THE ENVIRONMENTAL REVIEW OF SOLAR FARMS IN THE SOUTHEAST U.S.

Maximizing Benefits & Minimizing Impacts to Drive Smart, Sustainable Development of Solar Power

SOUTHERN ENVIRONMENTAL LAW CENTER SOLAR INITIATIVE POLICY BRIEF

Report prepared by the
Southern Environmental Law Center's Solar Initiative
March 2017

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INTRODUCTION

With continuing cost declines, solar power is playing an increasingly important role in how states meet their energy needs. Across the South, local communities, utilities and solar developers are seeing the benefits of solar energy through customer savings, energy independence, environmental benefits, and economic development. Solar farms above 1 megawatt in size make up a growing portion of this changing energy landscape. During the planning and regulatory approval stages of developing a solar farm, there are currently many review processes in place to evaluate and minimize environmental impacts.

The purpose of this policy brief is to provide an overview of the Environmental Review Processes that most solar farms in the Southeast currently go through, and to provide examples of best practices that developers are embracing to maximize benefits and minimize environmental impacts.

Setting the Stage: The Benefits of Clean Solar Energy

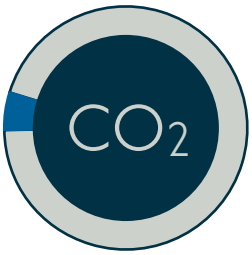
Solar power is a clean source of energy, especially when compared to alternative sources of electricity. In the Southeast, our electricity has traditionally come from fossil fuel sources, like coal-fired power plants, which produce negative environmental impacts, from dirty air to coal ash waste to overburdened water resources and carbon emissions. Fossil-fuel fired generating units are the leading contributor of climate-altering pollution in the United States.

By contrast, solar power generation is largely carbon- and pollution-free. Even when considering lifecycle greenhouse gas emissions—those that occur from manufacturing, operation and maintenance, and decommissioning solar facilities—solar generation produces less than one twentieth of the emissions of coal generation.[1]

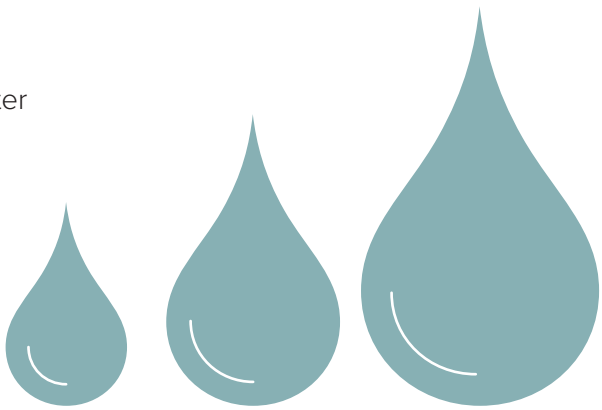
The two graphics below compare some of the environmental impacts of common energy sources. Solar energy not only generates fewer lifecycle greenhouse gas emissions than coal, but also uses much less water.

Solar farms have smaller land use footprints than coal, biomass, nuclear or natural gas. A Columbia University study found that on a life-cycle basis—including direct and indirect land impacts—utility-scale PV requires less land than the average U.S. power plant using surface-mined coal, which is how 70 percent of all coal in the United States is extracted. The study also found that, when comparing various renewable resources, both biomass and nuclear energy resulted

Even accounting for the full life-cycle impacts, solar produces **less than 5%** of coal's carbon emissions.[2]



Solar uses a fraction of the water compared to natural gas, nuclear and coal.[3]



Solar
20 gallons[4] used per kWh

Natural Gas
405 gallons[5] used per kWh

Nuclear
575 gallons[6] used per kWh

Coal
790 gallons[7] used per kWh

Solar plants average 25 years[8] of operation compared to coal and natural gas plants which average 30 years,[9,10] and nuclear plants which average 34 years.[11]

in more land impacts than solar power.[12] A study of renewable energy impacts in the western United States found that active oil and gas leases impact 4.5 percent of each terrestrial ecosystem evaluated, with a total potential for land disturbance in excess of 11.1 percent. In contrast, the potential land-cover impacts from utility-scale solar amount to less than 1 percent of all ecosystems combined.[13]

Even if solar farms alone were to supply 100 percent of America's electricity needs, solar installations would still only occupy 0.6 percent of the country's total land area, or less than 2 percent of U.S. land that is now in crop production.[14] By comparison, that is less land than is currently being used for corn ethanol production in our country.[15]

The advantages of solar generation go beyond reduced pollution, minimal water usage, and smaller land-use footprints. Solar power diversifies our energy supply, provides a hedge against volatile fuel prices, avoids the need for new transmission infrastructure, produces peak energy output when utilities need it the most, decreases stress on existing distribution and transmission lines, increases opportunities for rural electrification, and produces much-needed economic development benefits.

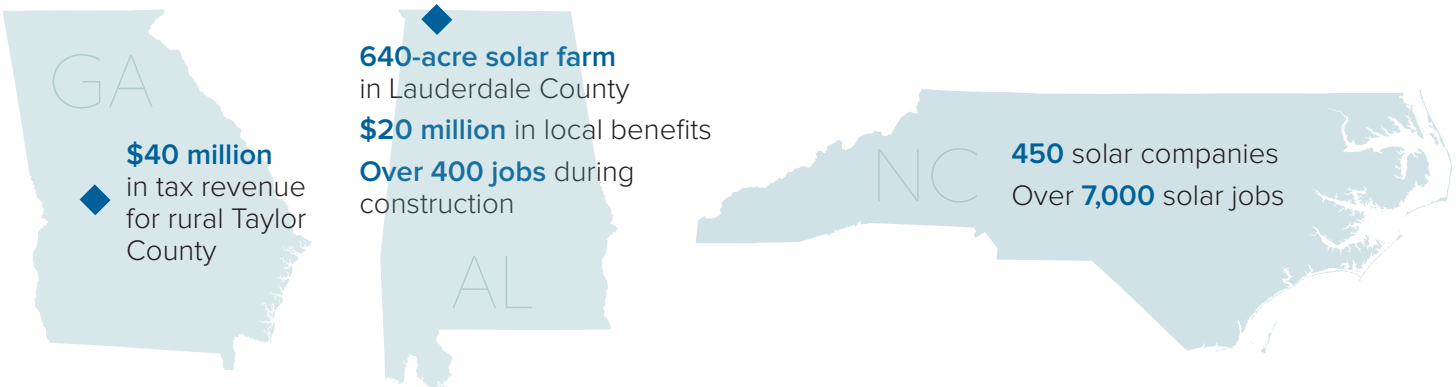
Nationally, there are now more workers in the solar industry than there are jobs in natural gas, and over twice as many solar jobs as coal jobs. In fact, solar industry employment has grown 17 times faster than overall job creation in the country.[16] In addition to new jobs, solar project development provides economic investment and revenue generation for local communities. For example, billions of dollars have been invested in North Carolina as a result of solar projects and approximately $300 million has been generated for state and local governments in tax revenue.[17]

Solar power provides many benefits over fossil-fuel based electricity generation. Still, solar farms do have some land-use impacts. Large-scale projects typically require 5-8 acres for every megawatt of generation (contingent upon the use of fixed tilt or single axis tracking technology), and can have impacts that accompany other land uses, such as effects on water resources, habitat, and sensitive species. Because of these potential impacts, existing federal and state laws and local ordinances in many places provide for environmental review of such projects. Some solar project developers are going beyond these requirements, finding new and innovative ways to maximize the benefits of their projects and minimize land-use impacts.

