Achieving Scale: Community Solar Technical Potential and Meaningful Benefits in the United States

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NREL Webinar
February 28, 2024

Agenda

- Welcome
- National Community Solar Partnership Overview
- Study Background
- Community Solar Technical Potential
- Meaningful Benefits of Community Solar
- Q/A
- Closing Remarks

Housekeeping

- This webinar is being recorded.
- Slides and a link to the recording will be shared with participants following the webinar.
  - The report is available online.
- Post questions for presenters using the Q&A function at any time.
  - Upvote questions in Q/A you'd like answered.

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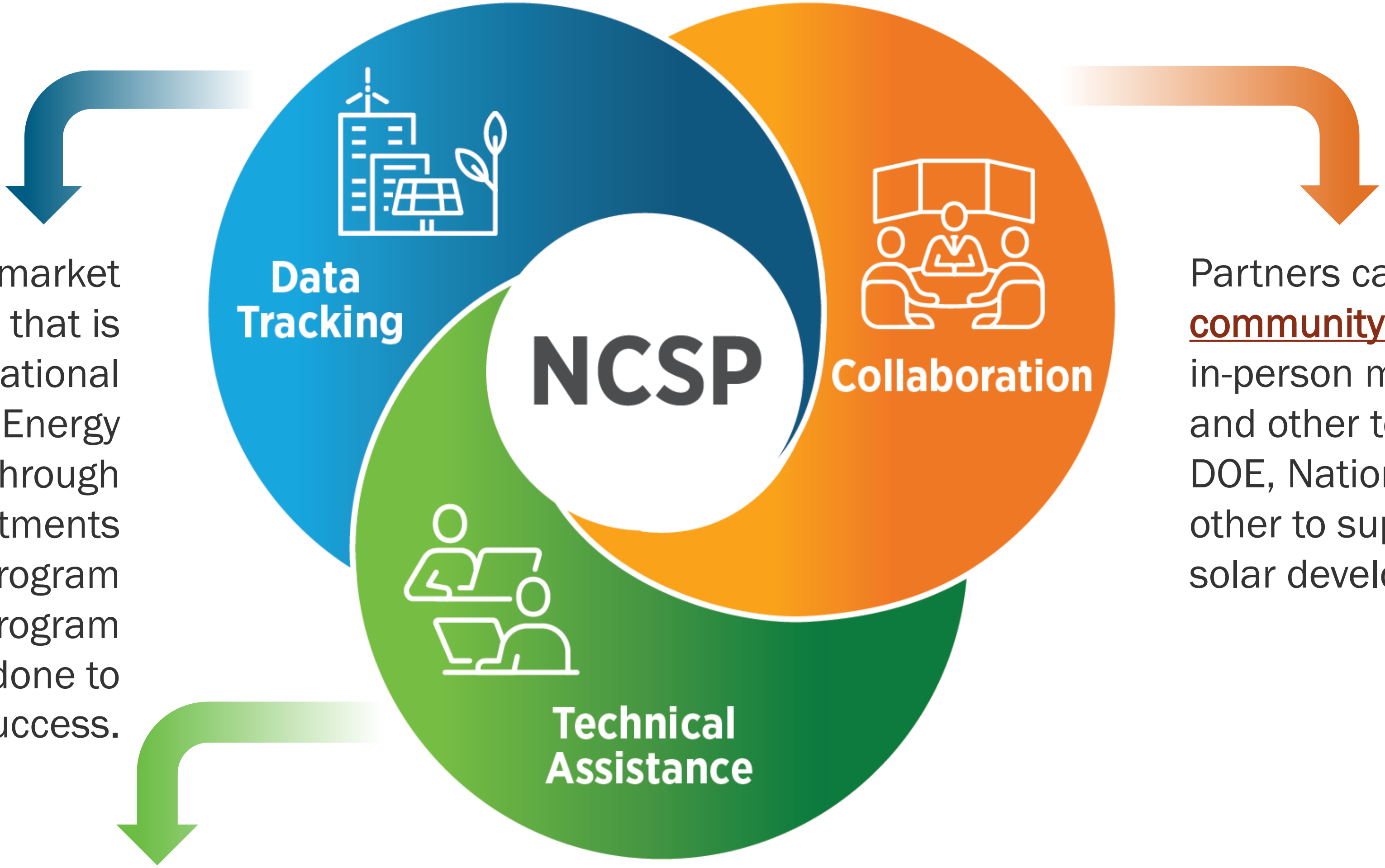
Solar Energy Technologies Office

