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Solar Mapping Tool

REPLICATION GUIDE

HOW TO SOLAR NOW

BUILDING A SMART SOLAR FUTURE

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Introduction

In New York, renewable energy targets and state programs to promote solar energy development at all scales—from residential rooftop to community solar projects to large, "utility-scale" facilities - will continue to incentivize solar development across the state. New York's landmark Climate Leadership and Community Protection Act (CLCPA), signed in July 2019, increased New York's 2030 renewable energy generation target from 50% to 70%. Many renewable energy generation facilities must be approved and built rapidly to meet this new 2030 goal.

Scenic Hudson, Inc., an environmental not-for-profit based in Poughkeepsie, New York, is focused on supporting the Hudson River valley as a regional model and leader in responding to the climate crisis. We promote accelerated renewable energy development while simultaneously preserving important natural assets and community character. It is critical that we identify a path forward to achieve the required level of renewable energy development while protecting valuable ecological, agricultural and cultural resources.

Scenic Hudson has developed a suite of resources for smart solar energy siting available at HowToSolarNow.org, including:

- *Clean Energy, Green Communities: A Guide to Siting Renewable Energy in the Hudson Valley*, published in 2018, which presents a strategic approach to renewable energy siting to reduce conflicts and promote successful development; and
- *Solar Ready, Climate Resilient: Best Practices and Recommendations for Solar Zoning in the Hudson Valley,* published in 2020, which empowers communities to take advantage of their solar energy resources as they translate local policies and goals into clear, enforceable plans and regulations.

We also recognized the need for a one-stop mapping system where stakeholders could assemble and visualize the information necessary for smart solar energy development in their community. We developed a concept for a decision-support tool that would combine education on planning for solar energy facilities with relevant geographic information system (GIS) datasets into a single, easy to use web-based platform.

In June 2019, Scenic Hudson received a 1-year, $50,000 grant from the Doris Duke Charitable Foundation to support development of this GIS-based decision-support tool that incorporates conservation priorities into local and regional planning and zoning for solar energy facilities at a range of scales. The result, *Scenic Hudson's Solar Mapping Tool for Your Hudson Valley Community*, is an on-line resource with a user-friendly design that supports decision-making for solar energy siting at a municipal and regional level.

From the beginning, Scenic Hudson intended the Solar Mapping Tool (SMT) to be easily replicated for other regions of New York State and throughout the US. This report chronicles the process of the SMT's development to inform replication for other geographical regions.

Steps + Recommendations for Replication

1: ASSEMBLE A PROJECT TEAM

It is important to assemble a project team of personnel with the necessary expertise and experience to create a GIS-based on-line mapping tool. Scenic Hudson's expertise and experience in GIS (including knowledge of existing GIS datasets appropriate for the Hudson Valley region), renewable energy policy, conservation science, stakeholder outreach, and local land use and planning were all vital in creating the SMT.

Once our team was assembled, we held a kick-off meeting and created two project sub-teams: one for stakeholder engagement and one for technical development of the SMT. To ensure the project team achieved the goal of developing the SMT within the one-year time frame, we established a timeline of tasks with assigned personnel, and set up regular meetings of the two sub-teams.

We envisioned the SMT as a unique combination of educational guidance and technical data in a single, web-based tool. To inform the SMT's design and structure, we considered two threshold questions:

1. **What should be the user flow?**
2. **What information relevant to solar energy siting should be included for mapping?**

In developing the SMT, we spent significant time considering the "user experience flow," i.e., the order in which information and GIS datasets were presented to users. Given the expected large amount of content, a cohesive and understandable flow was important to both encourage use and ensure effectiveness. The chosen user flow will inform the initial identification of the information and GIS datasets relevant to solar energy siting that should be included for mapping. Depending on the user flow and geographical region, the information needed might be different for other versions of a solar mapping tool.