ENVIRONMENTAL REVIEW REQUIREMENTS FOR SOLAR FARMS IN THE SOUTHEAST

The following Environmental Review processes currently apply to most solar farms in the Southeast. Specific state review procedures may differ, but the environmental impact considerations outlined below are likely to be examined across the region, helping to

For example, Taylor County in Georgia estimates that new local solar projects will bring in as much as $40 million for the county in property taxes and permit fees over the next 20 years.[18] Similarly, the University of Alabama recently estimated that a proposed 640-acre solar farm in Lauderdale County would provide $20 million in local benefits over a 30-year period and would involve over 400 jobs during the construction phase, in addition to positions for long-term maintenance of the site.[19] North Carolina, which ranks second in the nation for installed solar capacity, has an estimated 450 solar industry companies and over 4,000 jobs in the industry.[20]



ensure that solar is developed with minimal environmental impact.

Compliance with Federal, State and Local Environmental Laws

Solar farm development must comply with federal and state environmental laws. Applicable federal statutes may include the National Environmental Policy Act (NEPA), the Endangered Species Act, and the Clean Water Act.

NEPA requires a review of the effects of all Federal, federally assisted, and federally licensed actions, such as siting a project on federal lands, accessing federally-owned transmission lines, or obtaining a federal permit.[21] The level of review given to different projects varies with the likelihood of significant environmental impact, but for all federally associated projects, some level of assessment will be required.[22] The most common solar development requirement under NEPA is called an Environmental Assessment (EA). An EA is a public document, usually completed and paid for by the developer, which provides sufficient evidence and analysis to assist the agency in determining whether to prepare a more extensive Environmental Impact Statement (EIS) for a proposed action, and to comply with NEPA when no EIS is required. Developers can increase their chances of limiting environmental review to an EA, avoiding the need for a more extensive EIS, by minimizing project impacts and including mitigation measures in the initial proposal.[23] See Appendices II and III for more information on NEPA.

Projects that may affect threatened or endangered species or their habitat require compliance with the Endangered Species Act (ESA).[24] The ESA requires that a federal agency authorizing, funding, or carrying out any action that may affect protected species consult with the U.S. Fish and Wildlife Service (FWS).[25] Project developers should work with the reviewing agencies to engage the FWS in a discussion about impacts to species protected by the ESA. For utility-scale solar projects requiring federal approval, a Section 7 consultation will occur as part of the federal permit review process. Although such consultation is required only for activities that involve federal action or approval, project developers are advised to consult with FWS when there is even a possibility for protected species impacts due to potential liability under Section 9 of the ESA, a strict liability

Sensitive Species Case Study: The Gopher Tortoise

The State of Georgia is seeing increased solar farm development, especially on rural lands, resulting in significant economic development benefits for rural communities. This increase has also raised concerns over the protection of sensitive species such as the gopher tortoise, the official state reptile and a candidate for the federal endangered species list.

The same land that comprises the tortoise's habitat is also ideal for solar developers. The tortoise likes sparsely forested land where it can burrow into the sandy soil. This particular habitat is also home to other species such as gopher frogs, indigo snakes, and hognose snakes. Wildlife agencies and developers are taking steps to address the concerns over potential tortoise impacts. The wildlife agencies are developing maps of critical habitat locations and are partnering with solar developers to select sites that minimize and mitigate impacts to wildlife and these sensitive species. Georgia Power has already established a refuge for gopher tortoises and should continue to address this environmental concern and assess ways to alleviate wildlife impacts.

Where sensitive species exist, in Georgia and elsewhere, steps must be taken to protect those species when undergoing any type of development activities, including solar farms. Other species of concern in the Southeast include the bald eagle, Indiana bat, northern long-eared bat, and other birds, reptiles, and amphibians. Careful planning and use of best management practices during solar project development can relieve the burden on these affected species and ensure that these species continue to thrive in our region.

North Carolina's Solar Permitting Requirements

In North Carolina, which ranks second in the nation for installed solar capacity, there is an intensive state-level review process for proposed solar farms. Before a solar project is installed or operational, the solar developers must meet federal, state, and local requirements designed to ensure that the solar farm will not negatively impact local land, farmland, wildlife, or cultural resources. In addition to meeting any relevant federal requirements, a North Carolina solar farm developer must submit an application for a Certificate of Public Convenience and Necessity to the North Carolina Utilities Commission. The application is then passed through the North Carolina State Clearinghouse for environmental review, where agencies have an opportunity to comment on proposals. The Certificate will not be granted without review by the following statewide agencies: Department of Environmental Quality, Department of Administration, Department of Agriculture and Consumer Services, Wildlife Resources Commission, Division of Emergency Management, Department of Cultural Resources, and the Department of Transportation.

If a project makes it through the State Clearinghouse for Environmental Review, it is then subject to local review and approval, and must comply with relevant local ordinances or zoning restrictions.

provision that does not require intent or knowledge of a violation. Early consultation with the FWS to identify potential impacts to protected species can help to minimize potential liability under this Act.

Clean Water Act provisions must also be met if a solar project will cause a discharge of pollutants into certain surface waters or require filling wetlands.[26] If so, project developers will need to obtain authorization from the U.S. Environmental Protection Agency (EPA) or the U.S. Army Corps of Engineers, depending on the type of permit required.[27]

Finally, utility-scale solar projects are usually subject to state environmental statutes that may require additional compliance measures. Many states have their own versions of NEPA, which require compliance for actions taken by state entities affecting the environment. In addition, developers may need a state or local permits requiring the use of best management practices to limit soil erosion and sedimentation during the land disturbance phase of the project (Clean Water Act permitting is usually delegated to state environmental agencies by EPA). Furthermore, state utilities commissions or energy facility siting commissions may require additional permits for the construction and operation of solar generation facilities.

For more information on federal and state environmental statutes and other regulatory requirements, see Appendix III.

Specific Land Use Issues Addressed in Environmental Review of Solar Farms

Federal, state, and local environmental review processes for solar farms in the Southeast address a range of potential impacts, which are summarized below. Within each of these areas, this report recommends approaches that developers can use to further minimize impact.

1. Efficient Land Use

Early mapping for proposed solar projects can identify biological and cultural resources, agricultural lands, and regional land use patterns to identify areas where solar development will have the least amount of land-use impact. Using land efficiently can involve siting projects on previously disturbed or altered landscapes or prioritizing areas that will make use of existing transmission infrastructure. Seeking sites where multiple compatible land uses can be maintained simultaneously is another way to make efficient use of land. Such locations may include agricultural lands, other energy projects such as gas plants or wind farms, closed landfills, parking garages, existing buildings, and other sites. Siting projects in dual-use locations can benefit the surrounding environment, the developer, and the co-locating entity.

2. Minimize Wildlife Habitat Disturbance and Protect Ecology

When developers are siting a project, there are existing resources available to help avoid critical habitat and sensitive wildlife areas. These resources include mapping tools and technologies currently provided by

Local Review of Solar Farms

City and county governments are often charged with decisions about local land use, siting and permitting. The goal should be to balance local community needs and prevent adverse impacts, while preserving landowners' right to make clean energy investments on their property. Local decision-makers may want to consider establishing best practice permitting guidelines. Diverse stakeholders came together in North Carolina to craft a template local solar ordinance that can serve as an example for localities. This template is available at go.ncsu.edu/template-solar-ordinance.

state and federal wildlife agencies and non-profit conservation organizations to identify and avoid areas of potential conflict.[28] In many cases, there is also existing information on species and habitats in a potential project area. Contacting appropriate agencies early in the planning process can also help to identify ecologically sensitive areas.

