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

Lars Lisell
Megan Day

City and County Solar PV Training Program
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

Module 1: Develop your goals and team
Module 2: Identify Sites and Screen
Module 3: Complete Detailed Site Evaluation
Module 4: Decide on a Financial Model and Use all Available Incentives
Module 5: Issue a request-for-proposals
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**
  - Freeing the grid Annual Summary - [http://freeingthegrid.org/](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
• 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**

**STEP 1**
**Assemble**
Assemble utility bills and other relevant information. Understand types and magnitude of loads. Pull together requirements and constraints for developing site.

**STEP 2**
**Collect**
Gather information, take measurements and photos. Roof: Size, shading, slope, age of roof, orientation. Land areas: Shading, slope, and soil conditions.

**STEP 3**
**Connect**
Identify connections to existing electrical systems and location and limits of utility connection.
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

- 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
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

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Crystalline Silicon</td>
<td>4</td>
<td>3.3</td>
<td>11</td>
<td>8</td>
</tr>
<tr>
<td>Thin Film</td>
<td>3.3</td>
<td>2.7</td>
<td>9</td>
<td>6.6</td>
</tr>
<tr>
<td>Hybrid High Efficiency</td>
<td>4.8</td>
<td>3.9</td>
<td>13.2</td>
<td>9.6</td>
</tr>
</tbody>
</table>
Project goals should inform site selection and system type

Cost Implications of Solar PV Sites

- **Carport**
  - Most expensive
  - Compatible with other space uses

- **Rooftop**
  - Moderately expensive
  - Roofs that have sufficient life are ideal

- **Brownfield**
  - May have additional costs for ballasted racking
  - Can have unforeseen challenges

- **Greenspace**
  - Least expensive
  - Excludes most other land uses for project life
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

Ideal Orientation*
- Azimuth = Due South
- Tilt = Latitude

*Economics may supersede energy production
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 – 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

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

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

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

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?t=su](https://atb.nrel.gov/electricity/2017/index.html?t=su)
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?

United States transmission grid
Source: FEMA
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

<table>
<thead>
<tr>
<th>Consideration</th>
<th>Applicability</th>
<th>Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wetlands/waterways</td>
<td>• Are there wetlands, water bodies, washes, arroyos, drainage considerations, or floodplain on site?</td>
<td><a href="http://www.fws.gov/wetlands/Data/Mapper.html">http://www.fws.gov/wetlands/Data/Mapper.html</a></td>
</tr>
<tr>
<td></td>
<td></td>
<td><a href="https://msc.fema.gov/portal/search">https://msc.fema.gov/portal/search</a></td>
</tr>
<tr>
<td></td>
<td>• Caliche or bedrock may require costly drilling.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Sandy soils may require deeper post embedment to meet wind and snow loading requirements.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Corrosive soils can require measures to protect embedded posts.</td>
<td></td>
</tr>
<tr>
<td>Wildlife/habitat/flora</td>
<td>• Check for critical habitat, riparian areas, and endangered species of flora or fauna that may be impacted.</td>
<td><a href="http://ecos.fws.gov/crithab/flex/crithabMapper.jsp">http://ecos.fws.gov/crithab/flex/crithabMapper.jsp</a>?</td>
</tr>
<tr>
<td>Driveway/access</td>
<td>• Is a new driveway required? If so, is access available? (Limited-access highways may not allow a driveway.)</td>
<td>Check local, state, or federal department of transportation or equivalent</td>
</tr>
<tr>
<td></td>
<td>• Can equipment and materials be safely delivered to the site with no obstructions such as overhead utilities, trees, or vehicle weight limits?</td>
<td></td>
</tr>
</tbody>
</table>
# Ground-Mounted Site Screening