We developed a user flow informed by municipal planning principles, which we termed the Four Steps of Smart Solar Planning. The approach in this user flow focuses the user on recognizing what is most valuable to their community, and then planning for solar development around those valued resources. We hope this approach helps streamline permitting and project review by encouraging solar development that preserves and augments the resources of Hudson Valley communities and by reducing opposition to well-sited solar projects. This flow encourages users to first examine existing broad patterns of development and land use in the community. To assess existing development patterns, users would need to be able to map these patterns. We identified National Land Cover Data as a primary dataset for this first step.

Next, the user flow prompts users to identify "low-hanging fruit" solar opportunity areas such as rooftops and parking lots, and landfills. To identify solar opportunity areas, they would need to be able to map these areas. We developed an initial list of such opportunity areas to include rooftops of large buildings, parking lots, landfills, abandoned mines, remediated sites, and other types of previously disturbed sites.

Next users identify the natural and other resources that the community values and prioritizes for protection. To identify low impact sites that would have the least conflict with these resources, the user should be able to map important resources. We developed an initial list of such important resource categories to include agricultural resources, areas important for biodiversity, forested lands, wetlands and floodplains, and historic, cultural and recreation assets. This planning step will require identification, selection and incorporation of the largest number of datasets.

Finally, users explore solar feasibility in the community, i.e., where solar can be built and interconnected to the grid. To assess solar feasibility, the user would need to be able to map areas where there is suitable slope and aspect as well as potential locations for interconnection to the grid, i.e., the location of transmission and distribution lines.

3: SELECT A TECHNOLOGICAL PLATFORM

After confirming our initial concept for the SMT, we proceeded by selecting a technological platform for the SMT and developing a prototype for the purpose of gathering stakeholder input and feedback. In order for the tool to function as an educational resource, it is important to choose a web platform that both provides the ability for users to overlay their choice of datasets in an interactive map and displays narrative educational content relating each dataset to solar development in a single viewing frame.

Scenic Hudson elected to use a GIS platform called ArcGIS Online, which provides the ability to make web-based maps and create StoryMaps, which are flexible web-based applications that weave maps, multimedia, and other content together using relatively easy, out-of-the-box templates. We realized early in development that the educational information surrounding the maps would be as important as the maps themselves. There are many other options for web mapping and embedding maps in a website or web app that could support the dual goal of the SMT.

We selected a StoryMap template that allowed ample information to be displayed on one side of the screen while a map or graphic image is displayed on the other side. Again, we felt that this ability was key to the SMT, because we wanted not only to show maps but also to help users put the information they were seeing in the context of solar development. Simultaneously, we wanted users to learn more about how solar development in the Hudson Valley intersects with other resources and priorities for local communities. Another advantage to using ArcGIS Online is that many other organizations use the same platform to publish their datasets as streaming data services, allowing us to stream data directly into the SMT instead of hosting it ourselves (i.e., the data exist on the hardware of the organization that created them, and are only viewed through the SMT). These streamed datasets are updated in the SMT automatically as source organizations update their streaming services.

4: ENGAGE STAKEHOLDERS

Stakeholder engagement in the development of the SMT was important for several reasons: to ensure credibility and buy-in, confirm the approach taken in the prototype is relevant to users, obtain input on the selection of datasets to include in the SMT, and to build an audience of potential users for when it was completed and made public.

We sought to engage stakeholders throughout the process of developing the SMT to maximize its utility to communities in the Hudson Valley. Involving stakeholders from an early stage of development and throughout the development process allowed us to continually update, revise, and improve the SMT according to the significant stakeholder input we received.

We initially met with two municipal stakeholders and one industry stakeholder who had standing relationships with Scenic Hudson to pitch the idea of the SMT and communicate a general sense of how the SMT might work. The stakeholders gave helpful feedback regarding the overall utility of the SMT idea, the importance of recognizing and accounting for existing local code and planning documents, and some additional datasets to consider to make the SMT more applicable to urban areas as well as rural.

Scenic Hudson identified five stakeholder groups whose members might be either users of the SMT or subject experts on valuable resources in the region: biodiversity conservation experts; agriculture experts and farmers; municipal stakeholders (including elected officials, planners, and members of municipal boards and committees); solar developers; and electrical utilities. We conducted significant outreach to invite members from each of these groups to five separate meetings to present the SMT concept and prototype and to gather their feedback.

