Large-Scale Solar Information and Research Needs for NYS

Jennifer Ifft (PI)
Travis Grout
David Kay
Dylan Bugden
Frieda Kay
David Lane
Chris Rondem
Richard Stedman
Jeff Sward
Max Zhang

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New York State is pursuing an ambitious goal to source 50% of its electricity needs from renewable sources by 2030. To meet this Renewable Energy Standard (RES) target, the state will need to greatly expand large-scale solar, a process that will present new challenges for planners, landowners, utilities, environmental organizations and government at all levels. Over the past year, researchers at Cornell University have assessed the potential impacts of solar expansion in New York, identified obstacles to sustainable solar development, and interviewed multiple stakeholders, focusing on those currently involved the various aspects of solar siting. As a part of this work, we identified unanswered questions and information needs that are central to New York meeting its renewable energy goals while supporting sustainable, prosperous communities. The six broad areas of interest described below prioritize areas for further study.

Understanding the expansion of solar power at different scales, and the related distribution of impacts

At a basic level, researchers must understand the likely patterns of solar development in New York State to identify obstacles to meeting the state's 2030 goals. Where is large scale solar most likely to be located? Considering different aggregation, distribution and scale economies, what is the probable size distribution of new solar installations – fewer very large facilities, or a greater number of smaller ones – driven by what kinds of associated development and ownership models? Will facilities cluster in several parts of the state, or be more widely dispersed? How might development models and scale evolve over time? How do regulations and incentives at different levels of government, market forces, scale economies, technology and the like reinforce or conflict with the RES policy targets and timing? What are the likely effects of the proposed renewable energy credits (REC) allocation schemes that are intended to resolve uncertainty over ownership of the RECs potentially derived from solar power? Such issues have implications that can benefit from study at regional and statewide levels of analysis, which then can be matched with efforts to understand their significance in a variety of localized contexts. Special attention needs to be given to analyses that ensure that conclusions about positive and negative impacts are relevant to the different levels of jurisdiction at which policy is made and implemented.

Differentiated models that incorporate technical and socioeconomic factors influencing the pace, location, and scale of solar development can also more realistically highlight the costs and benefits of development. Research highlighting how these costs and benefits are likely to be distributed across time, geography, and socioeconomic groups is needed to support the informed engagement of key stakeholders. Such research would ideally be designed to improve understanding of how important economic, social, and environmental costs and benefits manifest at the site, local/regional, and statewide levels. Analysis at different geographic scales of the impacts of solar development would help stakeholders maximize both site-specific and cumulative potential benefits (e.g., rural economic development, brownfield redevelopment, grid reliability, reduced fossil fuel emissions, net improvements in carbon budgets, etc.) while mitigating possible negative effects (e.g., farmland conversion, reduced scenic values, soil compaction or erosion, habitat impacts, increased impermeable surface, etc.).

Solar facility siting

Solar developers and community stakeholders often have different preferences for locating solar facilities. A systematic study of how developers weigh different site characteristics, including how those priorities vary due to differing development strategies, landowner input, and technology, could help planners craft realistic zoning and incentives and inform the evolving Article 10 siting process. Insofar as this work could be designed to simultaneously help developers understand public sector and community siting concerns, the overall siting process could be enhanced. In general, studies from the perspective of development feasibility should be matched with research from a public perspective that helps policy makers understand which kinds of sites might best be incentivized for solar development, which dis-incentivized, and what trade-offs or synergies are involved. This research would be most helpful if the effectiveness of (dis)incentives was assessed, along with the impacts on the State's ability to reach RES targets, considering the quantities and locations of sites most and least suited to development. Ideal research would include an analysis of the size and nature of incentives needed to make it feasible for development to occur on acreage that society might deem most desirable (brownfields or obsolete power plants, industrial sites, parking lots, other energy generation or storage facilities, etc.)? What, then, would be the realistic potential by 2030 for so-called "brightfield development" in New York State? Such research could also help to determine the potential for, and costs of incentivizing, solar development serving various secondary social purposes, including community ownership of renewables as well as redevelopment of brownfields.

