Novel Solar Placement

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Overview

The development of solar energy has increased exponentially in the past decade, mostly through solar farms and residential systems. Solar farms, small or large-scale, often require the removal trees to create a vacant land for construction. Although the output of solar panels may surpass the benefit of carbon sequestration, the removing of trees is not necessary for solar placement. Tree retention is a significant tool for climate stability that should complement the goal of increasing use of solar panels. Trees also increase property values and protect ecosystem health. They therefore hold more value than they're given when replaced by panels without due consideration of these values.

Novel solar placement looks at more efficient use of land, combining the benefits of carbon sequestration via trees and solar energy capture. Taking innovative approaches to the placement of panels in order to avoid tree or other vegetation removal can also prevent communities from opposing solar since the replacement of natural/open space with solar farms raises controversy. To accelerate novel placement, governments must add incentives and give preference to projects that make it a priority to preserve trees and use existing land more efficiently.

The Request for Proposals.

There are existing tools to help governments encourage the production of solar farms or solar solutions. The American Cities Climate Change Challenge provides a template of a Request for Proposal (RFP) for on-site solar so that local governments can use this for their own use and insert any specific language. The goal of an RFP is to solicit competitive bids from contractors to select the best-qualified proposal to achieve any specific project goal of the government who issued it in the first place. The RFP provided by American Cities Climate Challenge[1] integrates best practices found in an existing RFP by the Department of Energy's initiative on better buildings, the National Renewable Energy Laboratory (NREL)'s template for photovoltaic systems,[2] and a few other references that include on-site solar language from different cities. (American Cities Climate Challenge, 2020). **However, there is no wording on the cutting down of trees to begin development or statement giving preference to projects that are more innovative.** An RFP should highlight the need for progress towards meeting renewable energy goals by using innovative ideas to reduce the impact of energy production on climate change. Encouraging novel placement of solar systems without being too "prescriptive and remaining flexible" on RFPs is ideal. Possible wording that could be added to the template provided on the "Purpose of RFP" section, could be "Increase novel solar placement without removing existing trees, and if necessary, providing relocation of displaced trees."

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Trees provide natural shading and cooling and can be used strategically for energy conservation. To mimic this effect, solar panels can be efficiently used in areas that could use shade. This could be encouraged through specific wording such as “shading or passive cooling provided for public spaces from design of projects.” In project details under section 1.4, a column could be added to list removed trees so that project details could be transparent when reviewed. A column could be added as “novel element” to ensure that developers are taking this requirement into account with options available such as passive cooling. Also, under section 2.8 Final Design Package, there is a bullet point on Electrical Interconnection which could include requirements on providing electrical service for public spaces that would add to community solar.

Government Incentives

Government incentives can better shape the development of solar placement that takes up existing land in more efficient ways. It is more economical to develop on vacant lands currently so naturally projects will follow what the market offers. The shift to smarter solutions would take place with financial incentives offered by local governments. Incentive programs could highlight preferred projects that would be approved based on efficient land use or siting that could provide other community developments like brownfields or the unused land leading to highways that are too small to develop economically without special incentives.

An example of how a state can guide growth in solar development has been the Solar Massachusetts Renewable Target (SMART)[3] program, which offers long-term incentives for residential or commercial solar projects throughout Massachusetts. Successful applicants to the Solar Program Administrator and the Department of Energy Resources (DOER), receive utility company payments directly. (Massachusetts Solar Program, 2022) The incentive only applies if the project is interconnected by the three utility companies listed, Eversource, National Grid, or Unitil.