In total, we met with 60 stakeholders across the five stakeholder groups, including state regulatory agencies, non-profits, municipal and county representatives, and solar developers (see **Table 1** for details). We held a meeting with each group of stakeholders to review the general concept for the SMT, the user experience flow, our candidate datasets, and which dataset we proposed to include in the SMT as the best dataset for a given category. We also encouraged stakeholders to suggest datasets we may have missed, alterations to the user flow experience, or information about each resource that should be included in the SMT. We incorporated suggestions and comments into the SMT wherever possible, although stakeholders primarily confirmed our proposed set of resource categories and datasets.

Finally, we sought out two communities with which to conduct pilot tests in the interest of further creating confidence in the SMT for municipal stakeholders. These two communities represent the diversity of landscapes in the Hudson Valley, and both had an imminent need and interest in addressing potential solar development in the community, for example by revising comprehensive plans and zoning to better address solar development. Throughout the pilot process, the SMT was continually improved and revised following comments, questions, and requests from pilot community members.

TABLE 1.

Stakeholder Group	# Stakeholders	Notes
Agriculture	11	Included NYS Dept of Agriculture and Markets, Energy Research and Development Authority (NYSERDA), and agriculture non-profit organizations
Conservation	11	Included NYS Dept of Environmental Conservation, Hudson River Estuary Program, NYSERDA, and conservation non-profit organizations
Municipal/County	18	Included county and municipal officials from 8 counties in the Hudson Valley, as well as quasi-governmental and non-profit organizations
Solar Developers	15	NYSERDA was also in attendance
Utilities	5	Included all 5 electrical utilities for the Hudson Valley, under the umbrella of the Joint Utilities of New York

5: SELECT REPRESENTATIVE GIS DATASETS

A critical aspect of tool development is selecting GIS datasets that accurately and adequately represent all of the desired information relevant to solar development in the geographic region covered by the tool. As we worked to assemble this information for the SMT, we had several considerations:

- identifying the most representative dataset(s) for each resource or asset considered in The Four Steps of Smart Solar Planning;
- providing sufficient information without overwhelming the user; and
- maximizing use of widely and publicly available GIS data in the interest of replicability.

After selecting the platform template for the SMT, we leveraged Scenic Hudson's existing collective expertise across disciplines and knowledge of local GIS datasets that might be relevant to smart solar planning. We began by defining general subjects for groups of datasets necessary to carry out the Four Steps of Smart Solar Planning: existing patterns of development; previously disturbed or developed sites that represent solar opportunity areas; agriculture; biodiversity; wetlands and floodplains; historic, scenic, and recreational resources; and solar feasibility. We then cast a wide net to create inclusive first lists of datasets reflecting resources in each subject.

By compiling the datasets on diverse subjects that are most relevant to solar development into a single mapper, we aimed to facilitate users' understanding of a multi-faceted issue: planning for and siting solar with minimal impacts to other valued resources. However, to avoid overloading new users, we minimized the number of datasets in the SMT as much as possible.

There is a wealth of GIS data publicly available, and often times many datasets cover a similar topic but have subtle and important differences. For example, in the biodiversity group of datasets, we considered both The Nature Conservancy's Forest Matrix Blocks and Linkages as well as the Hudson River Estuary Program's Core Forests datasets, both of which represent contiguous blocks of forest in the Hudson Valley. In a similar vein, soils of agricultural value are represented with several datasets developed by the US Dept. of Agriculture: Mineral Soil Groups; Land Capability Classes; or Farmland Classes.

In both cases, there are differences among these datasets that are relevant and useful to experts in the fields of biodiversity conservation or agriculture respectively. However, for the SMT we strove to include datasets that are accessible and easily understood by a more general audience, and to present a manageable amount of information. We therefore selected the one dataset that best represents each category of data for a general audience as it relates to solar development at a local or municipal scale. Although some nuance and detail may be lost, we wanted users of the SMT to be able to consider resources across multiple categories. We also omitted datasets that were too coarse in scale, such as some that were developed for the continental US and lacked precision when examined at the scale of a Hudson Valley community.

