# Agenda

**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**

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# Will PV Work for Your Site?
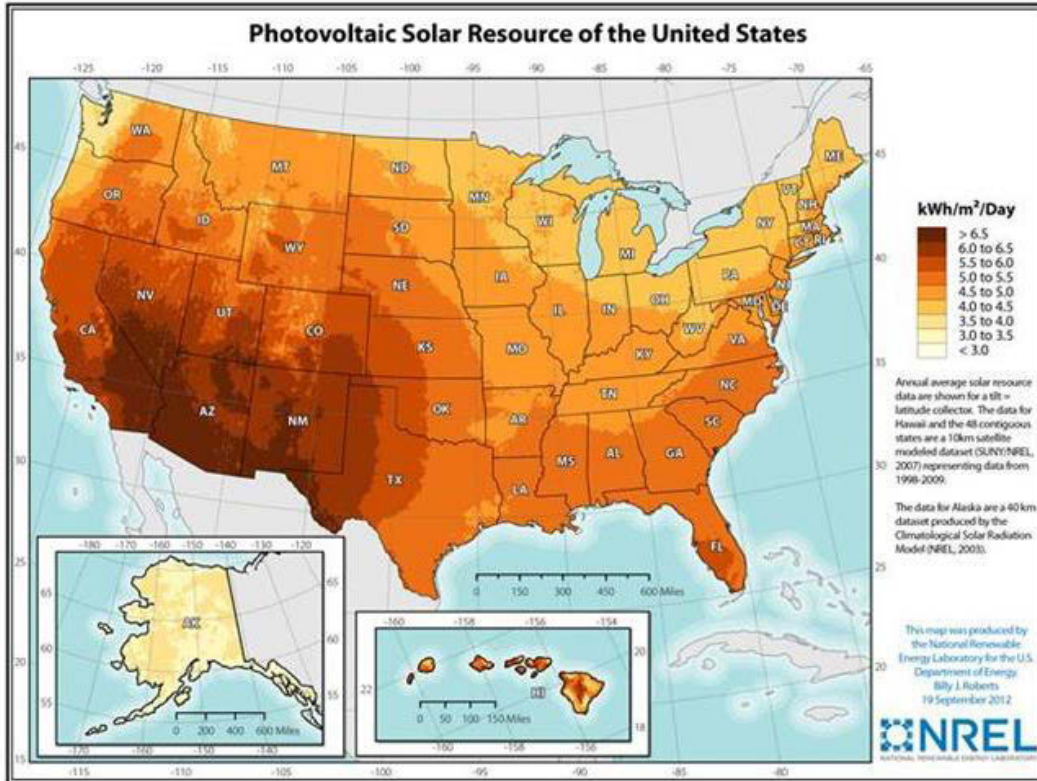
**Solar Resource**