Incentives and Questions Regarding Grid Integration

The state's transition to renewable energy would benefit from further research on effective incentives to improve coordination between solar developers, the NY ISO, and other electrical utilities. A variety of economic and technical issues are involved, including but not limited to transmission system upgrade planning, queue management, monitoring and control of distributed generation assets, substation backfeed, and anti-islanding protection.

Local planning for solar development

Not counting school and other special districts, there are approximately 1,600 general purpose local governments in New York State, each of which has policies relevant to solar development within that jurisdiction. State agencies have been called upon to provide strong support to the vast majority of local governments that are new to large scale solar development. Researchers can play a significant role in conducting regional economic analyses that highlight circumstances and policies likely to maximize economic development while capturing associated job, income and tax benefits locally, and in developing best practices for local cost-benefit analysis, commercial-scale solar zoning, and assessment of solar assets. More work is needed to, for instance, help communities predict taxes and employment from solar development and assess the long as well as short term impacts of infrastructure associated with solar projects (e.g., access roads, electrical poles,

Cornell University solar installation near Cayuga Lake power lines, fences). What guidance can be provided about the likely long term lifecycle of solar sites given evolving technology, climate and energy policy, grid development? What are the implications for best practices in decommissioning or panel recycling policies? At the same time, solar developers would benefit from better information on what time frames for permit processing are realistic and the impact of different local government policies on solar siting and project success.

Public education and involvement in planning

Renewable energy is broadly popular, but renewable energy projects often run into local opposition. If solar power is to contribute to meeting New York's renewable energy goals, developers and planners need a better understanding of the factors that drive local support for or opposition to large solar projects. What role will public support or opposition play in the attainment of renewable policy goals, both at the site specific level and statewide?

Answering this question will, in part, require a better understanding of the economic, social and political implications of large-scale renewables development in rural communities (mostly upstate) to provide energy for urban (mostly downstate) demand. In addition to the direct effects of construction and operation of solar arrays, expansion of transmission infrastructure may have significant impacts in affected areas. There is an urgent need to assess whether current regulatory frameworks promote meaningful, effective public involvement or need to be improved. This applies to facility permitting processes that involve local reviews and for those over 25 MW that are to be managed by a State siting board under Article 10. Messaging and effective education may also be factors in local discontent or negative spillover effects associated with solar projects. Further study may help government, developers, and civil society groups promote public understanding of the challenges and opportunities associated with solar development.

Solar development lease terms

Landowners, planners, community policy makers and others would benefit from reliable information on the typical terms and potential risks of solar development leases that have been and may be offered to New York state landowners. Given that large-scale solar is relatively new to New York state, there is a gap in knowledge regarding the individual and collective implications of various solar lease conditions for the social, economic and environmental health of the involved companies, landowners, and communities. Developing best practices for solar leases would help to ensure that development benefits the communities hosting facilities and facilitate public engagement. Trusted research into the drivers of landowners' decisions to pursue or reject a proposed solar lease could support the expansion of solar power by reducing the friction and suspicion and resentment that can arise from durable contracts that are based in inadequate. For example, it may be fruitful to investigate what constitutes a "successful" lease from various perspectives.

Solar development on farmland

Many actors in current solar siting in New York report that the most attractive sites for large-scale solar development are on farmland. This can present special challenges for landowners, farmers, planners, regulators, policy makers, and others. Further study of the impacts of solar development on agricultural land is needed to develop specific best practices and to identify the implications of restrictions (or no restrictions) on commercial-scale solar development of farmland. There are special concerns about development on valuable soils which should be informed by a stronger research base, part of which would address the implications for farms and for solar development of different standards for defining "valuable soils". Several important topics pertain to the physical effects of constructing, operating, and decommissioning a solar facility on farmland. These include the potential for soil compaction and erosion, the relative merits of different groundcover management techniques at solar facilities for the host farm and for neighboring farms, and the effectiveness of current state guidelines on the restoration of sites and soils after use. Both procedurally and terms of achieving desired outcomes, research is need that would help involved parties propose alternate sites or configurations that would effectively minimize prime farmland impacts.

