

Growing Solar, Protecting Nature

Executive Summary



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A rapid transition to clean electric power is imperative for meeting Massachusetts' commitment to net-zero greenhouse gas emissions by 2050. Solar energy in all its forms—rooftops, canopies, and ground-mount systems—must play a major role in this transition. The absolute urgency of the climate crisis, however, does not justify sacrificing our natural and working lands to make way for ground-mount solar. We can have our forests, working lands, and solar, too.

Since 2010, development of large ground-mount solar systems has become one of the largest factors driving land-use change in Massachusetts, causing the loss of thousands of acres of forests, other biodiverse lands, and prime farmland. Carbon emissions from the forests cleared between 2010 and 2020 exceeded 500,000 million metric tons of CO₂, equivalent to the GHG emissions of 112,000 cars each year. If the current approach to siting large ground-mount solar in Massachusetts continues, we will lose even more significant quantities of carbon stored by our forests, which currently remove roughly 10% of annual GHG emissions in the state. Our goals for biodiversity, climate-resilient lands, and local food production will be at risk.

Public opinion is clear: Massachusetts residents support a solar build-out that is balanced with nature and agriculture. A 2022 survey by the Massachusetts Division of Energy Resources (DOER) found that over 85% of residents believe that the state should strive to site solar on rooftops, parking lots, landfills, and other developed lands, rather than continuing to clear forests and convert productive farmland.

Growing Solar, Protecting Nature shows that it is possible for Massachusetts to meet its ambitious goals for clean electricity and net-zero emissions by 2050, while also protecting our most valuable natural and working lands. The results are incredibly promising: with the right policies, deliberate advance planning, and new incentives for protecting nature, **we can achieve both outcomes. And the moment to pivot from current solar siting practices to those that protect natural and working lands is now.** Massachusetts is already a national leader in rooftop solar, community solar, and incentives for solar on landfills, brownfields, and other developed lands. The public expects future solar deployment to be guided to sites like this, thereby protecting the natural and working lands that we also need.



Our Approach

To address the question of how to balance solar deployment with natural and working lands, Mass Audubon and Harvard Forest designed and modeled three scenarios of future solar deployment in Massachusetts. Importantly, each of these scenarios is projected to reach the GHG emissions targets set out in Massachusetts' *Clean Energy and Climate Plan for 2050*, though they do so by employing different blends of clean energy resources – i.e., solar, wind, and clean energy imports. Each scenario depicts the same technical potential for solar on rooftops and parking lot canopies: over 30 GW. But the scenarios differ with respect to which lands can host future ground-mount solar development.

- The *Current Siting* scenario approximates status quo siting practices for ground-mount solar i.e., those sites which are available to host projects under current legal and technical requirements. Supply of sites available for ground-mount solar: 1 million acres.
- Two *Protecting Nature* scenarios—Mid-Impact and Low-Impact—depict sites for ground-mount solar that protect natural ecosystems, biodiversity, and prime farmlands to varying levels. Supply of sites for available for ground-mount solar: 94,000 acres (Mid-Impact) and 38,000 acres (Low-Impact), respectively.




Applying the same energy-economic model used to develop the state's *Clean Energy and Climate Plan for 2050*, we first identified the subset of the most economically attractive acres from the total available acres described above for ground-mount solar under each scenario, and estimated their associated energy costs. Rooftop and canopy solar opportunities were analyzed in this same energy modeling step. Using estimates of economic solar from now until 2050 from the energy model, we then applied geospatial analysis and forest carbon data used in the state's Land Sector report, we then calculated impacts of projected ground-mount systems to natural and working lands, changes in forest carbon emissions, and carbon costs.

Note that in this Summary, we primarily report out results for the *Current Siting* and *Protecting Nature Mid-Impact* scenarios, respectively. Some results for the *Protecting Nature Low-Impact* scenario are also reported, but because this scenario represents a less likely boundary, we do not report out all results here.



Key Findings

In Massachusetts, large ground-mount solar systems installed since 2010 have come at high cost to nature and working lands; additional losses of nature and working lands from large ground-mount solar are poised to continue and possibly accelerate. Since 2010, ground-mount solar has displaced at least 1,800 acres of high biodiversity lands and nearly 1,300 acres of farmland. In addition, forest loss caused by solar development resulted in the emission of more than 510,000 metric tons of CO₂—equivalent to the annual emissions from 112,000 passenger cars. Continuing the current approach to siting ground-mount solar will jeopardize state goals for forest carbon, biodiversity, climate resilience, and local food production. If current siting continues, we estimate that cumulative carbon emissions from past and projected forest conversion for solar will reach 6.3 MMTCO₂e by 2050, and cumulative losses of prime farmland and high biodiversity lands will reach roughly 9,397 and 22,794 acres, respectively. With generous federal funding under the *Inflation Reduction Act (IRA)*, the pace of ground-mount solar development is poised to rapidly accelerate. *Unless we quickly pivot from our current approach, we risk losing public support for this valuable form of clean energy and putting long-term goals for forest carbon, biodiversity, climate-resilient lands, and local food production out of reach.*

