural resource systems.

2.3.1 State Goals Related to Preserving Ecological Systems

Vermont has a robust state agency system dedicated to ecological preservation. The Vermont Agency of Natural Resources is the primary agency overseeing the preservation of ecological systems. Their work is divided into three departments: Environmental Conservation; Fish and Wildlife; and Forests, Parks, and Recreation. Each department holds jurisdiction over an element of ecological preservation, including wetlands protections, endangered species protections, and forest management. The goals of each department vary with statutory directives and budgets established by the state legislature, with input from the agency and department heads. One example of department approaches to conservation includes Vermont Fish and Wildlife's Wildlife Action Plans, which

outlines a blueprint to facilitate efforts to conserve endangered species, and species of greatest conservation need, across Vermont.

Recently, a newly formed Climate Council identified statewide goals to protect environmental functions through land preservation. Based on the recommendations of the Climate Council, the Vermont Legislature passed H.606 in the 2022 session. The bill set a goal to protect 30% of the land in Vermont by 2050.[46] The bill represents a significant step towards planning for statewide biodiversity protection in Vermont and it coincided with national efforts by the Biden administration to conserve at least 30% of the land in the United States by 2030 (30x30 plan).[47] However, the Governor vetoed the bill, partially on the grounds that "permanent preservation has not been, and cannot be, the state's exclusive conservation tool".[48] Another iteration of this bill is currently circulating the Vermont Statehouse. H.126 the Community Resilience and Biodiversity Protection Act[49] echoes the call of the Vermont Climate Action Plan to continue investing in strategic, permanent conservation towards targets set in the 30x30 plan, setting state conservation goals at 30% by 2030, and 50% of the State's total land area by 2050. The Secretary of Natural Resources and the Vermont Housing and Conservation Board shall assist the State in achieving these goals under these provisions, which include the development of a conservation plan, assessments, and inventories to track progress being made towards these goals.

[46] H. 606, 2022 Vermont Legislative Session, https://legislature.vermont.gov/bill/status/2022/H.606
[47] The Biden Administration. *Year One Report America the Beautiful*. Office of the President of the United States of America, December 2021,
[48] Associated Press, *Gov. Phil Scott vetoes land conservation bill. Here's why.*, Burlington Free Press, June 3, 2022
[49] An act relating to community resilience and biodiversity protection. H.126, 2023 Vermont General Assembly. (2023)

2.3.2 Major Trends Related to Protecting Ecological Systems in Vermont

Vermont is a lush state, with high species richness in wildlife[50] and over 2,800 plant species.[51] Historic land use trends shifted from primarily agricultural use in the mid-1800s and early 1900s to primarily forestland from the mid-1900s to the present. This trend away from agriculture to forested lands coincided with an increase in public and private funding for conservation.[52] Currently, the state protects about 33%, or 1.3 million acres, of high priority targeted lands.[53] Through new efforts by the Vermont Climate Council and the Vermont Legislature, coupled with consistent work through private land trusts and public land conservation movements across the state, it is likely land conservation will continue across the state for the foreseeable future.

Of the current pressures on Vermont ecological systems, development interests are among the greatest threats. Currently Vermont, like many states, struggles to meet market demands for affordable single family and multi-family housing.[54] This, along with other development pressures, including second home development, has increased land use

[50] Schuyler B. Pearman-Gillman, Jonathan E. Katz, Ruth M. Mickey, James D. Murdoch, Therese M. Donovan, *Predicting wildlife distribution patterns in New England USA with expert elicitation techniques*, Global Ecology and Conservation, Volume 21 (March 2020) https://www.sciencedirect.com/science/article/pii/S2351989419304433?via%3Dihub

[51] Vermont Fish & Wildlife Department Website, https://vtfishandwildlife.com/conserve/conservation-planning/plant-inventory (Last Visited August, 16, 2022)

[52] Agency of Natural Resources. *Land and Water Conservation Study.* Agency of Natural Resources, January 15, 2020, https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwjRqKaghcD9AhXwGFkFHYjEBFIQFnoECAkQAQ&url=https%3A%2F%2Flegislature.vermont.gov%2Fassets%2FLegislative-Reports%2FAct-76-Land-and-Water-Conservation-Study_-Final-Report_1.15.20_ANR.pdf&usg=AOvVaw1vCywWm3ryZjA8YB4V0txE, Accessed 3/3/23

[53] Carolyn D. Loeb, Anthony W. D'Amato, *Large landscape conservation in a mixed ownership region: Opportunities and barriers for putting the pieces together*, Biological Conservation, Vol 243 (March 2008), https://www.sciencedirect.com/science/article/pii/S0006320719316416

[54] Derek Brouwer. "Expensive Housing is Limiting Who Gets to Live Where in Vermont – and Clouds the State's Future." *Seven Days*, Locked Out Series (Part 12), December 20, 2022 https://www.sevendaysvt.com/vermont/expensive-housing-is-limiting-who-gets-to-live-where-in-vermont-and-clouds-the-states-future/Content?oid=37090819

pressure across areas historically occupied by forest or farmland. Researchers at the University of Vermont estimate that Vermont is losing about 1,500 acres of forest land per year,[55] which threatens habitat and forest environments around the state. Because of the depth and extent of the housing problem in Vermont, it is possible ecological protections set under state law could be undermined as state policy makers fight for increased housing availability and development.

Several conservation goals are currently addressed through a mix of private and public conservation interests across the state. A broad trend across the world is that biodiversity has dropped significantly.[56] Both private and public conservation organizations seek to mitigate the loss of biodiversity by preserving land valued for its biodiversity or ability to support biodiversity in surrounding ecosystems. One key aspect of the biodiversity crisis in Vermont relates to forest fragmentation. In the 2017 Vermont Forest Action Plan, the State of Vermont found forest fragmentation and parcelization represent major threats to forest health, productivity, and exacerbate the impacts of climate change.[57] Reports from Vermont State Fish and Wildlife biologists confirm that Vermont is not following Massachusetts approach to solar development, where state activists warn already over 4,000 acres of forests have been clearcut for ground mounted solar.[58]

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[55] Carolyn D. Loeb, Anthony W. D'Amato, *Large landscape conservation in a mixed ownership region: Opportunities and barriers for putting the pieces together*, Biological Conservation, 243, 108462, (March 2020), https://www.sciencedirect.com/science/article/pii/S0006320719316416#!

[56] Abbass, K., Qasim, M.Z., Song, H. *et al.* A review of the global climate change impacts, adaptation, and sustainable mitigation measures. *Environ Sci Pollut Res* **29**, 42539–42559 (2022). https://doi.org/10.1007/s11356-022-19718-6

[57] The Department of Forests, Parks and Recreation. *2017 Vermont Forest Action Plan*. The Department of Forests, Parks and Recreation, 2017, https://fpr.vermont.gov/forest/vermonts_forests/action_plan. Accessed 3/3/2023

[58] Bob Flaherty. "The solar divide: Plans for large-scale solar projects in forests and on farms have riled neighbors who are fighting back." *Daily Hampshire Gazette*, 9/26/2021, https://www.gazettenet.com/The-solar-divide-solar-power-environment-forests-Amherst-ma-Shutesbury-ma-42535037

As developers seek to increase Vermont's existing housing stock, and interest in Vermont real estate continues to rise for primary and secondary homes, pressure has grown to expand development into farmed and forested areas. This follows a broader trend of human migration that trends away from cities and towards the edges of wilderness or forest land[59]. Other forested New England States like Maine have already begun flagging this issue through groups like the Maine Mountain Collaborative.[60] To mitigate these potential issues, Vermont state legislators and civil servants often utilize smart growth principles to balance considerations related to the natural environment, human livelihood, and efficiency of development.[61]

One final consideration related to Vermont's conservation approach includes the role natural communities and rare species play in Vermont's conservation priorities. Vermont prides itself on its high volume of biodiversity and natural community conservation, driven through a combination of efforts across the federal and state agencies, the Vermont Housing and Conservation Board, and private and non-profit land conservation interests. These efforts have accomplished incredible work related to protecting natural communities, but there are still development pressures that fail to consider natural community protections. State conservation interests will likely continue their efforts to conserve these unique and important natural areas as the climate continues

[59] Prichard, S. J., et al. 2021. Adapting western North American forests to climate change and wildfires: 10 common questions. Ecological Applications 31(8):e02433. 10.1002/eap.2433

[60] Janet McMahon. "The Environmental Consequences of Forest Fragmentation in the Western Maine Mountains Main." *Maine Mountain Collaborative*, 2018. https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwiB_-XYicD9AhV0F1kFHXNhBioQFnoECAYQAQ&url=https%3A%2F%2Fmainemountaincollaborative.org%2Fwp-content%2Fuploads%2F2019%2F01%2FEnvironmental-Consequences-Forest-Fragmentation-2019-01-08-Web.pdf&usg=AOvVaw08RHegft_G4aDq5Rt2iqLe

[61] Smart Growth America. "What is smart growth?" *Smart Growth America Website*, 2023. https://smartgrowthamerica.org/what-is-smart-growth/. Accessed 2/24/2023.

to shape the status of these natural communities, even as energy choices force states to choose between tackling climate change or the biodiversity crisis.[62]

2.3.3 The Vermont Conservation Design Initiative's Analysis of Ecological Functionality

The Vermont Conservation Design Initiative, a collaboration between the Vermont Department of Fish and Wildlife, Vermont Department of Forests Parks & Recreation, and Vermont Land Trust is a comprehensive analysis of ecological functionality across the Vermont landscape. The design intends to coordinate and plan conservation to "sustain the state's valued natural areas, forests, waters, wildlife, and plants for future generations," targeting the lowest number of natural features for effective conservation.[63] Survey and GIS data drive the approach to targeted conservation and management that offer a high confidence for continuing the land's ecological functions over time.[64]

The initiative uses a coarse filter approach to conservation[65] to raise awareness about the values of maintaining and connecting forest blocks, surface waters, and riparian areas, while also offering finer grain filters aimed at protecting unique or threatened natural communities. Both filters strive to amplify the identification and protection of vulnerable wildlife habitats, species movement, and an ecologically functional Vermont's landscape. The plan highlights preservation tools such as conservation easements, planning & zoning, and land procurement by public agencies or conservation organizations to preserve unique

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[62] Núñez-Regueiro, M.M., Siddiqui, S.F. and Fletcher, R.J., Jr (2021), Effects of bioenergy on biodiversity arising from land-use change and crop type. Conservation Biology, 35: 77-87. https://doi.org/10.1111/cobi.13452

[63] Eric Sorenson, Robert Zaino, Vermont Conservation Design: Maintaining and Enhancing an Ecologically Functional Landscape (2018)

[64] Ecological functionality is defined in the Vermont Conservation Design Initiative as "containing all native species, full range of native habitats, and all natural communities found in Vermont."

[65] Noss 1987, Hunter et al. 1988

landscape features.[66] This initiative illustrates the biological vulnerabilities across Vermont better than any other survey to date, and is therefore valuable to the issue of solar siting.

2.3.4 Vermont Fish and Wildlife Guidelines on Ecological Considerations in Developments

The primary agency involved in protecting critical wildlife habitat through development review is the Vermont Department of Fish and Wildlife. Department staff first review developments through an advanced notice assessment of the "wildlife and fisheries resources of interest and the potential for these resources to occur in the project area" or abutting properties.[67] Vermont Fish and Wildlife directs developers to email their project descriptions and maps to either members of the wildlife division or the fisheries division for a pre-permitting review.[68] Agency staff use data from the ANR GIS Atlas to look for potential impacts on wildlife and fisheries resources related to the development. If the development is of significant size, it could prompt further agency-wide review by the Agency of Natural Resources Regulatory Review Coordinator.

Documents listed on the agency's website detail several of the primary concerns related to ground-mounted solar development and deer winter habitat (DWH).[69] Focusing on deer wintering habitat, the agency directs developers to not remove softwood trees from these areas and to establish proper buffers of approximately 100 feet. Additionally, construction cannot occur from December 15 to April 15, and individuals can only visit

[66] Landscape features of interested to the Conservation Design plan include Interior Forest Blocks, Connectivity Blocks, Surface Waters and Riparian Areas, and Physical Landscapes. Each is defined in the Vermont Conservation Design plan, cited in footnote 21.
[67] Vermont Fish and Wildlife Department, Development Review, https://vtfishandwildlife.com/conserve/development-review (last visited August 16, 2022)
[68] Ibid
[69] Vermont Fish & Wildlife Department, Guidance to Address Impacts to Deer Winter Habitat Associated with Solar Energy Projects, November 12 2015

the project site once per month during this timeframe. To protect deer shelter and movement, shade trees must be identified and where wildlife movement is expected, usually between the DWH and wetlands. No fencing can be installed that restricts wildlife traffic between these areas.

Because solar development is often sited within grassland and open fields, grassland bird habitat is an important element to consider when siting solar projects.[70] Vermont Fish and Wildlife staff assess proposed development areas for potential as bird habitat, rather than just on whether avian species have been identified in the area. Only 4% of habitat across Vermont is grassland,[71] most of which lies in the Champlain Valley, the Lake Memphremagog basin, and the Connecticut River Valley. Grassland is defined by the agency as a field that consists of greater than 20 acres, is sufficiently open to attract and retain nesting grassland birds, is vegetated primarily with grasses, contains little to no woody vegetation, and has one or more indicator species present during their breeding season.[72] These definitions are particularly important for solar developers to keep in mind, as grassland birds are particularly sensitive to vertical structures.[73] New vertical structures cause grassland birds migrating to their breeding ranges to seek more ideal habitat, even if none exists close to their old breeding grounds.

[70] Vermont Fish & Wildlife Department, Guidance for the Review & mitigation of Impacts to Grassland Bird Habitat in Connection with Regulated Projects in Vermont, 1-16, October 2021
[71] Ibid, page 3
[72] Ibid, page 5
[73] Ibid, page 7

3. Goals and Methods

In this section, I review the goal objectives for this study, and the methodology by which I approached the objectives. This analysis included every large-scale solar development that was approved, denied, or approved in part and denied in part (N= 70), and excluded developments that had incomplete filed their CPG application, are currently pending approval, or were smaller than 1 Megawatt nameplate generating capacity[74]. Documents for analysis were procured from the Vermont Public Utilities Commission online case and document management system ePUC in the summer of 2022. Any cases with missing Final Orders or MOUs were counted as incomplete files and not coded in the process.

3.1 Project Goal & Objectives

The goal of this project was to characterize how ecological resources are assessed and addressed in the context of solar siting energy projects in Vermont. To meet this goal, I had two major objectives. The first objective was to identify the potential impacts from large-scale PV solar development and how they are monitored through the CPG siting process. To address this objective, I conducted semi-structured interviews with professionals involved the solar siting process. I then conducted a systemic review of Final Orders permitting CPGs for each large-scale solar siting case through the Vermont Public Utilities Commission. 80 projects 1 MW or larger in nameplate capacity were reviewed, with special analysis conducted on the 70 projects who were approved or denied between

[74] One exception to this rule was for a case related to a 500 kW project that had significant implications to solar development in forest blocks.

January 2010 to September 2021. My review quantifies treatments of potential impacts and challenges to development in the CPG process. I assigned values to indicate the level of review undertaken for each potential impact. I focused on challenges to developments related to ecological considerations reviewed in this process. This approach addresses objective 1 by obtaining background context related to solar siting in Vermont. It provides a basis to compare issues to evaluate which ones have greater salience within the Vermont solar siting context. The second objective of this study is to understand how the PUC and agencies involved in CPG siting mitigate potential impacts through stipulations tied to development in the CPG process. I addressed this objective by evaluating stipulations within Memorandums of Understanding (MOUs) tied to each large-scale solar development CPG. I quantified stipulations to assess whether a given stipulation assigned to mitigate potential impacts was standardized across other similar developments or if the stipulation is uniquely tailored to the context-specific nature of a development. This approach addresses objective 2 by illuminating differences between mitigation strategies for each criteria reviewed in the CPG permitting process.

3.2 Background Interviews

To gain insight into current issues across Vermont related to ecological conservation, solar energy development, and where the two issues intersect, I interviewed several experts involved in issues related to large-scale solar development. These experts included a wildlife biologist from the Vermont Agency of Natural Resources, a Professor of Energy Technology and Policy at Vermont Law and Graduate School, two city planners from New Haven Vermont, an employee at the Department of Public Service involved with

transmission issues, and a professor at the University of Vermont who specializes in grassland bird ecology. Questions for each interview were tailored to the interviewee. I evaluated the interviews as anecdotal accounts. Themes from them provided context for my review of documents from the PUC. Questions I posed during the interviews I conducted can be found in Table 1 in Appendix C, and summaries of each interview are provided in Appendix E.

3.3 CPG Evaluation Analysis

To better understand trends across large-scale solar developments in Vermont, I conducted two analyses for 70 solar projects with 1 Megawatt or larger generating capacity in Vermont. The first analysis quantified information on the salience of each natural resource issue found in each siting case's Final Order for a Certificate of Public Good (CPG) from the Public Utilities Commission (PUC). Because solar siting considerations are site-dependent, certain issues are more relevant in some cases and not relevant in others. To better understand the impact solar arrays have on the environment, I assessed which impacts to natural resources more often required stipulations that, if followed, would mitigate impacts enough for the PUC to approve their CPG. I quantified issue salience by evaluating stipulation complexity for each development consideration (water resources, soil erosion, Necessary Wildlife Habitat, etc.) in each siting case. The logic behind this approach is that the more complicated the stipulations were for a particular natural resource, the more salient that issue was in the CPG determination. I determined stipulation complexity by counting each numeric item under each natural resource consideration that contained a mitigation measure conditional to the project's approval. I then tallied the number of mitigation measures under each section and assigned a value between zero and

six to each issue to reflect the level of discussion and number of stipulations found under each development consideration. Zero indicated no discussion was had related to a natural resource issue, and 6 reflected in-depth discussion on an issue that lead the PUC to deny that CPG application. Table 2 in Appendix C details each score value, how it reflects the issue discussed, and text examples taken from development considerations in coded cases. Appendix D contains a visual aid to help explain the Salience Score coding system further.

Mitigation measures include any actions required by the PUC for the development under review, either as a condition for approval or to avoid an undue adverse effect on a natural resource. Examples of mitigation measures scored in this analysis were limited to (1) permits required for approval that the petitioner has not already applied for, (2) additional construction or operational practices to mitigate or monitor a potential impact, (3) issues where the PUC allowed for additional mitigation steps to be assigned in the future, (4) protocols for addressing an impact, (5) conditions that offset an impact, (6) or any conditions imposed by the hearing officer or PUC prior to the Final Order issuance. Items not considered mitigation measures included proactive project redesigns that avoided a potential impact, statements of fact that justify why a project will or will not require mitigation in certain areas, or a project description related to the issue but not a mitigation step. All text contained in the same numeric heading counted towards one mitigation measure, even if multiple actions were found in the same mitigation measure (i.e. following a protocol related to erosion that involves multiple steps, mitigation measures that have more than one action listed under the same numeric heading, acquiring a permit with additional conditions, etc.)

There are several limits to this analysis. First, the salience scores describe the degree to which the hearing officer and PUC engaged in discussion about certain natural resource issues, but the score itself is not weighted for or against any value judgements made in these discussions. For instance, extensive discussion with no stipulations (a salience score of 2) on the benefits a project has on a natural resource can receive the same score as extensive discussions with no stipulations on how the project will impact natural resources. Another limitation is that the lens for this analysis is at the state level; details related to the initial land procurement and local discussions related to development are absent. This analysis also does not include discussions between agency officials and project developers excluded from ePUC documents; details illuminating how natural resource issues were deliberated are not included in the scope of this analysis. Finally, while the natural resource considerations under Act 248 provisions are extensive, this analysis does not include natural resource considerations that are not codified into statute. For example, no statute mandates evaluation of impacts to forest health and sustainability for non-woody biomass electrical generating facilities,[75] and discussions related to forest health and sustainability only occur when impacts to forest blocks are raised by ANR under natural environment concerns.

3.4 MOU Analysis

The second analysis involved quantifying how common stipulations were under each natural resource issue across every memorandum of understanding (MOU) between petitioners and ANR. In this analysis, I reviewed Final Orders and separate MOU

[75] 30 V.S.A. § 248 (b)(11)(C)

documents for any stipulations agreed to between the Agency of Natural Resources and the Petitioners. Each stipulation was assessed for how frequently it was found under the same issue across all MOUs and Final Orders in the dataset. The stipulation was then assigned a value of 0, 1 or 2. 2 indicates that the stipulation was common across more than 5 developments, and 1 indicates that the stipulation was found in 5 or fewer other developments. I assigned 0 as a value to distinguish development consideration with no assigned stipulations. From here, I generated a list of common stipulations across all developments, recorded details related to each unique or uncommon stipulation, and summarized my findings for each consideration of natural resources or the natural environment within the CPG siting review process.