The SMART program is similar to other net-metering or tariff programs that provide payments to "distributed energy resources" like homeowners with solar panels on the roof. But SMART includes a document with guidelines on land use, siting, and project segmentation. The program uses Solar Tariff Generation Units (STGUs) which take into consideration land use criteria which is broken down extensively. This serves as an example to other local and state governments to ensure solar developments don't disturb natural landscapes, habitats, or

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protected areas. SMART breaks down land use categories into 3 segments and eligible projects in each as well. For example, Category 1 land that is considered non-Agricultural may be eligible for STGUs and examples are given such as floating or canopy STGU's. (Department of Energy Resources, 2021)

These are great examples of novel solar placement. There are many places that could benefit by preventing the evaporation of drier agricultural lands, and many places where shade can be beneficial. Different types of STGUs are described and added rates per acre impacted for "greenfield subtractors" (reducing incentives for removing vegetation) or pollinator adders (increasing incentives for protection of plants important to pollinators)[4]. Different rates are used to encourage development on specific zoning. Ineligible land uses are highlighted – such as protected open space that is held by local governments, wetland resource areas, or properties in the State Registrar. Although the program has wording on land use, there could be more text or preference given to projects that explicitly discourages the removal of trees. [5] Some examples given for types of solar facilities eligible are very "land efficient" in that they use brownfields or landfills for solar, areas that have limited development options.

Even the SMART program could more explicitly tackle the issue of the unnecessary removal of trees in the process. The SMART program could that priority clearly, including the value of land efficiency and the value of innovating new methods of solar placement for the purpose of avoiding having to remove vegetative carbon storage. SMART has had so much

[4] Navisun Advances its Solar Power Portfolio with Two Projects in Massachusetts and Announces New Pollinator Program pubished on April 26, 2021 through Navisun.

[5] Land use categories for ineligible land are specific to protected lands. However, for there is no information discouraging the development of solar systems on other land that may be vacant and fall under eligible zoning. This may be private vacant lands that could be sold for traditional solar farms.

success proving that incentives can drive changes, that being more explicit about these values should make a difference.

SMART offers an example that other states can follow. States with solar incentive programs can include wording on best practices for project development as an option to inform and require applicants to choose lands accordingly and build smarter. Having requirements or checkboxes for this program on tree removal could initiate projects that do consider land efficiency since they may be more economical than those who remove trees to make space for ground-mounted solar systems. It may also be beneficial to include a best practices guideline to highlight the issue at hand and how the program will want to move forward with future projects. Offering examples of innovative placement from successful projects may also inspire community projects that will benefit all parties. The SMART Program is a great model that other states should implement to encourage solar development at the rate that Massachusetts has.

Brightfields

Landfill solar has provided renewable energy projects, often termed brownfields. RMI [6] refers to these brownfields as brightfields, and according to the US EPA and their RE-Powering Tracking Matrix, these accounted for almost half of all renewable energy projects. (RMI, 2021) Landfills are sought out locations because of their sun exposure and limited possibilities for re-development. Additionally, landfill solar systems help boost the economy in their respective communities which are typically lower-income. There are more inactive landfills in the US that are using land inefficiently versus active landfills that could be sites for solar placement. The technical potential of closed landfills is about 63 gigawatts yet there is only 500 MW installed currently. (RMI, 2021) **The potential of just developing these inactive landfills would be enough to supply seventy percent of the solar capacity installed in the US in 2020**. Although there are many benefits to brightfields, they are not yet common practice in the renewable energy industry.

The SMART guidelines favor brownfield solar development and it is no surprise that eighty six percent of all utility-scale landfill solar projects are in New England and Mid-Atlantic, with fifty two percent of all projects just being in Massachusetts. This may indicate the efficiency of the financial incentive program. The rest of the US makes up only twenty seven percent of solar capacity via brightfields.

[6] Matthew Popkin, Manager at RMI, provided me with this report that he wrote with the help of another RMI employee. RMI is a nonprofit that guides energy systems globally towards solutions that follow a path towards a zero-carbon future.

It is important to note that in this report, RMI states that the sole driver in solar energy deployment via brightfields are state and local governments. If all states and the federal government created programs similar to SMART in Massachusetts, a solar capacity potential can be reached to accelerate renewable energy production. Land use inefficiency at inactive landfills offer a great opportunity for zero-carbon solutions and environmental justice. For example, community solar on brownfields can be used to reduce costs for neighbors of these sites, which almost always are in low—income communities.