The National Community Solar Partnership



Sharing the Sun is a market trends annual report that is managed by the National Renewable Energy Laboratory (NREL) through NCSP; partner commitments are tracked to the program and its goal, and program evaluation is done to determine success.

Partners can access an online community platform, virtual/in-person meetings, webinars and other tools to engage with DOE, National Labs, and each other to support community solar development.

Our technical assistance program, led by the Lawrence Berkeley National Laboratory, ensures that our partners have access to resources and direct technical assistance from DOE, National Labs, and third-party subject-matter experts to support local challenges.

The National Community Solar Partnership

>1500 PARTNERS

>1000 ORGANIZATIONS

50 STATES

LOCAL GOVERNMENTS	STATE GOVERNMENTS	UTILITIES	NON-PROFITS	FOR-PROFITS
Cities	Regulators	Investor Owned	National Scale	Developers
Counties	Agencies	Cooperatives	Community Groups	Financiers
Regional Planning	Legislatures	Public Power	Academia	Consultants

National Community Solar Partnership Target

5 million
HOUSEHOLDS*
*EQUIVALENT

$1 billion
IN ENERGY BILL SAVINGS

BY **2025**

Represents an increase from **3 GW to 20 GW** of community solar capacity

$1 billion in savings reflects an average **bill reduction of 20%**

Meaningful Benefits of Community Solar

EQUITABLE ACCESS & CONSUMER PROTECTIONS

- Contract terms that support strong consumer protections
- Inclusive outreach and engagement
- Financial products that are accessible to all households

Justice40 Priority 3: Increase Clean Energy Parity

MEANINGFUL HOUSEHOLD SAVINGS

- Guaranteed bill and/or household savings
- Wealth building opportunities
- Indirect multifamily affordable housing tenant benefits

Justice40 Priority 1: Reduce Energy Burden

RESILIENCE, STORAGE, AND GRID BENEFITS

- Household and community level resilience strategies
- Grid strengthening strategies
- Improved health outcomes through reduced or shortened power outages

Justice40 Priority 7: Increase Energy Resiliency

COMMUNITY-LED ECONOMIC DEVELOPMENT

- Opportunities for community ownership
- Community benefits agreements
- Support for entrepreneurship and local and minority and women-owned businesses

Justice40 Priority 8: Increase Energy Democracy

SOLAR WORKFORCE DEVELOPMENT

- Strategies that ensure jobs are accessible to workers of all backgrounds, offer competitive wages and union membership
- Training and apprenticeship programs

Justice40 Priority 6: Increase Clean Energy Jobs

National Community Solar Partnership (NCSP)

Pathway to Success Initiatives

Recognition, Resources, & Peer Networking

- Sunny Awards for Equitable Community Solar
- Sharing the Sun Database and Analysis Products
- NCSP Online Community
- Events

Low-Income Clean Energy Connector

- Stakeholder engagement & tool development
- Pilot with District of Columbia, Illinois, and New Mexico launching March 2024

Community Power Accelerator

- Community Power Accelerator Platform
- Credit Ready Checklist & Technical Assistance
- Learning Lab & Low-Income Community Solar Developer Workbook
- Community Power Accelerator Prize

States Collaborative

- Monthly peer-networking
- Low-income and Inflation Reduction Act working groups
- State policy tracker & policy analysis reports

Direct Technical Assistance Program

- Rolling technical assistance
- Technical assistance engagement summaries
- Municipal Utility & Multifamily Affordable Housing Collaborative resources

LODGE Model

Optimal grid expansion with Distributed Energy Resources (DERs)

- The Least-cost Optimal Distribution Grid Expansion (LODGE) model **provides the optimal portfolio of distribution system upgrades** to interconnect DERs and enable electrification.
- Available investments include voltage regulators, feeder reconductoring, transformers upgrades and non-wire alternatives, such as strategic siting of storage and distributed generation.
- LODGE can be used to **assess grid infrastructure costs and explore policy and regulatory solutions for distribution system planning** and DERs.