4. Results

The following section details the results from background interviews, the CPG documentation analysis, and a comparative analysis of stipulations mitigating potential impacts from large-scale solar. Select case studies are also discussed to illustrate how specific solar projects received either little opposition or significant delays during the CPG permitting process. Background interviews revealed trends that can be categorized as either relating to site development or approaches to stakeholder engagement. 3 out of the 6 interviews illuminate a need for greater state education and collaboration at the local level to achieve statewide goals. Development impacts of greatest concern for state agencies center around soil erosion, wetland protections, and protecting natural environment considerations like rare, threatened or endangered plans and forest blocks. Stipulations to mitigate development impacts have become standardized for soil erosion, impervious

surfaces, and wetland permits; water pollution controls; and fencing requirements to not impede wildlife traffic. Unique stipulations tailored to context specific issues normally materialize in vegetative management plans aimed at protecting RTE plant species, wildlife considerations specific to the development context, and evaluating impacts to abutting forest blocks.

4.1 Background Interviews

I interviewed professionals working in fields that intersect with the solar siting process to identify key themes and insights into how the permitting process can be improved. Questions in these interviews can be found under Table 2 in Appendix C. These themes fall into two main categories: trends related to site development and trends related to stakeholder engagement during solar siting proceedings. Site development is highly impactful and costly to developers. Both industry and agencies involved in protecting natural resources are interested in collaborating on these issues at the local level before projects move to the state level for approval. Stakeholder engagement can be improved with greater investment in energy education to illustrate how benefits of solar power materialize at the local level. Municipalities possess several levers for opposing solar development, especially in areas with municipal energy plans

4.1.1 Themes related to Site Development

It was broadly acknowledged across interviews that both developers and natural resource professionals do advise against solar development in undeveloped areas. From the developer perspective, costs related to site prep increase when the site is undeveloped as

shading and viewshed concerns increase when clearcuts or other site preparation steps are required in a particular site. The Agency of Natural Resources (ANR) aligns with this perspective through a "no clearcut for solar" policy that is enforced through agency intervention. Memorandums of understanding after the advanced notice period is crucial for natural resource professionals to flag siting concerns related to natural resources like forests or wetlands. The agency appears primed and ready to address these concerns on a site-by-site basis to ensure projects they approve comply with the agency's statutory directives to protecting the natural environment. Compliance is normally achieved through vegetation management plans, which delineate specific areas for shade management, no management, or preservation depending on the site-specific contexts like presence of endangered plant species or how tall abutting tree lines are.

Another siting element that incentivizes developing solar near developed areas is access to level three transmission and reduced upfront costs related to "plugging in" the new generating capacity. Without transmission, solar energy cannot move from the generating source to markets where it is consumed. This limits where solar can be developed. It can only be developed where capacity is available in the transmission system next to load that can consume the energy. This forces developers to look closer to populated areas where there is traditionally more load and transmission capacity when compared to more rural areas. New transmission, according to the Department of Public Service (DPS), is always built to serve load since costs to install new transmission are shared between the power purchaser and the power producer. The state is unlikely to invest more in extra transmission because of upfront costs and other grid issues that demand attention, like upgrading substations. Both the DPS and developers admit bigger solar arrays increase

efficiencies related to transmission, but ANR has stated that bigger projects often increase concerns related to impacts on natural resources. These concerns are echoed in the grassland bird advocate interview, where habitat fragmentation becomes a greater concern with a larger array sited on grassland bird habitat.

A major trend across 4 of the 6 interviews is that finding ideal real estate to site solar is the biggest concern for both industry and regulatory bodies. Proactively locating available real estate near load, substations and other energy infrastructure, and areas with fewer impacts may help agency officials and developers begin site assessment at the local level. Planners in interviews admitted that Regional Planning Commissions (RPC) can help facilitate these conversations better than municipal officials since RPCs interface more with state agencies and developers. Additionally, both officials from ANR, DPS, and the solar industry stated that an update to building codes that forces new buildings and subdivisions to consider solar generation could promote rooftop solar or solar in developed areas. DPS is especially interested in buildings that can become self-powering, as this decreasing the need for additional transmission and further reduces impacts to abutting properties.

4.1.2 Themes related to Stakeholder Engagement during Solar Siting Procedures

The other key takeaway from the interviews relates to stakeholder engagement and how tensions in development are addressed. Towns developing solar traditionally interface with state agencies through coordination with regional planning commissions. However, towns can become party to PUC proceedings by asserting substantial deference for cases that conflict with town energy plans or by registering as a party to a case with the PUC

after the developer files for a CPG. Local officials, like those in New Haven Vermont, can proactively choose to not allow solar sited in certain areas like wetlands, but they otherwise do not coordinate directly with the state on issues related to state goals for energy development or conservation. One way this trend could change is through the DPS's increasing focus on energy education as they engage with the public on complicated issues related to the grid or power systems more broadly.

Interviews with planners revealed several accounts related to communities and individuals who oppose solar project development. Opposition to solar projects from members of the local community traditionally come from more conservative, older individuals who care about aesthetics, available farmland, or other local concerns that intersect with a solar development site. Many opponents to solar use arguments that question why their town is being used to address a global issue. These arguments go further to assert that land used for solar cannot be used for traditional uses like farming or other developments that produce clear, tangible benefits to the town. Additionally, these arguments are compounded by a common disinterest, and sometimes fear, of outsider groups becoming involved in small town Vermont issues. This outsider fear stigmatizes collaboration with out-of-state developers, and often can cause solar advocates to become outed as "patsies" for working with or assisting solar development. New Haven planners and the DPS representative suggested countering opposition by focusing on incorporating secondary uses into solar projects to help make the land used for solar blend with the "rural aesthetic," assist local businesses, or promote town values. For instance, the dairy industry in Vermont has been struggling to make the business profitable. Offering incentives to farmers who incorporate solar power generation into their business plans could offer a

chance to support local business and find real estate close to available transmission. Additional attempts at educating interested parties about the energy system should be made to translate this solution to a global problem into one that also addresses local issues.

4.2 Certificate for Public Good Documentation Analysis

Large-scale solar developments in Vermont typically are 2.2 MW or less in generating capacity, and developers enter into a memorandum of understanding with the Agency of Natural Resources. Siting locations are typically near populated areas, built on farmland, and developed in areas with no zoning designation. Most projects took less than a year to permit, requiring approximately 6 acres of land per 1 MW of solar nameplate capacity. Tree clearing for solar was uncommon, however a few cases involved clear cutting for solar while the rest typically saw less than an acre of tree cutting for shade management.

4.2.1 Trends Related to Development Sites

Across all the large-scale solar case analyzed in this study (N = 80), 68 were approved, 8 were incomplete files, 2 were in development, 1 was denied, and 1 was approved in part/denied in part (Figure 1). The rate for partial or full approval is 85%, indicating the Public Utilities Commission has not been resistant to solar development, contrary to the sentiments from some individuals in the solar industry. Large-scale solar facilities listed as an incomplete file contain no details as to why they were incomplete. Any number of issues related to development impacts, local resistance, or issues related to the development itself could be the cause. 64 of the 69 approved PV solar arrays involved a MOU between ANR and the developers (Figure 2).

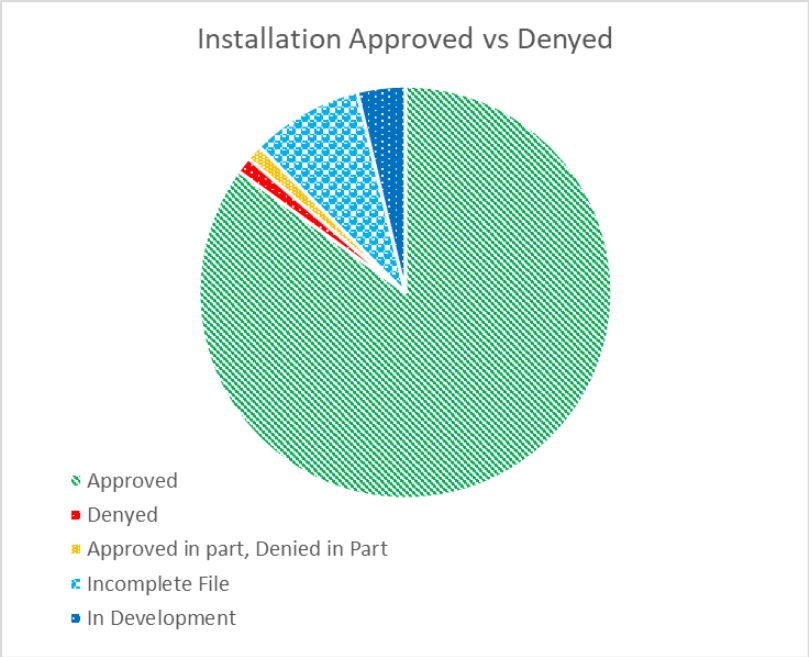

Figure 1 – Large-Scale PV Solar Installations that were Approved (N = 68), Denied (N = 1), Approved in Part and Denied in Part (N = 1), In Development (N = 3), or an Incomplete File (N = 7). This graph illustrates that the majority of large-scale solar projects in Vermont were approved.

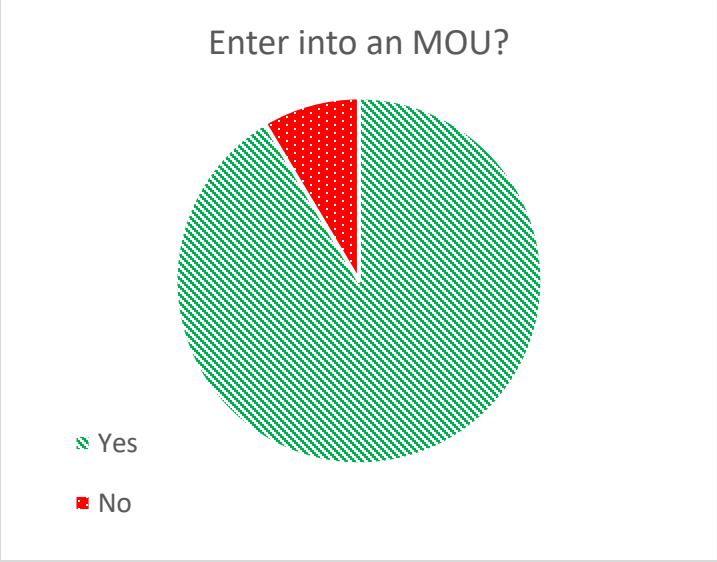

Figure 2 – Large-Scale PV Solar Installations that entered into an Memorandum of Understanding (MOU) with the Agency of Natural Resources. Overall, 64 projects entered into an MOU and only 6 projects did not enter into an MOU

Sizes of PV solar arrays (in Mega Watt Nameplate Capacity) in this study can be found in Figure 3. The most common array nameplate capacity was 2.2 MW (N = 21). 52 (or 75%) of the 69 operating facilities across Vermont are 2.2 MW or below in capacity. This suggests that the Standard Offer Program successfully cultivated interest in solar developments at or below 2.2 MW. Of the 17 arrays that were bigger than 2.2 MW, only 2 facilities were 15 MW or larger in nameplate capacity.

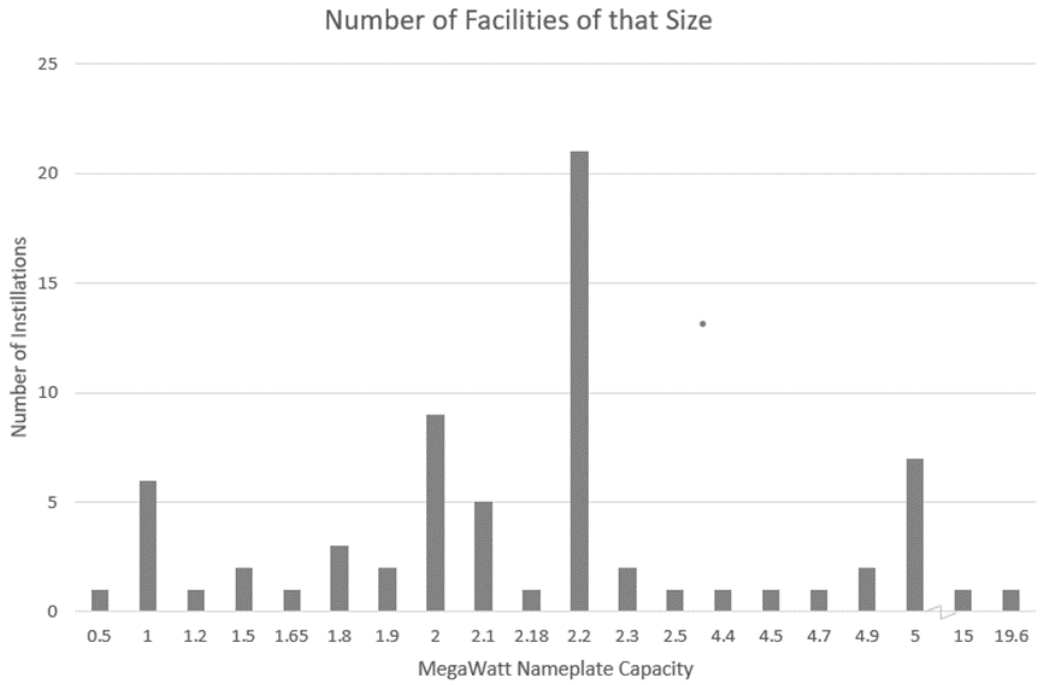

Figure 3 – Number of Large-Scale Solar Projects in Vermont by Size. This graph demonstrates that a vast majority of the projects to date are 2.2 MW in nameplate capacity or lower (N = 52). Of the 17 other projects larger than 2.2 MW, only 2 have been approved (as of this study) that are larger than 15 MW.

Rutland (N = 4) and South Burlington (N = 4) had the most large-scale solar facilities sited within their jurisdictions, followed by Bennington (N = 3) and Williamstown (N = 3). Common zoning designations for arrays analyzed in this study can be found in Figure 4. Large-scale solar development occurred most in areas with no zoning designation (N = 33). When development occurred in zoned areas, the most common zoning designations were Industrial/Commercial designations (N = 11) followed by Rural Residential/Agricultural (N = 7).

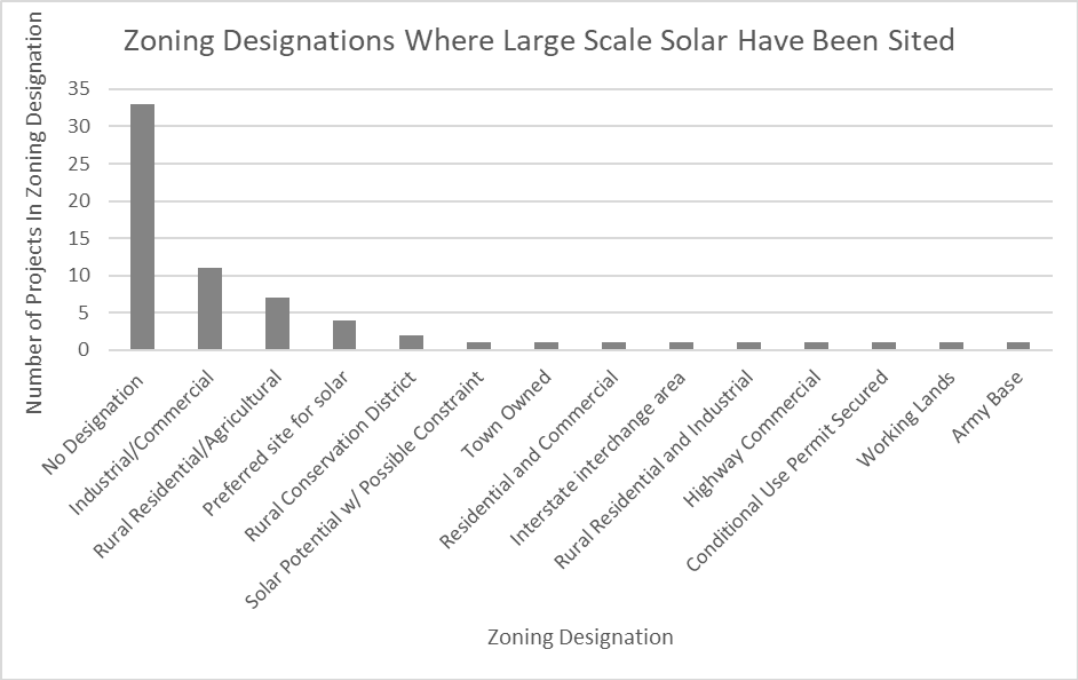

Figure 4 – Zoning Designations Where Large-Scale Solar Projects Have Been Sited. As of this study, a majority of the large-scale PV solar projects in Vermont have been zoned in areas with no zoning designations (N = 33). The second most popular zoning designation were areas zoned for Industrial or Commercial use (N = 11), followed by Rural Residential/Agricultural (N = 7) and Preferred Site for Solar (N = 4)

Excluding developments that took longer than a year or shorter than 100 days, the average time between filing for a CPG and getting a CPG approved was around 267 days (SD +/- 117 days, Figure 5). Although it is not clear how much the Public Utilities Commission weighs impacts to natural resources over other CPG criteria when evaluating solar development, plotting the time it takes to approve a project against the number of natural resource concerns flagged revealed a weak but significant correlation between the number of issues raised and the time it took for a project to receive approval ($R^2 = 0.2564$, $p < 0.05$).

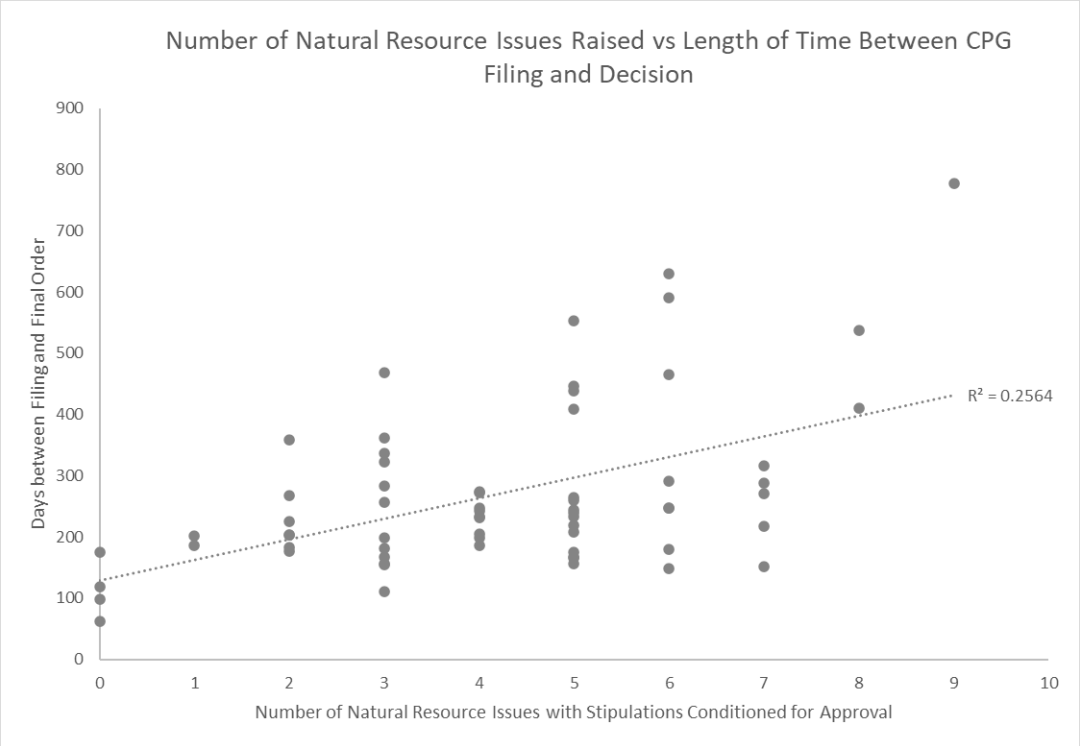

Figure 5 – Number of Natural Resource (NR) Issues with Stipulations in the CPG vs the Number of Days Between CPG Filing and Decision. A weak, positive correlation exists between number of NR issues with stipulations and the number of days between CPG filing and a decision ($R^2 = 0.2564$, $p < 0.05$), indicating the more natural resource issues that require mitigating stipulations within a large-scale PV solar project increases the number of days between filing for a CPG and a decision by the Vermont Public Utilities Commission.