Just as brightfields are more common in Massachusetts, the EPA's report states that it is also the leading state in number of re-powering projects. Re-powering projects are projects where renewable energy projects have been installed on former contaminated sites. (Environmental Protection Agency, 2021) The EPA published the report to keep track of all renewable energy projects that are built on formerly contaminated lands, landfills, and mine sites. As of 2021, the EPA only recognized 459 renewable energy installations, while ninety two percent are solar installations and most of the rest are wind installations. Of those that are solar, only fifty nine are percent are brightfield installations. Similarly, Massachusetts and New Jersey have the leading number of re-powering projects while being two out of only three states with financial incentives and streamlined permitting policies. States with financial incentives but no permitting policies have a few projects carried out, and states with no re-powering policies are very few. There are with some projects in states without incentives or

policies, such as California with 25 projects. However, improvements in policy and state incentives are what drive most re-powering projects. [7]

Agrivoltaics

Solar design can be used to provide shade to plants as well as passive cooling and shade for society. Co-locating agriculture and solar panels could provide benefits to growing plants that require some shade and avoid having to use double the land for the same uses. The Solar Energy Technologies Office at the Department of Energy has a program that funds several projects which offer potential solar and agricultural co-location, termed agrivoltaics. This program encourages efficient land use throughbelow ground-mounted solar panels, preserving pollinator habitats or producing crops.. (Department of Energy Solar Technologies Office, 2022) The importance of being able to use the land for both purposes is to avoid future land-use competition between solar development and agricultural uses. The Department of Energy also encourages this co-location because it'll help agricultural businesses to have multiple sources of revenue and ecological benefits. Current projects control panel transparency to manipulate conditions for crop yields such as raspberries and other crops tested for quality, grown by GroenLeven, a Dutch company focusing on agrivoltaics. (Bellini, 2020)

The largest commercially active research site for agrivoltaics in the USA is Jack's Solar Garden, which has installed over 3200 solar panels in Boulder County. This installation has been enough to power roughly 300 households while ongoing agricultural production for various

[7] The state map with detailed projects and programs in each state can be found on page 3 on the RE-Powering Matrix provided by the EPA. Although this map is for potentially contaminated lands, most projects are for solar on brownfields because these projects have a higher payment within the incentive policy to accelerate their development.

crops. The solar gardens developed have created microclimates by introducing pollinator habitats and studying the effects of solar systems co-locating on agricultural productivity. (Jack's Solar Garden, 2022) Co-locating these two efficient land-uses is a more efficient way to develop solar systems rather than cutting down trees to make space for solar systems solely.

Solar Parking Canopies

Solar canopies have increased in popularity because they can be built on developed lands on areas that would benefit from shading to conserve energy. A 22-acre solar power array installed in Disney World along with a 270-acre solar farm where there was orchard and forest land is built in Orlando, Florida yet none of thousands of parking spaces have any solar canopies built. If Disney World is the owner of all three of these lands, then surely a canopy can be considered to use the land more efficiently. Yale published an article that claims that only 2.5% of the solar power generated in the United States originates from urban areas and most from deserts in utility scale facilities. **A surprising ten percent is generated from former forests and grasslands**. (Yale Environment 360, 2021) Although it is cheaper to occupy croplands and drier lands than rooftops or parking lots, there is also a rush to develop renewable projects quickly to meet climate goals of replacing fossil fuels with renewable energy. Undeveloped land is becoming rapidly unattainable and shouldn't be used up to produce renewable energy inefficiently when there are better options available. The displacement of species, changes in landscape, and removal of native vegetation not only change ecosystems but also disrupt wildlife and migratory corridors.

Building on lands that have already been stripped of their biological value makes the most sense in terms of efficiency if this value is considered when permitting for solar farm

development. If this was a factor accounted for or through fees or penalty for building on undeveloped land, there could be a shift in the attractiveness of these lands for developers. Changing the market via taxes of financial incentives to push for novel solar placement is necessary or we see missed opportunities as at Disney World.