**PV Costs & Incentives**

**Space Available**
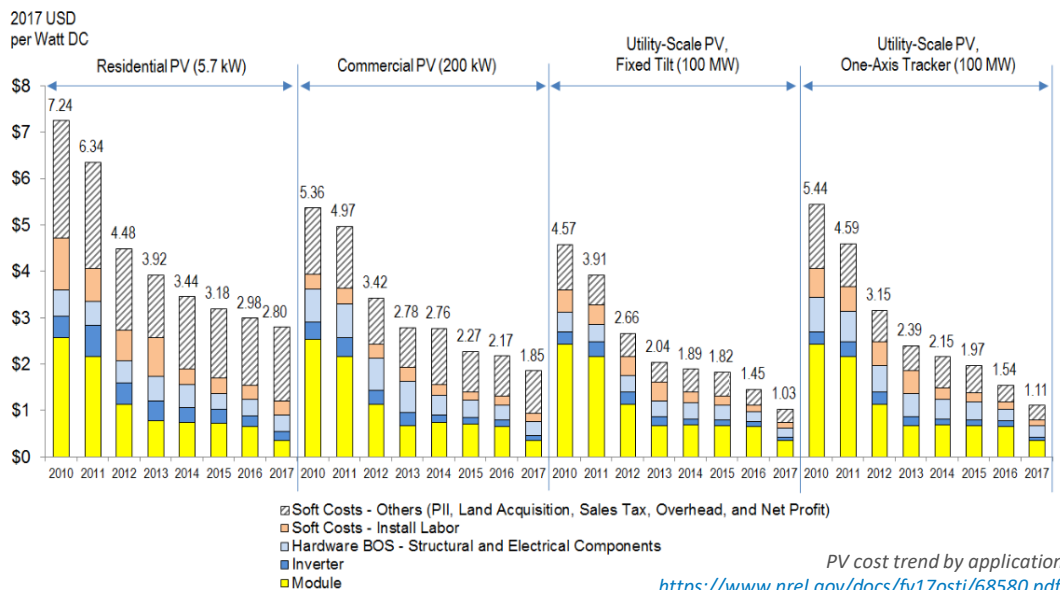
**Utility Cost & Consumption**

**Financial Parameters**

# Solar Resource across the U.S.



**Photovoltaic Solar Resource of the United States**

- Solar resource across the continental U.S. varies by a factor of 2

- Solar resource in:
  - Golden, CO is 5.53 kWh/m$^2$/day
  - Phoenix, AZ is 6.57 kWh/m$^2$/day
  - Buffalo, NY is 3.99 kWh/m$^2$/day

# PV Cost



2017 USD per Watt DC

PV cost trend by application
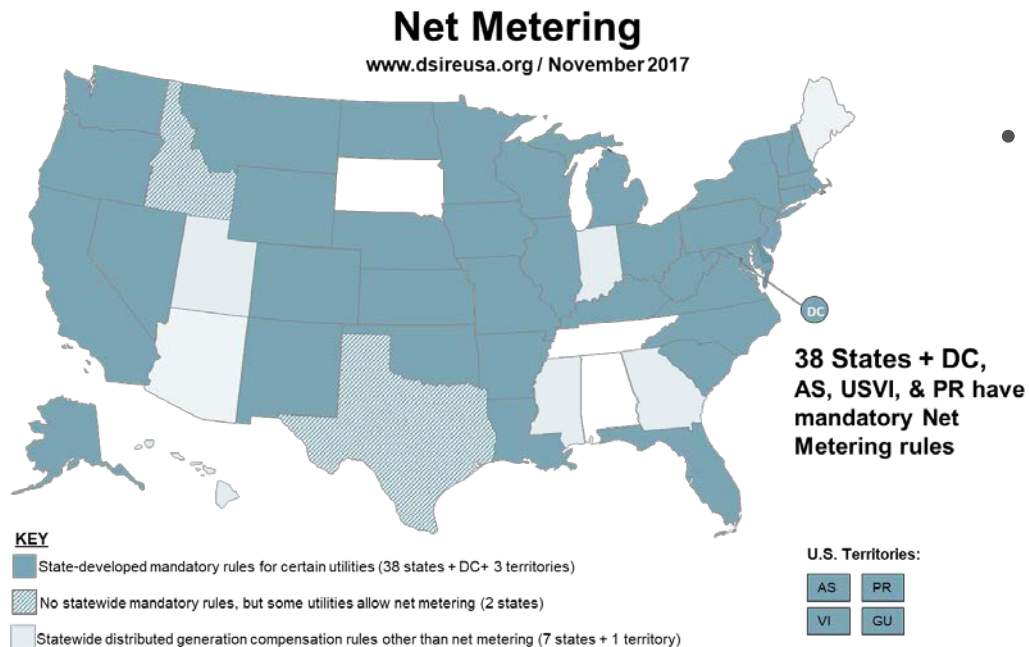https://www.nrel.gov/docs/fy17osti/68580.pdf

- 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

# Incentives



**Net Metering**
www.dsireusa.org / November 2017

38 States + DC, AS, USVI, & PR have mandatory Net Metering rules

KEY
- State-developed mandatory rules for certain utilities (38 states + DC+ 3 territories)
- No statewide mandatory rules, but some utilities allow net metering (2 states)
- Statewide distributed generation compensation rules other than net metering (7 states + 1 territory)

