NREL Suite of Tools for PV and Storage Analysis

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Solar in Your Community Challenge Training Event
March 13, 2018, Washington D.C.
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1. Will PV Work for Your Site? Drivers of PV Projects
2. PV Modeling Tools That You Can Use
3. REopt Lite Live Demo
4. SAM Live Demo
Will PV Work for Your Site?

- Solar Resource
- PV Costs & Incentives
- Space Available
- Utility Cost & Consumption
- Financial Parameters
• Solar resource across the continental U.S. varies by a factor of 2

• Solar resource in:
  – Golden, CO is 5.53 kWh/m²/day
  – Phoenix, AZ is 6.57 kWh/m²/day
  – Buffalo, NY is 3.99 kWh/m²/day
PV Cost

- Consider total installed system cost (soft cost, BOS, inverter, module)
- Costs vary by size, location, and installer
- Costs have decreased across all segments over the past 8 years

BOS: balance of system
PII: personally identifiable information

PV cost trend by application
https://www.nrel.gov/docs/fy17osti/68580.pdf
Incentives can help lower the total cost of a PV system

Common incentives include:
- Capacity: Based on the total installed size of the system
- Production: Based on electricity production
- Net metering: Credit if generation exceeds load
Space Available for PV

- Where you install the PV system impacts:
  - Packing density
  - System cost
  - The tilt and orientation
  - The viewshed of your site

- Typical packing density:
  - Ground: 5 acres/MW
  - Roof/carport: 10 Wdc/ ft²
### Utility Cost and Structure

<table>
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<tr>
<th>Component</th>
<th>How It’s Billed</th>
<th>How PV Can Help</th>
</tr>
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<tr>
<td><strong>Energy Charges</strong></td>
<td>Amount of kWh consumed</td>
<td>Reduce the kWh purchased (can vary by time of day)</td>
</tr>
<tr>
<td><strong>Demand Charges</strong></td>
<td>Based on highest demand (kW) of the month</td>
<td>Reduce demand if PV production coincides with monthly peak</td>
</tr>
<tr>
<td><strong>Fixed Charges</strong></td>
<td>Fixed cost per month</td>
<td>PV cannot offset these</td>
</tr>
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Other types of charges include:
- Minimum charge
- Departing load charge
- Standby charge

Maximum demand charge rates by utility service territory
[https://www.nrel.gov/docs/fy17osti/68963.pdf](https://www.nrel.gov/docs/fy17osti/68963.pdf)
Utility Consumption and Load Profile

*Energy Savings from PV Generation*

Energy cost: Area under curve

\[ \int PV \text{ offsetting energy use} \]

Demand cost: Max height

\[ PV \text{ not offsetting max demand} \]
Utility Consumption and Load Profile

Demand Savings from Battery Storage

A battery, along with PV, can be used to lower demand costs.
## Financial Parameters

<table>
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<th>Parameter</th>
<th>Impacts</th>
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<tbody>
<tr>
<td>Inflation Rate</td>
<td>General expected inflation rate</td>
</tr>
<tr>
<td></td>
<td>Future O&amp;M costs</td>
</tr>
<tr>
<td>Utility Cost Escalation</td>
<td>How electricity costs are expected to change</td>
</tr>
<tr>
<td>Rate</td>
<td>Costs that PV is offsetting</td>
</tr>
<tr>
<td>Discount Rate</td>
<td>Cost of money</td>
</tr>
<tr>
<td></td>
<td>Financing costs</td>
</tr>
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EIA: Energy Information Administration  
O&M: operation and maintenance
Resources

• Where can I view my solar resource?
  – NSRDB Viewer: https://maps.nrel.gov/nsrdb-viewer/

• Where can I find information about installed PV costs?
  – Annual Technology Baseline: https://atb.nrel.gov/

• Where can I find information about PV incentives?
  – DSIRE: http://www.dsireusa.org/

• Where can I find information about how much PV I can install?
  – Google Project Sunroof: https://www.google.com/get/sunroof#p=0

• Where can I find information about my utility rate?
  – Utility Rate Database: https://openei.org/wiki/Utility_Rate_Database

• Where can I find information about my financial parameters?
  – EIA: https://www.eia.gov/outlooks/aeo/
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**Tools That You Can Use**

- PV modeling tools take into account the factors that impact project potential
- Publicly available tools can be used to gauge initial potential, optimize system sizing, and refine project economics

<table>
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<tr>
<th>Expertise and Effort Needed</th>
<th>Required Inputs</th>
<th>Key Outputs</th>
</tr>
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</table>
| **FEMP Distributed Generation (DG) Screening Tool** | Low | • Location | • Map interface with geospatial layers  
 | | | | • High-level economics |
| **PVWatts Calculator** | Low | • Location  
 | | | • System configuration | • PV energy generation (no economics) |
| **REopt Lite Web Tool** | Medium | • Location  
 | | | • Energy Consumption  
 | | | • Rate tariff | • Optimized system size and dispatch  
 | | | | • High-level economics |
| **System Advisor Model (SAM)** | High | • Energy Consumption  
 | | | • Rate tariff  
 | | | • Detailed system configuration  
 | | | • Financing inputs | • Detailed technology performance  
 | | | | • Detailed economic modeling |
FEMP DG Screening Tool

- Leverages interactive resource maps and data layers for a simple user experience
- Allows user to click anywhere on the map for high-level metrics including:
  - Savings to investment ratio (SIR)
  - Payback period
  - Electricity rate required for SIR of 1
- Generates summary report

https://maps.nrel.gov/femp/
PVWatts

- PVWatts uses solar resource data and energy production models to estimate energy production from PV systems in a given location.
- Users enter their location and PV system size in a simple interface.
- Estimates annual and hourly energy production.

http://pvwatts.nrel.gov/
REopt Lite Web Tool

- REopt Lite offers a no-cost subset of NREL's more comprehensive REopt model
- Evaluates the economics of PV and battery storage at a site
- Optimizes PV and battery system sizes and battery dispatch strategy to minimize life cycle cost of energy
- Sizes PV+storage systems to sustain critical load during grid outages

https://reopt.nrel.gov/tool
System Advisor Model (SAM)

- Platform combines detailed performance and financial models to estimate cost of energy
- Energy performance:
  - Photovoltaics, detailed and PVWatts
  - Battery storage
  - Wind
  - Geothermal
  - Biomass
  - Solar water heating
- Financials:
  - Behind-the-meter (residential and commercial)
  - Power purchase agreements (single owner and equity flips)
  - Simple LCOE calculator

http://sam.nrel.gov/download
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