Webinar:

Register for a webinar on March 7th, 11am EST to learn more about the LODGE model pilot and other DOE Interconnection Resources.

Register here: https://bit.ly/LODGEModel

Are you a PUC, PRC, or utility interested in participating in the LODGE pilot? If so, please follow this QR Code:

bitly

Equitable Solar Communities of Practice

- **Stakeholder-led process** to analyze and identify gaps in existing resources, identify and highlight best practices, and propose pathways to scale meaningful benefits
- Project scope includes **community solar, low-income residential solar, and other types of distributed solar and storage located in or serving low-income and disadvantaged communities**
- **6-month project through fall 2024**
- **Community-wide public convening** for each meaningful benefit to be held this spring

5 Communities of Practice:

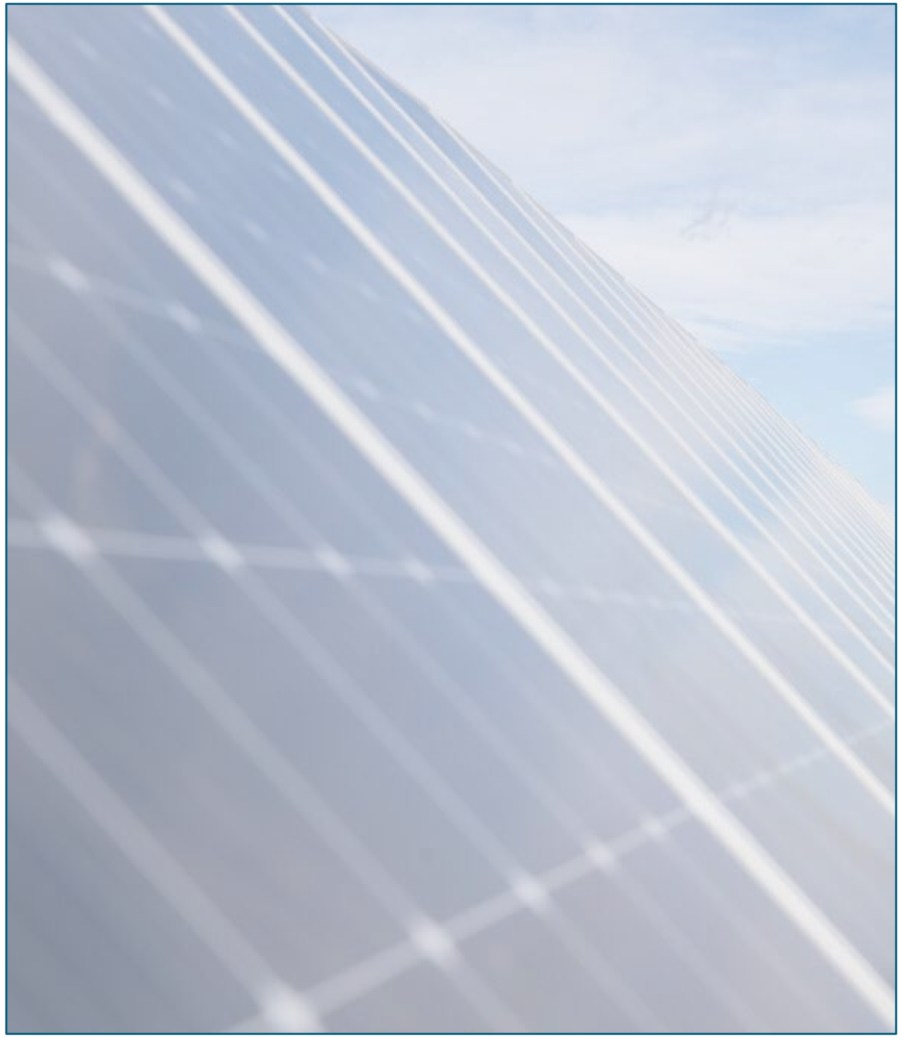
1. Access and Consumer Protections
2. Meaningful Household Savings
3. Resilience and Grid Benefits
4. Community-led Economic Development
5. Equitable Workforce Development