U.S. Territories:
AS  PR
VI  GU

- 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



**Potential Carport PV Area**

**Potential Roof PV Area**

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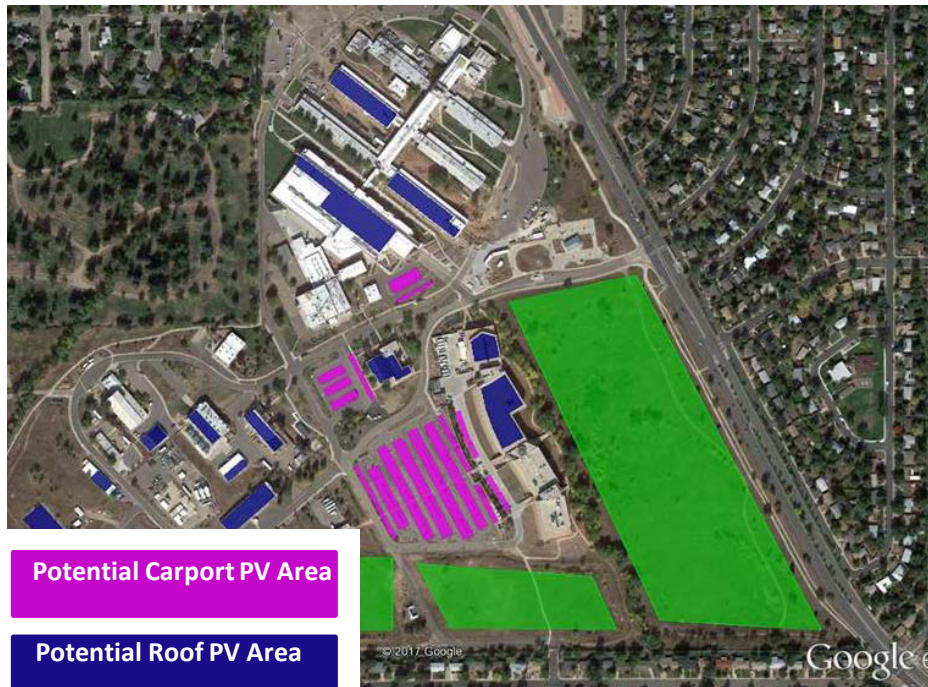
- Where you install the PV system impacts:
  - Packing density
  - System cost
  - The tilt and orientation
  - The viewshed of your site

- Typical packing density:
  - Ground: 5 acres/MW
  - Roof/carport: 10 Wdc/ ft$^2$

# Utility Cost and Structure

| Component | How It's Billed | How PV Can Help |
|---|---|---|
| **Energy Charges** | Amount of kWh consumed | Reduce the kWh purchased (can vary by time of day) |
| **Demand Charges** | Based on highest demand (kW) of the month | Reduce demand if PV production coincides with monthly peak |
| **Fixed Charges** | Fixed cost per month | PV cannot offset these |

Other types of charges include:
- Minimum charge
- Departing load charge
- Standby charge



Maximum Demand Charge ($)
- > 30
- 20 – 30
- 10 – 20
- 1 – 10
- 0
- No Data
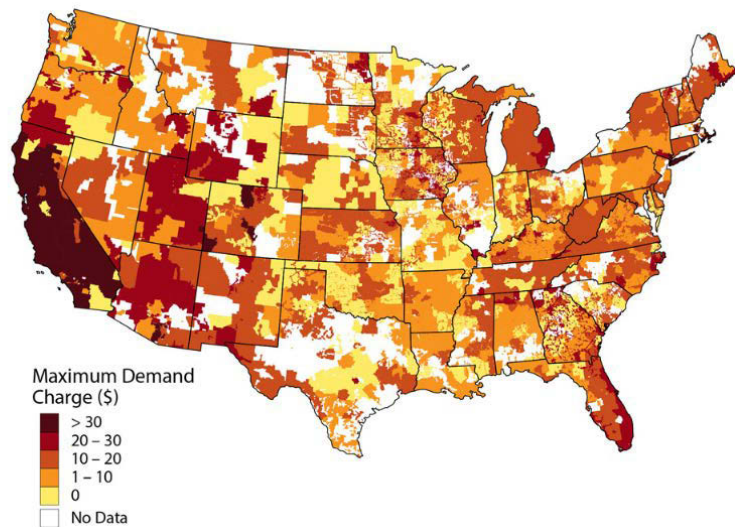
*Maximum demand charge rates by utility service territory*
*https://www.nrel.gov/docs/fy17osti/68963.pdf*