If during a site evaluation sensitive areas are discovered, developers should attempt to relocate or redistribute the project. Where impacts appear unavoidable, developers should consult federal and state wildlife agencies to discuss ways to minimize disturbances to wildlife and their habitat. While species relocation and other post-siting remediation may be possible, these measures are expensive and frequently ineffective, because they do not guarantee the long-term protection of the threatened species or habitat.[29] This is another reason developers should seek to identify and avoid biologically sensitive areas before beginning project development.

Developers can further minimize impacts by using existing roads, previously disturbed areas, and existing facilities whenever possible. Developers should avoid excessive vegetation removal and gravel placement—which may cause dust pollution harmful both to the environment and to PV output—and should consider leaving protective buffers. Buffers of 25 feet or more, either natural or man-made, can protect important resources such as critical habitat and water. Unnecessary nighttime lighting should also be minimized to avoid attracting migratory birds and other wildlife. Workers should schedule construction activities to avoid disturbing wildlife, especially in periods of the day or year during which wildlife are most vulnerable.

3. Protecting Water Resources

Solar farms use much less water than other forms of electricity generation. To further minimize water impacts, developers should strive to avoid stream and wetland impacts, including limiting stream crossings for access roads where possible, avoiding altering existing drainage systems, and rigorously implementing best practices for preventing erosion and sedimentation during site construction activities. Typically in the Southeast, limited water use is required for such uses as cleaning PV panels,[30] and developers should consider options for sustainable, re-usable sources for these limited water needs.

Special care should be taken to protect wetlands, which serve vital ecological functions, including protecting drinking water by filtering out chemicals, pollutants and sediments; providing natural flood control by absorbing runoff from heavy rains; and providing critical habitats for many important fish and wildlife. For these reasons, developers should enforce a protective buffer around wetland areas to ensure the protection of these important ecological resources.

Further, developers should consider other ways to protect the vital functions of wetlands in developing solar projects, including by: 1) minimizing soil disturbance associated with moving trees, stumps, brush, and other unwanted vegetation near wetland areas; 2) limiting erosion, overland flow, and runoff that could impact wetlands; 3) preventing disposal or storage of logs or logging debris in streamside management zones—defined areas adjacent to streams, lakes, and other water bodies—to protect water quality; and 4) maintaining the natural contour of the site and ensuring that activities do not immediately or gradually convert the wetland to a non-wetland.

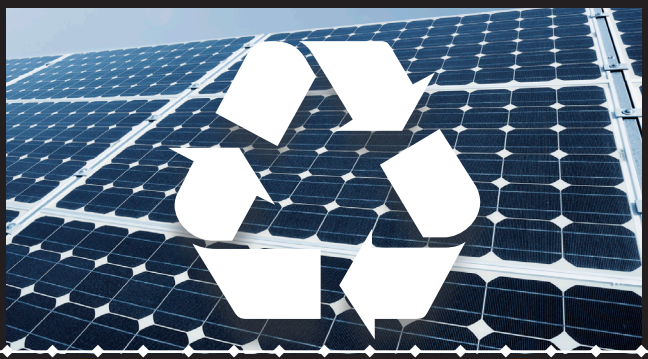
4. Land Reclamation and Restoration

Unlike a coal mining site, which must eventually be reclaimed or otherwise remain unusable, solar sites do not always require reclamation. Solar panels have an estimated life span of at least 25 years, and can readily be replaced with new panels, possibly eliminating the need for site reclamation. In cases where there will be a need

Recycling Solar Panels

The two most common types of solar panels—silicon-based and thin film—are both required to pass the Environmental Protection Agency's Toxic Leaching Characteristic Procedure (TCLP) test, meaning that these panels are nonhazardous.[32] In fact, PV panels are made of mostly very recyclable materials, including glass and aluminum, making it feasible to recover and reuse these materials at the end of a panel's useful life. The Solar Energy Industries Association (SEIA) recently launched a national solar panel recycling program. Working with solar manufacturers and developers, SEIA's program creates a network of cost-effective recyclers that can responsibly manage solar PV waste and end-of-life disposal of the panels. SEIA is also investing in research and development of recycling technologies to promote reuse of solar panels.[33]

"Our goal is make the entire solar industry landfill-free," said Tom Kimbis, SEIA's interim president. "By establishing a national network of collection points, recycling facilities, and an easy-to-use consumer web portal, this proactive program will help drive down the cost of recycling for all parties involved. This means the environment wins and so do our solar consumers and companies."[34]



to remove above-ground facilities, reclamation plans can help ensure that it is done appropriately, and developers may want to include reclamation plan funds in their operations and maintenance budgets.[31]

5. Sustainable Grounds Keeping

For sustainable grounds keeping, developers should select and plant native species. Benefits of native shrubs and groundcovers, such as grasses and wildflowers, include improved erosion control, pesticide avoidance, stormwater infiltration, wildlife habitat, and reduced overall maintenance. In addition, native fruiting and flowering plants provide a food source and habitat for wild native bees. Native bees make a considerable contribution to agricultural crops through pollination. Promoting habitat for native bees and other pollinators can have a positive ecological impact on disturbed sites, as well as, a positive economic impact on neighboring insect-pollinated crops.

Planting native grasses and wildflowers in low maintenance areas of solar farms also reduces long-term maintenance costs and emissions. These naturalized meadows, once established, are more drought tolerant, require little to no fertilization, and only need to be mowed once or twice a year.

In addition to more sustainable plantings, developers should also consider using sheep for grazing the project site. Sheep can greatly reduce emissions from gas powered maintenance equipment, improving air quality and reducing noise pollution.

Sustainable landscaping strategies serve as an educational tool to the community about positive agricultural and environmental practices, and act as a visual demonstration of commitment to land stewardship.

6. Partnership and Consultation with Environmental and Wildlife Agencies

Coordinating with natural resource agencies early in the project development process can make

Solar Panels and Your Health

Unlike fossil fuel energy sources, solar panels do not produce harmful emissions. There are no confirmed health impacts from solar panels at levels encountered by the public.[35] In fact, solar panels produce a lower electromagnetic field exposure than most household appliances, such as televisions and refrigerators.[36]

environmental review procedures smoother and can help ensure protection of wildlife species and the surrounding environment. Relevant federal agencies include the U.S. Fish and Wildlife Service, U.S. Environmental Protection Agency, U.S. Department of Energy, U.S. Army Corps of Engineers, National Marine Fisheries Service, and Bureau of Land Management (for projects on BLM land), among others. Developers should also communicate with state and local agencies, such as state soil conservation commissions and local permit issuing authorities.

ADDITIONAL SITING CONSIDERATIONS

1. Stakeholder Engagement and Education

Stakeholder engagement is a key component of large-scale solar development. The more the developer understands local values and policies, the easier it will be to develop a project that is acceptable to the community. Utility-scale solar projects frequently require local approval and permits. Contacting local stakeholders early in the process can help identify applicable local requirements, including any that may apply to sensitive land areas. Similarly, providing advance public notice of planned activities pertaining to the solar project and engaging with stakeholders will allow developers to minimize environmental impacts while also addressing any local concerns. Incorporating local public input into development plans can further ensure that benefits will be shared by local communities (for example, through support for the local tax base, community benefits agreements, local hiring or contracting during construction).