Of the 17 cases that fell outside that time frame, two projects took fewer than 100 days to approve, 10 cases took more than a year to site, and 5 cases took more than 2 years to approve. Of the 70 arrays approved or partially approved, only 6 did not involve a formal memorandum of understanding between the petitioner and ANR. On average, parcels where large-scale solar arrays were sited averaged at about 93 acres per parcel. The solar array itself, on average, took up only 17.67 acres of the parcel; a 1:5 ratio of acres used for solar per acres of parcel. Comparing this measurement to the average nameplate capacity for large-scale solar project, about 6 acres of land are used for about roughly 1 MW of solar nameplate capacity. This number is a rough estimate of how much land is needed to add additional megawatts of solar capacity with the current technology used by these solar developers

In the Final Orders issuing a CPG, agency personnel often documented the habitat types where these facilities were being sited under the project description. A summary of these habitat types can be found in Figure 6. The most common habitat for solar siting were open fields with a history of agricultural use (N = 27), followed by agriculture fields with some forests found abutting or on the property (N = 10). Sixteen cases were sited either next to developed land (4), sand mines (2), copper mines (1), landfills (4), or gravel fields (5). While Rare and Irreplaceable Natural Areas issues were few, four cases had stipulations to protect these areas from impact. This included one case where a clearcut of a Dry Oak-Maple Limestone Forest on cobble was narrowly avoided through ANR intervention during the advanced siting notice period.[76] Of the solar siting cases examined

[76] Petition of Davenport Solar, LLC for a certificate of public good, pursuant to 30 V.S.A. § 248, authorizing the installation and operation of a 15 MW solar electric generation facility in Brandon, Vermont, Case No. 18-3709-PET (12/11/2020)

in this report, 6 were sited within forested areas. Tree clearing wasn't required for each solar development site. The average acreage of tree clearing per site was roughly 3.74 acres per site (SD +/- 5.19). The high standard deviation indicates a contrast in what forests clearing was needed to site the project; while some projects required less than half an acre of tree clearing, others cleared over 9 acres of forest land for solar. Thirteen cases involved clearing more than 5 acres of forestland, and only 4 of these cases involved clearing about 15 acres of forestland.

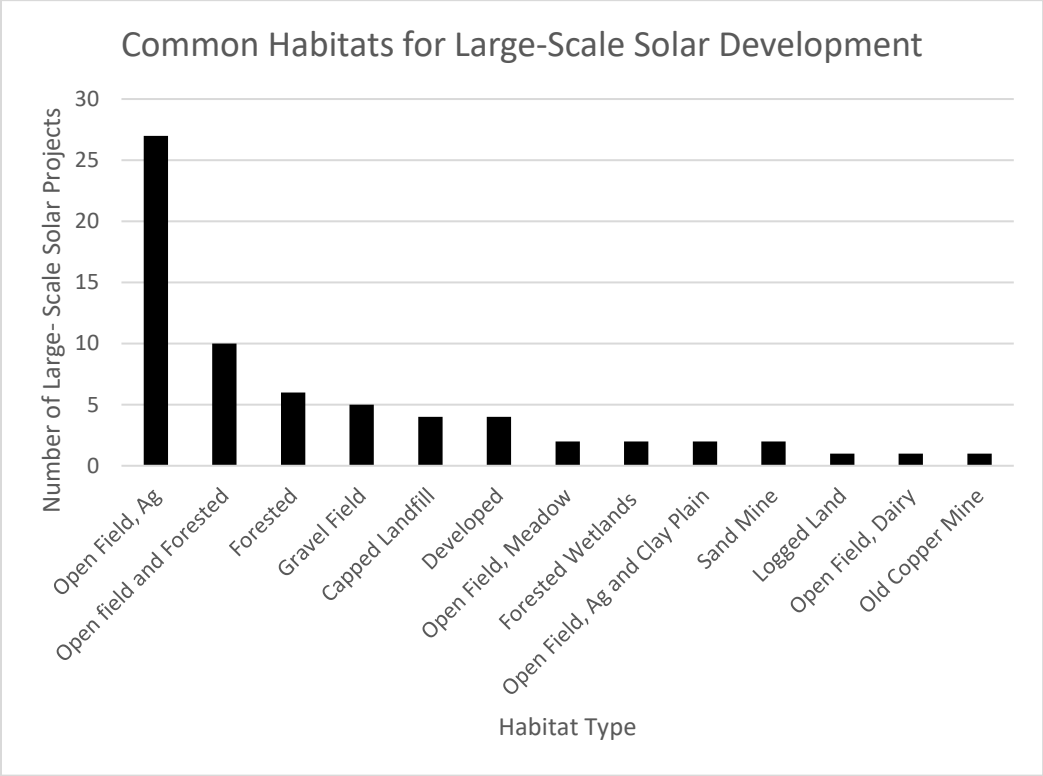

Figure 6 – Common Habitats for Large-Scale Solar Development. As of this study, most solar developments were sited in Open Fields with a history of agricultural use (N = 27). The second most popular habitat for solar development were Open Fields with some Forested areas (N = 10), followed by completely Forested areas (N = 6), Gravel Fields (N = 5), Capped Landfills (N = 4), and Developed areas (N = 4).

4.3 Issue Salience Across Review Criteria

This section details the results of the salience score analysis used to identify which issues evaluated through the CPG permitting process involved, on average, greater discussion and more stipulations to mitigate impacts from development. In this scale, higher scores indicate more discussion and stipulations under a specific review criteria. Lower scores indicate less discussion, or no stipulations issued for a specific review criterion. Scores do not reflect values related to the content of the discussions. Scores were divided into two groups: issues related to natural resources and issues related to the natural environment. Natural resource issues include considerations related to outstanding resource waters, water pollution, air pollution and greenhouse gas impacts, headwaters, floodways, streams, shorelines, wetlands, soils erosion, and rare or irreplaceable natural areas. Natural environments issues include considerations related to necessary wildlife habitat & endangered species, natural communities and invasive species, grassland bird habitat, rare threatened or endangered (RTE) plant species, deer wintering habitat, bear habitat, and forest blocks

4.3.1 Salience Scores for Natural Resource Issues

Issues that involved the greatest number of stipulations related to soil erosion (average salience score = 3.01 +/- 0.629) and water pollution (average salience score = 2.32 +/- 1.119). These values indicate that, on average, the large-scale solar facilities included at least 2 stipulations to mitigate soil erosion and water pollution. Impacts to wetlands were also significant across most large-scale solar facilities. Forty-three cases of the 70 approved cases in this analysis involved stipulations for wetlands. Wetlands received

an average salience score of 2.86 (SD = 1.06), indicating that each case involving wetland typically had at least 2 stipulations for protecting or mitigating impacts to wetland systems. Necessary Wildlife Habitat & Endangered Species are often a subject of discussion during these proceedings: receiving an average salience score of 2.35 (SD = 0.983) across the large-scale solar installations reviewed in this report

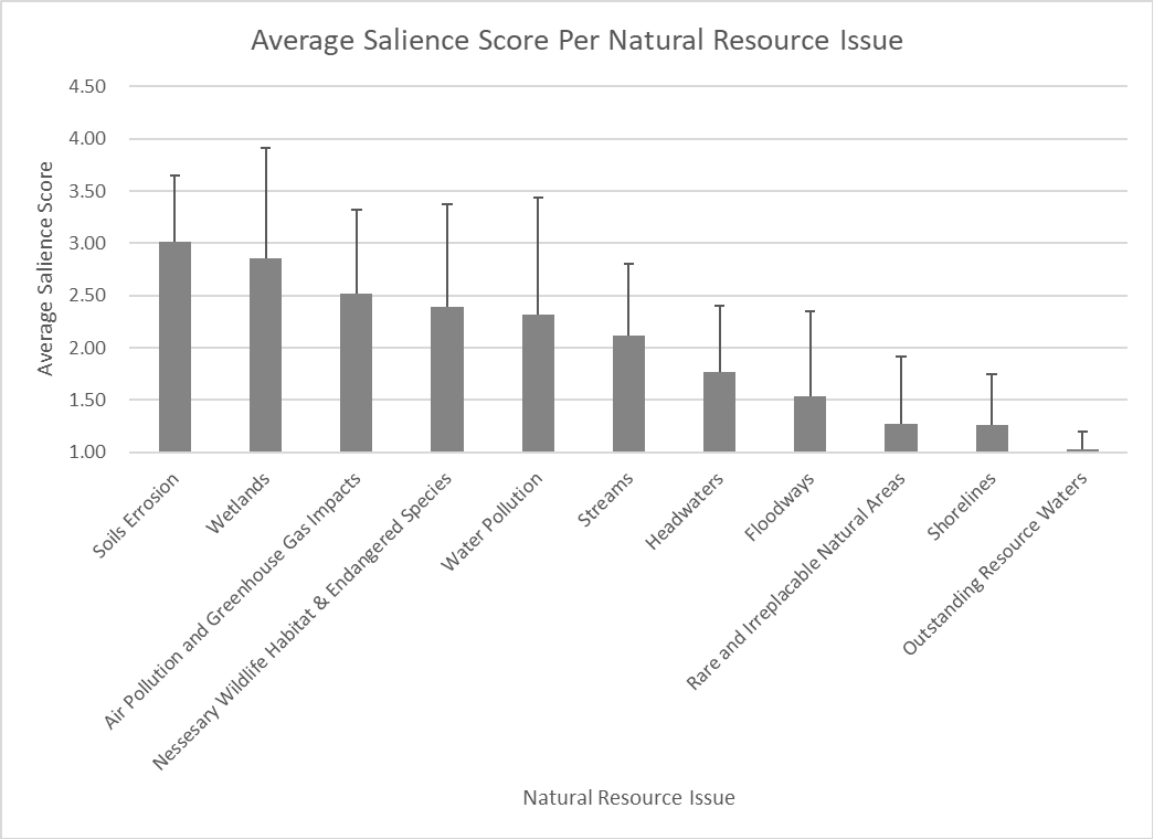

Figure 7 – Average Salience Scores Per Natural Resource (NR) Consideration. The most salient NR issues across those evaluated by the Certificate for Public Good process were those that delt with Soils Erosion (3.01 +/- 0.63), Wetlands (2.86+/- 1.06), and Air Pollution & Green House Gas Impacts (2.52 +/- 0.79). Other major issues involved Necessary Wildlife Habitat & Endangered Species (2.40 +/- 0.98), Water Pollution (2.32 +/- 1.12), and Streams (2.12 +/- 0.69). Issues that were the least salient out of issues related to Natural Resources involved Headwaters (1.77 +/- 0.63), Floodways (1.54 +/- 0.81), Rare & Irreplaceable Natural Areas (1.28 +/- 0.64), Shorelines (1.26 +/- 0.48), and Outstanding Resource Waters (1.03 +/- 0.17).

Air and sound impacts score high on the salience score, with the average at around 2.48 (SD = 0.796). This high salience score, however, does not reflect discussions of negative impacts, but rather a review of the positive impacts to air resources from solar power generation and ANR stipulations reporting on carbon offsets made across the state. Stipulations for streams received an average salience score of 2.1 (SD = 0.689), and only 20 cases involved at least 2 stipulations to protect stream resources. Headwaters, floodways, and shorelines all had relatively low salience scores (1.72 +/- 0.639, 1.55 +/- 0.814, and 1.28 +/- 0.482 respectively), indicating that agency personnel did not often issue stipulations to correct impacts to these resources. Although there were four instances where issues related to rare and irreplaceable natural areas were raised, most cases did not involve development near these areas, resulting in the issue receiving an average salience score of 1.28 (+/- 0.639). Outstanding resource waters received the lowest average salience score for natural resource considerations (1.03 +/- 0.169). This means solar developments were not often sited near outstanding resource waters. This development consideration serves as a baseline in this analysis when issues related to natural resources are rarely discussed because of their low relevancy during project evaluations.

4.3.2 Salience Scores for Natural Environment Issues

Another section of my analysis examined the extent to which natural environment issues were raised. These include issues related to natural communities and invasive species; grassland bird habitat; rare, threatened, or endangered (RTE) plant species; deer wintering habitat; bear habitat; and forest blocks. Frequency of these issues across the cases analyzed is displayed in Figure 8. 51 of the 69 approved cases involved at least one of these issues, with RTE plant species as the most common issue flagged in this analysis (N = 34).

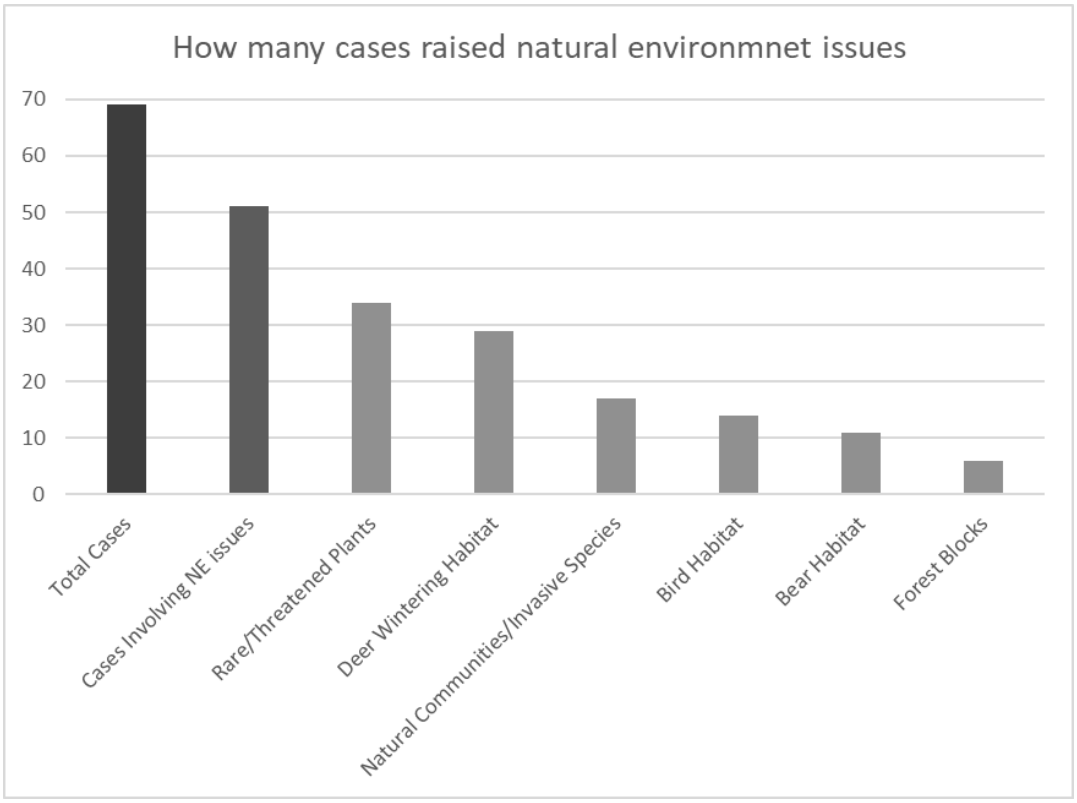

Figure 8 – Number of Times Large-Scale PV Solar Siting Cases Raised Natural Environment Issues by Issue Reviewed through the CPG process. Of the 69 approved or partially approved cases, 51 cases involved at least 1 Natural Environment (NE) issue. The most common NE issues that were raised dealt with Rare, Threatened, or Endangered Plant Species (N = 34) and Deer Wintering Habitat (N = 29). Other NE issues that were raised addressed Natural Communities/Invasive Species (N = 17), Bird Habitat (N = 14), Bear Habitat (N = 11), and Forest Blocks (N = 6).

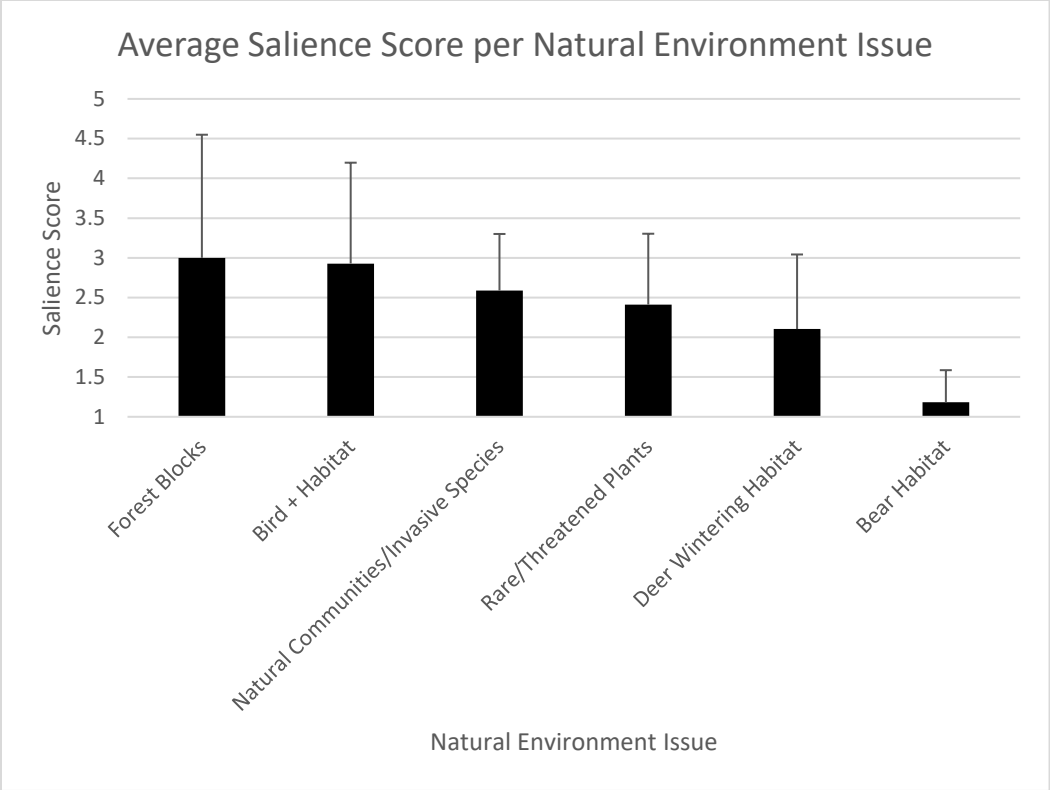

Figure 9 – Average Salience Scores Per Natural Environment Consideration. The most salient NE issues across those evaluated by the Certificate for Public Good process were those that dealt with Forest Blocks (3 +/- 1.55) and Bird Habitat (2.93 +/- 1.27). Other salient NE issues included Natural Community/Invasive Species (2.59 +/- 0.71), Rare, Threatened, or Endangered Plant Species (2.41 +/- 0.89), Deer Wintering Habitat (2.10 +/- 0.94), and Bear Habitat (1.19 +/- 0.41).

Figure 9 details average salience scores for each Natural Environment issue evaluated through the scope of this analysis. Deer wintering habitat concerns were the second most common issue flagged (N = 29). Despite being commonly flagged by ANR, issues related to deer wintering habitat did not often involve stipulations to mitigate impacts (average ss = 2.10). The same pattern was even less so for bear habitat (avg ss = 1.18), which did not have much discussion related to impacts or stipulations to mitigate impacts, if it was discussed at all. Average salience scores for natural environment issues include forest issues (avg ss = 3), bird habitat (avg ss = 2.93), issues related to natural communities

or invasive management (avg ss = 2.59), and RTE plant species (avg ss = 2.41). While these last natural environment issues were not common across all solar siting projects, potential impacts to these issues commonly required more than 2 stipulations to secure a CPG approval.

4.4 Impacts to Natural Resources and Environments from Utility Grade Solar Assessed by the Vermont ANR and PUC

In this section I assess each natural resource and environment issue reviewed through the CPG permitting process for how large-scale solar development affects each criterion. I start by evaluating criteria more commonly impacted by solar development, moving through each criteria reviewed in the CPG process. I conclude with some of the least impactful, and occasionally beneficial, areas considered during the CPG permitting process.

