



Module 3: Detailed Site Evaluation, Project Validation, and Permitting

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City and County Solar PV Training Program

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Learning Objectives

- Understand the importance of site evaluation in reducing risk and ensuring project success
- Understand steps to identify potential site and permitting barriers and challenges
- Understand different site evaluation requirements for rooftop and ground-mounted PV
- Understand differences between net-metered systems (small and medium) and non-net-metered systems (large)

PV Project Implementation Process



Relevant Solar Policy and Regulation Screening

Policy Considerations

- Net Metering
 - Value of energy pushed to the grid
 - Retail
 - Avoided cost
 - Size limit
 - Requirements of overproduction



- Resources
 - North Carolina Clean Energy Technology Center, *The 50 States of Solar: Q4 2016 & Annual Review Executive Summary*, January 2017
 - Freeing the grid Annual Summary - <http://freeingthegrid.org/>

Policy Considerations

- Interconnection Laws
 - Upper limit on system size (system capacity limit)
 - Utility types that are covered by interconnection regulations
 - Study requirements for systems above the interconnection limit
 - Cost
 - Time requirements
- Resources
 - Database of State Incentives for Renewables & Efficiency (DSIRE)
www.dsireusa.org
 - Interstate Renewable Energy Council (IREC), *Model Interconnection Procedures* , April 2013

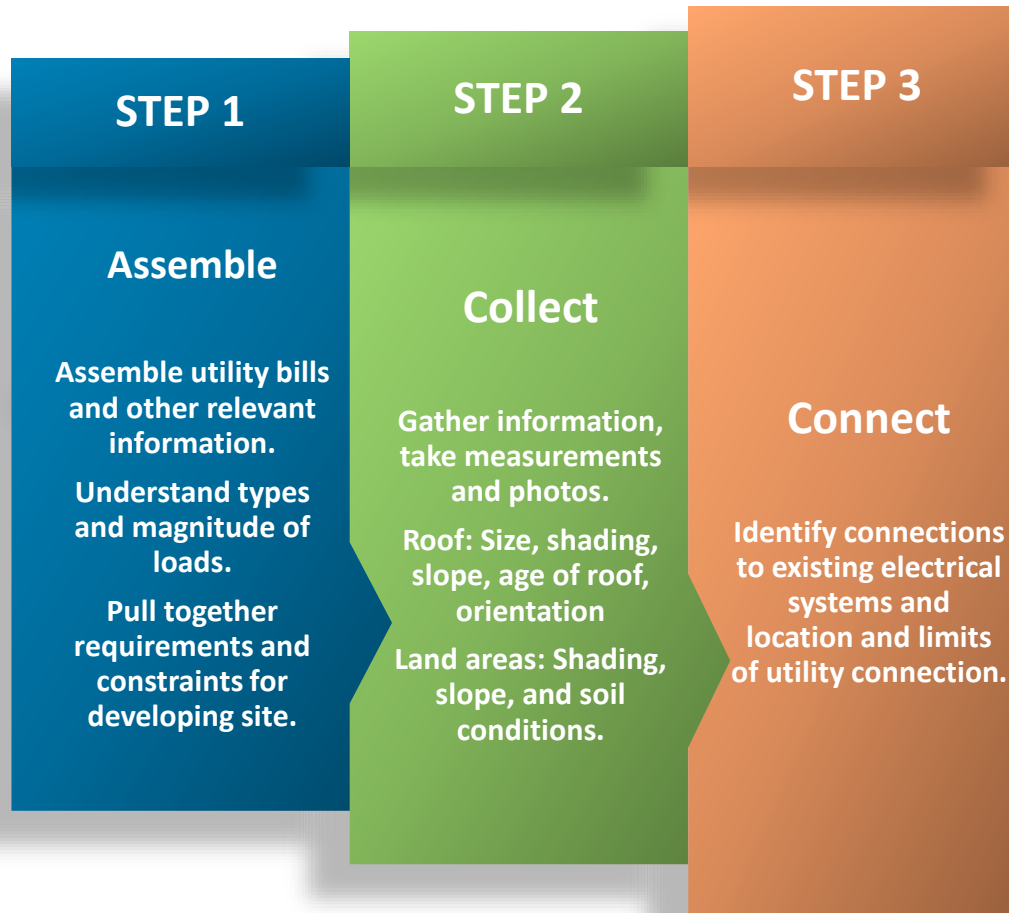
Policy Considerations

- Limitations on construction
 - Are there any limitations to projects in a jurisdiction?
 - In some jurisdictions, moratoriums have been placed on certain types of systems
 - Historic preservation restrictions
- Resources
 - Local and state government websites



Technical Feasibility – Small and Medium Scale Systems (net-metered)

Site Assessment Guidance





Technical Feasibility – Identify Roadblocks

- Interconnection point
- Required area
- Project financing type
- Existing infrastructure
- Site preparation
- Energy production
- Project economics
- Accessibility
- Shading
- Site usage