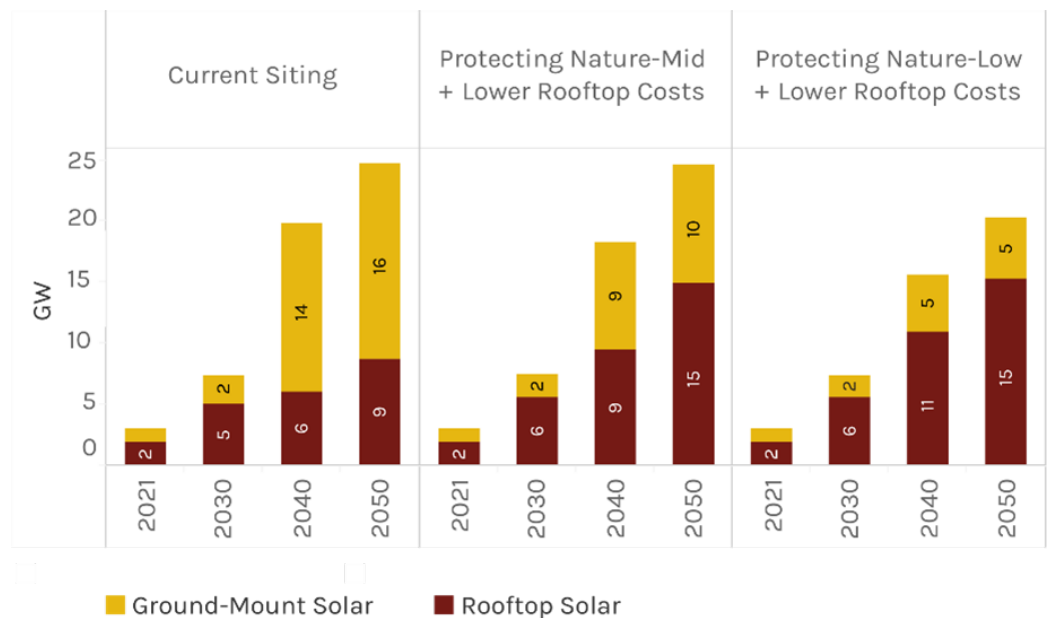
	Current Trend (2010-2050)	Protecting Nature Scenario-MID (2010-2050)	Protecting Nature Scenario-LOW (2010-2050)
 Forest LOST	39,150 Acres	7,556 Acres	6,152 Acres
 Key Wildlife Habitat LOST	22,794 Acres	1,825 Acres	1,825 Acres
Prime Farmland LOST 	9,397 Acres	1,278 Acres	1,278 Acres

The good news is we have an off-ramp to the current trajectory—Massachusetts has ample sites to locate affordable solar to meet the state’s clean energy and GHG goals, without incurring significant losses of natural and working lands. Our results show that on the low-end, over 40,000 acres could host highly cost-effective ground-mount solar with very low impacts to natural and working lands; an additional 53,000 acres could site low-impact solar that would cost only slightly more. Combined, these low-impact sites alone could support approximately 25 GW of ground-mount solar. And unlike installed ground-mount solar which has concentrated heavily on large parcels in Worcester, Bristol, and Plymouth counties, these low-impact opportunity sites are smaller, and can be more evenly distributed around the state, which could reduce community opposition focused on large utility-scale projects.

Solar potential on Massachusetts’ built environment—rooftops and parking lot canopies—is very significant at over 30 GW. State policies and incentives need to shift to capture even more of this potential. Our results show that when only federal *Inflation Reduction Act (IRA)* incentives for solar are analyzed, and no state incentives are modeled, the *Protecting Nature* scenarios result in less of the most economic solar capacity compared to *Current Siting* by 2050. Revisiting state policy and increasing incentives so that we capture more solar on the built environment and low-impact lands will increase capacity. Moreover, implementing approaches to reduce the ‘soft costs’ of rooftop and canopy systems, such as permitting and marketing, can help further unlock this potential and reduce the need for ground-mount systems. As shown in the figure to the right, we estimate that a 30% reduction in rooftop solar costs would nearly double rooftop

solar capacity, reduce the need for ground-mount solar by 38%, and would reach total solar capacity of 25 GW by 2050.