INTEREST FORM: bit.ly/EquitableSolarCOP

Join the National Community Solar Partnership!

Study Background

- Previous NREL research[1] suggests that roughly half of U.S. households and businesses face significant barriers to behind-the-meter (BTM) solar adoption (e.g., rooftop solar).
- Using updated methods, we calculate that about 42% of households (55.2 million) and 44% of businesses (14.6 million) face significant barriers to BTM solar adoption, representing roughly 31% (809 TWh) of all residential and commercial electricity demand.



Electricity Consumption Unmet by BTM PV

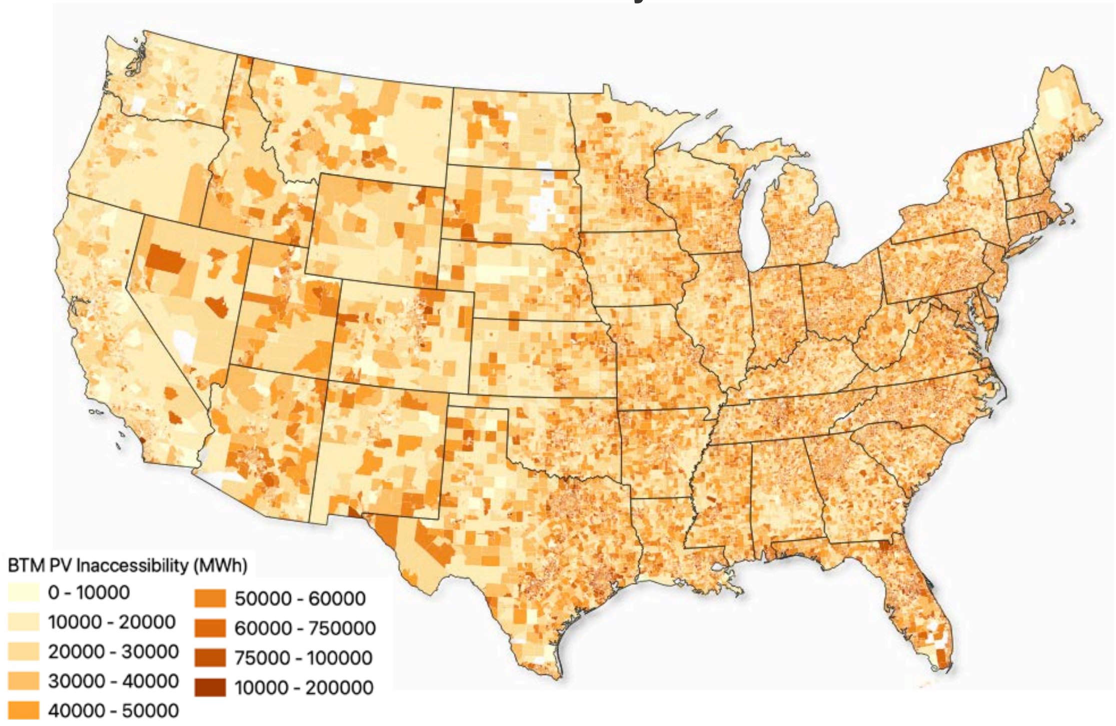
Residential

- BTM PV is considered inaccessible for 42% of households, including those that:
  - Rent
  - Are located in buildings with >3 stories
  - Are located in buildings with roofs unsuitable for PV.