Interconnection Point



Roof-Mounted

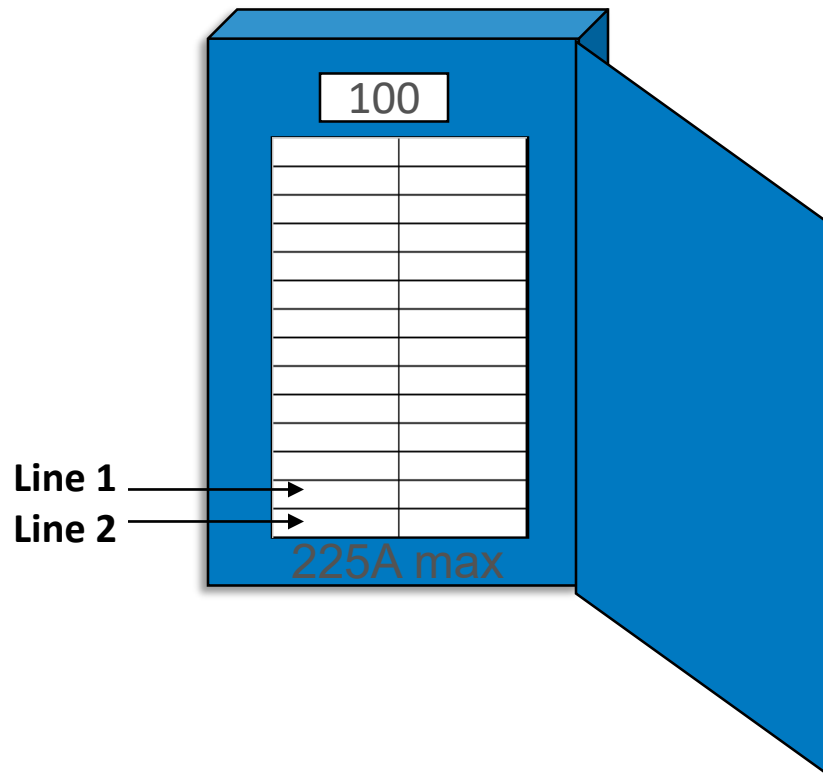


Ground

- Building electrical panel
- Spare capacity
- Distance to inverter
- Equipment space

- Transmission/distribution lines
- Transformer (step up)
- Infrastructure ownership
- Distance to inverter
- Right of way

Utility Interconnection – Where to Land Power? (small-scale)



Backfeed breaker in building panel (sum of main breaker and PV breaker not to exceed 120% of panel rating for commercial and residential buildings)

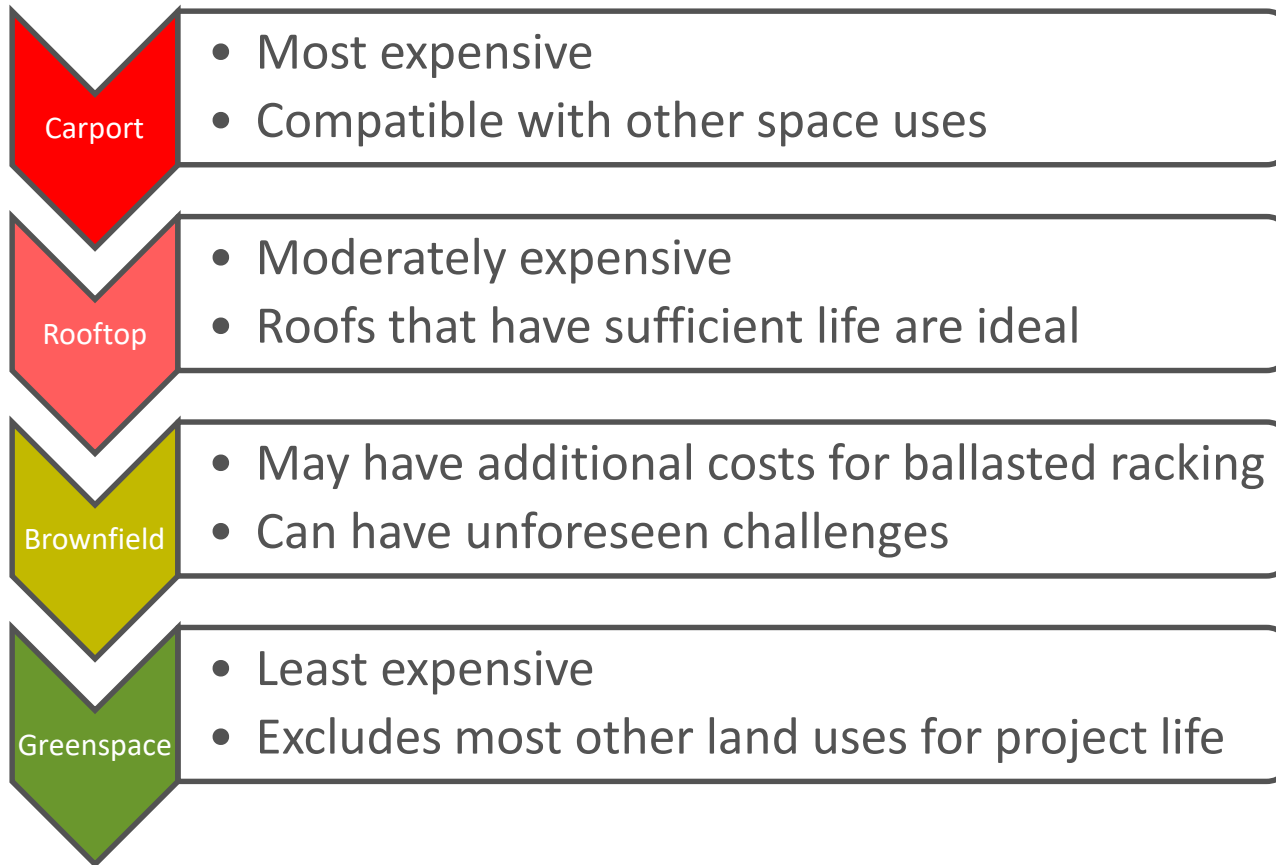
- **Too big?** Survey loads and reduce main breaker rating
- **Too big?** Upgrade panel
- **Too big?** Line-side-tap
- **Too big?** Upgrade electrical service

Required Area

- Available area can be used to estimate hosting capacity
- Systems cannot utilize all available space
 - Self-shading
 - Access for personnel
 - System maintenance
 - Balance-of-system (BOS) equipment