Another pressing subject for study is the effect of solar development on farm viability, local agricultural economies, and any ancillary short and long term impacts on food supply and security. Specific topics of study should include the financial and other benefits and costs that might accrue to individual farmers and to different types and sizes of farms and farmers. Related research is need to help predict farmers' behavioral responses to this potential source of non-farming revenue. This work would enhance understanding how frequently solar development might stimulate farm management and land use changes ranging from agricultural intensification at one end of the spectrum to the accelerated release of acreage to a variety of nonfarm uses at the other end. The research should address the potential for solar development to enhance or detract from the viability of farms, and farm support businesses, on a regional basis. Particular consideration should be given the implications of solar development or restrictions on development for farmers' credit constraints and for on-farm reinvestment, but also for investment or disinvestment in the rural communities and nonfarm business that enable farm families to thrive. Research should try to identify and quantify the amount and types of farmland most likely to be developed for solar; highlighting areas where solar developers might compete with agriculture for land (particularly the most productive soils), and the mechanisms through which competition would be effected. A related topic is the potential effect of solar leasing on the price and availability of rented farmland, and the significance of this new activity for different kinds of farmers and the different kinds of landowners who rent to farmers. Research should also address the extent to which renewables development on some farms could affect other farms, whether through economic or biological interdependencies; and the likelihood that land developed for solar will be returned to agriculture.

Colocation of agriculture and solar farms is another important research prospect. Overall, practical obstacles to dual use have made colocation the exception rather than the rule for solar facilities on agricultural land. However, the potential for colocation under New York's climate and agricultural conditions remains to be investigated. The research to be developed could help to inform policy decisions about the relationship between colocation and reduced agricultural assessments. Even without new techniques or technology, developers, farmers, regulators and landowners would benefit from a clearer understanding of the tradeoffs in management and design with agriculture/solar dual use. In addition, this work could inform policies to incentivize appropriate colocation enterprises.

Sheep grazing at Cornell University solar cite.

Background Information

Below we list ideal site characteristics and local impact considerations based on several discussions with developers and key participants in solar siting over the past year. These "realities" have played an important role in shaping the research priorities discussed above.

Ideal site characteristics:

Land parcels with many or all of the characteristics below may be particularly desirable to commercial solar developers. This list does not take into account local regulations and incentives to encourage development of previously developed or less valuable land.

Amenable topography and physical characteristics:

- Flat land (can develop up to a 20% grade);
- SW orientation if sloped;
- Few or no trees (clearing trees is expensive and can provoke controversy);
- No wetlands or floodplains;
- Deep bedrock (shallow bedrock makes PV foundations more expensive and complex);
- Soil type (ideal soil is firm and compacted, but does not contain very large gravel or buried rock);
- Previously undeveloped (building a solar farm on a brownfield site typically requires a lengthier permitting process and may require the developer to remediate prior contamination or modify the site extensively before construction);

Easy grid interconnection:

- Near 3-phase transmission line (ideally less than 2000 feet) with spare capacity and appropriate voltage;
- Close to electrical substation (reducing transmission losses);
- Stiff electrical system in the area of interconnection (solar farm interconnection will not cause harmful variations in voltage);

Adequate insulation:

- High total annual sunlight;
- Low seasonal variation;

Regional characteristics:

- Close to customers;
- High regional price of electricity;
- Pro-solar policies at the local and county level;
- Low local taxes;
- Low land values and lease expectations;

Parcel characteristics:

- Road access for construction and maintenance;
- No zoning restrictions, height restrictions, or other local regulations that would interfere with construction or maintenance;
- Large parcels or contiguous ownership that lower assembly and transaction costs.

Local impact considerations

The potential impacts listed below are not relevant to every site. These topics are sometimes raised as concerns in solar development planning documents.