4.4.1 Impacts to Soil Erosion

Concerns related to soil are particularly important issues, for both the Agency of Natural Resources and the Agency of Agriculture, Food, and Markets. The average salience score across all the large-scale solar projects analyzed in this work was 2.99 (SD = 0.629), meaning on average there were at least two stipulations to address impacts to soils for projects analyzed in this process. Since 58 of the 69 large-scale solar projects required some form of stipulation related to soil erosion protections, this is a highly salient issue that Vermont agencies focused on when considering new developments. Because installing

ground mounted solar involves a lot of heavy equipment,[77] agency personnel are concerned with sediment disruption, compaction, and run-off. These concerns increase when the site is on prime agricultural land, as defined by 30 V.S.A. § 6001(15). Productive agricultural soils are valuable assets to farmers and maintaining them preserves future agricultural uses on the site after decommissioning the solar array.

Compaction is another element at play when considering construction impacts to soil. During construction of any kind, heavy machinery is used to move equipment and materials from where they were sourced to where they will inevitably be installed. This heavy machinery, when driving along soil, compact material they drive over and change the soil's physical properties.[78] Changes due to compaction often negatively impact plants growth by making it difficult for roots to penetrate the soil, access nutrients, and provide secure structure to the plant.

Soil impacts depend in part on the mounting system that holds the panels. Racks and poles are common methods to hold solar panels since they can be adjusted to maximize sun exposure throughout the seasons.[79] To avoid being blown over by wind, however, these racks and poles must be rooted deep into the ground, a process that involves penetrating and disturbing the soil. Ballasts are an alternative to these penetrating systems because they mount the panels to a concrete block that rests on the soils surface.[80] These are ideal for

[77] University of Massachusetts Amherst. "Location Considerations for Ground-Mounted Solar PV Arrays." *Center for Agriculture, Food, and the Environment Clean Energy Extension*, February 2022. https://ag.umass.edu/clean-energy/fact-sheets/location-considerations-for-ground-mounted-solar-pv-arrays Last Accessed 3/3/2023.
[78]University of Minnesota. "Soil Compaction." *University of Minnesota Extension*, 2018. https://extension.umn.edu/soil-management-and-health/soil-compaction#soil-structure-1147260. Accessed 3/3/2023
[79] Melissa Smith. "How Ground Mounted Solar Panels Work." *EcoWatch*, February 14, 2023 https://www.ecowatch.com/solar/ground-mounted-solar-panels Accessed 3/3/2023.
[80] Kelly Pickerel. "What's up with solar ballast?" *Solar Power World*, April 7, 2016. https://www.solarpowerworldonline.com/2016/04/whats-solar-ballast/ Accessed 3/3/2023

industrial roof tops or capped landfills,[81] where there is no soil to penetrate or soil penetration risks disturbing the landfill cap. The main downsides to ballast systems are that the concrete can break down over time and these systems leave little room between the solar panel and the ground. This limits potential multiple uses for the space where the panels are installed.

4.4.2 Impacts from Water Pollution

Impacts from water pollution were frequently discussed. Aside from issues related to waste disposal or herbicide use, water pollution concerns raised in solar siting cases look primarily at the oil used for electrical transformers and how the oil is contained. Transformer oil, also known as insulating oil, is a mineral oil that is stable at high temperatures and insulates electricity well.[82] If a leak or disruption in the transformer occurs, the oil can leak and pollute the environment surrounding the transformer.

4.4.3 Impacts on Wetlands

Wetlands are significant ecological features when developments are reviewed in Vermont. These habitats draw intense evaluation from environmental professionals due to the role they play in many ecological functions that benefit natural and human environments alike. In addition to serving as prime habitat for many unique species across

[81]Petition of the City of South Burlington for a certificate of public good pursuant to 30 V.S.A. §§ 248(j) and 219a(m)(2) authorizing the installation and operation of a 1.55 MW solar group net-metered electric generation facility on a closed landfill in South Burlington, Vermont, Docket No. 8722 (10/12/2016)
[82] Frank D. Petruzella, *Industrial Electronics*, p. 51, Glencoe/McGraw-Hill, 1996.

Vermont, they also help buffer flooding and erosion, filter pollutants out of the water cycle, provide a sink for atmospheric carbon, and support fishery activities.[83]

Vermont's Department of Environmental Conservation has a program dedicated to evaluating, delineating, and tracking wetlands found across the Vermont landscape. Wetlands are separated into three classes. Class 1 wetlands are characterized as exceptional or irreplaceable in their contribution to Vermont's natural heritage and provide unmatched environmental functions and values. These are afforded a high level of protection, and development in these areas is highly discouraged. Class 2 wetlands are categorized as being the same type and threshold size as ones mapped on the Vermont Significant Wetlands Index. They often contain dense and persistent non-woody vegetation, are adjacent to a stream, river, or open body of water, and are over 2,500 square feet in size. Vernal pools and headwater wetlands are also counted towards class 2 wetlands, as are wetlands that contain a rare, threatened, endangered, or uncommon species or exemplary natural communities that appears in the Vermont Natural Heritage Inventory. These are more common in development considerations as changes in topography or hydrology can create new wetlands or expand previous wetland complexes. Class 3 wetlands are defined as neither class 1 or class 2 wetlands and carry fewer protections so long as the wetland functions and values are not significant. The Army Corp of Engineers also conducts similar evaluations for wetlands found in federal jurisdictions.

Class 1 and 2 wetlands are evaluated by their significant contributions to functions and values of wetlands. There are a wide range of functions wetlands can serve in their environment, and development near these wetlands can diminish the effectiveness of these

[83] Dahl, T.E. 2011. Status and trends of wetlands in the conterminous United States 2004 to 2009. Washington, DC: U.S. Department of the Interior, Fish and Wildlife Service

functions in the short and long term. Hydrological and topographic changes can influence the flow of water into these wetlands, potentially changing their classification and ability to serve as valuable habitat or hydrologically important areas. These changes have cascading effects on the species composition of these sensitive habitats, as even slight changes to these environments can impact listed species, their fitness, and long-term productivity. Wildlife biodiversity, which utilize wetlands for food and habitat, can also become deterred from using wetlands near developments if changes near their habitat are significant.[84]

4.4.4 Impacts to headwaters, floodways, shorelines, and streams

Vermont comprehensively reviews the impacts to headwaters, floodways, shorelines, and streams. The Public Utility Commission defines headwaters through a six-part test, which involves assessing if the development site is characterized by steep slopes and shallow soils, has drainage areas of 20 square miles or less, is above 1,500 feet elevation, has watersheds of public water supplies designated by the Agency of Natural Resources, or are areas supplying significant amounts of recharge waters to aquifers. If it meets some of these criteria, there can be additional stipulations added to minimize impacts to the headwater "to protect reduction of the quality of ground or surface waters" flowing through the area.[85]

Floodways and shorelines are similarly contextual because they are limited to solar developments in flood hazard areas, along river corridors, or along shorelines.

[84]Albert, J.S., Destouni, G., Duke-Sylvester, S.M. *et al.* Scientists' warning to humanity on the freshwater biodiversity crisis. *Ambio* **50**, 85–94 (2021). https://doi.org/10.1007/s13280-020-01318-8
[85] 10 V.S.A. § 6086(a)(1)(A)

Encroachment, a term used by the Vermont Department of Environmental Conservation to describe development along natural water bodies, is a land use pattern that can damage ecosystem functionality along these areas, in addition to leaving development susceptible to damages from flooding or erosion.[86] In proceedings that involve flooding, the applicant must prove that their development will not restrict or divert the flow of floodwaters, cause or contribute to fluvial erosion, and endanger the health, safety, and welfare of the public or of riparian owners during flooding.[87] Similar concerns exist for shorelines related to erosion and maintaining the natural condition of the shoreline,[88] with additional provisions created to enable continued access to the waters of the shoreline and screening requirements related to development along a shoreline. When solar installations are built in developed environments, capped landfills, or other areas with existing plans to mitigate impacts on these bodies of water, often no additional stipulations are issued. Updating plans to include the new solar development is often sufficient to pass impact assessments during the siting process.

Stream protections were commonly implemented when streams or creeks were found during stream surveys conducted by ANR officials. Any potentially impacted streams around the project are discussed, and on some occasions a few stipulations are issued to protect these resources from development. Because construction can be an intense process, agency officials always check for streams to ensure none are accidentally

[86] Department of Environmental Conservation. "What is Encroachment?" *Department of Environmental Conservation Website,* January 2017, https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwjGwZeOoMD9AhVXElkFHfRKBsIQFnoECAgQAw&url=https%3A%2F%2Fdec.vermont.gov%2Fsites%2Fdec%2Ffiles%2Fdocuments%2Fwsmd_swms_StressorPlan_Encroachment.pdf&usg=AOvVaw1-cQUDa_TBiJELUOly43NN Accessed 3/3/2023.

[87] 10 V.S.A. § 6086(a)(1)(D)

[88] 10 V.S.A. § 6086(a)(1)(F)

redirected by construction activities. Since solar panel placement can be easy to redesign compared to other issues, developers can move or change their set up to avoid building in or near streams delineated prior to site preparation.

4.4.5 Necessary Wildlife Habitat and Endangered Species

Necessary wildlife habitat and endangered species cover a wide range of fauna found throughout the Vermont landscape. Impacts to grassland birds are frequently discussed where flat areas with good solar potential overlap with potential grassland bird habitats. Grassland bird surveys are frequently conducted by ANR to assess habitat potential for these vulnerable species, since adding vertical structures to a grassland bird habitat can cause obligate grassland birds to avoid that habitat in the future.[89] This avoidance behavior prevents grassland birds from utilizing the area for breeding or nesting as they search for more desirable habitat that contain food to forage, nesting material like hay, and freedom from vertical structures. It is imperative that any new solar installation avoid displacing these vulnerable bird species, because grassland habitat is already scarce across Vermont.

Common wildlife habitats are monitored for impacts due to the ease at which these habitats can be delineated and mapped in large statewide databases. Deer wintering habitats are one such habitat that can be mapped based on tree stand type and concentration. Southward facing concentrations of softwood trees next to mixed hardwoods can provide

[89] Helzer, C.J. and Jelinski, D.E. (1999), THE RELATIVE IMPORTANCE OF PATCH AREA AND PERIMETER–AREA RATIO TO GRASSLAND BREEDING BIRDS. Ecological Applications, 9: 1448-1458. https://doi.org/10.1890/1051-0761(1999)009[1448:TRIOPA]2.0.CO;2
Shustack, D.P. and Rodewald, A.D. (2010), A method for detecting undervalued resources with application to breeding birds. Ecological Applications, 20: 2047-2057. https://doi.org/10.1890/09-1295.1

ample access to advantageous microclimates for bedding and potential forage for winter sustenance. Bear habitat is also easier to delineate and map. Surveyors will look for stands of beech and oak along with wetlands, which are viewed as important feeding areas for black bear.[90] They also check these trees for bear claw marks as indications of bear activity, since bears will climb trees to access hard to reach food or escape threats. Any development near these areas can remove habitat features that deer and bear depend on. It can also frighten animals out of these area as they avoid human activity. This may reduce their fitness as they spend more time searching for ideal habitats and food sources.

Bats and their habitat are often discussed when tree clearing activities occur on development sites. To keep solar panels from being shaded out by neighboring tree lines, developers and ANR demarcate specific areas for selective cuts or clearcutting. Bats can be affected by these habitat alterations when a tree that serves as summer roosts or winter hibernaculum is felled. These trees are usually dead, dying, hollow, or possess big slabs of peeling bark where bats can roost. Trees with these characteristics are incredibly important for many bat species, especially for reproductive females in the endangered Indiana bat species.[91] Normally site assessment professionals mark potential roost or hibernaculum trees, and selective cuts can allow foresters to avoid them. Felling a tree actively used as a roost for these endangered bats can kill reproductive individuals and leave developers open to an Endangered Species Act unauthorized take suit if a permit for the take was not acquired before cutting.

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[90] Vermont Fish and Wildlife Department. "Black Bear" *Agency of Natural Resources Fish and Wildlife Department Website*, 2023. https://vtfishandwildlife.com/learn-more/vermont-critters/mammals/black-bear Accessed 3/3/2023

[91] U.S. Fish & Wildlife Service. "Indiana Bat" *U.S. Fish & Wildlife Service Website*, Accessed 3/3/2023 https://www.fws.gov/species/indiana-bat-myotis-sodalis

Rare, threatened, or endangered (RTE) plant species are common issues found in siting development. To demonstrate the project has no undue adverse impact on any RTE plant species, the developer or ANR normally assess the property for RTE species as a part of their CPG application. A variety of RTE species have been found during these assessments. Due to the impacts from construction, developers are required to assess impacts to any RTE plants to avoid potential takes and destroying dwindling populations of rare plant species. It is equally important for developers to consider invasive plant species during pre- and post-construction activities. Disturbance and heavy traffic from vehicles and individuals can track invasive seedlings to freshly disturbed ground. If developers are unaware of this impact or do not consider invasive management during develop, they risk creating new habitat for invasive species to exploit, furthering their spread into new areas of Vermont both on and abutting the development site.

4.4.6 Forest Blocks and Landscape Connectivity

Solar development impacts landscape connectivity in several ways, and agencies evaluate these concerns as they relate to forest blocks, specific wildlife habitat, and natural communities. When evaluating the impacts to forests blocks, ANR evaluates the quality of the forest blocks near or located on the development site. Because members at the Vermont ANR are concerned about impacts to forest blocks from development, several cases involve ANR providing evidence to the PUC on how development near these forest blocks impacts the forest blocks themselves.[92] Any human development near forest blocks can degrade the

[92] Petition of Norwich Technologies, Inc. for a certificate of public good, pursuant to 30 V.S.A. §§ 248 and 8010 and Commission Rule 5.100, authorizing construction of a 500 kW solar net-metering system in Windsor, Vermont, Case No. 18-1730-NMP (01/22/2020)

abutting forest block over time, as forest edge species intrude deeper into forest habitat through disturbance from development. This pushes deep forest species further into the forest block, which poses an issue for areas with limited forest habitat or intense development surrounding the forest block. These developments can also further the spread of invasives into forest blocks, degrading their condition as forest blocks and limiting their value for conservation in the future.

To better characterize the microenvironments across the landscape, natural resource professionals delineate natural communities to enhance landscape evaluations and create a clearer picture on how certain activities impact these microenvironments. These microenvironments are not often well understood by developers, so protecting these sensitive environments requires close consultation with ANR to create better dialogue on how different natural communities respond to human disturbance. Like forest blocks, any disturbances abutting natural communities has the potential to degrade the quality of the natural community, even if the development is not directly inside the natural community. Invasive species introduction, restricting sunlight, increased human activity, changes to soil or hydrology, or fencing all have the potential to negatively impact ecological processes that enable these natural communities to exist.

4.4.7 Air and Sound Impacts

Impacts to air quality are rarely negative, since air pollution related to construction is temporary and no other impacts to air resources traditionally accompany solar power generation. Additionally, long-term air quality improvements are made with a shift towards low lifecycle carbon renewable energy. The only negative impact to air from solar

development relates to dust pollution during construction. These impacts are localized temporally and spatially to the site during construction. ANR reports on greenhouse gas emission reductions, and it has become standard practice for ANR to issue stipulations that track upgrades and power production from these renewable, low-carbon electrical energy sources. Reporting on greenhouse gas emission avoidance was found to be noncontroversial across both developers and agency personnel evaluating large-scale solar project impacts.

Sound, on the other hand, is often mentioned as a potential impact from these facilities. Noise generated during construction is often impactful to the area surrounding the site due to the rural environment in which many of these installations are developed. This noise can deter migrating wildlife or wildlife that live in potentially sensitive habitats abutting the property, forcing them into areas they might not otherwise go.[93] Additionally, during the daytime, electrical transformers make noise that can range from 25 to 35 decibels (dBA).[94] Impacts from this sound occur during the day, and a trail camera observation of a grey fox visiting a solar site at night suggest these impacts might not carry over from the day.[95] Long term analysis of sound impacts in New England have not been

[93] Kunc Hansjoerg P. and Schmidt Rouven. "The effects of anthropogenic noise on animals: a meta-analysis." *Biol. Lett*. **15** (2019) https://doi.org/10.1098/rsbl.2019.0649
[94] John Wanjiku and Jonathan Melvin. "Why are power transformers so noisy?" *Siemens Blog*, January 9, 2023 https://blogs.sw.siemens.com/simcenter/why-are-power-transformers-so-noisy/ Accessed 3/3/2023.
[95]Personal observation

fully studied, however their potential impacts is noteworthy considering sound can impact wildlife fitness[96] or induce fear responses in animals conditioned to avoid human noise.[97]

4.5 Common Stipulations Agreed Upon by Developers, ANR, and the PUC

In this section I evaluate how the PUC and ANR mitigate impacts to reviewed criteria using stipulations tied to each criterion evaluated. Stipulations have either standardized approaches to mitigating impacts to a specific criterion or involve tailored approaches to a specific context located on the development site. Standardized stipulations are covered first in this section, while examples of unique stipulations are covered towards the end of this section

4.5.1 Soil Erosion

The Agency of Natural Resources have several common stipulations related to soils protections during development. Many soil protections are issued through a 3-9020 Stormwater Construction General Permit, which classify projects as either low or moderate risk for erosion. All other projects that fall outside these two categories require an individual stormwater discharge permit. The 3-9020 permit requires low risk project developers to follow the Low-Risk Site Handbook for Erosion Prevention and Sediment Control, while moderate risk projects require a site-specific Erosion Prevention and

[96] Francis, C.D. and Barber, J.R. (2013), A framework for understanding noise impacts on wildlife: an urgent conservation priority. Frontiers in Ecology and the Environment, 11: 305-313. https://doi.org/10.1890/120183

[97] Suraci, J.P., Clinchy, M., Zanette, L.Y. and Wilmers, C.C. (2019), Fear of humans as apex predators has landscape-scale impacts from mountain lions to mice. Ecol Lett, 22: 1578-1586. https://doi.org/10.1111/ele.13344

Sediment Control Plan (EPSC Plan) conforming to Vermont Standards and Specifications for Erosion Prevention and Sediment Control.

Outside of these permits and erosion mitigation plans, ANR or the Agency of Agriculture and Food Markets will sometimes require prime agricultural soils to be stockpiled in an area away from the development site. These stockpiled soils are sometimes separated by horizon, and all are returned to the development area after decommissioning is finalized. Recovered soils are then tested for density after reapplication, and native grass or plant seed mixes are required to be spread on disturbed areas as an additional erosion prevention measure. Passive revegetation can also be mandated, depending on the site, as well as tilling soils after decommissioning to minimize compaction issues. Erosion control measures in areas where trees clearing occurs include leaving tree stumps in the ground, rather than grubbing them into wood chips. If erosion measures through the permitting system are insufficient, the PUC could mandate permanent erosion control measures to protect vulnerable soils.

4.5.2 Stormwater Permits for Impervious Surfaces

When issuing stipulations to protect water resources, ANR assigns stipulations based on the site-specific context and impact to site-specific water resources. One common stipulation assigned to most new developments is the issuance of an Operational Stormwater Permit 3-9050, which regulates stormwater runoff from impervious surfaces. Before July 1st, 2022, the threshold that required this permit was any new development with more than 1 acre of new impervious surface. After July 1st, 2022, a rule change lowered this threshold to any project with more than ½ an acre of new impervious surfaces.

While large-scale solar developments have traditionally not exceeded 1 acre in new impervious surfaces, a vast majority of them do exceed ½ acre of new impervious surfaces. Thus, this rule change raised requirements for solar developers siting large-scale solar sites in Vermont. On developed land with existing impervious surfaces, ANR and the PUC have sometimes promulgated stipulations that require the breakup and removal of legacy impervious surfaces. While costly to the developer, the PUC speaks favorably towards developments sited in already developed areas because these stipulations can help restore natural conditions within these developed areas.

4.5.3 Water pollution

Stipulations that address potential threats to water quality typically focus on the electrical transformers and the insulating oil they use. If developers do not consider it prior to the final order, the PUC will require the developer to install a secondary containment system around the transformer that can hold over 100% of the oil used in the transformer. This secondary containment system is designed to prevent any oil leaks by having enough room to store all the oil used in the transformer, plus any additional liquid potentially introduced to the transformer over time. Additional mitigation stipulation for oil spills could require the construction of earthen berms to contain potential spills in case the secondary containment fails; or developers can update existing spill mitigation plans if they exist for the development site. As a final failsafe, the PUC or ANR will require developers to use either a non-toxic or vegetable-based oil for their cooling oil to prevent hydrocarbon contamination on the site in the case of a spill.