System Type	Ground Mount Fixed Tilt Energy Density (DC-W/ft²)	Ground Mount Single-Axis Tracking Energy Density (DC-W/ft²)	Sloped Rooftop Flush-Mounted (DC-W/ft²)	Flat Rooftop Tilted Panels (DC-W/ft²)
Crystalline Silicon	4	3.3	11	8
Thin Film	3.3	2.7	9	6.6
Hybrid High Efficiency	4.8	3.9	13.2	9.6

Cost Implications of Solar PV Sites



Project goals should inform site selection and system type

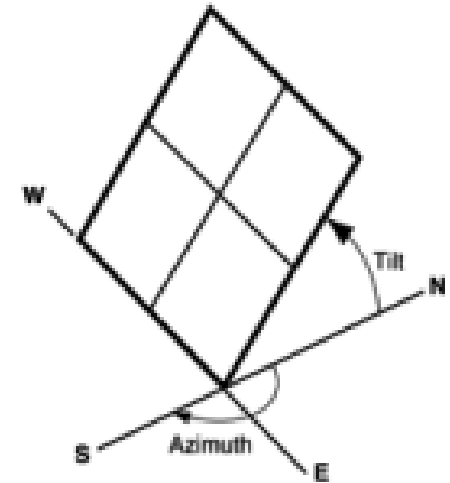
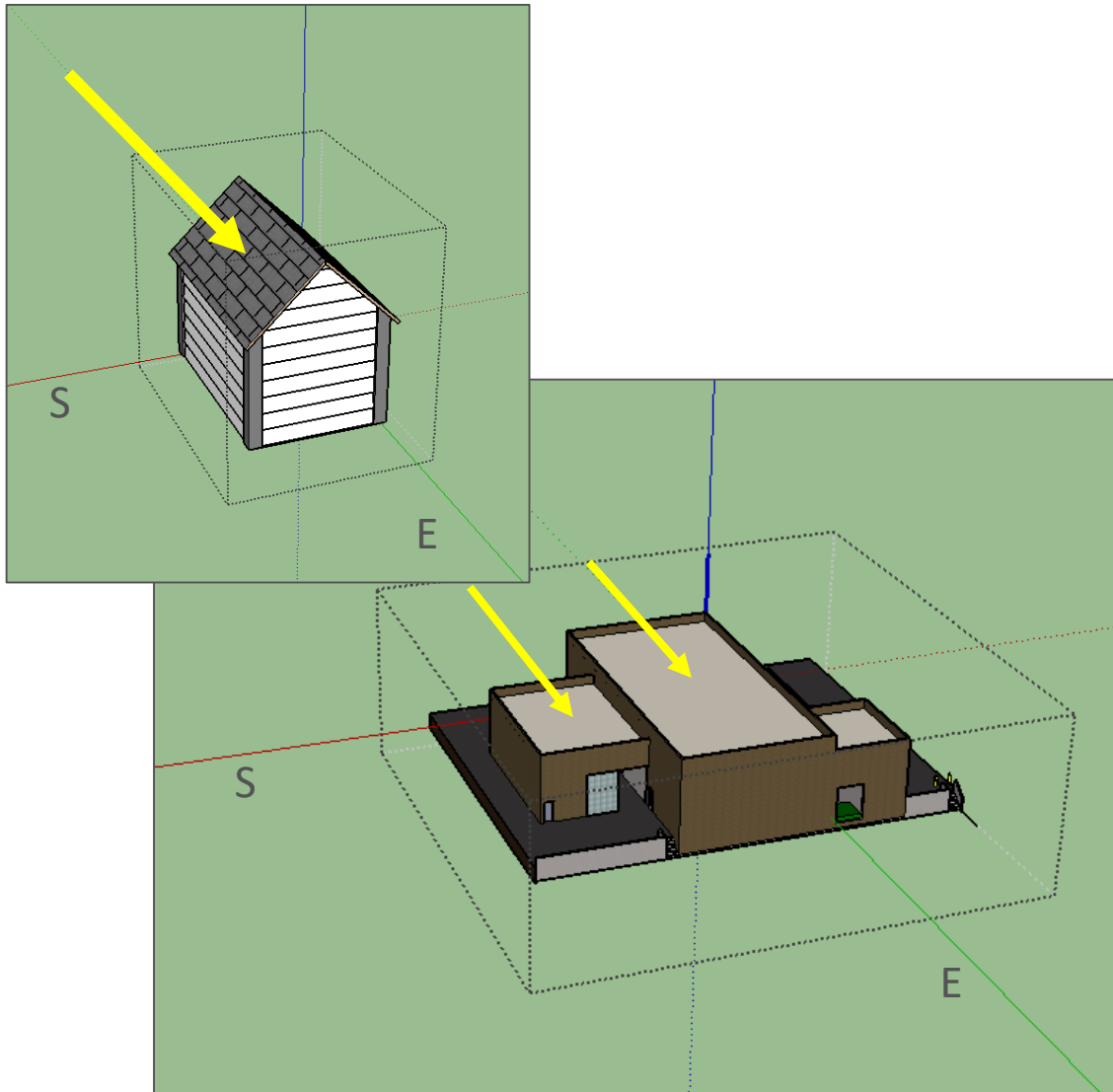
Priorities: Where to Install Rooftop Solar PV

Ideal – Install PV on new roof, require 25 year roof warranty w/ PV installed (PV modules come with 25 year warranty).

Acceptable – Install PV on roof with at least a 15 year expected life.

- **Roof MUST be able to accept added weight and wind load of PV – typically 2-5 lbs/square ft.**
- **Do not install PV on lightweight roofs such as mobile homes or on roofs in poor condition.**

Priorities: Rooftop Space



PV array facing south at fixed tilt.