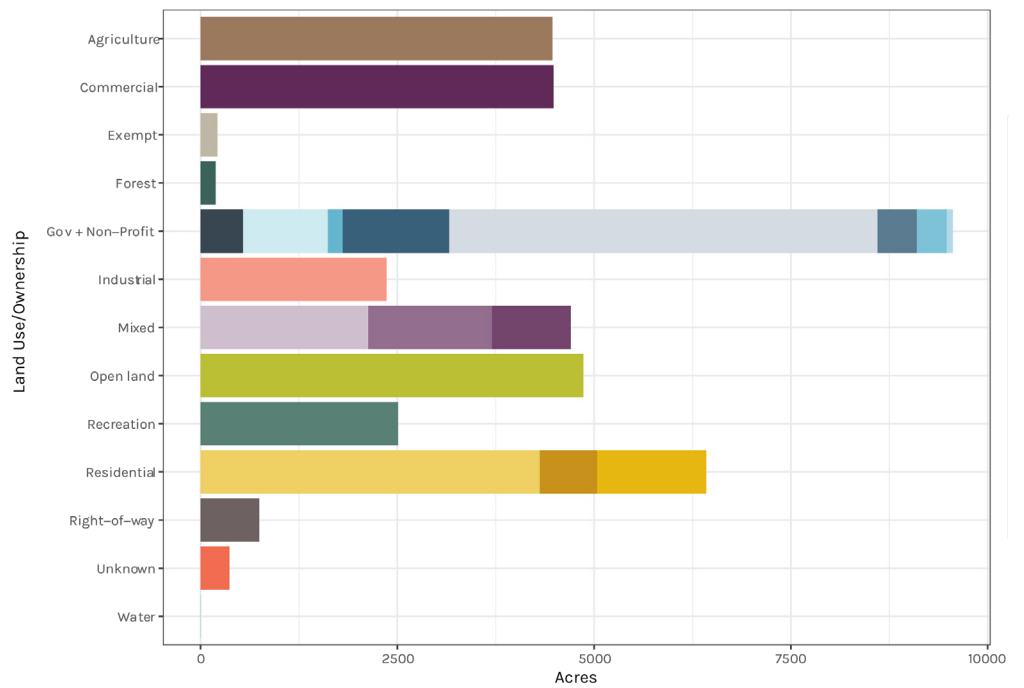
When the true costs of losing nature and farmland are considered, current solar siting practices result in higher costs than Protecting Nature. Results from the *Current Siting* scenario project a net loss of carbon from forests ranging from 4.7 to 4.9 MMTCO₂e by 2050, compared to the two *Protecting Nature* scenarios, respectively. To understand what would be needed to make up for this deficit of carbon removal by forests and still meet net-zero emissions by 2050, we calculated the costs of achieving other types of GHG emission reductions in this timeframe (at a cost of approximately \$200/ton CO₂e). We estimate that replacing this quantity of lost carbon removal by forests alone could cost \$940M to \$980M. This is actually greater than the difference in the energy costs – roughly \$900M in present value – between the *Current Siting* and the *Protecting Nature Mid-Impact* scenario. And carbon removal by forests is just one ecosystem service that fares considerably worse under continuation of current solar siting practices. This estimate does not reflect the value of losses to biodiversity, local food production, or lands that provide us with resilience to the worst impacts of climate change itself. Losses of these ecosystem services are incalculable, and many are irreplaceable.