4.5.4 Buffers and Flagging for Management Areas

Flagging and buffers are common stipulations issued to protect stream and wetland resources near new large-scale solar developments. These buffers can be stipulated to remain undisturbed, but sometimes site-specific requirements related to selective tree cutting or minor clearcuts are implemented to prevent shading. Native plantings can also be included in these provisions as screening for the project or erosion control measures. Vegetative management plans, constructed in consultation with ANR, traditionally demarcate what areas around the new development allow clearcutting, allow selective cutting, or require no disturbance. Many times, these vegetative management plans deal with aesthetic and shading concerns, since tree shade and impacts to viewsheds are big concerns developers and community members have about vegetation surrounding the solar array. Ecologists interested in promoting native tree, shrub, and herbaceous plant species should consider tailoring vegetative or aesthetic management plans to require native plantings whenever additional plantings are required. Developers are also instructed to contact ANR when there are any additional concerns related to selective cuttings in or around buffers.

4.5.5 Streams and floodways

When it comes to direct stream impacts, any movement, excavation, or fills involving 10 or more cubic yards annually in any perennial stream requires a stream alteration permit from the Department of Environmental Conservation.[98] Solar panels are flexible as it relates to their placement, so it is common for developers to work with ANR

[98] "Vermont Stream Alteration Rule" *The Department of Environmental Conservation*, March 10, 2017. https://dec.vermont.gov/content/vermont-stream-alteration-rule

on redesigning the project to avoid impacts to streams rather than seeking a stream alteration permit. There has been several instances where upgrades to culverts were stipulated as a part of the CPG approval process, usually to avoid road impacts to streams, repair infrastructure, or improve wildlife crossing in select wildlife corridors.

Floodway considerations are relatively straightforward, as the PUC typically requires developers to delineate floodways along the site and raise the panels height to accommodate potential flooding. In some instances, special flood hazard area management plans or additional planting to enhance floodway buffers were required by the agency or municipality. Overall, floodways appear to be of lower concern compared to other issues related to protecting natural resources from development, as seen in a case where a project was redesigned into a floodway to avoid impacts to wildlife connectivity.[99]

4.5.6 Wetlands

To protect wetlands across Vermont, the Department of Environmental Conservation manages a wetland program that delineates, tracks, and protects wetlands across the state. A common stipulation for all developments close to wetland areas is to demarcate all existing wetlands within the development area prior to construction. Additional demarcation requirements are usually put into decommissioning plans to track how wetland complexes have changed over time. Mowing restrictions are also common to implement in or around wetland areas, and normally accompany vegetative management plans.

[99] Petition of Davenport Solar, LLC for a certificate of public good, pursuant to 30 V.S.A. § 248, authorizing the installation and operation of a 15 MW solar electric generation facility in Brandon, Vermont, Case No. 18-3709-PET (12/11/2020)

Any construction activities occurring within the wetlands require a wetland permit, unless they are exempt or considered an allowed use. One allowed use that is frequently associated with CPG applications is the installation of transmission upgrades in existing right aways. These upgrades are often evaluated with the project itself when considering wetland impacts. To acquire this permit, petitioners must demonstrate "they are unable to perform the activity outside of the wetland or buffer zone and that they are not lowering the quality of the wetland's protected functions and values."[100] The applicant must also seek an additional wetland permit prior to decommissioning to ensure no wetlands that formed after construction will be impacted by decommissioning activities. When a permit is issued, another common stipulation for construction operations conducted in a wetland is for construction to occur on mats or during frozen conditions to minimize impacts to the wetland complex. Similar permits and protection considerations exist under regulations overseen by the Army Corps of Engineers when a wetland falls within their jurisdiction. The ANR is frequently in close contact with developers as it relates to wetland impacts.

4.5.7 Timing Requirements for Construction, Tree Clearing, or Mowing

Many stipulations are issued related to the natural environment, wildlife, and habitats of interest to the ANR. A common stipulation used for concerns related to wildlife are time of year and time of day requirements. These requirements can be for construction activities, mowing, or for selective tree cuttings. Construction restrictions during the winter months are normally implemented to protect deer inside deer wintering habitat from December 15th to April 15th. Construction restrictions can also be delayed if there are large

[100] "Vermont Wetland Rules" *Department of Environmental Conservation*, February 10, 2023. https://dec.vermont.gov/watershed/wetlands/jurisdictional/rules

nesting raptors, such as osprey, found near the development site. These restrictions can only be lifted after an official from the Fish and Wildlife confirms the raptor has abandoned their nest, as seen in one case involving an osprey nest near a development site.[101]

Mowing restrictions are traditionally enforced near potential hay nesting grassland bird habitat throughout the early summer months. Restricting mowing during this time prevents disruptions to their mating behaviors and nests. If the site is within the summer range of the Indiana Bat, tree cutting operations and tree cutting size restrictions can be stipulated to occur only between November 15th and March 15th to better protect the Indiana bat reproduction roosts. Depending on the situation, acoustic studies and bat preservation plans can be required to properly assess and protect bat populations in the development area. Shade management plans are sometimes used to demarcate areas where cutting is allowed, mark potential bat roosts and hibernaculum, and specify what kinds of trees can be cut during certain times of the year.

4.5.8 Fencing

Fencing is a point of slight tension between natural resource professionals and electrical engineers because fencing can restrict wildlife movement and is traditionally used by electricians to limit access to electricity-producing facilities. Addressing the fencing issue, as it relates to a solar array, requires a site-specific approach. For instance, if there are areas where public access is guaranteed and fencing the array would prevent said access, Fish and Wildlife have successfully required no fencing in those cases to

[101] Petition of GMPSolar - Panton, LLC, for a certificate of public good, pursuant to 30 V.S.A. § 248, authorizing the installation and operation of a 4.90 MW solar electric generation facility off Panton Road in Panton, Vermont, to be known as the "GMPSolar Panton Project", Docket No. 8637 (7/8/2016)

preserve public access rights. Additionally, where migrating wildlife is concerned, stipulations have been included to minimize impacts on animals like salamanders[102] and small mammals like fox, skunk, or mink.[103] These fences are built to restrict larger wildlife like deer, which can crawl under fencing and get stuck inside the array if they are determined to access the solar array site. As this fencing problem has evolved over time, ANR has crystalized around a stipulation that requires fencing with 6"x 6" gaps to allow smaller wildlife to navigate through and prevent exploitation by larger, more adventurous wildlife.

4.5.9 Rare, Threatened, or Endangered plant species

As a part of early ANR engagement and site visits, a Rare, Threatened, or Endangered (RTE) plant species survey is nearly always conducted to properly assess the project's potential impact on vulnerable plant species. After this happens, RTE species are normally flagged and monitored during construction to prevent an accidental take by the developer. Another RTE plant survey is usually attached as a condition prior to decommissioning. Unique stipulations related to this criterion can be found later in this section.

[102] Petition of Sudbury Solar LLC for a certificate of public good, pursuant to 30 V.S.A. § 248, authorizing the construction and operation of a 2.0 MW solar electric generation facility on Vermont Route 30, Sudbury, Vermont, Docket No. 8225 (9/3/2015)

[103] Petition of GMP MicroGrid -Milton LLC for a Certificate of Public Good, pursuant to 30 V.S.A. § 248, authorizing the installation and operation of up to a 4.99 MW solar electric generation facility and 2 MW battery storage facility to be located off Mears Road in Milton, Vermont, and to be known as the "GMP MicroGrid-Milton Project," Case No. 17-5003-PET (02/04/2019)

4.5.10 Invasive Species Management

Depending on how prevalent invasive species are surrounding the development site, ANR or the PUC can require invasive management plans to be implemented during construction and/or operation. ANR can require developers to wash their equipment prior to entering the development site to prevent invasive seeds from spreading in the newly disturbed area. They can also create conditions that monitor and manage spread for specific invasive species if they are concerned about invasives, natural communities, or RTE plant species near or on the development site. While ANR can ban the use of herbicides in some cases to prevent water pollution, they will allow some use of herbicides to control for invasives. Reseeding the area with native plants is another way ANR requires developments to prevent the spread of invasives.

4.5.11 Unique Stipulations related to Flexible Mitigation Strategies, Vernal Pools, Grassland Bird Habitat, RTE plant species, and Forest Blocks

As siting issues are always context-dependent, some instances occur where special considerations or tailored mitigation steps are included to prevent undue adverse impacts to the natural environment. For instance, in some instances questions about impacts on natural resources, like sound from operation of the solar array, can only be answered after construction. In these cases, the PUC leaves open the possibility for additional mitigation requirements if post-construction assessments determine the impacts to be undue and adverse. The PUC is flexible when it comes to innovations that mitigate issues like oil containment,[104] illustrating how solar siting is never a one-size-fits-all scenario.

[104] Petition of Rutland Renewable Energy, LLC for a certificate of public good, pursuant to 30 V.S.A. § 248, authorizing the construction and operation of the "Cold River Project," consisting of up to a 2.3 MW solar

In certain cases, habitat considerations go beyond what was described above to include more intensive monitoring or mitigation stipulations. Vernal pools are one such habitat classification that receives special monitoring considerations by ANR, especially if egg masses were discovered during initial site surveys. ANR has stipulated that, in these situations, a scientist from the agency be granted access to the development site to inspect the vernal pools weekly and record egg mass presence into the Vermont Fish & Wildlife vernal pool dataset.[105] ANR can also seek future reentry to the installation if the array is built on a landfill, as they return to the site to evaluate the landfill cap integrity.

Grassland bird habitat is another environment where extra stipulations are put on the project to protect and monitor grassland bird occurrences. Thanks to several ornithologists concerned about solar development on grassland bird habitat, several cases include annual payments to the Bobolink Project as a stipulation for operating solar developments in Bobolink habitat.[106] These payments can then be leveraged to incentivize further Bobolink monitoring. Developers can forgo forgo payments to the Bobolink project if they spot mating Bobolink near the project area.[107] In other cases, purchasing grassland bird or deer wintering habitat, in 2:1 or 3:1 ratios of offset land to developed land, are required as mitigation requirements. Stipulations related to decommissioning can also be

electric generation facility located at the intersection of Cold River Road and Stratton Road in Rutland, Vermont, Docket No. 8188 (3/11/2015)

[105] Petition of Vermont Solar Farmers, LLC, requesting a certificate of public good pursuant to 30 V.S.A. § 248, authorizing the construction of the "Bondville Solar Farm" consisting of a solar electric generating facility of up to 2.2 MW, to be located off Gleason Hill Road at 219 VT Route 30 in Bondville in the Town of Winhall, Vermont, Docket No. 8443 (10/9/2015)

[106] Petition of Sudbury Solar LLC for a certificate of public good, pursuant to 30 V.S.A. § 248, authorizing the construction and operation of a 2.0 MW solar electric generation facility on Vermont Route 30, Sudbury, Vermont, Docket No. 8225 (9/3/2015)

[107] Petition of GMP MicroGrid -Milton LLC for a Certificate of Public Good, pursuant to 30 V.S.A. § 248, authorizing the installation and operation of up to a 4.99 MW solar electric generation facility and 2 MW battery storage facility to be located off Mears Road in Milton, Vermont, and to be known as the "GMP MicroGrid-Milton Project," Case No. 17-5003-PET (02/04/2019)

used for conservation, as some MOU stipulations have secured a promise from the developer to place the land under a permanent easement following the solar project's decommissioning.[108] Developers have good reason to be concerned about impacts to grassland birds, as in one case where a hearing officer submitted a CPG denial to the PUC when the developer could not sufficiently prove that their project would not create undue, adverse effect on this habitat type.

Rare, Threatened, or Endangered (RTE) plant species often have specific mitigation stipulations that can vary.[109] Occasionally, if an RTE species is found, it can lead to a project redesign to protect the RTE plant from project impacts. In cases where the project was not redesigned to avoid impacting the RTE plant, temporary or permanent fencing is installed around the RTE plant to prevent an accidental take during construction or operation. Mowing regime restrictions are commonly implemented around areas where RTE plant species are found. In some cases, the RTE plants will be transplanted to another area outside the impacts of the project, monitored, and watered when needed. Developers may even be conditioned to harvest seeds from the RTE plant and sow them near the project post-construction, although is not clear from this analysis what specifics related to the plant or its biology make this mitigation step possible. In this analysis, there has only been one example of a preemptive ESA take permit being acquired prior to project construction.[110]

[108] Petition of Davenport Solar, LLC for a certificate of public good, pursuant to 30 V.S.A. § 248, authorizing the installation and operation of a 15 MW solar electric generation facility in Brandon, Vermont, Case No. 18-3709-PET, (12/11/2020)

[109] As an aside, I do not claim to know if this has something to do with the plant's specific biology or if experimentation has occurred with a variety of conservation techniques to ensure any adverse impacts to the RTE plant species will not be undue.

[110] Petition of Barton Solar LLC for a certificate of public good, pursuant to 30 V.S.A. § 248, authorizing the construction and operation of a 1.890 MW AC solar electric generation facility, to be located on Glover Road in the town of Barton, Vermont, Docket No. 8148 (6/30/2014)

It is uncommon for issues related to forest blocks to come up in solar siting, but when they do, they are addressed in the early ANR engagement process and discussed at length in the final order from the PUC. Impacts to forest blocks are evaluated based on the quality of the impacted forest block.[111] A scale out of 10 is used to describe the forest block quality, with 1 describing extremely low-quality forest block and 10 describing a very important forest block worthy of extreme protections. As of this analysis, the highest quality forest block witnessing development for solar was rated as a 5 out of 10 on the above scale. Development near higher quality forest blocks have not been tested, but ANR has communicated the importance of these forest blocks to the PUC when the issue is raised.

4.6 Outliers in Time Taken between CPG Filing and CPG Approval

On average, most of the large-scale solar siting cases in this analysis took 267 days (SD +/- 117 days) days between filing and approval. Three kinds of outliers did not conform to this pattern: cases that took less than 100 days, cases that took more than a year but less than two years, and cases that took over two years between filing and approval. Several themes within each case are worth discussing to shed light on how these timeline differences came about.

[111] Petition of Chelsea Solar LLC, pursuant to 30 V.S.A. § 248, for a certificate of public good authorizing the installation and operation of the "Willow Road Project," a 2.0 MW solar electric generation facility on Willow Road in Bennington, Vermont, Case No. 17-5024-PET (06/12/2019)
Petition of Davenport Solar, LLC for a certificate of public good, pursuant to 30 V.S.A. § 248, authorizing the installation and operation of a 15 MW solar electric generation facility in Brandon, Vermont, Case No. 18-3709-PET (12/11/2020)
Petition of Norwich Technologies, Inc. for a certificate of public good, pursuant to 30 V.S.A. §§ 248 and 8010 and Commission Rule 5.100, authorizing construction of a 500 kW solar net-metering system in Windsor, Vermont, Case No. 18-1730-NMP (01/22/2020)

4.6.1 Timeline That Was Less Than 100 Days Between Siting and Approval

Starting with the two cases that took less than 100 days between siting and approval, both cases involved standard offer solar (with 2.1 and 2 MW respectfully), were sited on developed land, and neither involved any natural resource issues. The more straight forward of the two cases took 62 days to site a 700 square foot solar array complex on Burlington's International Airport for use by the Vermont Army National Guard base.[112] The case had very few problems with impacts to natural resources or aesthetics because of how small the facility was and how the highly developed area is used by aircraft. The second case took 99 days to site 12 acres of panel on a "dilapidated" old racetrack in Pownal, Vermont. There were no major issues with siting solar at this location, in part because, as the commission noted, the site was zoned for commercial and light industrial use. The project also furthered energy goals of the Regional Plan, which "encouraged the development of renewable energy" like solar. The biggest benefit for the project was from a plan to "facilitate the responsible reclamation of a dilapidated site…. identified both locally and regionally as an important area for redevelopment without impacting any significant natural features or sensitive natural resources."[113] The Public Utilities Commission stated the project would "improve the aesthetic condition" of the site, giving a huge boost to the CPG application.

[112]Petition of Norwich Technologies, Inc. for a certificate of public good, pursuant to 30 V.S.A. §§ 248 and 8010 and Commission Rule 5.100, authorizing construction of a 500 kW solar net-metering system in Windsor, Vermont, Case No. 18-1730-NMP (1/22/2020)

[113]Petition of EOS Ventures, LLC for a Certificate of Public Good, pursuant to 30 V.S.A. § 248, authorizing the installation and operation of a 2.2-MW solar electric generation facility located at the Southern Vermont Energy Park on Route 7 in Pownal, Vermont, Docket # 7618 (9/8/2010)

4.6.2 Timelines That Took Over a Year but Less Than Two Years between Filing and Approval

Looking to cases that took longer to approve, 10 cases took more than a year between filing their CPG application and becoming approved. Certainly, these cases were not siloed to just natural resource concerns, but it is likely that the time needed to deliberate between the agencies and the petitioner contributed to the lengthy proceedings between filing and approval. While there is no clear throughline that suggests a unilateral answer to why these facilities took longer to approve, three central themes dominated discussion across this group of outliers.

The first theme involved four cases that involved lengthy discussions about impacts to natural environments that ANR is deeply interested in protecting. Two of these cases involved significant forest clearing into a forest block to make room for the project,[114] and the other two involved significant development in wetlands.[115] While all four cases ended up receiving approval, large sections were dedicated to discussing impacts to forest blocks, wetland complexes, or rare natural communities. It was clear from looking at these cases that, compared to other cases, deliberations about these landscape issues were more extensive in describing each natural environment, the relative pros and cons for developing

[114] Petition of Norwich Technologies, Inc. for a certificate of public good, pursuant to 30 V.S.A. §§ 248 and 8010 and Commission Rule 5.100, authorizing construction of a 500 kW solar net-metering system in Windsor, Vermont, Case No. 18-1730-NMP (1/22/2020)
Petition of Otter Creek Solar LLC, pursuant to 30 V.S.A. § 248, for a certificate of public good authorizing the installation and operation of a 2.2 MW solar electric generation facility at Cold River Road in Rutland, Vermont, Case No. 8797 (02/27/2018)

[115] Petition of GMP MicroGrid Ferrisburgh LLC for a Certificate of Public Good, pursuant to 30 V.S.A. § 248, authorizing the installation and operation of up to a 4.99 MW solar electric generation facility and 2 MW battery storage facility to be located off Greenbush Road in Ferrisburgh, Vermont, Case No. 17-5236-PET (02/04/2019)
Petition of South Forty Solar, LLC, for a certificate of public good, pursuant to 30 V.S.A. § 248, authorizing the installation and operation of a 2.5 MW solar electric generation facility located off Sunset Cliff Road in Burlington, Vermont, to be known as the "South Forty Solar Farm", Docket No. 8600 (9/27/2016)

near these sites, and how ANR and the PUC were able to proceed forward with mitigation steps that would allow for a project approval.

The second major theme was project impacts on Bobolink habitat, which could be seen in three of the cases that took more than a year but less than two years. Each case was sited on an old hay field, and in two of these cases bobolink had been seen engaging in nesting and breeding behavior near the site.[116] In these two cases, payments to the Bobolink project, further monitoring requirements, allocation of space for Bobolink habitat, and mowing requirements (only once per year after August 1st) were issued as stipulations to protect the bobolink. Deliberations, field studies, and discussions between the petitioner and ANR took more time to evaluate if there would be an undue adverse effect on these habitats.

The third case was different in that the petitioner mistakenly assumed that because no government agency identified the site as necessary wildlife habitat, they were able to proceed as if it was not grassland bird habitat.[117] This judgment, however, neglects to consider that the petitioner has the burden of proving the project's effects on the environment under Section 248(b)(5) are not unduly adverse. Because no grassland bird studies had been conducted to identify the potential for the site to host grassland bird habitat, and both ANR and the petitioner suggested the project area "has at least the

[116] Petition of Sudbury Solar LLC for a certificate of public good, pursuant to 30 V.S.A. § 248, authorizing the construction and operation of a 2.0 MW solar electric generation facility on Vermont Route 30, Sudbury, Vermont, Docket No. 8225 (9/3/2015)
Petition of GMP MicroGrid -Milton LLC for a Certificate of Public Good, pursuant to 30 V.S.A. § 248, authorizing the installation and operation of up to a 4.99 MW solar electric generation facility and 2 MW battery storage facility to be located off Mears Road in Milton, Vermont, and to be known as the "GMP MicroGrid-Milton Project", Case No. 17-5003-PET (02/04/2019)
[117] Petition of ER South Street Solar, LLC for a certificate of public good, pursuant to, 30 V.S.A. § 248, for a 5 MW ground-mounted solar project located in Middlebury, Vermont, Case No. 20-1219-PET (08/26/2021)

potential for providing grassland bird habitat," the hearing officer could not conclude the project would have an undue adverse effect on the bobolink habitat. The officer accordingly recommended the Commission deny the project on grounds that the impacts to natural resources and the environment could not be determined by the evidence presented. After this recommendation, it is recorded under the Commission Discussion that, following the hearing officer's recommendation, events between ANR and the petitioner resolved the issue related to undue adverse effect on wildlife habitat. Resolving these issues took another six months of work with the ANR to ensure proper mitigations were in place to protect potential bobolink habitat on the property, contributing to the lengthy proceedings in this case.