# Utility Consumption and Load Profile
## *Energy Savings from PV Generation*
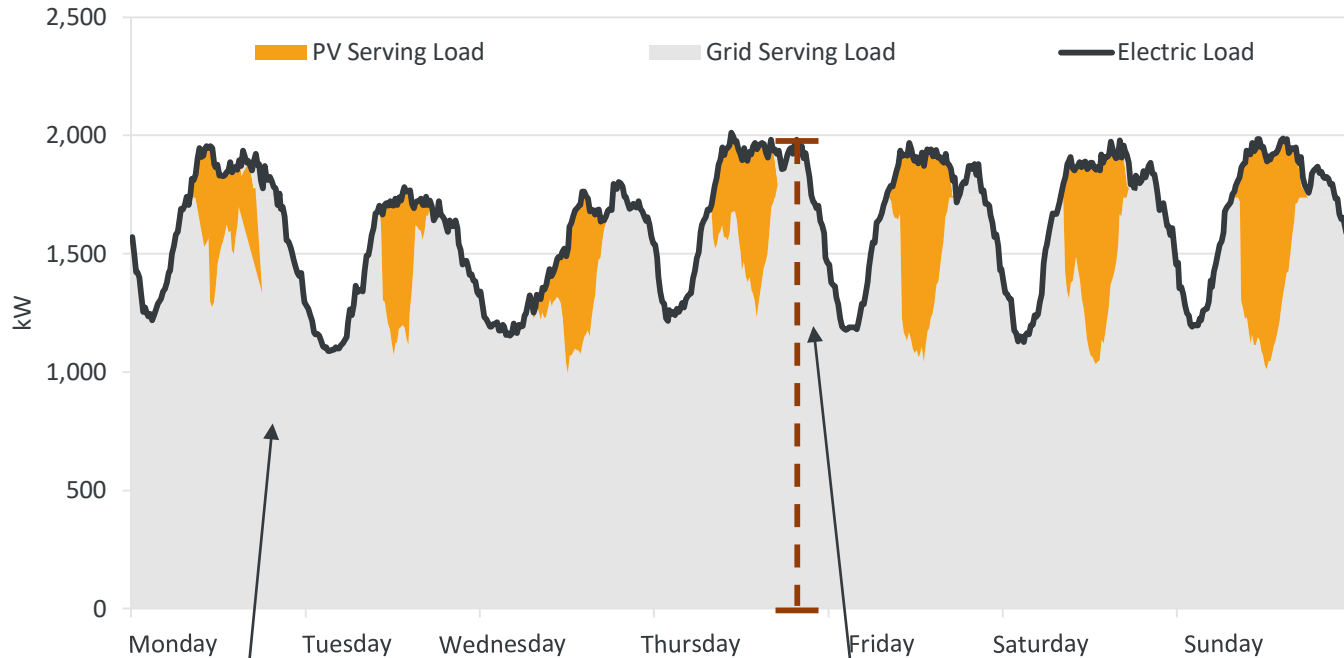