In our development of the SMT, we also sought to facilitate replicability through the selection of a widely used, web-accessible GIS platform and the use of predominantly public datasets. Nearly all of the datasets in the SMT are currently available in other web maps.

Although many datasets are national or statewide in scale, such as farmland soils, wetlands, and solar opportunities, others are specific to our region. For example, the

Important Areas for Biodiversity dataset, which is a compilation of the Natural Heritage Important Areas datasets developed by the NY Natural Heritage Program for the Hudson Valley, funded by the Hudson River Estuary Program. This data is critical for locating and assessing regionally important biodiversity resources, and those seeking to replicate the SMT should identify analogous datasets more relevant to their region.

Some datasets may require obtaining permission and an agreement for inclusion in a tool. In the event an agreement cannot be reached, simply providing information and/or links to the relevant data can be used as a substitute. In the SMT, one notable data set is that of hosting capacity, i.e., the amount of additional load an electrical distribution line can take on from solar or other distributed generation without affecting reliability of service to customers. In New York State, the electrical utilities are required to provide this data publicly, and to do so in a uniform manner organized by the Joint Utilities of New York. Scenic Hudson worked with the Joint Utilities to stream this dataset into the SMT, which will hopefully facilitate and ease the process of doing so for efforts in other regions of the New York. Those outside New York State would have to explore hosting capacity data availability.

Finally, to be complete, tool developers may need to create a new dataset. The sole dataset created by Scenic Hudson for the SMT is the Solar Feasibility Landforms dataset, which reflects where slope and aspect (terrain or landforms) are most suitable for solar at a broad scale. Scenic Hudson created this dataset through discussions with local solar developers and using in-house GIS expertise, but it can be recreated for any region in GIS using a digital elevation model (DEM) and the metadata from the Scenic Hudson dataset.

6: DEVELOP GUIDANCE

The purpose of Scenic Hudson's SMT is to inform decision-making regarding where and how to site solar energy at various scales in the Hudson Valley region. A key aspect of the SMT is the user guide, which walks users through the SMT, and describes solar energy and its land use implications, as well as the purpose of the SMT, how to use the SMT, and how to interpret the information shown on the map. The guidance that goes along with each dataset is critical, not only for introducing and explaining technical datasets to users but also in explaining how those datasets relate to solar development. For example, farmland soil classes are already available publicly; the SMT not only shows users where these farmland soils are in their community, but also explains how agriculture and solar can complement each other through co-location.

In addition, we felt that it was important for communities to identify and prioritize those resources most important to them. As noted at the outset, the approach taken in the user flow focuses the user on recognizing what is most valuable to their community, and then planning for solar development to lessen the impact on those valued resources. The guidance should also help users understand that they must bring in local knowledge and refer to relevant local plans and codes. To aid in this process, we developed and included a blank workbook for users to record information learned by using the SMT, as well as important local considerations.

7: PUBLICIZE WIDELY

Finally, **it is important to publicize your solar mapping tool widely** in order to ensure its use in the interest of promoting smart solar energy development in your region. In addition to notifying all stakeholders that participated in its development, the public can be made aware of its availability through press releases, social media, webinars, presentations at conferences and meetings and other methods. Outreach can be focused on members of the target audience of users, i.e., municipal decision makers and relevant associations, as well as others including developers, land trusts, state agencies, and other planning and conservation groups.

Conclusion

Smart solar energy development is critical to accelerating the amount of clean, renewable energy on the grid and reducing greenhouse gas emissions that cause climate change. Providing information to decision-makers through a GIS-based tool like the SMT will help communities proactively plan for renewable energy installations, streamline reviews and reduce conflicts, and ultimately achieve renewable energy targets. We hope that this guide is a useful resource, and leads to smart, successful solar energy development across New York and the country.