During construction

- Soil erosion and compaction;
- Nuisance noise and dust;
- Tax penalties associated with loss of agricultural exemption for converted land.

During operation

- Runoff issues, including contamination by herbicides or cleaning agents used on site, soil erosion, and interruption to surrounding drainage;
- Shading of neighboring crops;
- Reduced habitat for wildlife;
- Habitat fragmentation from fencing;
- Introduction of invasive plants or pests;
- Risk of increased taxes, decreased price of electricity, or change in solar regulations during a multi-decade lease;
- Glare from panels interfering with drivers or quality of the view-shed;
- Impact on local property values;
- Aesthetic concerns, if the solar farm is located in a scenic area;
- Restrictions on landowner access to and use of the project area and surrounding land (particularly if the development took place on agricultural land);
- Reduction in land available for other uses (e.g., rental as farmland);
- Technical or economic obsolescence of equipment (e.g., in the event of a breakthrough in solar technology or a change in renewable energy policies);
- Impact of electromagnetic fields on health (there is little evidence of harm from magnetic and electrical fields associated with solar electricity infrastructure, but this subject is frequently raised by community members and groups skeptical of solar power).

Decommissioning and long-term impacts

- Removal of solar panel foundations;
- Soil erosion and compaction during decommissioning process;
- Incomplete restoration of project area and access roads to prior use;
- Abandonment of obsolete or damaged equipment by the owner (e.g., in the event of bankruptcy).

Policies to address solar siting and agricultural land in other states:

1) CALIFORNIA: (#1 in installed solar capacity, #3 in capacity per acre)
    a) California has issued extensive guidance for local governments planning for solar expansion. As a matter of policy, the state favors solar development on "land that is not valuable habitat, open space, or farmland" (with some explanation of what that means).
    b) The Williamson Act provides for taxation of farmland based on use value rather than fair market value, in exchange for an annually-renewable 10-year easement. Canceling a Williamson Act contract requires payment of a penalty: 12.5% of the fair market value of the land, and is a lengthy and expensive process involving an extensive public comment process.
        i) Roughly half of agricultural land (and 1/3 of all privately held land) in CA is covered by a Williamson Act contract.
        ii) Local governments may determine compatible uses, within certain limits set by the state.
        iii) Compatible uses are most constrained for prime land; more compatible uses are allowed on non-prime and marginal farmland.

c) Owners of high quality farmland may petition for a Farmland Security Zone (FSZ) contract. FSZ land is taxed at 65% of the Williamson Act rate, in exchange for a 20-year easement. The penalty for canceling an FSZ contract is 25% of the land's fair market value (as well as expenses associated with petitioning for cancellation, as described above).

d) In 2011, California established a mechanism for solar development on non-prime agricultural land.

i) When non-prime agricultural land is converted for solar development (subject to Department of Conservation approval), the landowner is responsible for a penalty of 6.25% of the land's fair market value.

ii) The solar lease must be at least 20 years to qualify for this rate (as opposed to 12.5%)

iii) At the end of the lease, the land must be restored to its original condition

2) NORTH CAROLINA: (#2 in installed solar capacity, #8 in capacity per acre)

a) If farmland taxed at use value is converted to a non-agricultural use, the owner must pay "deferred taxes" on that land for the current and three previous years. This is equal to taxes that would have been paid on the land at fair market value (less taxes actually paid), plus interest.

i) Farmers may not have to pay this penalty if the solar installation allows a dual agricultural use (e.g., grazing)

b) Land use planning and regulation handled at the local level. Zoning and requirements vary significantly across the state.