# Utility Consumption and Load Profile
## *Demand Savings from Battery Storage*
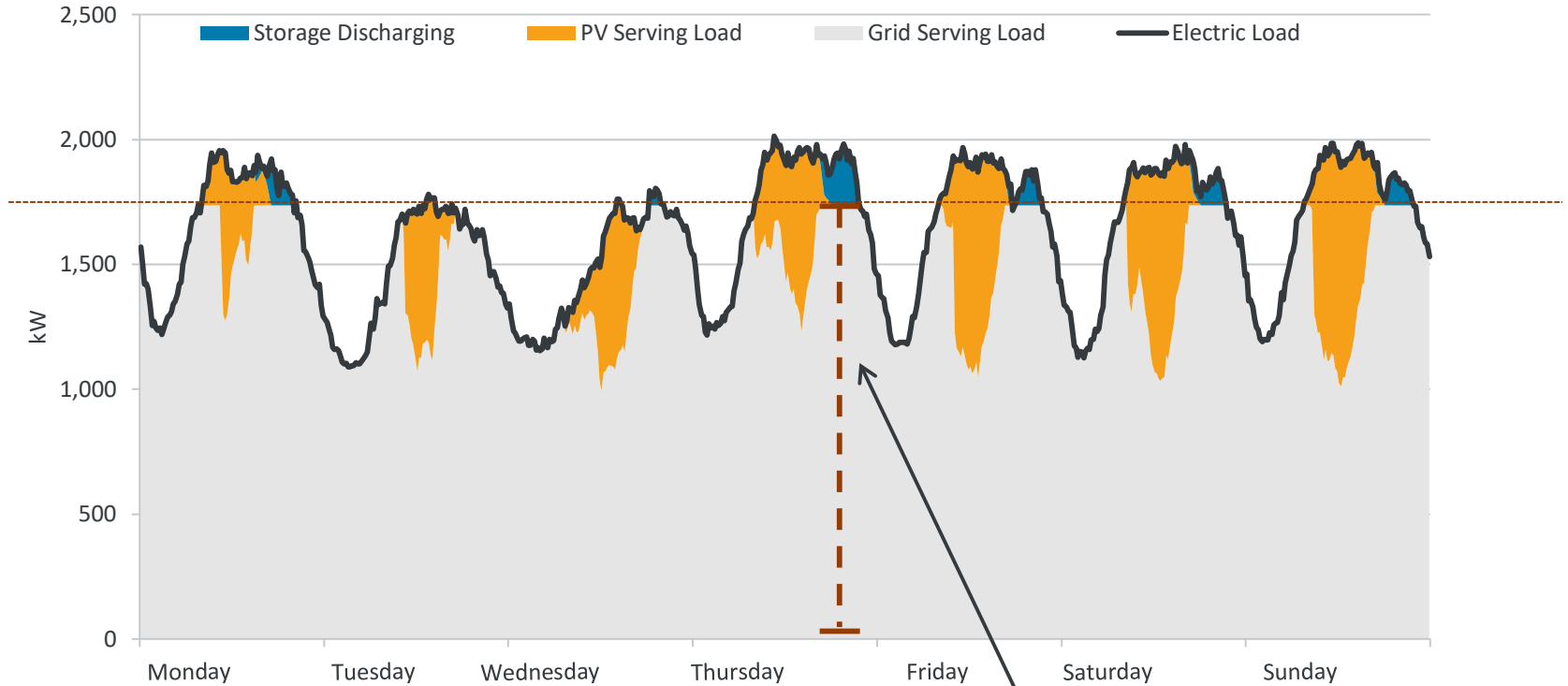