DORIS DUKE
CHARITABLE FOUNDATION

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Appendix: Annotated List of Data Layers

Resource Group: Overall Land Use Pattern
Layer: Land Cover
Source: National Land Cover Database
Coverage: National
Notes: The National Land Cover Database is helpful for getting general impressions of patterns of development at the county or municipality level, but we found its use limited at the site level by the large pixel sizes and lack of accuracy at a fine scale.

Resource Group: Solar Development Opportunities
Layer: Rooftops
Source: Microsoft & ESRI
Coverage: National
Notes: This dataset is extremely valuable when considering rooftop solar. Because the Solar Mapping Tool is intended for planning purposes and not for siting rooftop solar in particular, we used a GIS filter to limit the building footprint size shown to relative large buildings of half an acre (approximately 20,000 sq. ft.) or more. Finer-scale examination of rooftops is beyond the scope of the Solar Mapping Tool, but this dataset could be useful in such cases. A parking lot dataset would be equally valuable but was unavailable at an appropriately fine scale at the time the Solar Mapping Tool (SMT) was developed.

Resource Group: Solar Development Opportunities
Layer: Re-Powering America Sites
Source: US Environmental Protection Agency
Coverage: National
Notes: This dataset draws from EPA and state agency data and includes initial assessments of potential to develop alternative energies of all kinds, making it valuable for other types of renewable energy development as well as solar. It is particularly useful for those states whose state agencies contributed data, including New York State.

Resource Group: Solar Development Opportunities
Layer: Mined Lands
Source: New York State Dept. of Environmental Conservation
Coverage: New York State
Notes: This dataset is especially applicable the Hudson Valley, where quarries are fairly common and represent a terrific opportunity for solar development on already altered lands. It would be more valuable as a polygon dataset to denote the boundaries of the mines, but is only available as point data.

Resource Group: Agriculture
Layer: Farmland Soils
Source: US Dept. of Agriculture
Coverage: National
Notes: In a meeting with agricultural stakeholders, we discussed three layers from the US Dept. of Agriculture's SSURGO Soils Database: Farm Class (Prime, Prime-if-drained, Soil of Statewide Significance); Mineral Soil Groups (1-10); and Land Capability (I – VIII, e [susceptible to erosion], w [excess water], s [shallow]). Although the stakeholders agreed that all three layers have use to a farmer or someone who studies agriculture, they are to some degree redundant to each other in broad patterns of soil quality for agriculture. Because Farm Class was the easiest to explain to those unfamiliar with soil science and agriculture, as well as the fact that Farm Class does reflect agricultural value of soils, we elected to use this layer and omit the other two.

Resource Group: Agriculture
Layer: Agricultural Districts
Source: Cornell University/New York State Dept. of Agriculture and Markets
Coverage: New York State
Notes: Agricultural Districts are designated through a nomination process and provide landowner incentives and protections meant to keep land in farming. They are relevant to solar because land in agricultural districts may receive tax benefits or legal protections that can be affected by solar development. We therefore included this layer in the SMT.

Resource Group: Wetlands and Floodplains
Layer: National Wetlands Inventory
Source: US Fish and Wildlife Service
Coverage: National
Notes: The National Wetland Inventory, while not legally binding, is a comprehensive dataset that includes many wetlands and stream corridors not captured in New York State Wetland maps. We therefore included it to inform users of possible wetlands that bear ground-truthing.

Resource Group: Wetlands and Floodplains
Layer: New York State Wetlands
Source: New York State Dept. of Environmental Conservation
Coverage: New York State
Notes: As mapped wetlands, this layer carries with it regulatory protections in New York State.

Resource Group: Wetlands and Floodplains
Layer: 100-yr and 500-yr Floodplains
Source: US Federal Emergency Management Agency
Coverage: National
Notes: Floodplains represent both a hazard and an opportunity for solar development, as detailed in the Floodplains Info Dive in the SMT. A weakness to this layer is that many Federal Emergency Management Agency (FEMA) floodplain maps do not adequately account for the effects of climate change on increasing frequency and intensity of rainfall and flood events.