Ideal Orientation*

- Azimuth = Due South
- Tilt = Latitude

*Economics may supersede energy production

Solar Assessment – PV is VERY Shade Sensitive

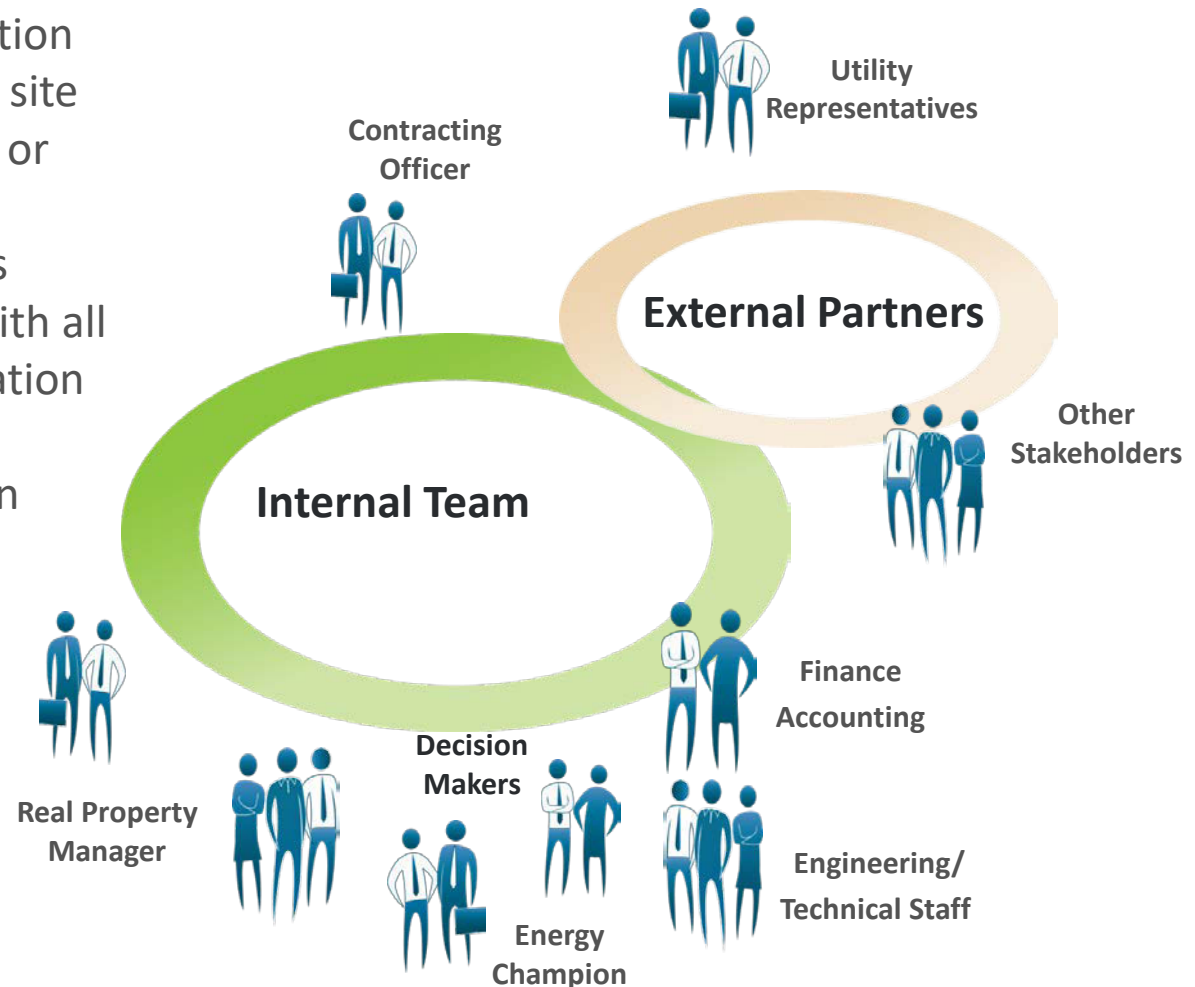


Once preliminary site assessment is complete . . . what you want to know:

- Remove/mitigate areas that have shading
- Estimate system size
- Estimate production (kWh/year)
- Estimate cost
- Some economic analysis

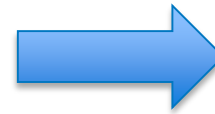
Leverage the Team

- Make sure to speak with everyone on the team about site selection
 - Long-term plans for the site
 - Knowledge of past uses or sensitivities
 - Creative multi-use plans
 - Circulate project idea with all members of an organization and partners
 - Get buy-in from decision makers early