A battery, along with PV, can be used to lower demand costs

# Financial Parameters

| | Parameter | Impacts |
|---|---|---|
| **Inflation Rate** | General expected inflation rate | Future O&M costs |
| **Utility Cost Escalation Rate** | How electricity costs are expected to change | Costs that PV is offsetting |
| **Discount Rate** | Cost of money | Financing costs |

EIA: Energy Information Administration
O&M: operation and maintenance

### Energy Cost Escalation Rate Impact on Future Electricity Costs



$0.093/kWh–$0.152/kWh

Blended Rate ($/kWh)

EIA High

EIA Reference

EIA Low
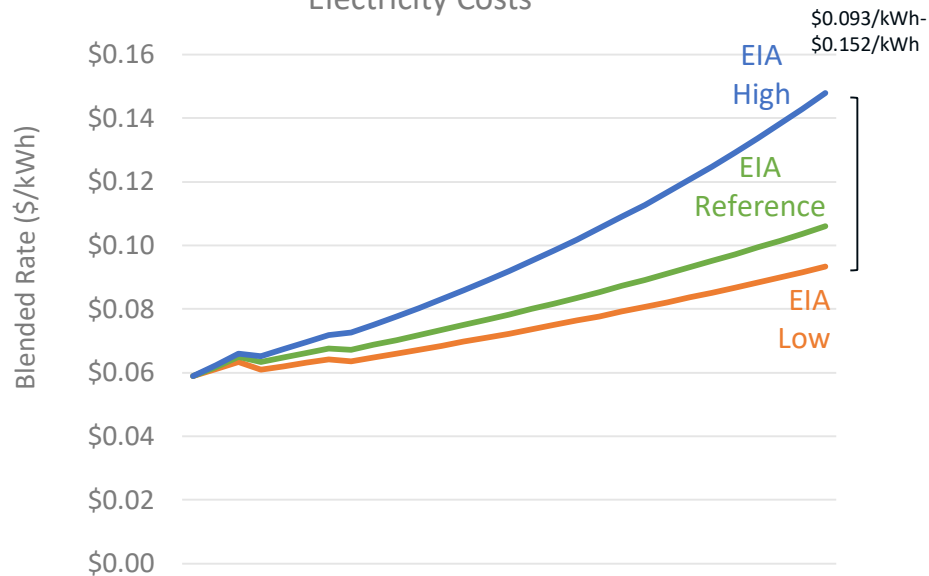
# Resources

- 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

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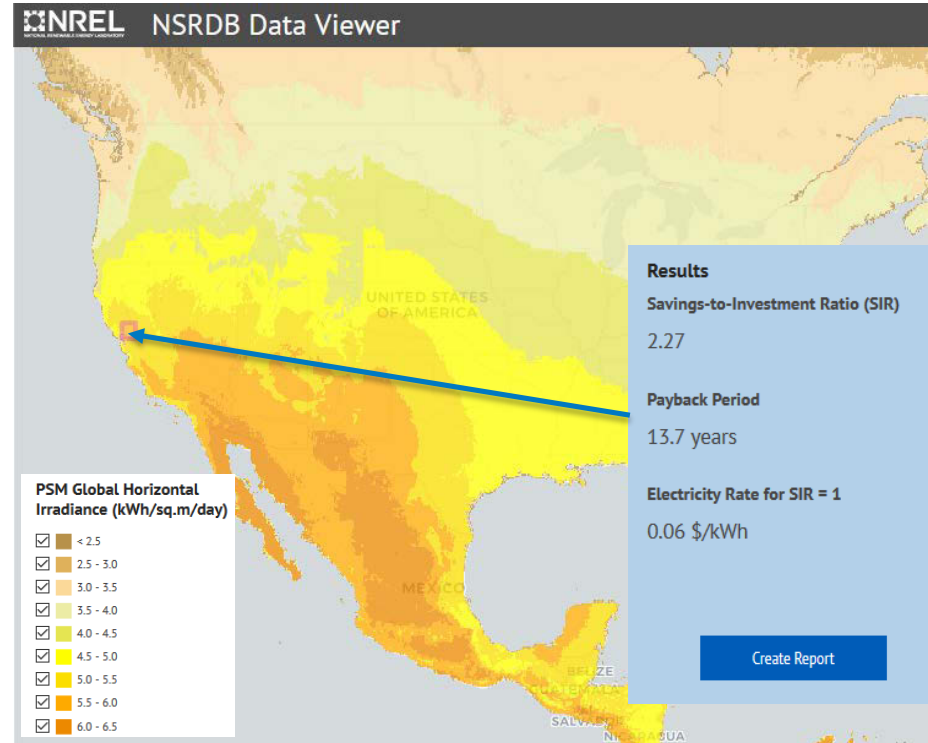
# PVWatts

- 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/**



**Get Started:** Enter a Home or Business Address   **GO »**    HELP   FEEDBACK

### NREL's PVWatts® Calculator

Estimates the energy production and cost of energy of grid-connected photovoltaic (PV) energy systems throughout the world. It allows homeowners, small building owners, installers and manufacturers to easily develop estimates of the performance of potential PV installations.