Commercial

- BTM PV is considered inaccessible for 44% of businesses, including those that are located in:
  - Buildings with >5 establishments
  - Buildings with <10,000 square feet with 2–5 establishments
  - Buildings with <10,000 square feet with one establishment and developable areas that cannot support 20+% of building electricity demand.

Electricity Consumption for Businesses and Households Unable To Access BTM PV by Tract

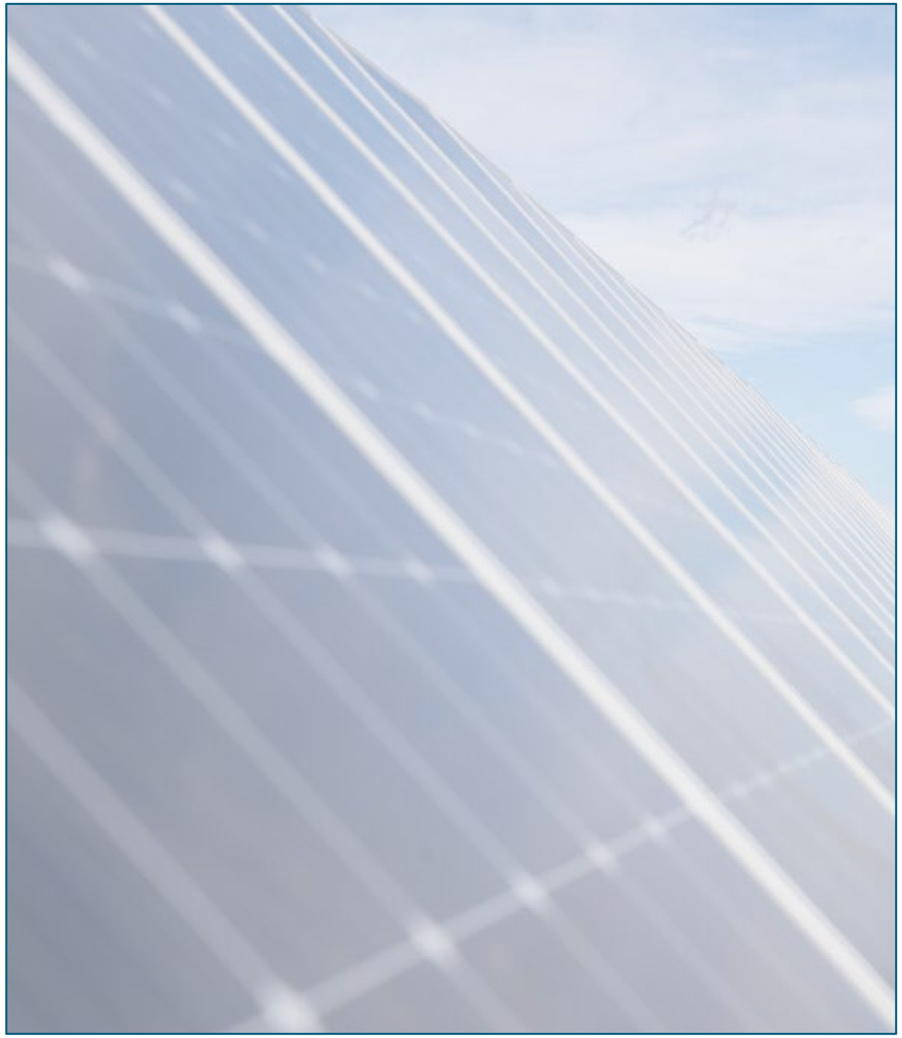


These criteria are not an exhaustive representation of potential community solar subscribers. These are based on previous NREL work[1] that quantified which electricity customers had physical, structural, or legal barriers in accessing BTM PV.

[1] Feldman, David, Anna M. Brockway, Elaine Ulrich, and Robert Margolis. 2015. *Shared Solar: Current Landscape, Market Potential, and the Impact of Federal Securities Regulation*. Golden, CO: National Renewable Energy Laboratory. NREL/TP 6A20-63892. https://www.nrel.gov/docs/fy15osti/63892.pdf.