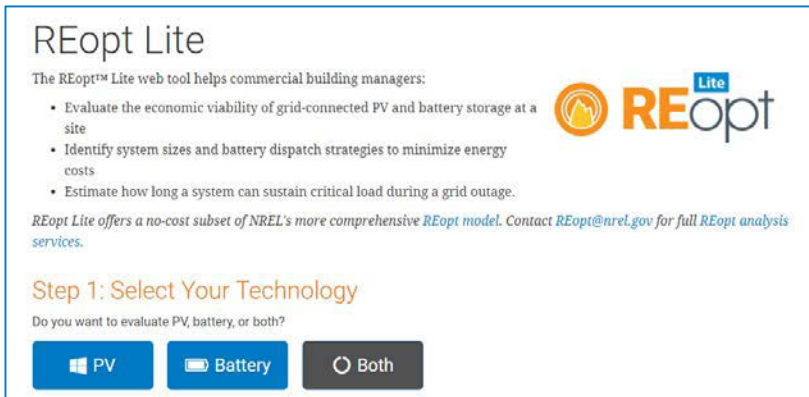


Economic Feasibility

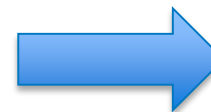
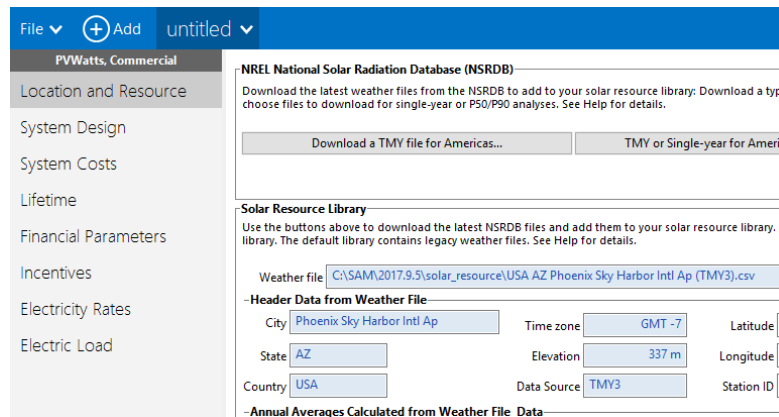
High Level Economic Analysis – Calculation Tools



PVWatts – Fast with few inputs



REopt Lite – Fast with a medium level of inputs

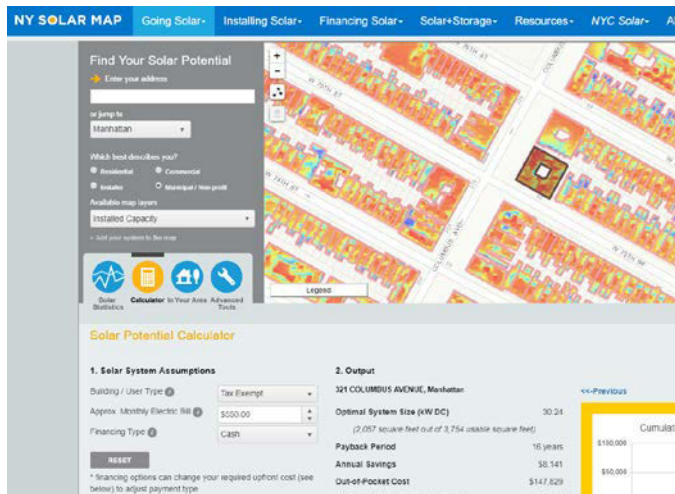


SAM – Detailed analysis

High Level Economic Analysis – Map Tools

Nationwide geographic mapping tool:
Google Project Sunroof
<https://www.google.com/get/sunroof>

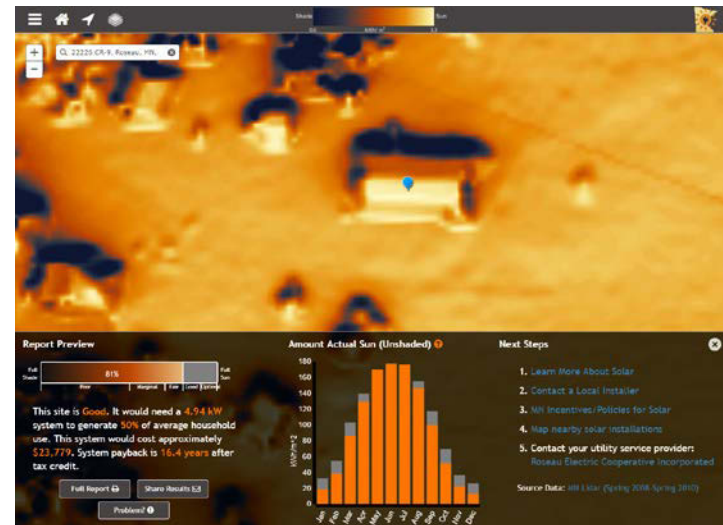
NY Solar Map– Location-specific analysis, local incentives



Local map tools:

- Cambridge Solar Map
- NY solar map
- Cook County Solar Map
- Others

MN Solar Suitability – Tool with LIDAR datasets



Research Other Nearby Projects



City Agency Projects



School Projects



Municipal Projects

Introduction to Non-Net-Metered, Ground-Mounted PV Sites

Ground-Mounted PV

Dangling Rope Marina, Glen Canyon National Recreation Area, Utah
Photo by Warren Gretz, NREL



Arizona Public Service, Prescott, Arizona
Photo from Arizona Public Service



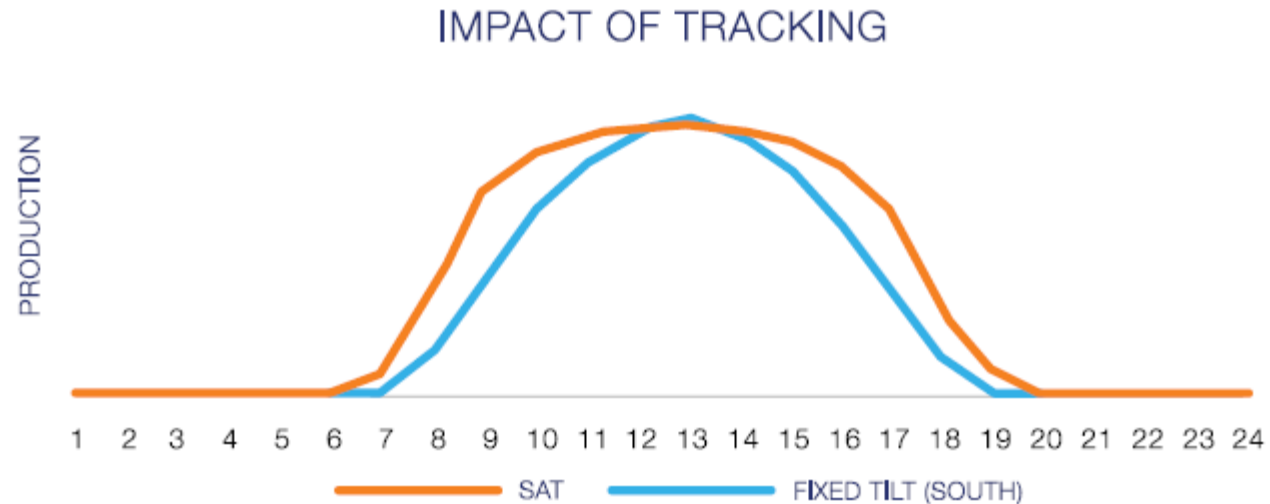
Alamosa PV System, Alamosa, Colorado
Photo by Tom Stoffel, NREL