**RESULTS**
Print Results

## 76,392 kWh per Year *

System output may range from 70,961 to 78,646kWh per year near this location
Click HERE for more information

| Month | Solar Radiation ( kWh / m² / day ) | AC Energy ( kWh ) | Energy Value ( $ ) |
|---|---|---|---|
| January | 3.57 | 4,666 | 516 |
| February | 4.21 | 4,881 | 539 |
| March | 5.61 | 7,108 | 785 |
| April | 6.15 | 7,342 | 811 |
| May | 6.46 | 7,791 | 861 |
| June | 6.74 | 7,671 | 848 |
| July | 6.60 | 7,578 | 837 |
| August | 6.44 | 7,397 | 817 |
| September | 5.99 | 6,791 | 750 |
| October | 4.99 | 6,044 | 668 |
| November | 3.80 | 4,892 | 518 |
| December | 3.38 | 4,431 | 490 |
| Annual | 5.33 | 76,392 | $ 8,440 |

# 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**

## REopt Lite

### Step 1: Select Your Technology
Do you want to evaluate PV, battery, or both?

[⊞ PV] [🔋 Battery] [⭘ Both]

### Step 2: Enter Your Data
Enter information about your site and adjust the default values as needed to see your results.

**📍 Site and Utility** (required)

* Required field

| | |
|---|---|
| * Site location ❓ | Homer, AK, United States |
| * Load profile ❓ | ◉ Simulated |
| | ◯ Custom Load Profile |
| * Type of building ❓ | Retail Store |
| * Annual energy consumption (kWh) ❓ | 116800 |
| * Electricity rate ❓ | Homer Electric Assn Inc: Industrial |

URDB Rate Details

➕ Show more inputs          ♻ Reset to default values

**$ Financial** ➕

**⊞ PV** ➕

**🔋 Battery** ➕

**🛡 Resilience** ➕

[Get Results ❯]

# 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
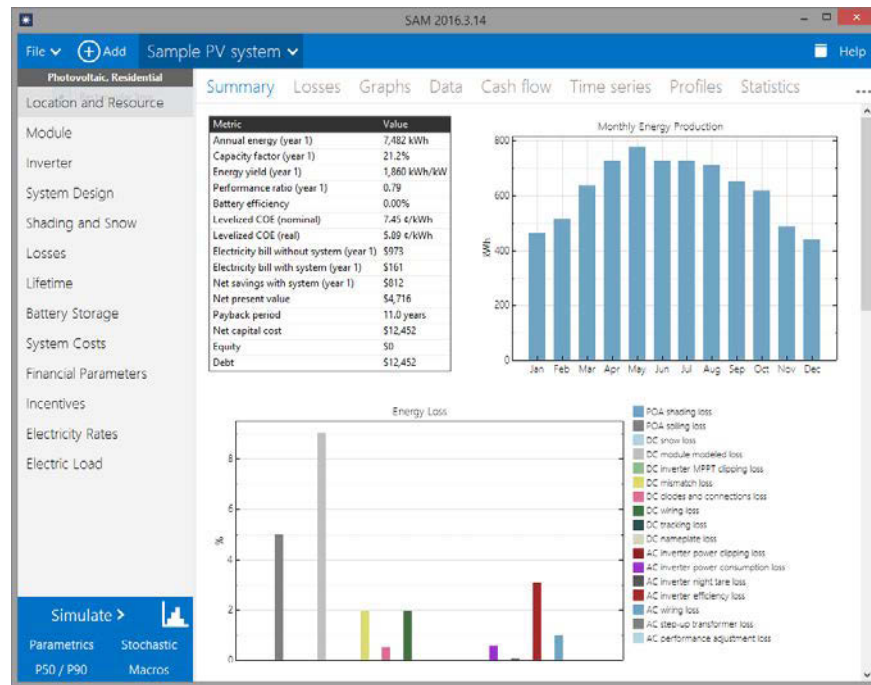
  **http://sam.nrel.gov/download**

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