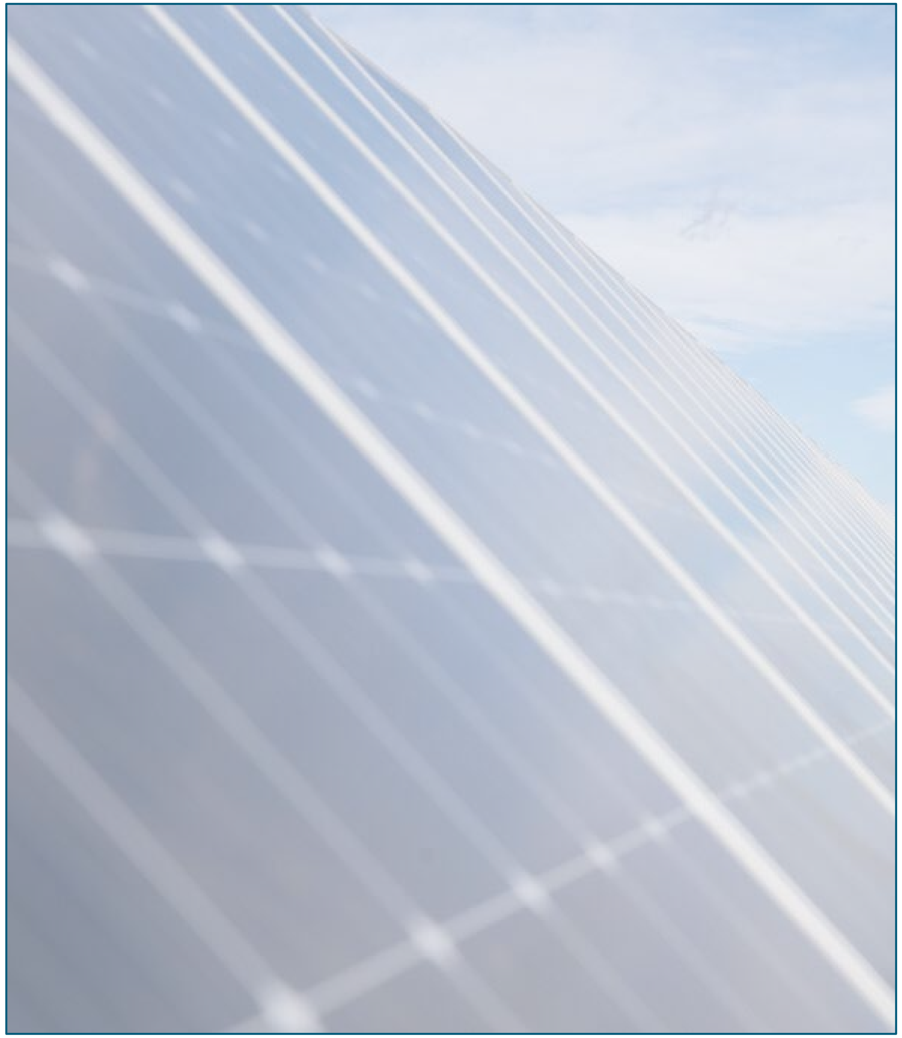
Study Background

- Community solar provides one potential pathway to expand solar access to the millions of households and businesses that cannot easily adopt BTM solar.
- In this study, we quantify the technical potential of community solar and evaluate it against current electricity consumption levels.
- We explore community solar technical potential in terms of customer type, housing, and income levels.
- We also explore the potential benefits of scaling community solar in line with its technical potential.



Key Results

- **967 GW:** Estimated community solar technical potential capacity in the United States
- **1,710 TWh:** Estimated annual electricity production
- **The opportunity space for community solar to meet unmet demand for solar energy is not primarily constrained by technical potential**, but by technological, market, and policy factors.
- Maximizing the ability of community solar to serve households and businesses that cannot access behind-the-meter solar could require prioritization of key customer bases, such as low-income households and disadvantaged communities.