5–10 acres per megawatt (MW) for PV systems. Land can be left as is or graded

Single-Axis Tracking vs. Fixed-Tilt PV

- Single-axis tracking increases energy production by ~20% over fixed tilt
- Tracking usually limited to large, ground-mounted systems



Source: SEPA, 2016

IMPACT OF SYSTEM DESIGN FOR 20 MW PV PROJECT IN PHOENIX

	FIXED TILT	SINGLE-AXIS TRACKING
CAPACITY FACTOR	30.5%	36.0%
BUILD COST	\$1.60/Watt-dc	\$1.68/Watt-dc
LCOE	\$63/MWh	\$55/MWh

Source: SEPA, 2016

See NREL's Annual Technology Baseline data for generation, capital costs, and operations and maintenance costs for utility-scale, single-axis tracking and fixed-tilt commercial and residential systems:

<https://atb.nrel.gov/electricity/2017/index.html?#su>

Large-Scale PV

A security fence is required and is generally 6' with an additional 1' barbed or razor wire



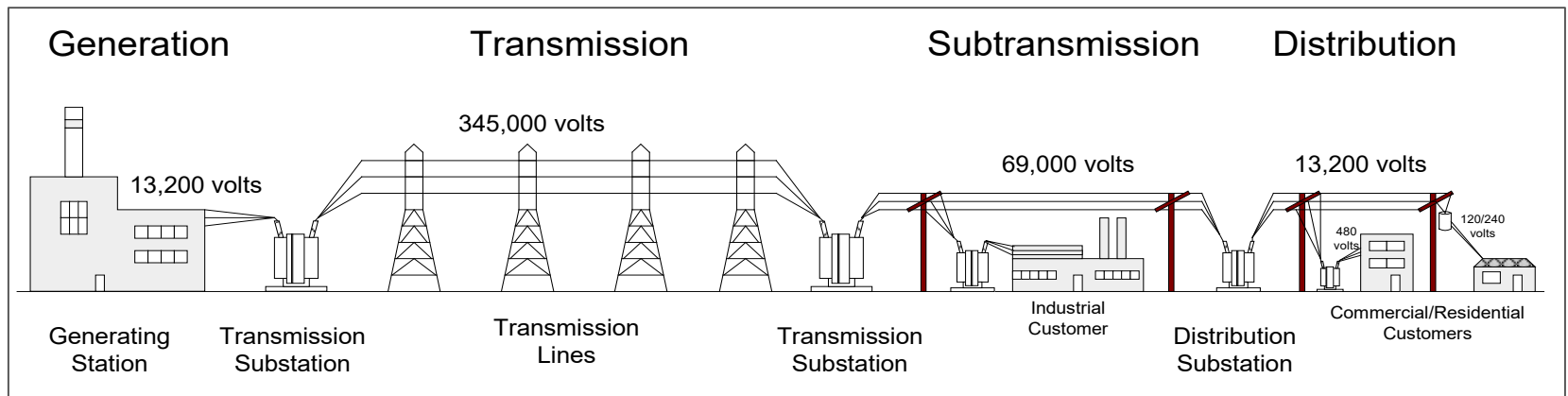
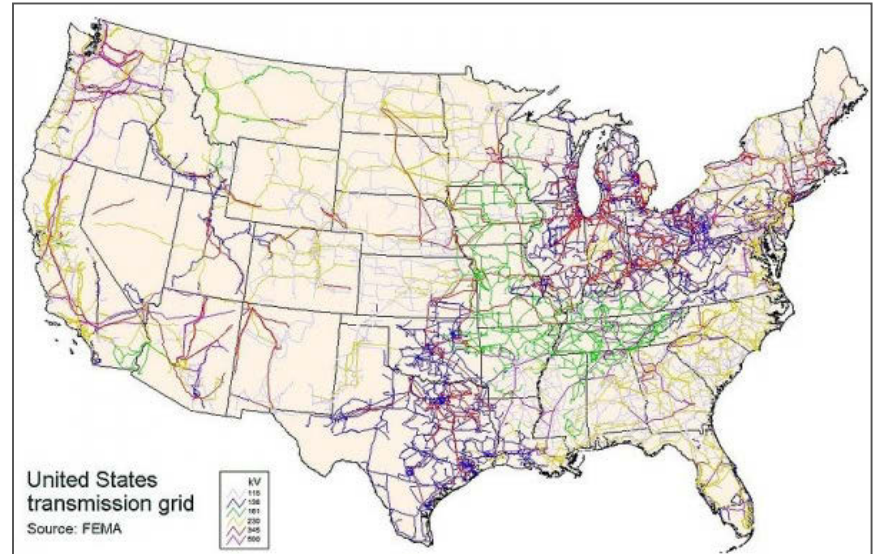
Street view: 19 MW, 118 acre solar farm in Arizona

(Solar farm views generally limited to fence and first row of modules)

Interconnection for Large-Scale PV

Proximity to interconnection is a key siting consideration

- Voltage of interconnection lines?
- Capacity of interconnection lines?