Solar canopies recently were proposed in Washington D.C. to be built on rail station parking lots which is projected to supply 12.8 megawatts of energy. Business plans from projects in the past in Rutgers University, of Evansville Regional Airport have already reported "cash-positive results from the get-go." *(Yale Environment 360*, 2021) Even if payback is after 10 years or more, the outlook must change to make this more desirable. Another reason for the scarcity of building on developed land is due to conflicts of interest from utilities and fossil fuel companies.[8] Furthermore, some states even have policies that actively dissuade rooftop solar and happen to be the states with the most solar potential supplying the least energy.[9]

Floating Photovoltaic Systems

Floating Photovoltaic (FPV) Systems represent another technology with the potential for increasing land use efficiency, especially when solar systems are made to float on man-made bodies of water such as tailing ponds with no other designated uses. The benefits of FPV

[8] For more information on conflicted interests, refer to *Blocking the Sun*, a report published in 2017 from Environment America which is a coalition of state environmental groups based in Denver. It describes how utility and fossil fuel companies have challenged government policies that facilitate solar systems in novel placements like rooftops or parking canopies.

[9] A report published in 2018, *Throwing Shade,* from the Center for Biological Diversity claimed that ten states had failing policies that discouraged solar. This included, in alphabetical order, Alabama, Florida, Georgia, Indiana, Louisiana, Oklahoma, Tennessee, Texas, Virginia, and Wisconsin, that only contributed seven and a half percent of solar power while being the warmest states with the most potential for more. They deter residential solar by not allowing third party installers and making it very costly for installation.

systems go beyond efficient land-use and provide reduced evaporation, very helpful in retaining water in systems open to the air; reduced algae growth, increased ability to use the water as a natural coolant, and of course avoiding disturbance of land-based natural habitats. The technical potential of these systems on suitable water bodies could generate almost ten percent of current national generation if only twenty seven percent of the bodies are covered in floating systems. [10]The bodies of water filtered out for eligibility were those used for recreation, tailings, navigation, or fish and wildlife ponds. (Robert S. Spencer, 2019) It is important to note that most bodies of water are already in areas with water insecurity and expensive land costs, so the generation of solar energy in this novel way would be beneficial to prevent water evaporation in areas that are most susceptible to water loss and generate revenue without having to pay acquisition costs.

Solutions

As undeveloped lands become less common and acquisition becomes more expensive, building solar systems the "quick and cheap way" won't be an option anymore and there must be paths to work efficiently towards global renewable goals. With various novel solar placement options available, greater land use efficiency is an attainable principle for shifting to renewable energy production. To encourage projects to implement a renewable portfolio standard that will prohibit the removal of trees or biologic value, there must be financial incentives and policy provisions. The success of the Massachusetts program shows that aligning

[10] Information on technical potential was taken from publication *Floating Photovoltaic Systems: Assessing the Technical Potential of Photovoltaic Systems on Man-Made Water Bodies in the Continental United States* by Robert S. Spencer published in *Environmental Science & Technology* journal.

land use with sustainability and economic goals will likely succeed.[11] Incentives for landfill solar (brightfields) took off and became the most popular solar generation project, which served to further encourage innovative solar technologies. Creating explicit incentives for novel solar placements and prohibiting or discouraging the removal of trees should guide states towards the same successes, or more, that Massachusetts has experienced. The addition of language to deter biological disturbance is the missing link in most templates that are available for local and state government use, which can make the most difference.

In many states it is necessary to establish incentives for distributed energy resources, and to counter opposition from utility and energy companies to transitioning the from the heavily fossil-fuel-based systems of today. Where a lack of education or political support or budget insecurities [12] inhibit progress, the federal government can step in to fill the gap. When and if it does, or a state acts to promote solar and other renewables, it should include in its program explicit guidelines that encourage novel solar placement over the easy, cheap alternative of placing solar where trees or vegetation are now serving to sequester carbon and provide so many other benefits.

[11] John Weaver, a commercial solar consultant, told *PV Magazine* that "the problem might be that the state has created a program that is too successful," speaking about the SMART Program in Massachusetts.

[12] I interviewed an employee from Solar United Neighbors who mentioned the need for updated policies although the company is having success with rooftop solar in local communities. However, when SUN attempted to develop community solar arrays on underused green space, the main challenge they encountered was receiving no cooperation from the local government and complications in land use. The county claimed they wouldn't provide permission to construct due to plans of releasing a competitive RFP for future projects although there were none in the works.

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