The final theme across cases that took more than a year, but less than two years, was unrelated to natural resources. In four of these cases, significant resistance from either the town or a neighbor near the site seemed to contribute to the lengthy proceedings as they raised issues related to aesthetics, orderly development of the region, and even the decommissioning fund. While outside the purview of this analysis, these topics have been repeatedly used to oppose solar with mixed success. Some of these cases were successful in acquiring more screening or decommissioning stipulations related to impacts to the issues mentioned previously, but none of these cases resulted in a flat denial by the PUC on these grounds. Regardless of how effective these issues are as hooks to compel development to either move elsewhere or mitigate impacts, it illustrates the need for greater community engagement over how projects like these will impact the communities in which they are sited.

4.6.3 Timelines That Took Over Two Years Between Filing and Approval

The final outlier group includes five cases that took more than two years to complete CPG proceedings. No central themes tie these cases together, but the issues at the heart of each are worth describing. Starting with a less consequential cases, Penn Energy Trust appeared to have issues related to assigning internal responsibilities for managing their 2.0 MW project in Clarendon, Vermont. [118] During the proceedings, they had to delay work on the project twice as they reoriented internal staff to manage the project. The project did not seem to contend with natural resource issues, so it is likely internal organizational issues played a substantial role in the project taking 862 days to fully complete.

Another smaller case, a 1.5 MW facility in Williamstown, took 878 days in between filing their petition and a final order approving the project. During the proceedings, ANR and the Commission opened an investigation related to site preparation and construction along an access road that was in violation of 30 V.S.A. § 248(a)(2). This statute states "no company…may begin site preparation for or construction of an electrical generation facility" unless the Commission first issues a Certificate for Public Good (CPG). This investigation lasted approximately 8 months, ending in a joint Stipulation of Dismissal with Prejudice to end the investigation filed by ANR and the Department of Public Service. After this investigation, another lengthy study, "the Facilities Study," was conducted as a requirement by Green Mountain Power Corporation. This delayed the proceedings for another year. There were not many discussions about impacts to natural resources for this

[118]Petition of Penn Energy Trust, LLC for a certificate of public good, pursuant to 30 V.S.A. § 248, authorizing the installation and operation of a 2.0 MW AC solar electric generation facility located at the southeast corner of the intersection of Route 103 and Route 7 in Clarendon, Vermont, Docket No. 7647 (9/11/2012)

project, so it is likely these studies and investigations related to early construction prior to obtaining a CPG were the cause of the increased approval timeline.

A more consequential case involved a 15 MW project in Brandon Vermont, which took 777 days to complete. This can be attributed to the site's location between two Highest Priority Connectivity Blocks providing connection between the Taconic Mountains and the Green Mountains.[119] The project underwent several redesigns to avoid negative effects on wildlife connectivity. The area was described as "the best remaining landscape connection in the Vermont Valley" between those two mountainous biophysical regions. To address this meant moving part of the array into a floodplain fringe, scrapping plans to clearcut a Dry Oak-Maple Limestone Forest on northern cobble, and including minimal alterations to avoid impacts on other sensitive native communities. Provisions were found both in the standard natural resource considerations, and a summary investigation in a 9-page section titled Natural Environment: Ecological Landscape Connectivity. This reflects a common means by which ANR highlights issues of great concern for the PUC. Given the extent of coverage this case had with respect to the habitat connectivity issue, it is clear that siting the facility without paying heed to High Priority Connectivity Blocks set out in the Vermont Conservation Design Initiative caused the lengthy PUC proceedings, project redesigns, and intervention from multiple state agencies to ensure the project minimally impacted the surrounding landscape.

The final two cases took over two years to permit. These were Apple Hill Solar, a 2.0 MW array that took 1291 days to approve, and Chelsea Solar, a 2.0 MW array that took

[119]Petition of Davenport Solar, LLC for a certificate of public good, pursuant to 30 V.S.A. § 248, authorizing the installation and operation of a 15 MW solar electric generation facility in Brandon, Vermont, Case No. 18-3709-PET (12/11/2020)

2183 days before it was denied. These two cases took place in approximately the same location, and the history surrounding these cases is tied together. Both cases were some of the longest and most litigated solar siting cases to come before the PUC. I recommend any interested parties read these cases as I cannot review in this analysis the full extent to which the petitioners managed to draw condemnation from so many interested parties. The major themes related to why these cases took so long start with opposition from the town of Bennington, followed by a near 30 V.S.A. § 248(a)(2) violation investigation by ANR and the Department of Public Service, intervention by the Apple Hill Homeowners Association, and a lack of ability by the petitioners to positively engage support for the project from members of the Bennington community and other Vermont interest groups. While Apple Hill was approved after all these proceedings, Chelsea solar received the first ever CPG denial for a large-scale solar array in Vermont.

While many arguments were made about the impacts Chelsea solar had on natural resources, inadequate evidence related to natural resource impacts prevented the PUC from denying the project on any of these issues. Instead, the PUC denied Chelsea Solar on the grounds that the petitioner's claim that the Chelsea Solar array and Apple Hill Solar array were separate plants was inaccurate. The two plants filed separately for two different CPGs, and after the Apple Hill array was accepted while the Chelsea solar case was denied, petitioners made substantial changes to the Chelsea solar array before resubmitting their application. These changes involved moving the Chelsea array to a spot adjacent to the Apple Hill array, resulting in the "two" facilities sharing the same road and power line interconnection. Intervenors filed a brief arguing that sharing the road and the power line interconnection meant that they were not two facilities, but rather a single 4.0 MW plant.

This “Single Plant Issue” was addressed by the Commission, which ruled that, because they shared such similar infrastructure and new changes to the Chelsea array brought the facility directly next to the Apple Hill array, the two plants were a single plant. This ended the proceedings. A lot of things went wrong with these two cases, but the Single Plant issue is a clear standard by which the PUC operates when considering how adjacent facilities can qualify for benefits under the standard offer program.

5. Discussion

In this analysis, I demonstrated an approach that quantifies information about levels of attention and assigned stipulations to mitigate impacts on natural resources from large-scale solar siting projects. I also summarized common and unique stipulations from the Agency of Natural Resources and the Public Utilities Commission that minimize, mitigate, or offset impacts from large-scale solar arrays on natural resources. Impacts from large-scale solar siting are largely dependent on where they are sited. Overall, large-scale solar siting documents suggest impacts to the environment can be mitigated through stipulations, moving projects to less impactful areas, downsizing installations, or requiring offsets conditional to project approval.

In this section, I review how this analysis provided insights about how solar siting in Vermont may be improved to further reduce impacts and facilitate deployment of renewable energy resources. Improving monitoring requirements holds promise to further minimize impacts despite potential costs associated with monitoring methods. Additionally, understanding how planning approaches in the Act 174 process have incentivized and deterred solar development in areas with and without municipal energy

plans may improve future state planning efforts and prevent development in undesired areas. I also review findings and future directions to address issues that materialize at the local level. This includes how solar development on farmland impacts the natural environment and communities, how local resistance creates siting challenges, and the dissonance between state and local goals related to energy generation.

5.1 Enhancing Monitoring Requirements

Monitoring requirements are a great opportunity for natural resource professionals and local planners to assess the effectiveness of CPG stipulations over time. ANR and other regulatory agencies currently conduct periodic site visits to ensure projects remain in compliance with obligations conditioned under their CPG. These site visits, however, are context specific and lack comparative analysis. Formal, comparative studies of development sites may clarify questions about how effective stipulations are at mitigating impacts and what the long-term effects are from solar projects on specific natural resource concerns. For instance, many tailored approaches exist to mitigate impacts to RTE plant species. These range from collecting RTE plant seeds in development sites and sowing them in spots outside impacted areas, to establishing permanent fencing around RTE plants found in development sites. Tracking mitigation efforts across development sites would provide insights into how effective these approaches are to conserving RTE plant species and how different RTE plant species respond to impact mitigation. It would also inform scientists about the biophysical conditions that RTE plants need to maintain their populations around solar facilities. Long-term impacts to soil may be investigated in

tandem within these studies. This can provide a basis to assess claims that solar facilities help soil health recovery and nutrient buildup.

Policy professionals and plant scientists can take this work a step further to evaluate how vegetative management plans can create conditions for long-term viability for RTE plants found in these areas. Conservation biologists have the opportunity to affect site management by working with developers on vegetative management plans. These plans can be tailored to reduce impacts, mitigate damage to protected species, or protect valuable natural resources or the natural environment. Studies investigating the potential these plans have as a conservation tool may focus on how these plans might foster plant recovery post-construction, protect abutting natural communities, and prevent the spread of invasive species. Further investigations may examine how management choices in these plans may reduce forest blocks degradation in abutting solar developments and provide opportunities for scientists to cultivate areas around development for local biodiversity and native species conservation.

Monitoring studies may also provide valuable insight into the long-term impact of solar developments on wildlife. This includes impacts from fencing near wildlife traffic areas and the effects sound has on natural areas abutting the development site. Fencing installed around the property can prevent wildlife traffic through areas previously accessible to them. This may include seasonal impacts.[120] This issue is further complicated by fencing requirements that mandate 6"x6" openings so smaller animals may pass through

[120] R.R. Hernandez, S.B. Easter, M.L. Murphy-Mariscal, F.T. Maestre, M. Tavassoli, E.B. Allen, C.W. Barrows, J. Belnap, R. Ochoa-Hueso, S. Ravi, M.F. Allen, "Environmental impacts of utility-scale solar energy." *Renewable and Sustainable Energy Reviews*, **Volume 29** (2014) https://doi.org/10.1016/j.rser.2013.08.041

the fencing. How different species exploit this new niche could have implications for wildlife managers interested in creating environments that promote wildlife despite the presence of development. In addition to fencing, how constant low level daytime sound from transformers impact wildlife movement is still unknown. If wildlife are deterred by low levels of daytime sound, solar development may have more impacts on abutting properties beyond impacts from the physical structures on the development site.

The Davenport Solar development could serve as a testing ground for how solar installations impact wildlife traffic. This site, as discussed by ANR in the Final Order permitting the project, rests between the Taconic Mountains and Green Mountains. This location also contains Dry Oak-Maple Limestone Forest, which wildlife can use as protective cover as they move between these two biophysical regions. Studying the way wildlife move around and interact with the site could provide valuable information to managers interested in mitigating impacts from large-scale solar developments with 15 MW or more in nameplate capacity. This site is especially valuable since the site moves into a permanent conservation easement after the power and purchase agreement sunsets. Investigating how the site recovers after the solar development is removed would further demonstrate the long-term impacts large-scale solar arrays have on the development site and abutting parcels. Investigators will require a control site with similar conditions to the Davenport site without solar development to better make such a study translate across site-specific contexts and to gauge how wildlife engage with sites pre-development. Further investigations similar to the one proposed here may be applied to new large-scale solar

arrays of 15 MW or greater in nameplate capacity, especially as the PUC begins to hear cases on large-scale solar in New Haven and other parts of the state.[121]

Grassland birds continue to be impacted by solar development on farmland, since hay meadows and fallow are valuable habitat for grassland bird species. Considering the sparse availability of grassland in Vermont, a study investigating solar buildout on farmlands should include measures to evaluate how large-scale solar development impacts grassland bird populations. Additional investigations in this area should consider whether contributions to the Bobolink Project and other grassland bird conservation efforts are keeping pace with the loss of grassland habitat. These investigations can help wildlife managers address impacts to these birds and strategize new management approaches to habitat fragmentation if grassland bird populations continue to decline.

While increasing monitoring efforts would advance our understanding of mitigation measure effectiveness and the long-term impacts from solar developments on the Vermont landscape, several challenges exist to implementing such studies. Developing, implementing, and analyzing a study across field sites could impose financial and workforce capacity costs on whatever entity embarks on such monitoring efforts. While oversight agencies like ANR might have the resources and authority to dedicate funds and labor to these studies, using resources for this may detract from current oversight efforts or priorities by the agency for other issues under its jurisdiction. Developers might not investigate these concerns on their own given they normally specialize in fields related to energy and engineering, rather than wildlife or natural resource conservation. Cooperation

[121] "Solar Split: Does large-scale energy development belong in Vermont?" *WCAX3 News*, Kevin Gaiss, WCAX3, 2023 https://www.wcax.com/2023/02/24/solar-split-does-large-scale-energy-development-belong-vermont/

with developers may also be limited if they perceive monitoring requirements as a potential path to shut down current or future development if monitoring reveals impacts to protected natural resources or the natural environment. Agency staff can and have imposed monitoring conditions through MOUs. These conditions, however, may upset developers concerned about costs associated with the project, especially since variable power generation without power and purchase agreements that guarantee power price stability can vary in their returns on investments. Imposed monitoring requirements may lead to lackluster execution by developers if they approach these stipulations with the minimum actions needed to remain in compliance monitoring requirements. This can be especially true if fines related to compliance violations are cheaper than the time, money, and effort it takes to establish comprehensive monitoring programs.

5.2 Improving Planning Efforts and Municipal Participation

Act 174 established a statewide program that used state resources to support energy development planning within municipalities and RPCs across the state. The goal was to incentivize local energy planning by affording substantial deference to participating towns whenever a solar development did not align with local energy plans. While the program provided mapping resources for RPCs and municipalities, not every municipality participated in the process. After assessing zoning designations for every large-scale solar siting project in Vermont, I found it was far more common for solar development to occur in undesignated areas than in areas zoned for prime solar or commercial/industrial use. This may suggest the Act 174 process was not effective at incentivizing solar development in areas mapped for such development, and that developers were still more likely to seek areas

with no zoning designation even when presented with areas where development was favored. Further studies are required to confirm this trend. Because my analysis did not evaluate these zoning designations over time, it is possible that planning efforts conducted through the Act 174 process have yet to have an impact in solar siting caselaw. If solar developers are developing in areas zoned for prime and secondary solar over areas with no designation, site descriptions following 2016 may reflect this trend as municipal energy plans are used, and solar siting cases slowly make their way to the PUC.

I have identified several possible explanations for why development trends favor areas with no zoning designation. First, the substantial deference provision in CPG proceedings was used to incentivize municipal participation in the Act 174 process. This incentive for municipalities may have become a disincentive for developers. Local opposition is already a major concern for the solar industry, according to testimony taken from three out of the six interviewees. Giving municipalities greater deference when opposing solar developments may cause developers to seek areas without zoning designations. No zoning on a development site might avert a situation where energy plans may be used to stop their solar project, either for justified or arbitrary reasons. Another potential reason for this trend is that ideal siting locations did not adequately conform to areas mapped for prime solar. Solar developers may already have the expertise to identify suitable locations for solar power generation, so it is possible they use their own industry expertise when making siting decisions rather than agency guidance. Additionally, as revealed through an interview with the Director of the Institute for Energy and the Environment at Vermont Law and Graduate School, available real estate close to tier 3 transmission is one of the main factors affecting solar deployment. Finding prime real

estate may have eclipsed efforts to comply with statewide energy planning efforts. Further investigations are needed to determine how developers evaluate these considerations when identifying development sites.

To respond to development trends favoring areas with no zoning designations, greater strides may be made to connect developers to local communities and businesses who are interested in powering new load developments with solar energy. Because solar power generation is a site-specific development, incorporating a site-specific approach to statewide solar siting might prove more effective at guiding solar developers to areas zoned for development. Mapping can be an effective way to identify potential sites but cannot substitute for bridging connections between local communities and solar power professionals interested in servicing new load. As Stone (2012, pg 279) describes "the passage [of incentives] from one group of actors to the next is treacherous. Rarely is there a direct correspondence between the incentive as proposed by the designer and as applied by the giver."[122] Regional planning commissions would be a suitable candidate to bridge these divides, as they have more resources and capacity to facilitate these conversations when compared to local volunteer officials or staff. RPCs can act as intermediaries to highlight areas identified in the Act 174 process and guide developers to specific locations where solar development is desired within a municipal energy plan, as compared to betting developers will find the right real estate at the right time for development. Overall, without proactive efforts to guide developers to specific real estate opportunities within communities who prepared municipal energy plans, incentives designed to support solar development in target areas may have the opposite effect.

[122] Stone, Debora. *Policy Paradox: The Art of Political Decision Making*. New York, London, Norton & Company, 2012.

5.3 Impacts at the Local Level and Need for Further Investigations

Several other issues emerge at the local level when considering the impacts of siting solar developments in Vermont. To start, development interests of all kinds are increasingly located on old farmland.[123] While PUC documentation suggest solar energy may have some benefits to local air quality, especially when used to power heat pumps or electric vehicles, solar arrays can prevent secondary uses of the land. Secondary uses can include opportunities for agricultural operations, recreation, or other potential developments like housing or commercial developments. Limitations to secondary uses are especially restrictive if developers neglect to consider secondary uses for the site during the initial project design. Since acres used for solar traditionally take up only a portion of the overall parcel, at an average ratio of 1:5 acres of solar panels to acres of the total parcel, there is ample opportunity to consider how to design developed parcels with secondary uses in mind. However, my study did not consider engineering constraints related to solar development. It is likely that coupling secondary uses with solar may have complications not anticipated by my work. Legislators, the Agency of Agriculture Food and Markets, and agricultural researchers should consider how to optimize farming models to include solar development considerations without detracting from local farming potential. This may be an opportunity to reduce energy costs related to farming operations, especially for struggling small scale agricultural operations or dairy farming.

While I did not review aesthetics of solar developments, it is important to consider the role they play in siting these projects. Smaller sizes and integration of solar into developed environments have fewer aesthetic impacts compared to large-scale projects. As

[123] Baxley, Susanna, The Working Landscape: Vermont Land Trust and Farmland Access in Vermont. *Food Systems Master's Project Reports*. **15**. (2021) https://scholarworks.uvm.edu/fsmpr/15

of this study, however, there are no instances where aesthetic or natural environment claims against large-scale solar at the PUC level have succeeded in stopping development. This is partly due to how the PUC will permit adverse impacts to aesthetics or the natural environment if the impacts are not "undue." Local resistance to solar projects will likely not dissipate unless aesthetic concerns can be met at scale. During my time considering this issue, many Vermonters have said to me that they came to Vermont to live amongst farms rather than development. Many of these individuals were concerned about the way solar development has taken off recently, and that if development continued farming communities may become dominated by this energy generating source. Solar development may beget more solar development in surrounding areas. For example, since one case involving a 5 MW solar site was deemed by the PUC as compatible with its surroundings because another solar site was located 800 feet north of the project.[124] These aesthetics questions are complicated, however they do warrant a conversation about how this land use choice fits within Vermont's concept of working lands. Further case studies could investigate local reactions to different methods of solar deployment, how to improve screening options to hide panels from viewsheds, how solar development can be utilized to improve dilapidated locations (as we saw with Pownal Solar[125]), and how renewable energy can be integrated into developed environments in ways that align with Vermont's aesthetic vision.

[124] Petition of GMP MicroGrid Ferrisburgh LLC for a Certificate of Public Good, pursuant to 30 V.S.A. § 248, authorizing the installation and operation of up to a 4.99 MW solar electric generation facility and 2 MW battery storage facility to be located off Greenbush Road in Ferrisburgh, Vermont, Case No. 17-5236-PET (02/04/2019)

[125] Petition of EOS Ventures, LLC for a Certificate of Public Good, pursuant to 30 V.S.A. § 248, authorizing the installation and operation of a 2.2-MW solar electric generation facility located at the Southern Vermont Energy Park on Route 7 in Pownal, Vermont, Docket # 7618 (9/8/2010)

Another trend this analysis highlights is the need for greater coordination between state agencies and local communities to achieve state goals related to renewable energy buildout. While the state understands its own goals related to energy development, local planners and officials might have a harder time understanding how their localities fit into these broader statewide goals. This challenge is complicated by the fact that many municipal leaders are volunteers, part-time, or have limited capacity or expertise to study state goals and connect them to the contexts in their locality. Local officials can read agency documentation detailing state plans and how they can best contribute to them, but this requires proactive insight and knowledge not uniformly shared across municipalities. Additionally, local officials do not have a state perspective on statewide goals. Planners in the interview mentioned this can hinder municipal participation in statewide goals, since it may be difficult to extrapolate how municipalities are contributing to statewide goals from a local perspective.