2. Co-Locating Solar Farms

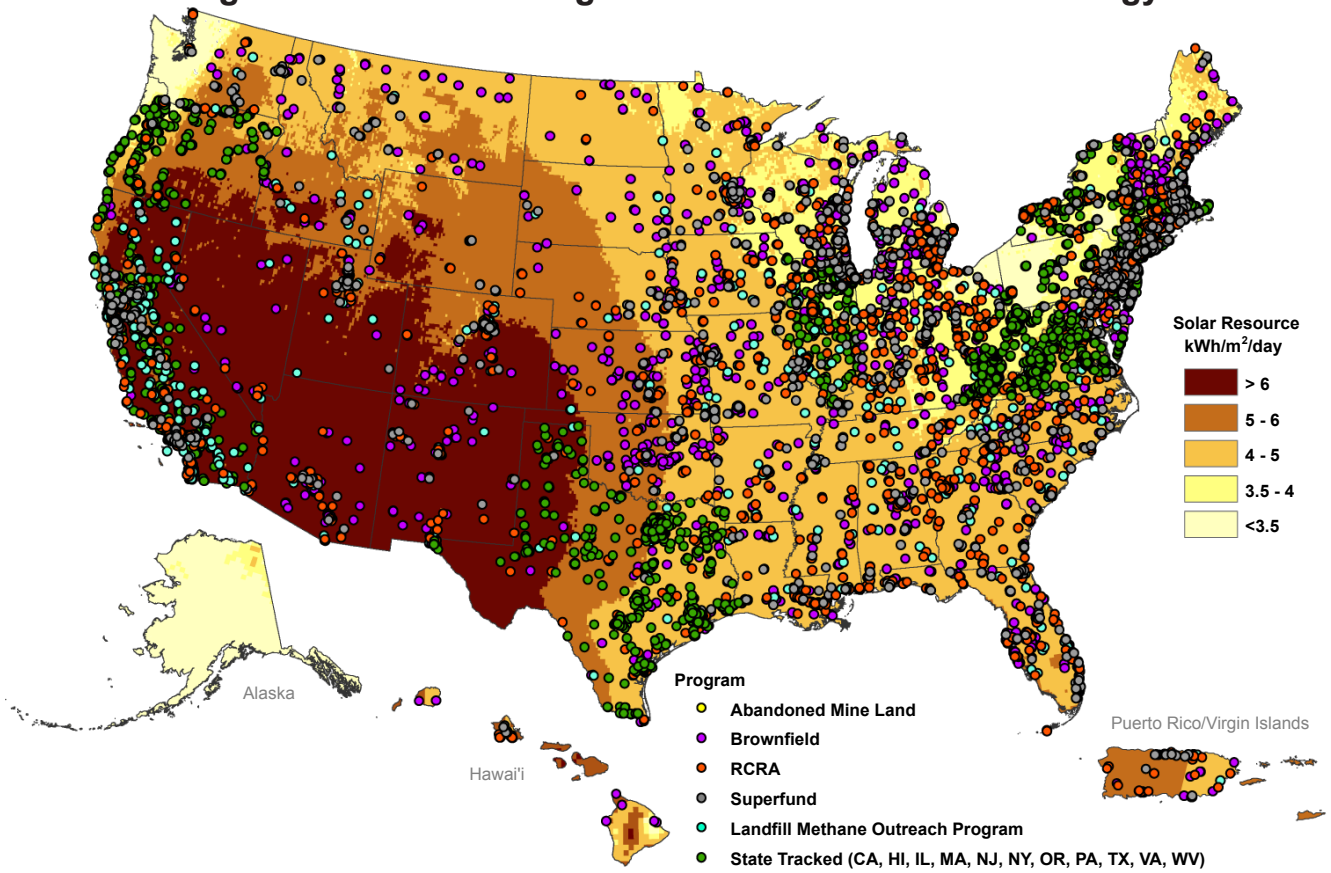
Locating solar at a site that is already in use (as agricultural land, rooftops, parking garages, or other energy generation sites like wind farms) provides dual-use opportunities, maximizing the efficiency of land use. Solar generation is easily deployable in the built environment: it can be sited on existing structures such as rooftops and parking garages, thereby avoiding land impacts altogether.[37] Up to one-fifth of the country's total power needs could be sited on rooftops.[38] Beyond rooftops, co-location with wind or other energy generation close to pre-existing transmission corridors and infrastructure also eliminates the need for new infrastructure and accompanying land disturbance.

Family Farmers, Sheep, and Solar Facilities Make a Perfect match

In North Carolina, Sun-Raised Farms is setting the bar for sustainable management of solar projects. Started in 2011 by Chad Ray of Ray Family Farms in Bunn, North Carolina, Sun-Raised Farms connects local farmers across the state with solar project developers. Sun-Raised Farms works with Solar Farm owners to provide an "Agricultural" solution to maintaining vegetation on a solar farm. Instead of paying landscaping companies to mow, weed and spray sites, solar farm owners pay Sun Raised Farms to identify, train and manage a local farmer to maintain the vegetation using livestock. Sheep in particular are a good match for solar farms as they keep grass low without damaging the projects. While the farmers have land to graze their sheep, the solar company in exchange gets all-natural lawn care—no pesky weeds shading the panels, no glass-shattering rocks kicked up by gas-powered lawn mowers."

Agricultural lands often provide ideal opportunities for dual-use of lands as solar can be strategically placed to provide energy while allowing continued productive agricultural use of the site, such as for grazing purposes. Furthermore, solar facilities can provide economic benefits by allowing for the use of agricultural property that would otherwise sit dormant or have only nominal use.[39] For example, solar leases can help farmers stabilize their income in the face of declining crop prices, even allowing them to make triple the average rent for pasture land.[40]

RE-Powering Screened Sites: Large-Scale Solar Photovoltaic Energy Potential



3. Using Previously Developed or Degraded Lands

Avoiding and minimizing adverse environmental impacts begins with site selection. Because land disturbance impacts are site-specific, site selection is one of the most important decisions a developer will make. New environmental impacts can be avoided, and a number of benefits realized, through the use of previously developed or degraded lands, such as brownfields. The EPA defines a brownfield as a "property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant."[41] Brownfields include Superfund and RCRA sites.[42] However, a site does not need to be a brownfield to qualify. This Best Practices guide uses the term "previously developed or degraded lands" to include any former industrial or commercial sites that could be repurposed for solar development.

The EPA has established a program to encourage the development of renewable energy projects on potentially contaminated lands. The agency's RE-Powering America's Land Initiative encourages renewable energy projects on current and formerly contaminated lands, landfills, and mine sites when such development is aligned with the community's vision for the site.[43]

More than 150 renewable energy installations on 144 contaminated land sites have been established since the inception of the RE-Powering Initiative. A recent example is Xcel Energy's siting of a 2,000 panel community solar project on a Superfund landfill in Boulder, Colorado. The project allows participating customers to invest in the solar PV system and receive credits on their bills for the power generated.

The EPA initiative aims to provide technical and programmatic assistance to encourage renewable energy on contaminated lands, and partner with stakeholders to leverage agency efforts.[44] Through this initiative, the EPA provides resources for developers and other involved parties, shares best practices and highlights successes, facilitates partnerships and technical assistance, and provides outreach and communications support.