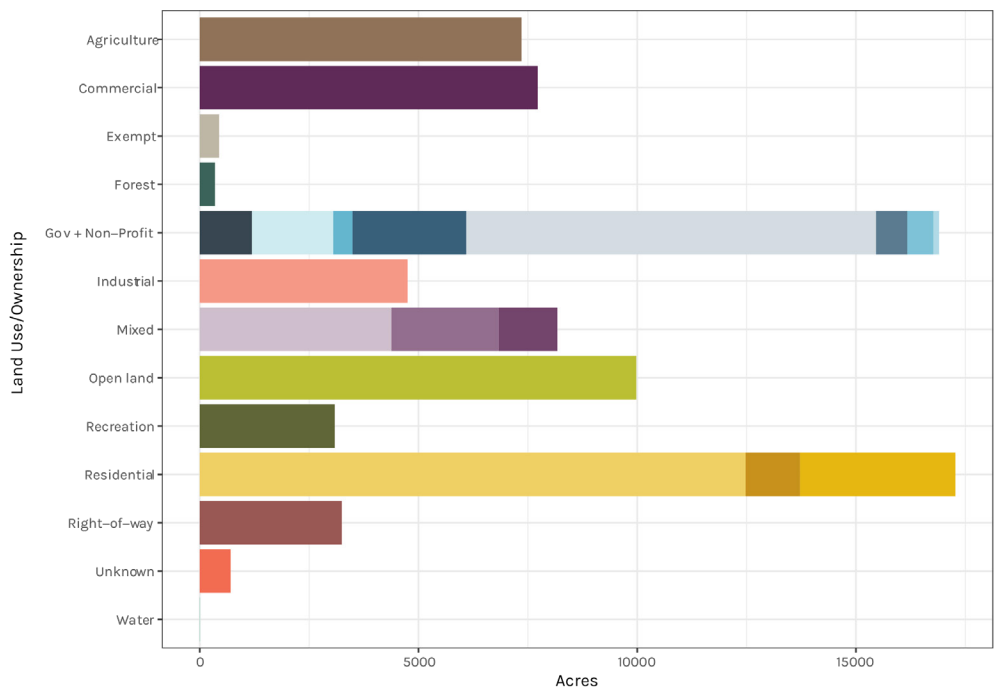
Cities and towns, the state, and non-profit institutions own or manage many of the best sites and buildings for low-impact solar.

Of the 94,000 total acres identified as desirable sites for ground-mount solar under the *Protecting Nature - Mid* scenario, our cities, towns, the Commonwealth, and non-profit institutions own between 10 and 18%. Many of these owners of low-impact lands for ground-mount solar also own buildings and parking lots which could host rooftop and canopy solar. Because mission-driven organizations and governments can sometimes accommodate longer repayment periods for climate investments like solar energy, this presents real opportunities for scaling low-impact solar. Homeowners along with commercial and industrial landowners also own many low-impact sites for ground-mount solar, ranging from nearly 15,000 on the low-end to nearly 40,000 acres on the high end. Other open lands under various ownerships could also host low-impact solar, on an additional 5,000 to 10,000 acres. Capitalizing on these opportunities may require some creative marketing and development approaches.

Mid-Impact Ground-Mount Sites by Ownership (Low End)



Mid-Impact Ground-Mount Sites by Ownership (High End)



Land Use Type

- Municipal
- Single Family
- State
- Multi-Family
- Federal
- Mixed Residential
- Quasi-public
- Mixed Other
- County
- Mixed Commercial
- District
- Residential other
- Private exempt
- Unclassified exempt

Policy Recommendations

Growing Solar, Protecting Nature shows that a more constructive path forward to reaching solar and GHG goals is possible, one that is both highly protective of nature AND scales up affordable, low-impact solar to communities across the state. To build durable public support for ground-mount solar, state policies, incentives, and plans must align with the public's desire for a balance among clean energy resources, nature, biodiversity, and local food production.

We identify three major areas where innovative policies, programs, and approaches are needed: energy incentives and policies; state and local planning and community outreach; and policies specifically focused on protection of forest carbon, biodiversity, and productive farmlands. Our high-level policy recommendations for each of these areas are below. We provide additional recommendations in our full report.

Energy Incentives & Programs

- Cease state incentives for large ground-mount solar on high biodiversity and other natural and working lands; reprogram funds toward solar on low-impact lands and in the built environment.
- Invest in approaches to reducing soft costs of distributed solar projects, such as a statewide permit for solar on the built environment and low-impact lands.
- Support state, cities, and non-profits and residential, commercial, and industrial landowners to capitalize on significant opportunities for distributed and low-impact ground-mount solar.
- Prioritize projects for interconnection that minimize both grid upgrade costs and land use impacts.

Planning & Outreach

- Update model municipal by-law for solar.
- Leverage *Green Communities* and other state programs to maximize use of IRA and possible EPA *Solar for All* funds toward low-impact solar that supports low-income ratepayers.
- Engage and support communities directly in advance planning for solar and transmission build-out on lowest impact sites (leveraging DOER and Mass Audubon/Harvard Forest mapping data and tools).
- Conduct holistic, integrated state-wide land use planning for multiple needs: clean energy infrastructure, transportation, and affordable housing.

Natural & Working Lands Incentives

- Fund permanent protection of highest-value natural and working lands, at funding levels commensurate with the state's Resilient Land goals to protect 30% of Massachusetts highest-value lands by 2030, 40% by 2050, and realizing 'no net loss' of forests and farms.
- To raise funds for permanent protection of highest value natural and working lands, establish clear goals and performance standards for natural carbon removal, biodiversity and farm production, and set a fee to internalize cost of losses to carbon, biodiversity, and food production to developers of solar and other projects.