Ground-Mounted Site Screening



Site Due Diligence – First Steps

- Explore the site on Google Earth
 - Look at topography maps
 - Find out the zoning
 - **Walk the site**
- Look for:**
- Flat areas
 - Site constraints
 - Proximity of interconnection
 - Access
 - Shading

Ground-Mounted Site Screening

Consideration	Applicability	Resources
Wetlands/ waterways	<ul style="list-style-type: none"> • Are there wetlands, water bodies, washes, arroyos, drainage considerations, or floodplain on site? 	http://www.fws.gov/wetlands/Data/Mapper.html https://msc.fema.gov/portal/search
Soils	<ul style="list-style-type: none"> • Soil conditions impact structural design and site feasibility. <ul style="list-style-type: none"> • Caliche or bedrock may require costly drilling. • Sandy soils may require deeper post embedment to meet wind and snow loading requirements. • Corrosive soils can require measures to protect embedded posts. 	http://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx
Wildlife/habitat/ flora	<ul style="list-style-type: none"> • Check for critical habitat, riparian areas, and endangered species of flora or fauna that may be impacted. 	http://ecos.fws.gov/crithab/flex/crithabMapper.jsp?
Driveway/access	<ul style="list-style-type: none"> • Is a new driveway required? If so, is access available? (Limited-access highways may not allow a driveway.) • Can equipment and materials be safely delivered to the site with no obstructions such as overhead utilities, trees, or vehicle weight limits? 	<p>Check local, state, or federal department of transportation or equivalent</p>

Ground-Mounted Site Screening

Consideration	Applicability	Resources
Easements/ encumbrances/ rights-of-way	<ul style="list-style-type: none"> • Are there easements or rights of way for pipelines, utilities, or rail roads that will be crossed or impacted? • Are there plans for road expansions or improvements, new pipelines, or future utility rights of way at any time during the life of the project? 	<p>Check with land management authorities, transportation plans, USGS</p> <p>https://ngmdb.usgs.gov/topoview/viewer/</p>
Cultural, agricultural, and visual resources	<ul style="list-style-type: none"> • Are there known cultural resources on or near the site? If not, are further studies required? • Is the site under agricultural protections? • Is the site within a protected or sensitive viewshed? 	<p>State Historic Preservation Office</p> <p>http://nrhp.focus.nps.gov/natr/eg/docs/Download.html (Google Earth layer)</p>
Land use and building permits	<ul style="list-style-type: none"> • Zoning – Is the facility allowed as a principal or accessory use? Is a special or conditional use permit or re-zoning required? What setbacks apply? • Rights of way permits, including interconnection line, driveway, drainage • Building permit requirements 	<p>City or county zoning map, zoning code, state or local building code and permit requirements</p>
Storm water/drainage	<ul style="list-style-type: none"> • Are measures such as retention ponds or swales required for erosion and sediment control or storm water mitigation that could reduce the area available for system capacity? • If the site is an acre or more, a construction storm water permit and mitigation measures are required. 	<p>http://water.epa.gov/polwaste/npdes/stormwater/EPA-Construction-General-Permit.cfm</p>

Ground-Mounted Permitting Screening

Permitting Types

Key Types of Permitting	Always	Sometimes	Rarely
Interconnection agreement	✓		
Environmental permitting		✓	
Transmission permitting		✓	
Off-take agreement	✓		
Local permitting/coordination	✓		
State permitting		✓	
Federal permitting		✓	

Permitting Agency	Permit/Approval	Required?
Federal/National		
USFWS (or State Agency)	Wildlife review	
Army Corps of Engineers	Nationwide Permit or other permit if wetlands or waters of U.S.	
DUNS number	Unique number assigned to project company	
EPA	Spill Prevention Control and Countermeasure (SPCC)	
GATS	Registration of facility for certification number to generate RECs	
FERC	Self-certification of facility as a qualifying facility	
NEPA	Federal nexus? EA, EIS, FONSI	
State		
State environmental protection agency	Construction Storm Water General Permit, notice of termination	Yes if >1 acre
	Storm Water Pollution Prevention Plan (SWPPP)	Yes if >1 acre
Water management or aquifer authority	Coordination/approval/additional permitting requirements	
Historic preservation office	Cultural resources survey review/concurrency	
State power siting authority	Siting approval	
State PUC or electric resource council	Interconnection/resource plan approval/REC registration	
Secretary of State	Notice of Commencement	
City/County/Local		
City/County	Platting	
	Zoning/land use approval	
	Tree/site clearing permit	
	Floodplain development permit	
	Regional stormwater management participation	
	Driveway/right-of-way permit	
	Cultural resources survey review	
	Construction trailer permit	
	Site work permit, building permit, Certificate of Occupancy	
County Fire Marshal	Fire code/fire plan approval	
Soil & Water Conservation District	Approval/coordination	
Nearby airport/FAA	Construction notice, crane notice, glare study	
Utility	Interconnection Agreement	

Community Outreach

And Education



Addressing Community Concerns

No glare

- Less reflective than water and windows and compatible with nearby residential, office, or aviation uses

Very low noise

- 45 decibels at 10 meters from the inverters, which is slightly less noise than a refrigerator makes

Safe

- Photovoltaic modules are enclosed in glass, carry a 25-year production warranty, and meet all applicable electrical and safety standards

Low voltage

- Far lower voltage than transmission lines – No electromagnetic field (EMF) impacts