The solar resource map above shows potentially contaminated sites with renewable energy potential as surveyed by the EPA.[45] Many of these properties are located in the Southeast. All told, EPA has identified more than 11,000 potentially contaminated sites and almost 15 million acres that have the potential for hosting renewable energy such as solar. These sites contain an estimated 1 million MW of renewable energy potential.[46]

Available properties include retired coal plants. For example, in the summer of 2015, Google announced that it would locate a new data center powered by solar and wind energy at the retired Widows Creek Coal Plant in Alabama. Google will use the plant's preexisting electric infrastructure to power the data center and plans to work with the Tennessee Valley Authority to create new renewable energy projects in the area.[47]

Siting solar energy projects on previously developed or degraded lands can provide the following benefits:[48]

- **Environmental benefits** – facilitating the cleanup of sites, the protection of open space, and reduction in greenhouse gas emissions;
- **Water conservation** – especially where solar generation minimizes agricultural overuse, solar can provide much-needed relief in drought-stricken areas;
- **Saving money to provide electricity** – projects can be structured to require little upfront investment and then provide electricity to local residents, businesses, and industries at a reduced cost;
- **Providing jobs** – renewable energy projects can spur direct and indirect local employment opportunities;
- **Providing annual tax revenue** – installations bring unproductive land back to productive use, thus increasing the tax base;
- **Promoting revitalization** – finding uses for lands that may have limited reuse options;
- **Other development advantages** – reduced project costs and development time, as well as opportunities to create partnerships with communities in efforts to revitalize contaminated lands

For developers concerned about transactional costs and potential liability stemming from solar development on previously developed or degraded lands, the EPA and other state and local agencies are able to assist in the resolution of these issues in order to support safe reuse of sites. Private sector environmental insurance, and in some cases federal and state regulations and programs, can help address these concerns.[49] For example, Georgia's Brownfields program, which was initially funded by an EPA grant and has a goal to promote voluntary cleanup and reuse of brownfields, provides tax incentives and liability limitation for prospective purchasers.[50] The Georgia Brownfield Act protects purchasers of contaminated properties from third party lawsuits based on prior contamination and groundwater contamination.[51] Developers are encouraged to reach out to their state regulatory agencies for similar opportunities.

For developers wanting to redevelop a potentially contaminated site into a solar energy project, the EPA has published a helpful decision tree and handbook to assist with the cost-effective execution of such projects.[52]

CONCLUSION

The Southeast has abundant solar energy potential. Solar farms provide clean, affordable, and sustainable energy to homes and businesses throughout the region. Solar power avoids pollution and reduces water use and land use compared to other forms of energy production. With many solar projects already under development, the Southeast is well-positioned to reap the benefits of solar power.

Like any land disturbance, solar projects, and particularly ground-mounted solar farms, can have environmental impacts. Existing federal, state, and local environmental review processes provide protection from many adverse impacts. And some solar developers are paving the way for new approaches to sustainable solar siting and project management. Following best practices, along with careful planning, research, and collaboration between developers, community members, and environmental agencies can help ensure that solar power continues to be one of the cleanest forms of energy at our disposal.

APPENDIX I

HELPFUL RESOURCES FOR SOLAR DEVELOPMENT AND MITIGATION

This appendix contains resources that will assist in implementing best management practices when siting and developing a large-scale solar project.

1. U.S. Dep't of Energy SunShot Initiative, Solar Outreach Partnership: Solar Zoning & Access Toolkit (Nov. 2015). http://solaroutreach.org/wp-content/uploads/2015/12/SolarOPs-Revised-Solar-Zoning-and-Access-Toolkit_Dec.-2015.pdf.
2. NC Clean Energy Technology Center, Template Ordinance for Solar Energy Development in North Carolina. https://nccleantech.ncsu.edu/technology/renewable-energy/solar/template-ordinance-for-solar-energy-development-in-north-carolina/
3. Final Solar Energy Development Programmatic Environmental Impact Statement (Solar PEIS). Office of Energy Efficiency and Renewable Energy, US Department of Energy; Bureau of Land Management, Department of the Interior, 2012. http://solareis.anl.gov/documents/fpeis/index.cfm
4. Solar Photovoltaic Decision Tree: Screening Sites for Solar PV Potential, Emphasis on Redevelopment of Potentially Contaminated Sites, Unutilized Sites, or Rooftops. US Environmental Protection Agency, RE-Powering America's Land Initiative; National Renewable Energy Laboratory. http://www.epa.gov/renewableenergyland/docs/solar_decision_tree.pdf
5. Handbook on Siting Renewable Energy Projects While Addressing Environmental Issues. US Environmental Protection Agency, Office of Solid Waste and Emergency Response. http://www.epa.gov/oswercpa/docs/handbook_siting_repowering_projects.pdf
6. RE-Powering America's Land Initiative, US Environmental Protection Agency. http://www.epa.gov/renewableenergyland/
7. Georgia Environmental Protection Division Brownfield Development. http://epd.georgia.gov/brownfield
8. Draft Programmatic Environmental Assessment, TVA Solar PV Projects. September, 2014. https://www.tva.gov/file_source/TVA/Site%20Content/Environment/Environmental%20Stewardship/Environmental%20Reviews/TVA%20Solar%20Photovoltaic%20Projects/PV-final%20PEA-Solar%20PV-reduced%20size.pdf
9. Citizen's Guide to NEPA. http://www.powercompanyofwyoming.com/about/docs/A_Citizens_Guide_to_NEPA.pdf
10. EPA's Liability Reference Guide for Siting Renewable Energy on Contaminated Properties. http://www2.epa.gov/sites/production/files/2014-07/documents/liability-renew-energy-contamprop-2014.pdf
11. RE-Powering America's Land initiative: Action Plan 2.0. http://www.epa.gov/oswercpa/docs/action_plan_2.0.pdf

APPENDIX II

IMPACT ANALYSIS FOR NEPA OR STATE EQUIVALENTS[53]

Impact analysis is an important tool used to assess early potential impacts of a project that will affect the environment. A site-specific impact analysis can identify opportunities to avoid or mitigate impacts to minimize the project's overall effect on the environment. Major objectives of a site-specific analysis are to determine the anticipated impacts of project implementation and develop mitigation strategies to avoid or reduce impacts to important resources. The following impact analysis framework, based on Tribal Energy and Environmental Clearinghouse guidance,[54] may be helpful to project developers who are required to complete an EA, EIS, or similar state or local analyses:

Describing the Proposed Project

An accurate and comprehensive description of the proposed project serves as the basis for the impact assessment. To ensure that the project description is comprehensive and covers all bases, the analysis must include the following:

- **All Proposed Facilities and Activities**
  - Proposed Facilities, Layout, and Functional Interrelationships
  - General Project Description
    - Describe the overall project and its purpose
  - Description of Primary Facilities
    - Scope of the project's impact including the function of each facility, size of the area occupied by each facility, and relationship to other project facilities
  - Description of Support Facilities
    - Provide a detailed description of project facilities that support the primary function of the proposed project
  - Description of Connected Actions
    - To conclude if an action is connected to the proposed action, determine whether or not that action would be made regardless of the project
  - Description of Project Timeline and Activities
    - Provide a general description of the project timeline including phases of development
- **Site Characterization Requirements and Activities**
  - The amount of land disturbance, length of activities, number of people involved, and seasonal pattern of activities all affect the level of disturbance and should be described
- **Construction Requirements and Activities**
  - Provide a detailed description of all construction activities
    - Construction footprint for primary and support facilities
    - Setbacks from areas to be avoided
    - Land surface clearing and grading plan
    - Energy, water, and materials needs
    - Fencing and lighting requirements
    - Waste stream management plan
    - Construction work force and time frame
    - Protection plans for soil, disturbed areas, and surface water
- **Operational Requirements and Activities**
  - Provide a detailed description of operations while considering impacts long-term
    - Footprint for primary and support facilities
    - Facility characteristics