3) NEW JERSEY: (#3 in installed solar capacity, #1 in capacity per acre)

a) Farmland Assessment: use-value taxation for farmland liable to roll-back taxes in the event of a change in use. Roll-back taxes are equal to taxes that would have been paid on the land at fair market value (less taxes actually paid) for the current and two previous tax years.

b) Agricultural land used for solar production retains its farmland assessment if:

i) The solar facility generates less than 2MW of power AND

ii) Uses no more than 10 acres AND

iii) At least 5 acres of land remains in agricultural use AND

iv) The ratio of land used for energy to land in agriculture does not exceed 1:5.

v) Thus, a 6-acre farm could devote 1 acre to solar; a 60-acre farm could devote 10 acres to solar; and a 500-acre farm could devote 10 acres to solar without roll-back taxes.

c) Installations up to 110% of farm's consumption covered by Right to Farm laws.

d) 29% of NJ farmland under some sort of conservation easement. All solar development projects on protected farmland must be reviewed by the State Agriculture Development Committee in consultation with the holder of the easement.

e) NJDEP developed the state's Solar Siting Analysis in 2012, including a mapping application that used Anderson land use codes to determine whether a given plot of land was a "preferred" (primarily urban or barren land) or "non-preferred" (primarily agriculture and natural lands) area for solar development. This was updated in 2017.

f) NJ Energy Master Plan privileges "dual benefit" solar development for approval. State also offers benefits for development on brownfields. Explicitly encourages development on sites other than farmland.

g) Solar development designated an "inherently beneficial use" under state law, restricting the ability of local governments to prevent solar development within their jurisdictions.

4) MASSACHUSETTS: (#5 in installed solar capacity, #2 in capacity per acre)

a) Department of Energy Resources (DOER) developed model zoning and planning guidance for solar development which encourages local governments to limit development on productive agricultural land or prime farmland soils (an explicit exception to state laws limiting local governments' ability to restrict solar development).

b) DOER is circulating proposed changes to state solar incentives to further discourage solar development on prime, unique, or important farmland.

c) State government has prioritized development on contaminated lands, landfills, and other low-value lands (more so than any other state I know of). In addition to streamlining the planning process for such projects, there is direct state support in the form of grants, loans, insurance, and tax incentives. Statewide goal of 25 MW of solar on contaminated land.

d) Agricultural Preservation Restriction (MA's use-value easement program) requires farmers to get permission from the Massachusetts Department of Agricultural Resources. This generally prevents utility-scale solar on covered land, though solar facilities generating up to 200% of the farm's demand may be approved on a case-by-case basis. A 2017 survey of farmers participating in the program suggests that permits are denied or too difficult to obtain ground-mounted solar, even on unproductive land or colocated pasture.

5) GEORGIA: (#6 in installed solar capacity, #11 in capacity per acre)

a) Utility-scale solar development not compatible with an Agricultural Preferential Assessment (APA), under which agricultural land is assessed at 40% of current use value. APA participants sign a 10-year covenant, renewing automatically every 10 years. "Breach of the covenant" requires payment of a penalty equal to the difference between the taxes owed under fair market valuation and those paid under preferential assessment in the current year, multiplied by a "penalty factor" between 2 (for breaches in years 7-10 of a covenant) to 5 (for breaches in the first or second year of a covenant.

i) (FMV taxes – APA taxes) *factor

b) No state-specific disincentives to siting solar on farmland. Proposed projects seem to be sited predominantly on farmland.

c) Georgia has an interesting map of solar installations

6) MINNESOTA: (#26 in installed solar capacity, #31 in capacity per acre)

a) The Green Acres program allows use value taxation of farmland, assessed according to a state-determined formula. Technically, it is a tax deferral. The penalty for converting land to a non-agricultural use is equal to taxes that would have been paid on the land at fair market value (less taxes actually paid) for the current and previous two years, plus interest.

b) State PUC has sole authority to approve/deny projects over 50 MW; local governments take the lead for smaller projects, though the state offers extensive guidance and requires an environmental assessment worksheet (EAW) for projects between 25 and 50 MW.

c) Interestingly, commercial solar siting guidance from the Minnesota Department of Natural Resources does not identify farmland in a list of lands to avoid for solar development.

d) Statewide standard established for land management under and around solar farms (bill text)

Solar panel installation