Regional planning commissions may improve municipal coordination by proactively coordinating discussions between developers, local planners, and state agency personnel reviewing projects for compliance issues. RPCs may also create more educational tools and allocate more staff time to provide local leaders with statewide knowledge related to agency goals, how their specific municipality can contribute, and what the risks are to not participating in local energy planning. State agencies may benefit from earlier coordination between local officials and agency personnel during real estate acquisition for solar development. Such coordination would help reveal or solve siting issues related to natural resources or the natural environment earlier and at the local level, rather than waiting for review at the state level. Consolidating this review period may help

reduce anxieties developers have related to working across local and state officials. A consolidated review period may also allow planning staff to more effectively guide development, contribute to statewide goals across agencies, and interface earlier with community stakeholders or concerned citizens.

5.4 In Summary

Solar development, at smaller scales in already developed regions, and in conjunction with energy efficiency practices, holds promising benefits as a flexible renewable energy choice for areas near load across Vermont. Overall impacts from this energy choice should continue to be assessed over time, especially as it relates to grassland bird habitat and wildlife connectivity. Diligent work, however, by the Agency of Natural Resources has proven effective at identifying and mitigating known potential impacts on natural resources. Policy and planning professionals should continue evaluating how the development trends towards siting solar in agricultural fields impacts local communities, everyday Vermonters, and the natural environment abutting these properties. Greater incentives to proactively facilitate solar development near load, in the developed areas, and as energy efficiency measures for new buildings may prove more effective to deploy solar, protect natural resources, and minimize impacts to aesthetics.

6. Conclusion

I conclude this review with broad implications of my assessment of the impacts to natural resources and the natural environment from siting large-scale solar in Vermont. My analysis reveals how Vermont's CPG siting process comprehensively considers impacts to

natural resources and the natural environment. Despite this comprehensive siting process, no large-scale solar project has been denied on grounds related to impacts to natural resources or the natural environment. This pattern may be in part due to the siloed way agencies contributed to the CPG process. The PUC may still permit a project despite potential adverse impacts related to natural resources or the natural environment. The two-pronged test to evaluate impacts within the CPG siting process may be too lenient towards environmental impacts, as it permits adverse impacts that are not "undue." Further site studies and caselaw reviews are required to properly evaluate this test and how potential impacts materialize across development sites. Finally, defenders of environmental resources may better facilitate responsible solar development by finding areas with the lowest conservation potential in addition to areas with the highest conservation potential. This would allow ANR to be specific when they are helping developers avoid environmental impacts, rather than stating development cannot occur in specific areas. Overall, this new land use choice reflects a new element added to the conversation of what working lands in Vermont mean with respect to energy generation.

Energy and environmental considerations appear to be siloed within the agencies charged with evaluating these issues. While this has been effective for each agency to address issues under their statutory mandates, this structure may negatively impact their ability to collaborate across agencies to achieve goals siloed in one particular agency group. For example, solar development is normally seen as an energy issue, however trends suggest solar generation is replacing some working lands like farmland. Farmland across Vermont continues to converted to other uses for several reasons ranging from pressures favoring low density residential land use to the rising costs associated with small scale

farming. Agencies furthering permanent landscape conservation or in-state renewable energy development goals may be failing to consider impacts to farmlands, partly due to minimal collaboration between agencies. This lack of close collaboration may be perpetuating farmland conversion as development is directed away from forests to farmland and CPG siting procedure fail to consider impacts to farmland outside prime agricultural. Agencies may consider increasing their collaborations with Vermont Housing and Conservation Board as it relates to their own internal goals, so statewide goals within agencies can be more effectively implemented with respect to other agency goals.

Another example of siloing as a barrier to agency collaboration can be found in the CPG siting process. While the CPG siting process evaluates impacts to the natural resources and environment at each development site, no large-scale development has been stopped because of impacts to these resources, even if impacts to natural resources or the natural environment are adverse. This can be explained in part by a standard of review that places the threshold for denying a project to finding an impact is both "adverse" and "undue." Many cases in this review have failed the first part of this two-pronged test while passing the second part. This enabled the PUC to permit projects despite potential adverse impacts. This test may be preventing accurate evaluation of potential impacts under the PUC review, since caselaw, the PUC, and a hearing officer (and not agency expertise) determine what constitutes an "undue adverse" impact to natural resources or the natural environment on a development site. Lawyers interested in improving PUC evaluations of environmental impacts may consider how current and future caselaw can rework the definition of "undue" impact to improve environmental considerations.

Additionally, agency staff and lawyers presenting evidence related to the context-specific impacts of a CPG case may want to tailor their evidence to reflect the facts found in the specific case they are involved in. Throughout these CPG documents, impacts to natural resources and the natural environment have been raised despite a lack of clear evidence tying impacts by a project to the facts of a case. The PUC has also stated bluntly in the Chelsea Solar case that they do not consider unforeseen impacts as rising to the level of "unduly adverse" when considering evidence about impacts on natural resources and the natural environment. These patterns illustrate a continued need for comprehensive, scientific studies evaluating how facts within a solar siting case lead to undue, adverse impacts to natural resources or the natural environment. Studies that can be plainly coupled to facts within a solar siting case may be more effective at demonstrating the impacts large-scale PV solar generation has on the development site and abutting properties.

Environmental considerations are not without their share of issues related to siloed Vermont agencies. When mapping and planning development, agency staff are often tasked with looking for areas with the greatest conservation value, as demonstrated by the Conservation Design Initiative. While this establishes clear targets for conservation, it does not help mediate development interests as developers face opposition in areas of high conservation interest despite a lack of clear alternatives. Developers are left wondering if "not there, then where?" after being told development cannot happen in an area due to impacts to conserved resources. A lack of development alternatives can cause developers to seek out low areas of resistance first despite agency efforts to guide development into target areas. Providing clear and practical alternatives to development in priority conservation areas may reduce impacts from development in ecologically sensitive areas

by finding comparable development sites in dilapidated or developed areas of Vermont. Proactively suggesting alternative development sites might also further create bridges between developers and agency personnel that may reduce developers circumventing agency or local planning efforts to curtail development.

Finally, this review suggests the need for further study investigating how Vermont's concept of working lands might incorporate energy generation within that definition. Land use in Vermont has evolved from primarily centering around agriculture to reforesting and conservation of valuable working lands like timberland or farmland. As solar energy becomes more efficient and adapted to constraints in New England, the State of Vermont and the Vermont Housing and Conservation Board may need to consider how solar energy production can contribute to working lands culture around the state. Definitions for how solar energy generation intersect with working lands may vary based on region and site-specific contexts. It is unlikely, however, that trends towards solar energy use will dissipate as Vermonters consider how they can meet new load demands with in-state generation or energy efficiency measures.

As innovative techniques are discovered that service new or existing load with solar energy or creating opportunities for viable self-generating developments, potential exists to consider how solar energy contributes to sectors such as agriculture and subdivision development. RPCs can substantially advance these efforts as they have knowledge and expertise of state agencies and their goals, the capacity to translate this information into a municipal setting, and the ability to provide planning resources local governments would otherwise lack. As localities around Vermont continue to be affected by capacity limitations, it is imperative that RPCs take leading roles in facilitating conversations so

frameworks guiding working lands can keep pace with current land use trends and technology. The future of Vermont's landscape hinges on the answers to these questions, and future studies should investigate these issues within the community context across Vermont. Overall, this initial study investigating impacts from large-scale solar development reveals how focusing on communities and how site-specific contexts compare across development sites may illuminate opportunities and constraints more effectively than statewide approaches involving mapping or incentives to guiding solar development across the state.

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Petition of Barton Solar LLC for a certificate of public good, pursuant to 30 V.S.A. § 248, authorizing the construction and operation of a 1.890 MW AC solar electric generation facility, to be located on Glover Road in the town of Barton, Vermont, Docket No. 8148 (6/30/2014)

Petition of Chelsea Solar LLC, pursuant to 30 V.S.A. § 248, for a certificate of public good authorizing the installation and operation of the "Willow Road Project," a 2.0 MW solar electric

generation facility on Willow Road in Bennington, Vermont, Case No. 17-5024-PET (06/12/2019)

Petition of EOS Ventures, LLC for a Certificate of Public Good, pursuant to 30 V.S.A. § 248, authorizing the installation and operation of a 2.2-MW solar electric generation facility located at the Southern Vermont Energy Park on Route 7 in Pownal, Vermont, Docket # 7618 (9/8/2010)

Petition of Otter Creek Solar LLC, pursuant to 30 V.S.A. § 248, for a certificate of public good authorizing the installation and operation of a 2.2 MW solar electric generation facility at Cold River Road in Rutland, Vermont, Case No. 8797 (02/27/2018)

Petition of GMP MicroGrid Ferrisburgh LLC for a Certificate of Public Good, pursuant to 30 V.S.A. § 248, authorizing the installation and operation of up to a 4.99 MW solar electric generation facility and 2 MW battery storage facility to be located off Greenbush Road in Ferrisburgh, Vermont, Case No. 17-5236-PET (02/04/2019)

Petition of South Forty Solar, LLC, for a certificate of public good, pursuant to 30 V.S.A. § 248, authorizing the installation and operation of a 2.5 MW solar electric generation facility located off Sunset Cliff Road in Burlington, Vermont, to be known as the "South Forty Solar Farm", Docket No. 8600 (9/27/2016)

Petition of ER South Street Solar, LLC for a certificate of public good, pursuant to, 30 V.S.A. § 248, for a 5 MW ground-mounted solar project located in Middlebury, Vermont, Case No. 20-1219-PET (08/26/2021)

Petition of Penn Energy Trust, LLC for a certificate of public good, pursuant to 30 V.S.A. § 248, authorizing the installation and operation of a 2.0 MW AC solar electric generation facility located at the southeast corner of the intersection of Route 103 and Route 7 in Clarendon, Vermont, Docket No. 7647 (9/11/2012)

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8. Appendices

Appendix A: Basic Energy Concepts for Natural Resource Professionals

Before exploring energy systems, I will review a few basic concepts related to the energy policy and the power grid. According to Professor Tade Oyewunmi, from the Vermont Law and Graduate School, there are three principal dimensions of energy policy: the reliability of energy supply, the cost and affordability of the energy supply (i.e. does the energy supply have a reasonable price per kilowatt of energy and return on investment for the utilities), and how can environmental harms be curtailed. Grid operators consider these elements when they direct power from generation source to the end consumer or "load". Without a demand for power, energy cannot be sent to a location since energy that cannot be stored must be consumed by the load once it arrives. An important factor reinforcing this concept is the second law of thermodynamics, which states that the total entropy of a system either increases or remains constant in any spontaneous process: it never decreases. This means energy in a system, like a grid, will flow from areas with high concentrations of energy to low concentrations of energy; much like how heat spontaneously transfers from hot to cold areas and not the other way around. In an energy policy context, grid operators and regulators utilize this concept when considering where to add additional generation capacity. Traditionally, new energy generating capacity is not added to a system unless there is a new demand for new energy that cannot be met with existing generational capacity.

Another set of important considerations in energy policy are the differences between generating sources and how they meet energy demand. Depending on the time of day, season, or area of the world, there are variations in power demand. The famous Duck

Curve illustrates this concept well[126], as it shows power demand decreases during the day and peaks towards early evening. Because electricity cannot be efficiently stored at the source of consumption, power must be supplied as it is needed to the place where it will be consumed. To meet the basic demands of the grid, operators use "base-load" plants that supply steady electricity to the end users[127]. These plants, which include hydropower, nuclear, and coal, are typically expensive to construct but can produce constant energy at a low cost. Any additional demand during intermediate or peak energy consumption can be supplemented by additional power plants that are "turned on" in response to this demand. These power plants are often inexpensive to build but require significant operating costs that prevent them from being useful base-load power plants.

The last important concept, pertinent to our discussion of solar power, is the difference between energy sources and how they supply power to the system. There are three types of energy sources, defined by how readily they're able to produce electricity: continuous energy sources, dispatchable energy sources, and variable energy sources. Continuous energy sources, like nuclear or geothermal, are always "on" and producing energy[128]. Usually, these energy sources are costly to start up, so they are kept on to address base-load demand[129]. Dispatchable energy sources are energy sources that can be "turned on" cheaply and their power output can be adjusted to meet the demand as needed. The

[126] Bess Krietemeyer, Jason Dedrick, Ehsan Sabaghian, Tarek Rakha. "Managing the duck curve: Energy culture and participation in local energy management programs." *Energy Research & Social Science*, Volume 79 (2021) https://doi.org/10.1016/j.erss.2021.102055

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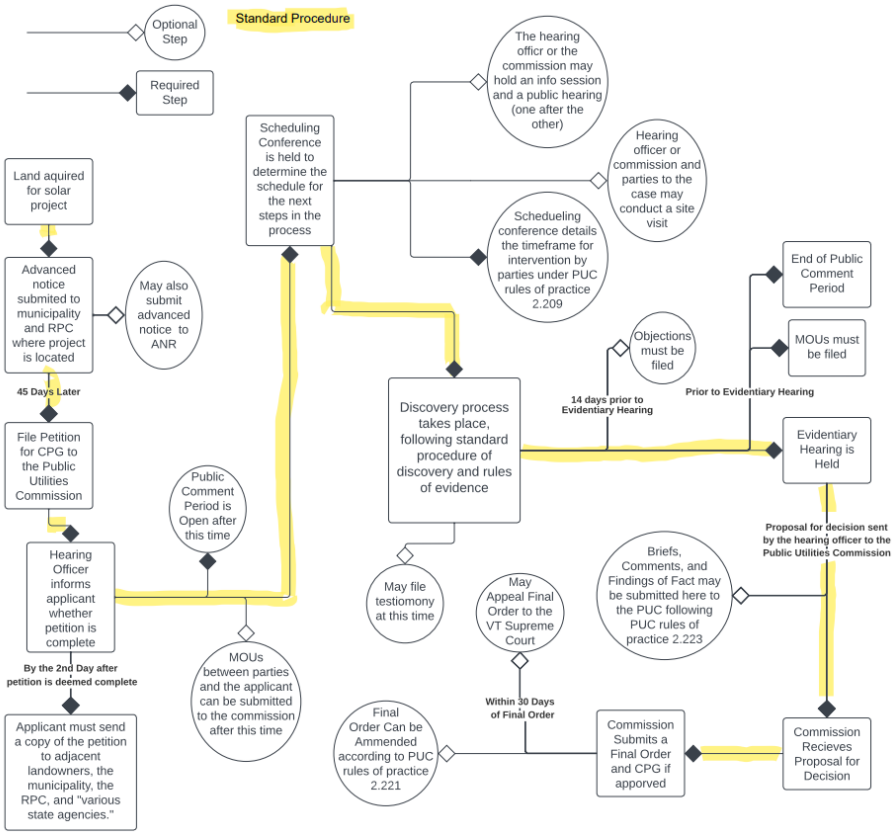
[128]*An Energy Evaluation System: Part 6. Continuous Energy*. Sutton Technical Books, 2022, Accessed 2/25/2023 https://iansutton.com/energy/energy-evaluation-system-part-6-continuous-energy

[129]Ben Harack. "Electrical Grid: Key Terms and Definitions." *Vision of Earth* (September 7 2010) https://www.visionofearth.org/industry/electricity-grid-key-terms-and-definitions/#Intermittent Accessed 2/25/2023

energy plants related to this are commonly based around fossil fuels but also include biomass and some forms of hydroelectric. Finally, variable energy sources are generating sources that produce energy only when external factors that cannot be controlled, like sunshine or wind speeds, create conditions that generate electricity. While operators can predict these external factors, these generating sources are still reliant on these external factors. Variable generation sources can be accented with energy storage systems that carry over energy generated during low demand times to high demand times. Accenting variable energy generation with battery storage, however, raises costs significantly since energy storage is very expensive at this point in battery technology development. Grid operators, energy policy professionals, and electrical engineers consider all the factors mentioned above when they're considering permitting new energy generating facilities, setting up new electrical transmission, and considering the energy grid's responsiveness to load demands now and into the future.

Appendix B: Public Utilities Commission Procedure to Acquire a Certificate of Public Good for New Electrical Generating Sources in Vermont



Appendix C: Tables

Interviewee	Questions Asked
Fish and Wildlife Biologist	Can you describe your background and how you've interacted with the solar development issue? How does ANR respond/think about renewable energy development? What development pressures in the renewable sector are the greatest? What biologic concerns are investigated when dealing with a proposed solar development? Are there nationwide trends in solar development that are found also in Vermont? How is Vermont bucking these nationwide trends? To what extent does ANR work with the Public Utilities Commission & developers on these issues? To what extent does ANR see clearcutting for solar development? What are the implications for this pattern in Vermont?
Solar Policy Professor	Can you describe your background and how you've interacted with the solar development issue? What engineering and policy barriers exist for solar development in Vermont? How does battery power play a role in reducing variability of solar? How has the public utilities commission evaluated solar siting across Vermont?
New Haven City Planners	Can you describe your background and how you've interacted with the solar development issue? What are your experiences with solar development in New Haven? How do planners work with the state and developers on solar siting? What is substantial deference? Can you tell me more about what solar power looks like in New Haven? What are the barriers to solar development from your perspective? How does the town represent itself in cases with the public utilities commission? Are there any ecological concerns you see related to solar development at the local level? Are there any solar cases you'd recommend as case studies for solar siting in Vermont? What groups have been historically pro solar/against solar?

	Are there any examples of solar sited in forests?
Department of Public Service Employee	Can you describe your background and how you've interacted with the solar development issue? How does the Department of Public service interact with solar siting cases? What are the engineering technicalities related to energy transmission? What restrictions exist for developing solar in the developed environment? How does the Department of Public service and Public Utilities Commission evaluate landscape impacts when siting transmission or new solar generation? How do municipalities and state agencies interact with the Department of Public Service and public utilities commission when dealing with solar siting cases?
Ornithology Professor	Can you describe your background and how you've interacted with the solar development issue? How much of the South Street Solar siting process did you see? What does the Bobolink project entail & how did they come up with the offsets that they did? In your experience, how vulnerable are grassland birds to this kind of development? Do you know how ANR handles solar siting cases and the impacts those cases have on natural resources or grassland bird habitat?

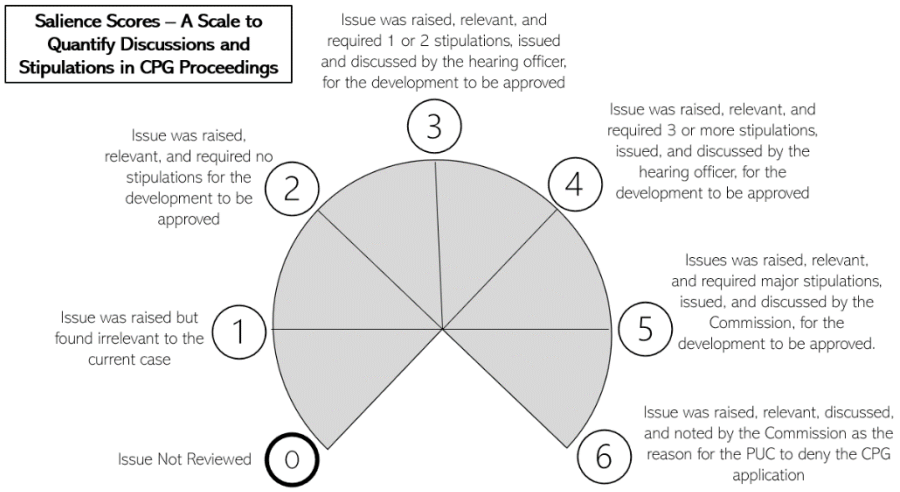
Table 1 – Interview questions asked during background research on the Vermont solar siting issues. Reports from these interviews were considered as anecdotal evidence and do not constitute scientific evaluations of the solar siting issue in Vermont.