    - Protected areas and setbacks
    - Maintenance activities and schedule
    - Vegetation management plan
    - Fencing and lighting requirements
    - Spill prevention plan
    - Waste stream management plan
    - Construction work force and time frame
    - Protection plans for soil, disturbed areas, and surface water
- **Decommissioning and Reclamation Requirements and Activities**
  - Decommissioning refers to the removal of project structures. Reclamation refers to activities that are used to return the site to pre-disturbance conditions.
    - Facilities and structures to be removed
    - Facilities to remain in place
    - Restoration plan
    - Decommission and reclamation schedule
    - Surface and groundwater protection plan
    - Fencing and lighting requirements
    - Spill prevention plan
    - Waste stream management plan
    - Construction work force and time frame
    - Protection plans for soil, disturbed areas, and surface water

Identifying Impacting Factors, Area of Influence, and Resources Affected

This section provides guidance on identifying direct, indirect, and cumulative impacts from the project. Direct impacts are those that occur as a direct result of an activity. Indirect impacts are those that are related to but removed from an activity by an intermediate step or process.

- **Impacting Factors**
  - To identify impacting factors, the analysis should determine how each activity or project element could affect the environment
- **Area of Influence**
  - The area of influence is often, if not always, variable and dependent on the impacting factor (both direct and indirect) and the affected resource
- **Affected Resources**
  - The resources affected by a project are resources that occur in the area of influence. A multitude of resources can occur in the area of influence and it can be a challenge to determine which of these are of greatest concern and should be considered in the assessment.
  - Assessments usually evaluate the impacts to geology, soils, air quality, noise, water resources, ecology, land use, waste management, socioeconomics, environmental justice, and health and safety
  - Consider regulatory status, economic importance, operations, and societal value of resources when determining affected resources to include in assessment

Determining the Magnitude and Significance of Impacts

This determination provides decision makers with the information needed to determine if a project should be approved or modified in some way that would make the magnitude of impacts acceptable. This section provides guidance on determining the anticipated magnitude and significance of direct, indirect, and cumulative

impacts. Consideration is given to the size of the area affected, status of resources, sensitivity of resources, and the anticipated departure from current conditions.

- **Determining the Magnitude of Impacts**
  - Impact magnitude depends on the degree and extent to which the project changes the environment and usually varies according to project phase.
  - Factors to consider include area of influence overlap between area of influence and resource of interest, deviation from baseline conditions, project duration, resource sensitivity, and project timing.
- **Determining the Significance of Impacts**
  - Determining significance of impacts can be one of the most difficult portions of an impact assessment. Significant impacts will be the focus of mitigation measures and project adjustments.
  - Establish significance levels prior to determining impact magnitude. Predetermined significance criteria allow an objective determination of the anticipated effectiveness of mitigations. If possible, establish these criteria with regulatory agencies.
  - When determining impact significance, consider area of influence, percentage of resource affected, persistence of impacts, sensitivity or resources, status of resources, regulatory status, and societal value.
- **Identifying Uncertainties**
  - It is important to understand the level of uncertainty associated with impact determinations. Decision makers often consider uncertainty when deciding among alternatives. Monitoring programs typically address areas of uncertainties.
- **Determining Mitigation Requirements**
  - The goal of mitigation is to reduce the magnitude of project impacts to a level that is considered insignificant.
  - When developing mitigation plans, the following principles should apply:
    - Mitigation should be focused
    - Mitigation should be proportionate to the significance of the impact
    - Mitigation should be a function of project phase
    - Mitigation should be developed in consultation
    - Mitigation effectiveness should be monitored

APPENDIX III

COMMON FEDERAL AND STATE PERMITTING AND APPROVAL REQUIREMENTS FOR SOLAR FARMS

Developers seeking to build large solar projects will be required to obtain multiple permits or approvals, depending on the project's location and size. There are a number of federal, state, and local laws governing the siting and development process for solar projects. The charts below describe common federal and state requirements that developers may encounter as they complete a utility-scale solar project.[52] Projects may require permits or approvals in addition to those listed below. The first chart lists common federal requirements, and the second chart lists common state requirements.

FEDERAL

Regulatory Authority	Statute	Permit/Approval	Description	Triggers
Council on Environmental Quality Regulations (CFR 1500-1508) and supplemental regulations from Lead Agency, which varies by project	National Environmental Policy Act (42 USC 4321)	Record of Decision, FONSI, or Categorical Exclusion	Establishes national mandate for federal agencies to review environmental impacts of proposed federal actions. Process can be combined with state and local environmental reviews	Federal permit or approval required Siting on federal lands Accessing federally owned transmission line Receipt of federal grants
U.S. Fish and Wildlife Service (50 CFR 13 and 17)	Endangered Species Act (16 USC 1531-1544)	Endangered Species Act Consultation and Incidental Take Permit	Regulates activities affecting threatened and endangered species: **Section 3** (16 USC 1532) defines Terminology **Section 7** (16 USC 1536) establishes federal interagency Consultation **Section 9** (16 USC 1538) establishes prohibited actions **Section 10** (16 USC 1539) establishes permits and exceptions **Section 11** (16 USC 1540) describes penalties and enforcement	Consultation with FWS under Section 7 always recommended Activities that may result in take or harm to species and their habitat, such as site clearing
U.S. Fish and Wildlife Service (50 CFR 13 and 21)	Migratory Bird Treaty Act (16 USC 703-712)	Consultation	Prohibits harm, possession, or take of migratory bird species, nests, and eggs. Strict liability statue.	Potential impact to migratory bird species protected by the act
Advisory Council on Historic Preservation, Tribal Historic Preservation Office and State Historic Preservation Office (36 CFR 60 and 800)	National Historic Preservation Act (16 USC 470)	Section 106 Consultation	Requires federal agencies to review impacts to historic and Tribal resources and allows ACHP to provide comments. Consultation authority delegated to SHPO and THPO	Consultation with the SHPO is always recommended to determine need for Section 106 Consultation Federal permit or approval required Activity may impact property listed in or eligible for listing in the National Register of Historic Places (NRHP) Activity may impact Tribal resources

U.S. Army Corps of Engineers (33 CFR 320-331 and 40 CFR 230)	Clean Water Act (33 USC 1251 et seq) Section 404 (33 USC 1344)	Individual, general, and nationwide permits	Regulates discharge of dredged or fill materials into waters of the United States	Activities that may impact federal waters, including wetlands
U.S. Army Corps of Engineers (33 CFR 320-331)	Rivers and Harbors Act of 1899 (33 USC 401 et seq) Sections 9 and 10 (33 USC 401 and 403)	Section 9 and 10 Permit	Regulates obstructions to navigable waters of the United States	Building or replacing bridges
Environmental Protection Agency and state agencies (40 CFR 122 and 123)	Clean Water Act (33 USC 1251 et seq) Section 402 (33 USC 1342)	National Pollution Discharge Elimination System (NPDES) Stormwater Permit	Regulates discharges into waters of the United States. Usually delegated to state authority	Potential for discharge from site assessment, construction, and operation
Environmental Protection Agency	Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) (42 USC 9601-9675)	ASTM Environmental Site Assessment	CERCLA is the principal statue that governs liability with respect to contaminated properties	Contaminated property

State law often requires that utility-scale solar projects obtain necessary permits or other approvals. These approvals may be similar to federal requirements, but solar developers must coordinate with the applicable state agency. Developers should consult with state agencies to determine which permits may apply.