Resource Group: Biodiversity and Habitat
Layer: Important Areas
Source: New York Natural Heritage Program/Scenic Hudson
Coverage: Hudson River Estuary Watershed
Notes: The Natural Heritage Program's Important Areas datasets are available to view individually in the Hudson Valley Natural Resource Mapper. However, to simplify visual overlays for the Solar Mapping Tool, Scenic Hudson combined the multiple types of Important Areas into a single layer. We retained the type of Important Area of each polygon in the layer attributes so users can differentiate them and seek more information from the Hudson Valley Natural Resource Mapper as needed.

Resource Group: Biodiversity and Habitat
Layer: Core Forests
Source: New York Natural Heritage Program/Hudson River Estuary Program
Coverage: New York State
Notes: We considered including the Forest Condition Index layer, created in 2020 by the NY Natural Heritage Program for the Hudson River Estuary Program, instead of this Forest Cores layer. Although the Forest Condition Index contains rich and useful information for conservation planners and practitioners, as well as municipal officials, the communities pilot-testing the Solar Mapping Tool noted that the complexity of the information presented in the Forest Condition Index layer is quite complex for general audiences, especially in concert with all the other layers in the Solar Mapping Tool. The Forest Cores layer is easier to understand and interpret for general audiences, so we used that layer but refer users to the Hudson Valley Natural Resource Mapper for additional information in the form of the Forest Condition Index. An added benefit to the Forest Cores layer is that it has statewide coverage, whereas the Forest Condition Index only covers the Hudson Estuary watershed, and excludes parts of the 11 counties covered in the Solar Mapping Tool.

Resource Group: Historic, Recreation, and Protected Sites
Layer: New York State National Register of Historic Places
Source: New York State Office of Parks, Recreation, and Historic Preservation
Coverage: New York State
Notes: The New York State version of this national dataset is maintained and served by the New York State Office of Parks, Recreation, and Historic Preservation, making it convenient and easy to incorporate into the Solar Mapping Tool. This dataset helps highlight places that have cultural, historic, scenic, or recreation value to their communities.

Resource Group: Historic, Recreation, and Protected Sites
Layer: Protected Areas Database of the US
Source: US Geological Survey
Coverage: National
Notes: At the time of development, the PADUS was the most complete database of protected lands publicly available. However, the strength of the dataset depends on organizations' submitted data to the database, a potential weakness. Scenic Hudson and several other partners in the Hudson Valley are working to improve administration of the New York Protected Areas Database (NYPAD). Upon completion of the NYPAD update, we anticipate that NYPAD will be more locally accurate and a better dataset.

Resource Group: Solar Feasibility
Layer: Landform Solar Feasibility
Source: Scenic Hudson
Coverage: Hudson Valley (11 counties)
Notes: The only dataset in the Solar Mapping Tool created by Scenic Hudson, this layer is based on conversations with solar developers about the technical and financial limitations of solar panel construction in relation to slope and aspect. As technology advances, this layer may need to be reassessed.

Resource Group: Solar Feasibility
Layer: Transmission Lines
Source: US Dept. Homeland Security
Coverage: National
Notes: Transmission line locations are vital to planning utility-scale solar developments, since the transmission lines are needed to bring the large amount of electricity generated to substations for distribution to users. At the time of the Solar Mapping Tool's development, utility-scale solar projects in the Hudson Valley were being sited along transmission lines in order to be economically viable, since building new transmission lines represents a substantial cost to solar developers. This dataset therefore gives planners a sense of where these larger solar projects could potentially be sited, allowing Smart Solar Planning to consider possible locations for utility-scale solar.

Resource Group: Solar Feasibility
Layer: Hosting Capacity
Source: Joint Utilities of New York
Coverage: New York State
Notes: The Joint Utilities of New York are mandated by New York State to provide the public with hosting capacity maps. Scenic Hudson worked with the Joint Utilities to make these data available as streamed services in the Solar Mapping Tool, an effort that will hopefully facilitate similar opportunities in other areas of New York.