Salience Score	Score Definition	Score Operational Definition and Example Text
0	Issue was not raised in the documents	No text, subheadings, or discussion in the final order related to the development consideration
1	Issue was raised but found irrelevant to the current case	Some text and a subheading related to the development consideration, but there is no in-depth discussion of the issue ***55.*** *The project is not located on a shoreline"*
2	Issue was raised, relevant, and required no stipulations for the development to be approved	Some text, a subheading, and discussion are in the final order related to the development consideration, but no additional mitigation steps were issued. **93.** *The Project will not have undue adverse impacts on any necessary wildlife habitat or endangered species. There are no Vermont Wildlife Diversity Program mapped instances of rare, threatened, or endangered species within the Project area. A supplemental field study performed on July 16, 2013, confirmed that no rare, threatened, or endangered species are present on the Project site.*
3	Issue was raised, relevant, and required 1 or 2 stipulations, issued and discussed by the hearing officer, for the development to be approved	Text and discussion, by the hearing officer, on a development consideration describe one or two additional mitigation steps that are conditional to the project's approval. ***46.*** *Work activities at this crossing will include management of recent beaver activity that is compromising the existing culvert and road stability. To address recent beaver activity, Petitioner will coordinate with the VT Fish and Wildlife Department to install metal fencing at the culvert in the farm road leading to the Project as a barricade to future culvert plugging and will also install a beaver baffle to maintain water levels upstream of the access road and at a level that will not compromise the integrity of the road and culvert crossing….*

4	Issue was raised, relevant, and required 3 or more stipulations, issued, and discussed by the hearing officer, for the development to be approved	Text and discussion, by the hearing officer, on a development consideration describe three or more additional mitigation steps that are conditional to the project's approval. ***149.*** *In response to the presence of the bobolink at the Project site, NGSF agreed to the protocol below to mitigate impacts for the life of the project so that such impacts are not unduly adverse…* *a. both areas, excepting those locations identified in d. below, shall be mowed no more than once per year, and shall not go un-mowed for more than 5 years* *b. mowing shall not take place before August 1 in any year….* ***151.*** *NGSF agrees that the ANR MOU prohibits plantings of any shrubs or trees of any sort in the managed area.* ***152.*** *NGSF agrees that any plantings or other landscape mitigation in areas outside of the project site, but on the underlying legal parcel are also prohibited by what ANR considers to be an open-field bobolink habitat.* ***153.*** *NGSF has agreed to time of year construction restrictions during the bobolink breeding season from April 15 to August 15.*
5	Issues was raised, relevant, and required 3 or more stipulations, issued, and discussed by the Commission, for the development to be approved.	Text and discussion, by the Commission, on a development consideration describe three or more additional mitigation steps that are conditional to the project's approval. **VII. Board Discussion** *First, ANR states that under the terms of the First Amended ANR MOU and proposed CPG Condition 7, NextSun is required to obtain and comply with the terms and conditions of authorization under the Construction General Permit #3-9020.*
6	Issue was raised, relevant, discussed, and noted by the Commission as the reason for the PUC to deny the CPG application	Text and discussion, by the Commission, on a development consideration list it as the reason the project's CPG application was denied. **VIII. Commission Discussion** *Having considered the parties' comments about the proposal for decision, the parties briefings of the single-plant issue, and the parties' oral argument, we do not adopt the hearing officer's recommendation of approval of the petition. Specifically, we disagree that the Willow Road Facility and the neighboring Apple Hill Facility are separate plants as contemplated by 30 V.S.A § 8002. Therefore, the Petition is disapproved without prejudice to the Developer's ability to file an amendment to the Petition reflecting our determination.*

Table 2 – Salience score values, definitions, and example text used when coding.

Appendix D: Salience Score Visual Aid



Appendix E: Individual Interview Summaries

E.1 ANR Wildlife Biologist

To gain a better perspective on how the Agency of Natural Resources evaluates impacts from ground mounted solar installations during a CPG siting process, I held a zoom interview with a lead biologist for Franklin, Lamoille, Washington, and Orange counties in Vermont. Coming from the University of Vermont with a B.S. in Wildlife and Fisheries Biology, with a minor in Forestry, he's served at Vermont Fish and Wildlife since 2015. His primary responsibilities are assessing impacts to habitat under Act 250 in three districts, reviewing timber harvest notifications, and evaluating permits for wildlife impacts on general and individual wetland permits in four counties. He also reviews fish

and wildlife habitat impacts associated with new renewable energy and telecommunication tower projects statewide. The interview was conducted on April 14th, 2022.

We began the interview by discussing the scope of projects under his review, which does not usually include rooftop solar. Solar projects come to his office after the town reviews and approves them at the local level. He stated that ANR is interested in being involved in these local discussions, as the data to vet projects isn't being evaluated at this level: even for areas where solar would be preferred. He went on to note that this extends to how zoning incorporate conservation design or priority solar development areas, which he said only occurs when towns proactively reach out to ANR for help on how to utilize statewide data during their initial review.

During a project review, he applies Act 248 evaluation requirements to the development site and the specific issues surrounding it. This is commonly done after the petitioner files for advanced notice pre-development. At that time, ANR has about a week or two to comment on the site-specific impacts of the project. The advanced notice process, he notes, helps ANR highlight natural resource concerns for the applicant so they can hire consultants to investigate raised concerns further, add addendums, or redesign the project as needed. Once the ANR comments on the site are compiled, they are sent off to a planner at the office of planning, who compiles comments across all the agencies into a single comment sent to the PUC. When these concerns aren't addressed at the PUC level, the case can move into litigation.

The number of solar development projects he receives depends on the year. Transmission corridors, he notes, heavily impact where solar can be placed. ANR is involved in guiding how vegetative management is conducted under and around these

corridors. While they don't often review rooftop solar, he admitted that ANR favors solar development in already developed areas. The only exception to this might be for solar sited on old tailings piles, since these habitats are excellent scree mimics and can provide habitat for bats who nest within the rocks. Many projects are proposed in forest blocks, which he says is a considerable trigger for review since the ANR currently holds a policy that is opposed to clearcutting forests for solar installations. The agency utilizes the Vermont Conservation Design Initiative whenever development occurs away from already developed areas. Any forest cutting is evaluated through the Conservation Design lens prior to raising issues. For example, some clearcutting has occurred in less valuable forest blocks, however smaller forests in the Champlain valley or developments that intrude into priority forest blocks are scrutinized at a much higher level. Because "things like to grow in Vermont", as the lead biologist remarked, developers are very concerns about shade around their solar arrays. Mowing and selective cutting are planned in consultation with the ANR to cultivate pollinator species, avoid potential nesting birds, and protect trees that could serve as good bat hibernacula.

Generally, bigger projects have more context dependent resource concerns. For example, aesthetic issues are more common with larger arrays, especially in areas where older generations of farmers still work their fields. This extends to invasive management, since larger development areas create larger successional habitats that can be exploited by invasive species; a problem not often considered by developers. Additionally, because electrical codes sometimes require fencing, wildlife movement can be impacted especially along wildlife corridors or near deer wintering areas. As a compromise, he often recommends developers use fences with 6"x6" opening to allow for small animal traffic.

He reiterated, however, that the greatest impact likely falls on grassland birds because of their decline, their regular use of agricultural fields, and how developers consider unused agricultural fields as the best spots to develop solar. The birds he's most concerned about are bobolink, eastern meadow lark, the grassland sparrow, and norther harrier. The impacts to grassland birds come from the solar panels themselves acting as vertical structures in an otherwise open grassland or meadow habitat. These birds avoid these areas like the plague because vertical structures are seen as potential roosting areas for predatory raptors. When ANR conducts a site review, they look at how much potential the site has as prime habitat to evaluate how impacts to these grasslands should be mitigated, rather than relying on incidental observation of a species occurring on the property. Different field types carry different levels of scrutiny. For example, many grassland birds love to nest in hay, so hay fields are scored higher as potential habitat when compared to corn fields, which provide fewer nesting and forage benefits despite occurring along similar biophysical areas. Only in instances that concern rare, threatened, or endangered species will the Fish and Wildlife department be called into help with wetland mitigations; otherwise, the Department of Environmental Conservation handles everything else with wetlands.

E.2 Director of the Institute for Energy and the Environment at Vermont Law and Graduate School

To better understand the perspective of energy policy professionals working on solar policy reform, I interviewed the Director of the Institute for Energy and the Environment at the Vermont Law and Graduate school on April 19th, 2022. In previous roles he served as the Director of Power Market Policy for the Long Island Power Authority

and as the Director of Energy Policy for the City of New York. His educational background started at the University of Vermont in undergrad, completing his Masters at the LBJ School of Public Affairs at the University of Texas at Austin, and finishing his PhD from Rensselaer Polytechnic Institute's Lally School of Management and Technology. He currently teaches Sustainable Energy Technology and Policy at the Vermont Law and Graduate School.

When asked about the barriers to solar development, besides the need for proper sun exposure throughout the day, he pointed to transmission as one issue that often prevents solar development. Because transmission infrastructure is limited to certain areas, solar development can only occur where one can "plug in" to that interconnection. Another problem with solar development is the need for greater load (or energy consumption) before solar can be sited in an area. The transition towards more solar is, in this way, stifled. Since energy needs can be met through non-renewable means, places that traditionally relied on non-renewable energy continue to consume that energy; making it hard to justify adding more renewable energy to the grid if these areas don't have load needs. When I asked him about accenting solar with battery storage to make the energy source less variable, he suggested it's a better solution for islands, remote areas, or places where energy is already expensive due to battery storage equipment being incredibly expensive technology.

The biggest factor limiting solar, even more than the solar industry itself, has to do with finding prime real estate to house solar arrays. Optimal areas for solar development might not be up for sale when developers are ready to develop. Once the right environment is located, it can be easier to mitigate for aesthetics ahead of time through proper project

design, engaging with the community early, and resolving concerns neighboring landowners or communities might have related to the project. Developers are incentivized to do this early and often because, in his mind, the Public Utilities Commission is very receptive to the concerns of the people.

Besides the physical barriers, there are several policy-level issues that limit solar development. Because solar is more efficient at greater sizes, large-scale projects are loved by engineers but loathed by individuals concerned with aesthetics and impacts to natural resources. This creates tension around siting solar in areas favorable to development, since places with the most load and transmission to accommodate new solar are often close to populated areas and larger installations are harder to hide from public viewsheds. Turning to rooftop solar, incentive programs to build more rooftop solar helps cover the expensive costs of retrofitting roofs to hold heavy photovoltaic generating equipment. He commented that rooftop solar is easier to site since impacts to the natural environment or aesthetics are more easily mitigated. He suspects that the PUC reduced rooftop solar incentives because they listen very closely to the needs of Green Mountain Power and the work they're doing to create more ground mounted solar. Greater generation and transmission inefficiencies, coupled with greater need for stakeholder engagement across property owners selling power to the utilities from their electrical solar generation, further disincentivizes investment in rooftop solar resources.

E.3 New Haven City Planners - Person 1

To better gauge the perspective of city planners involved in this issue, I interviewed two members of the New Haven Planning Commission on their perspectives regarding

solar energy in Vermont. The first member I interviewed worked with the Clean Energy States Alliance to promulgate best practices for solar within the residential and government permitting process in Charlotte and New Haven. In his own experience, installing solar can be easy, as he had been able to acquire rooftop solar for his home through SunCommon. Despite this, supply chains for ground mounted solar are still an issue. He pointed to high financing prices for the panels in addition to high prices on ground mounts materials like steel and wood. Labor was also deemed a high cost since it involved siting professionals, engineers, and consultants. Additionally, transmission line congestion can stop solar projects before they even have a chance to submit an CPG application to the PUC. He did not see grassland bird habitat as a genuine concern at the local level, but he did suggest partnering with dairy farms could help find more places to site solar. According to him, farms in New Haven that are no longer being farmed are being sited for solar. This is despite opposition coming from older, more conservative members of the town who pushback on aesthetic issues. Because there aren't many new dairy farmers entering the market, in his opinion, it's likely solar partnerships will continue to grow as existing dairy operations seek ways to substitute their income through declining milk prices and low productivity.

When he spoke to the size of solar projects in Vermont, he highlighted that GMP was not aiming to build big solar projects like we are seeing occur in Maine and Massachusetts. He also commented how developers from out of state often don't seek meaningful understanding of the communities they're building in. This can make them appear pushy or threatening if they try to force development. Projects of a certain size can submit their plans directly to the PUC, who will then notify the town where the project is

being developed. Towns can then become an interested party in PUC proceedings as support or opposition, but the town does not have final say on if the project is permitted. They do, however, have some ability to add stipulations to a project so it does not contradict municipal plans.

The town can oppose projects at the PUC level if a town plan is made prior to siting, and the project doesn't follow the town energy plan. This Substantial Deference is afforded to the towns for participating in energy planning initiatives, and litigation surrounding the issue has yet to test if substantial deference to the town plan is enough to stop siting solar in areas that were not marked for solar development. He did note that, in creating a town plan, the town does not have the power to zone against solar projects and must not contradict state planning. He went on to say that while town planning must consider priorities like ecological areas or aesthetics, the town cannot effectively approach these issues without the perspective of state agencies already investigating these issues.

E.4 New Haven City Planners - Person 2

The second member from the New Haven Planning Commission I talked with served on the energy committee and was formerly a biologist who became interested in solar energy after learning more about the climate crisis. She stated that community siting standards employ a lot of natural resource mitigation, but local solar siting and screening requirements don't interface heavily with natural resource conservation at the state level. They do, however, try to employ natural resource mitigation at the town level by not permitting solar in wetlands or floodplains across New Haven. She mentioned that the PUC approval process investigate the number of solar development applications, what solar has

already been added, and calculate the capacity needed to add additional solar and transmission. If there is already solar in an area and the transmission is reaching its maximum capacity, she asserts the PUC automatically denies new solar siting applications. According to her, GMP is reluctant to add more transmission because that would raise rates on customers, and the state wont fund additional transmission.

When speaking on the solar facilities themselves, she stated that insurance representatives like fencing to protect their panels; despite the impacts it has on wildlife movement. She also spoke on the value of incentive programs like the Bobolink project, which seeks to delay mowing till after July to protect hay-nesting birds. The program, in her opinion, is underutilized given how dairy operations around New Haven have not been able to utilize their idle land. To make ends meet, dairy farmers will sell minimal lot sizes along the road for residential development. These areas are also prime for solar, especially if they're located near phase 3 transmission: a critical requirement for siting solar. Considering the power and purchase agreements for solar development can last 25 years, she thinks more partnerships between solar developers and dairy farmers can help dairy stay in business. This also helps solar developers since land for solar needs secondary uses to be more appealing to some folks in town. Small grazing animals, pollinator habitat, or other creative uses could give areas around solar arrays a more "rural aesthetic" and help them get approved.

There are many environmental groups who help towns write pro-renewable energy plans. Localizing the issue, however, can always be a challenge since no community is the same and pushback is easy to stir up if developers are not careful. For instance, because big solar fields went up fast & hard around Vermont, the state's dominance over the issue

made municipalities feel left out. Anti-solar opposition groups gained support by pointing to solar on agricultural fields as examples of how outside groups are monopolizing use on their land without benefiting the municipality or it's residents. Outsider resentment also factors into this, as tougher members of the town call folks who partner with outsiders "patsies" and discredit partnerships made between outsiders and local energy advocates. This compounds when folks who don't believe in climate change or who are helped by fossil fuel distribution businesses add their voices to the public discourse.

E.5 Department of Public Service Employee

To better understand the transmission side of solar development, I interviewed a member of the Department of Public Service who explained how the transmission element is considered at the state level. In response to asking about transmission siting, he said entities purchasing the energy usually help pay for transmission after the power maker speculates on capacity prior to construction. The transmission is always built to serve load, and the costs for new transmission are shared regionally. Sub and bulk transmission are highly regulated, with exhaustive siting and permitting reviews under Act 248 and a little under Act 250. The cheapest plan for transmission is traditionally used after a robust stakeholder engagement process through ISO New England. The Department of Public Service is planning for greater load due to electrification. This new load will likely not all be served with solar, since solar is a variable power producer and they fit the power generation type to meet the reliability demanded by consumers.

One reason he thinks there a great push for bigger solar facilities is because bigger solar facilities are more efficient in reducing losses due to transmission. Higher voltage from a

facility means the power can be sent on a lower current, which can reduce energy loss depending on the voltage class. It's also difficult to find available land that is not only large enough to host a solar array, but also southward facing, not shaded out by vegetation or mountains, and near transmission lines with available capacity to transmit the power. It is also harder to transmit power from rural areas since it takes longer to reach load: leading to lower efficiencies. At this point, he says there is greater need to evaluate transformer upgrades as this is currently the weakest part of the Vermont grid system.

According to the Department of Public Service representative, towns don't interface with them directly but rather handle transmission issues through the regional planning commissions (RPCs). Act 174 required RPCs to help towns write energy plans, with different levels of engagement across the state. Those towns which did finalize an energy plan can obtain Substantial Deference in situations where solar siting contradicts a town's energy plan. In the end, it all comes down to siting costs since preparing land through clearcuts and additional transmission can incur heavy costs to the developer.

Speaking on what the Department of Public Service is looking for when it comes to new power projects, he mentioned that they're often very interested in smaller, self-powering projects. Rooftop solar is one example of these kinds of projects, as they can reduce overall energy demand from a building; especially if it's factored prior to the building's construction. He says it's possible many homes in Vermont don't qualify for rooftop solar since the roof itself must be able to bearing the weight of the panels and their equipment. There are also cost of materials and labor concerns, to which he could not speak directly on. Overall, the Department of Public Service is always interested in flexible load management and aggregate generation. Location in proximity to substations is an added

plus, since they can more easily inject or absorb power depending on the energy context. In the long and short term, the Department of Public service is becoming increasingly involved in energy education as people become more involved in energy issues facing their communities.

E.6 University of Vermont, Professor of Ornithology

After hearing how grassland bird habitat is being deeply affected by solar development across the country, I interviewed a Professor of Ornithology at the University of Vermont. This professor is a Fellow of the American Ornithological Society and serves as the Chair of Vermont's Endangered Species Committee. He conducts research on bird ecology and conservation, how anthropogenic habitat modification impacts bird population, and is currently investigating the economic and ecological feasibility of implementing bird-friendly management practices for grassland birds in the Champlain Valley. In the South Street Solar siting case, he and several other grassland bird advocates submitted a Vermont Grassland Bird Management and Recovery Plan to clarify management efforts for several at-risk grassland bird species.

When I asked him about the Bobolink Project, a financial assistance program for farmers who modify their mowing schedules to avoid impacting nesting grassland birds, he said regular contributions, from solar developers to the project, are used as mitigation steps for impacts to grassland birds. They also fund the project based on donations from interested ornithologists or other conservation minded folks. The program involves paying a sum to a farmer to manage their fields to support Bobolink, awarding contracts to the people with the most efficient impact to bobolink habitat. The money is good for accenting

income, but not something that can be relied upon. Program participants are required by a contract to delay their mowing season till after Bobolink mating season. Participation can vary since hay nutrition decreases over time, and hay is still a product worth selling to local markets. Another way to participate in the project is by bidding to become involved after incorporating Bobolink habitat into the farmers business plan; a system modeled off ecosystem services.

Other mitigation steps used to help mitigate impacts to grassland birds involve enrolling offset land suitable for bird habitat at a 2:1 or 3:1 ratio. This helps combat fragmentation, which is the biggest issues as it relates to grassland bird habitat. So far, the program is averaging about 4 acres over 3,000 spots. The goal is to eventually acquire bigger chunks of habitat of equal or greater quality, since bigger areas dedicated to habitat are more valuable to wildlife. This comes as dairy agriculture continues to dwindle, with few farmers replacing the ones who are leaving the industry. These agricultural plots are usually becoming abandoned or being turned into housing development. Some agricultural set ups are diversifying their production, which he says is not great for biodiversity but probably good for enhancing local food systems. What he hopes to see in grassland bird conservation is more mitigation banking; where large farms are bought by communities and managed for large area conservation. Barriers to this solution stem from a problem where few groups can afford to purchase large tracks of land just to have it sit idle. Still, he’s hopeful that there will be continued interest in bird conservation well into the future.

9. Glossary

PUC	–	Public Utilities Commission
CPG	–	Certificate for Public Good
MOU	–	Memorandum of Understanding
ANR	–	Vermont Agency of Natural Resources
DPS	–	Vermont Department of Public Service
RPC	–	Regional Planning Commission
DWH	–	Deer Wintering Habitat