STATE

Agency	Permit/Approval	Description	Trigger
Lead Agency varies by project	State-level environmental policy act decision	Many states have their own environmental impact review or environmental planning laws that are similar to the federal NEPA process. The state review may be required when the federal process is not. When both the federal and state reviews are required, one environmental impact assessment is typically coordinated among federal and state agencies to satisfy both sets of requirements.	Review threshold established by state statute
Public Service/Utility Commission or State Energy Facility Siting Commission/Board/Council	Siting approval and/or Certificate of Public Use and Convenience	Some states delegate siting approval of solar projects and transmission lines to a public service or utility commission or to an energy facility siting authority. These agencies may review all energy projects, only specific types of projects as defined by state regulations, or projects that request a consolidated state process.	Often required for transmission lines above established voltage or length or that cross county boundaries. May be required for solar projects above established MW.
State environmental quality agency	Permit for stormwater discharges	Administration of the federal National Pollution Discharge Elimination System (NPDES) program is often delegated to state agencies. Many states have developed general permits and permits-by-rule as part of their programs.	Potential for discharge from site assessment, construction, and operation

State environmental quality agency	Water Quality Certification under Section 401 of Clean Water Act	Section 401 Water Quality Certification is necessary to demonstrate that a project will comply with state water quality standards. The Water Quality Certification is typically required before USACE can approve a Section 404 permit. Some states may also require Water Quality Certification as part of a state water quality permit.	Need for Section 404 permit.
State environmental quality agency	Wildlife and habitat consultation/permit	Some states issue permits for impacts to protected wildlife or habitat. More often, these agencies do not have permits like the FWS Incidental Take Permit, but consultation is necessary to identify state-protected species and habitat within a project area and to determine need for mitigation measures.	Impacts to state wildlife
State Department of Transportation	Oversize/overweight vehicle permits	Most states set size and weight limits for vehicles traveling on state roads. Permits are required for vehicles that exceed the established limits. Special permits for construction equipment are often available.	Travel of oversize or overweight vehicles on state roads
State Department of Transportation	Utility permit	If project transmission line plans require utilities along state rights-of ways, this permit would be required.	Placement of utility lines within state rights-of-way
State Department of Transportation	Entrance/Access Permit	If project plans require the construction of new roads that enter state roads, this permit would be required.	Construction of access road onto state road

ENDNOTES

[1] Solar power lifecycle greenhouse gas emissions (including those from manufacturing, operation and maintenance, and decommissioning) are limited to an estimated median of 44 g of CO_2/kWh, in contrast to the estimated median lifecycle emission rates for coal of 979 g of CO_2/kWh. *Crystalline Silicon and Thin Film Photovoltaic Results – Life Cycle Assessment Harmonization,* National Renewable Energy Laboratory (2012), available at http://www.nrel.gov/analysis/sustain_lca_pv.html; *See also Coal-Fired Electricity Generation Results – Life Cycle Assessment Harmonization,* National Renewable Energy Laboratory (2012), available at http://www.nrel.gov/analysis/sustain_lca_coal.html.

[2] See *Life Cycle Assessment Harmonization Results and Findings,* National Renewable Energy Laboratory, *available at* http://www.nrel.gov/analysis/sustain_lca_results.html.

[3] These numbers only refer to electricity production; they do not include water usage for resource extraction.

[4] *Issues & Policies, Water Use Management,* Solar Energy Industries Association, http://www.seia.org/policy/power-plant-development/utility-scale-solar-power/water-use-management.

[5] Mielke, E., et al., *Water Consumption of Energy Resource Extraction, Processing, and Conversion,* Harvard Kennedy School: Belfer Center for Science and International Affairs (Oct. 2010), *available at* http://belfercenter.ksg.harvard.edu/files/ETIP-DP-2010-15-final-4.pdf.

[6] *How it Works: Water for Coal,* Union of Concerned Scientists, http://www.ucsusa.org/clean_energy/our-energy-choices/energy-and-water-use/water-energy-electricity-coal.html#.Vbp2LPlVhBc.

[7] *See* Mielke, E., et al., note 6, *supra*.

[8] Daniel Shapiro, et al., Solar PV Operation & Maintenance Issues, Desert Research Institute (2014), *available at* http://www.dri.edu/images/stories/editors/receditor/Solar_PV_Article.pdf.

[9] *Life Cycle Analysis: Natural Gas Combined Cycle (NGCC) Power Plant,* U.S. Department of Energy's National Energy Technology Laboratory (Sept. 2012), available at https://www.netl.doe.gov/File%20Library/Research/Energy%20Analysis/Life%20Cycle%20Analysis/NGCC-LCA---Final-Report---Report---9-10-12---Final---Version.pdf.

[10] Spath, P., et al., *Life Cycle Assessment of Coal-fired Power Plants,* National Renewable Energy Laboratory (June 1999), *available at* http://www.nrel.gov/docs/fy99osti/25119.pdf.

[11] *Frequently Asked Questions*, U.S. Energy Information Administration, http://www.eia.gov/tools/faqs/faq.cfm?id=228&t=21.

[12] Fthenakis, V. & Kim, H.C., *Land Use and Electricity Generation: A Life Cycle Analysis*, 13(6) Renewable and Sustainable Energy Reviews 1465-74 (2009).

[13] *See* Hernandez, R.R. et al. *Solar energy development impacts on land cover change and protected areas.* Proceedings of the National Academy of Sciences (2015), http://www.pnas.org/content/112/44/13579/; *See also* Copeland, H.E., Pocewicz, A. & Kiesecker, J., *Geography of Energy Development in Western North America: Potential Impacts to Terrestrial Ecosystems, Energy Development and Wildlife Conservation in Western North America* 7-22 (2011). PV also has similar land use requirements as nuclear energy, which is often considered a low land use power source. See Lovins, A., *Renewable Energy Footprint Myth*. 24 Electricity J. 40, 41 (2011).

[14] Denholm, P. and R. Margolis, NREL, *Land-use requirements and the per-capita solar footprint for photovoltaic generation in the United States,* 36(9) Energy Policy 3531-3543 (2008).

[15] *Id.*

[16] The Solar Foundation, 2016 National Solar Jobs Census (Feb. 2017), http://www.thesolarfoundation.org/national.

[17] RTI International, Economic Impact Analysis of Clean Energy Development in North Carolina (2016), https://c.ymcdn.com/sites/energync.site-ym.com/resource/resmgr/Docs/RTI_2016_FINAL_4-18.pdf.

[18] Dan Chapman, Ga. Farmers Harvest Rays as Solar Grows (Oct. 2, 2016), http://www.myajc.com/news/business/economy/ga-farmers-harvest-rays-as-solar-grows/nnrT2/.

[19] Tom Smith, Times Daily, Solar Farm Bonanza? Study Shows Great Economic Potential from Project (June 22, 2015), http://www.timesdaily.com/news/local/solar-farm-bonanza-study-shows-great-economic-potential-from-project/article_0d3beea8-18c1-5ffb-8400-5b5a9890cf55.html.