<table>
<thead>
<tr>
<th>Consideration</th>
<th>Applicability</th>
<th>Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Easements/encumbrances/rights-of-way</td>
<td>• 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?</td>
<td>Check with land management authorities, transportation plans, USGS <a href="https://ngmdb.usgs.gov/topoviewer/">https://ngmdb.usgs.gov/topoviewer/</a></td>
</tr>
<tr>
<td>Cultural, agricultural, and visual resources</td>
<td>• 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?</td>
<td>State Historic Preservation Office <a href="http://nrhp.focus.nps.gov/natrereg/docs/Download.html">http://nrhp.focus.nps.gov/natrereg/docs/Download.html</a> (Google Earth layer)</td>
</tr>
<tr>
<td>Land use and building permits</td>
<td>• 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</td>
<td>City or county zoning map, zoning code, state or local building code and permit requirements</td>
</tr>
<tr>
<td>Storm water/drainage</td>
<td>• 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.</td>
<td><a href="http://water.epa.gov/polwaste/npdes/stormwater/EPA-Construction-General-Permit.cfm">http://water.epa.gov/polwaste/npdes/stormwater/EPA-Construction-General-Permit.cfm</a></td>
</tr>
</tbody>
</table>
Ground-Mounted Permitting Screening
# Permitting Types

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

Photo: Prairie Restorations, Inc.
# Addressing Community Concerns

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>No glare</td>
<td>Less reflective than water and windows and compatible with nearby residential, office, or aviation uses</td>
</tr>
<tr>
<td>Very low noise</td>
<td>45 decibels at 10 meters from the inverters, which is slightly less noise than a refrigerator makes</td>
</tr>
<tr>
<td>Safe</td>
<td>Photovoltaic modules are enclosed in glass, carry a 25-year production warranty, and meet all applicable electrical and safety standards</td>
</tr>
<tr>
<td>Low voltage</td>
<td>Far lower voltage than transmission lines – No electromagnetic field (EMF) impacts</td>
</tr>
</tbody>
</table>

Resource: [https://www.nrel.gov/technical-assistance/blog/posts/top-five-large-scale-solar-myths.html](https://www.nrel.gov/technical-assistance/blog/posts/top-five-large-scale-solar-myths.html)
## Pollinator-Friendly Vegetation

<table>
<thead>
<tr>
<th><strong>State Policy</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Minnesota</strong> standards for pollinator-friendly solar legislation – Statute 216B.1642</td>
</tr>
<tr>
<td><strong>Maryland</strong> Department of Natural Resources – Solar Generation Facilities – Pollinator-Friendly Designation – SB1158</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Local Policy</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Linn County, IA</strong> – Amended the Development Code requires solar farms to be planted with native grasses and wildflowers, and prohibits application of insecticides</td>
</tr>
<tr>
<td><strong>Stearns County, MN</strong> – Land Use and Zoning Ordinance requires solar farm ground cover to meet above state statute</td>
</tr>
</tbody>
</table>
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/

ESTIMATED SOLAR INSTALLATION POTENTIAL

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

<table>
<thead>
<tr>
<th>Roofs</th>
<th>Roofs</th>
</tr>
</thead>
<tbody>
<tr>
<td>63%</td>
<td>111K</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Roof space</th>
<th>Capacity</th>
<th>Electricity</th>
</tr>
</thead>
<tbody>
<tr>
<td>151M sq ft</td>
<td>2.1K MW DC</td>
<td>3M MWh AC per yr</td>
</tr>
</tbody>
</table>

State & Local Energy Data

Toolbox: Learn about community energy actions
Explore how communities have implemented energy policies. Find resources to take action today.

Small Building Rooftop PV Potential, Denver CO

- Suitable Small Buildings: 108,500 buildings
- Unsuitable Small Buildings: 64,000 buildings
- Suitable area: 6,000,000 m²
- Capacity potential: 700,000 kW
- Energy generation potential: 1,000,000 MWh
Technical Assistance through SolSmart

Designation

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

Technical Assistance

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

www.solsmart.org/
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

www.nrel.gov

NREL/PR-7A40-71690

This presentation was recorded as part of NREL’s City and County Solar Photovoltaics Training Program. To hear the recording, please visit: https://www.nrel.gov/technical-assistance/local-governments.html.