Pollinator-Friendly Vegetation

State Policy

Minnesota standards for pollinator-friendly solar legislation – Statute 216B.1642

Maryland Department of Natural Resources – Solar Generation Facilities – Pollinator-Friendly Designation – SB1158

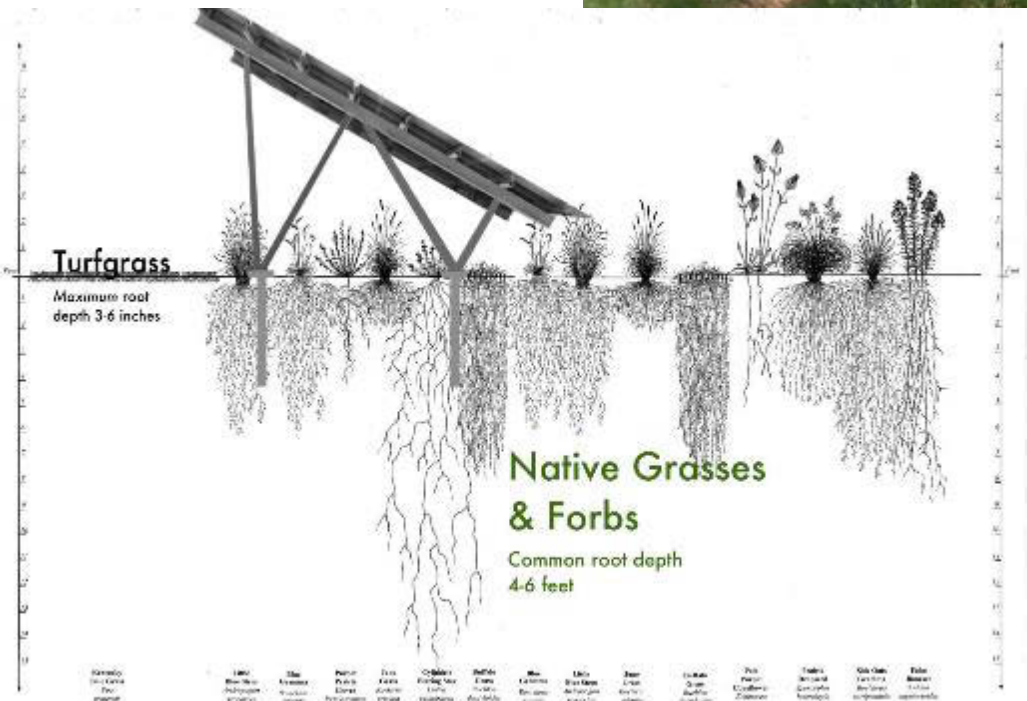
Local Policy

Linn County, IA – Amended the Development Code requires solar farms to be planted with native grasses and wildflowers, and prohibits application of insecticides

Stearns County, MN – Land Use and Zoning Ordinance requires solar farm ground cover to meet above state statute



Low-Impact Solar Development



NREL's National Wind Technology Center solar installation where native grasses and revegetation techniques were tested.

<https://www.nrel.gov/docs/fy17osti/66218.pdf>

Resources

Local Solar Resources

Google Project Sunroof for cities

<https://www.google.com/get/sunroof/data-explorer/>

apps1.eere.energy.gov/sled/#/

U.S. DEPARTMENT OF **ENERGY** | Energy Efficiency & Renewable Energy

State & Local Energy Data

Toolbox: Learn about community energy actions

Explore how communities have implemented energy policies. Find resources to take action today.

[Browse Energy Actions](#)

Small Building Rooftop PV Potential, Denver CO



■ Suitable Small Buildings
 108,500 buildings
■ Unsuitable Small Buildings
 64,000 buildings

Suitable area	5,000,000 m ²
Capacity potential	700,000 kW
Energy generation potential	1,000,000 MWh

ESTIMATED SOLAR INSTALLATION POTENTIAL



Overall

Total estimated size and solar electricity production of viable roofs for Denver, CO

Roofs	Roofs
63%	111K

Roof space	Capacity	Electricity
151M sq ft	2.1K MW DC	3M MWh AC per yr

Technical Assistance through SolSmart

Designation

- Three-tiered designation program
- Core prerequisites and options for pathways to success



www.solsmart.org/

Technical Assistance

- Communities seeking designation can receive free technical assistance on:
 - Siting
 - Permitting
 - Inspection
 - Planning and Zoning



Detailed Site Evaluation Conclusions

1. Rigorous, upfront site evaluation and data collection can save time and money during implementation.
2. Technical solutions can overcome many barriers. With proper screening, most issues can be identified and mitigated.
3. Dig deep. Talk to everyone who has knowledge of the site to uncover any complicating factors and ensure project success.

Knowledge Check #1

What are the benefits of thorough site evaluation? (Select all that apply.)

- Save time and money on project development
- Get better pricing from developers
- Avoid road blocks that may delay or prevent a project
- Plan for investments needed at the site

[Answer: All of the above]

Knowledge Check #2

Of the following roofs, which one would be an ideal candidate for rooftop PV?

1. Lightweight metal roof
2. Newly replaced roof with 25-year warranty
3. Relatively new roof, with 15 years of useful life remaining
4. Old roof with 5 years of useful life remaining

[Answer: #2]

Knowledge Check #3

Why are the zoning district of the potential PV site and references to solar in the zoning code important?

1. The zoning district indicates the building permit submittal requirements.
2. The zoning code and zoning district may have exemptions, allowances, and requirements that will impact how the installation is designed such as height restrictions, setbacks, and lot coverage regulations.
3. The zoning district indicates where the best solar resource is.

[Answer: #2]

Thank You

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<https://www.nrel.gov/technical-assistance/local-governments.html>.

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