[20] Duke University, The Solar Economy: Widespread Benefits for North Carolina (2015), http://www.cggc.duke.edu/pdfs/02152015Duke_CGGC_NCSolarEnergyReport.pdf; *see also* National Solar Jobs Census at Note 16.

[21] 42 U.S.C. § 4321 et seq.

[22] *The NEPA Review Process,* National Preservation Institute, http://www.npi.org/NEPA/process.

[23] *Wind Energy Siting Handbook,* American Wind Energy Association, Chapter 4, 4-5 (Feb. 2008), http://awea.files.cms-plus.com/AWEA_Siting_Handbook_Feb2008.pdf.

[24] 16 U.S.C. §§ 1531-1544.

[25] 16 U.S.C. § 1536. The Fish and Wildlife Service is the federal consultation agency for land-based species. Marine species consultations are handled by the National Marine Fisheries Service.

[26] 33 U.S.C. §§ 1251-1388. Discharges of pollutants into waters of the U.S. will require permitting under Section 402 of the CWA, while filling wetlands or other waters of the U.S. will require permitting under Section 404.

[27] In most states, the EPA delegates its Clean Water Act permitting authority to the state environmental protection agency.

[28] For example, the Audubon Society and the Natural Resources Defense Council have created Google Earth maps to support renewable energy planning and development by facilitating siting decisions. Landscape Conservation cooperatives in the southeast are also a good source for mapping information and stakeholder engagement. The maps and data layers identify areas where land use is legally restricted and other areas that should be avoided in energy development, including habitats critically important to wildlife.

[29] *See* Hernandez, R.R. et al., note 13, *supra*.

[30] Macknick, J. et al., *A Review of Operational Water Consumption and Withdrawal Factors for Electricity Generating Technologies,* National Renewable Energy Laboratory (2011), http://www.nrel.gov/docs/fy11osti/50900.pdf.

[31] The Bureau of Land Management requires solar project developers on BLM land to provide a Performance and Reclamation Bond that covers: Environmental liabilities, such as the securing, removal or use of hazardous materials and substances, hazardous waste, herbicide, petroleum-based fluids, and dust control or soil stabilization materials; Decommissioning, including removal, and proper disposal, as appropriate, of any improvements and facilities; and Interim and final reclamation, revegetation, recontouring, and soil stabilization. See *Solar and Wind Energy Performance and Reclamation Bond Requirements,* Bureau of Land Management, (IM 2015-138 8/31/2015), http://www.blm.gov/wo/st/en/info/regulations/Instruction_Memos_and_Bulletins/national_instruction/2015/IM_2015-138.html.

[32] *SEIA Has a Plan for Reusing and Recycling Old Solar Panels,* PVSolarReport (Sept. 15, 2016), http://www.pvsolarreport.com/seia-plan-recycling-solar-panels/.

[33] *Id.; see also* http://www.seia.org/seia-national-pv-recycling-program.

[34] Massachusetts Dep't of Energy Resources, Questions & Answers Ground-Mounted Solar Photovoltaic Systems (June 2015), http://www.mass.gov/eea/docs/doer/renewables/solar/solar-pv-guide.pdf; Brookhaven National Laboratory (Jan. 2003), CdTe PV: Facts and Handy Comparisons, https://www.bnl.gov/pv/files/pdf/art_165.pdf.

[35] *See*, e.g., National Institute of Environmental Health Sciences, *Health Effects from Exposure to Power-Line Frequency Electric and Magnetic Fields*, Research Triangle Park, NC (1999); *see also* National Research Council, Committee on the P*ossible Effects of Electromagnetic Fields on Biologic Systems, Possible Health Effects of Exposure to Residential Electric and Magnetic Fields*, National Academy Press, Washington, D.C. (1997); World Health Organization, *Extremely Low Frequency Fields*, Environmental Health Criteria Monograph No. 238, Geneva (2007).

[36] Letter from the U.S. Department of Energy to the Oregon Department of Transportation at 2 (Nov. 12, 2009), available at https://ntl.bts.gov/lib/60000/60200/60294/US_DOE_Letter_to_ODOT_on_EMF.pdf.

[37] A report by the National Renewable Energy Laboratory states that existing rooftops can site enough solar for about a fifth of U.S. power needs. Lopez, A. et al., *U.S. Renewable Energy Technical Potentials: A GIS-Based Analysis,* National Renewable Energy Laboratory (July 2012), http://www.nrel.gov/docs/fy12osti/51946.pdf.

[38] *Id.*

[39] Chapman, D., *Georgia Farmers Harvest Rays as Solar Grows,* The Atlanta Journal-Constitution (Oct. 2, 2015), *available at* http://www.myajc.com/news/business/economy/ga-farmers-harvest-rays-as-solar-grows/nnrT2/.

[40] Ryan, J., *Harvesting sunshine more lucrative than crops at some U.S. farms,* Bloomberg (Mar. 29, 2016), http://www.bloomberg.com/news/articles/2016-03-29/harvesting-sunshine-more-lucrative-than-crops-at-some-u-s-farms.

[41] *Brownfield Overview and Definition,* Environmental Protection Agency, http://www.epa.gov/brownfields/brownfield-overview-and-definition (last updated Oct. 21, 2015). As further noted by the Agency: "Cleaning up and reinvesting in these properties protects the environment, reduces blight, and takes development pressures off greenspaces and working lands." *Id.*

[42] Superfund sites are those that are regulated under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA), 42 U.S.C. § 9601 et seq., and RCRA is the Resource Conservation and Recovery Act, 42 U.S.C. § 6901 et seq.

[43] *Marshall Landfill Solar Array,* Center for Social Inclusion, http://energydemocracy.centerforsocialinclusion.org/cec-marshall-landfill-solar-array/.

[44] *RE-Powering America's Land Initiative: Renewable Energy on Potentially Contaminated Land, Landfills and Mine Sites,* U.S. Environmental Protection Agency (July 2015), http://www.epa.gov/oswercpa/docs/re_powering_program_overview.pdf.

[45] *Id.*

[46] *RE-Powering Mapping and Screening Tools,* U.S. Environmental Protection Agency, http://www.epa.gov/renewableenergyland/docs/repower_mapping_tools.pdf.

[47] Sverklik, Y., *Google to Turn Alabama Power Plant Into Data Center,* Data Center Knowledge (June 24, 2015), http://www.datacenterknowledge.com/archives/2015/06/24/alabama-power-plant-to-be-converted-to-google-data-center/.

[48] *RE-Powering America's Lands,* U.S. Environmental Protection Agency, http://www2.epa.gov/re-powering.

[49] *Learn More About RE-Powering,* U.S. Environmental Protection Agency, http://www2.epa.gov/re-powering/learn-more-about-re-powering#benefits.

[50] *Brownfield,* State of Georgia, Environmental Protection Division, https://epd.georgia.gov/brownfield.

[51] O.C.G.A. § 12-8-200 et seq.

[52] *RE-Powering's Electronic Decision Tree,* U.S. Environmental Protection Agency, https://www.epa.gov/re-powering/re-powerings-electronic-decision-tree.

[53] *Conducting Project-Specific Impact Analyses,* Office of Indian Energy and Environmental Development, Tribal Energy and Environmental Regulations CLEARINGHOUSE, http://teeic.indianaffairs.gov/am/assess/index.htm.

[54] *Id.*

[55] These charts have been adapted for utility-scale solar projects from an American Wind Energy Association Handbook. *See* note 23, *supra*.

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