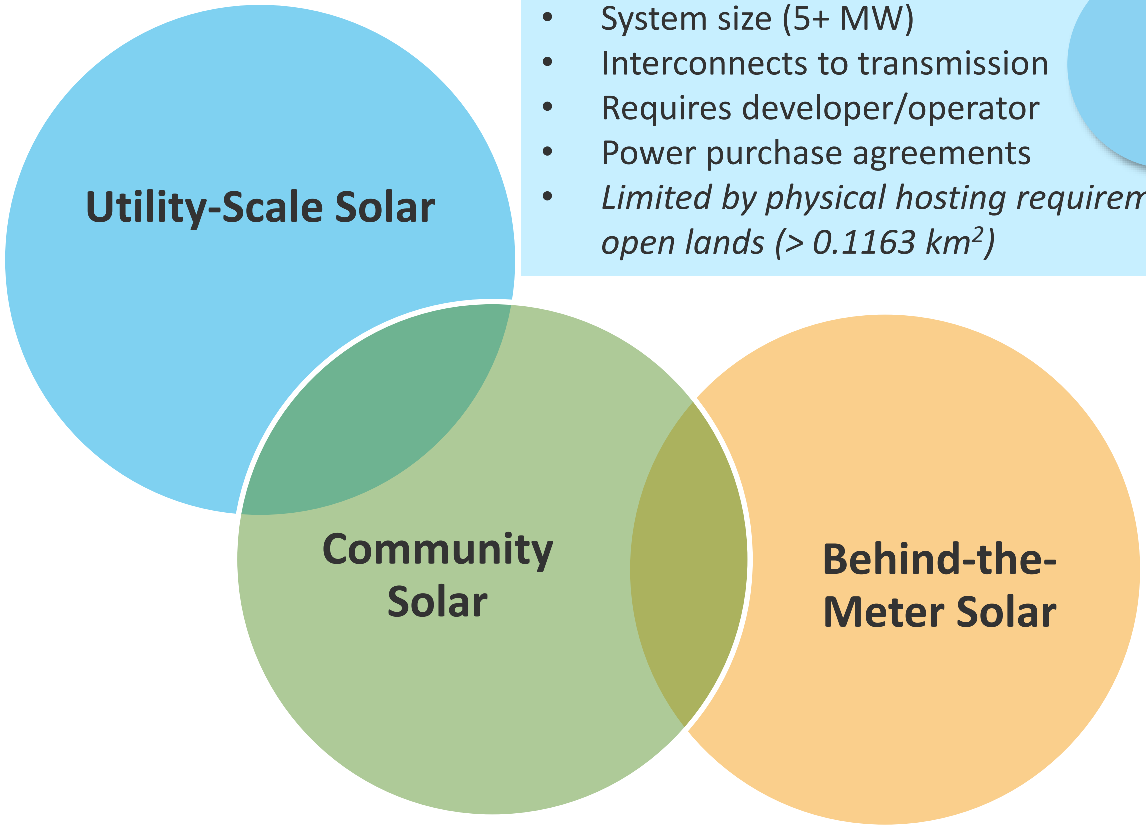


Approach to Community Solar Technical Potential

Estimating Technically Potential Supply

- Community solar technical potential considers both ground-mount and rooftop solar systems with siting constraints specific to community solar.
- Community solar is defined by how it's used and not by system size. These assumptions reflect market trends at time of the study.

STUDY ASSUMPTIONS



- System size (5+ MW)
- Interconnects to transmission
- Requires developer/operator
- Power purchase agreements
- *Limited by physical hosting requirements: open lands (> 0.1163 km^2)*

- System size (38+ kW)
- Interconnects to substation or distribution
- Requires developer/operator
- Customer subscriptions
- Limited distance from production to consumer
- *Limited by virtual hosting requirements*

- System size (< 500 kW)
- Interconnects to distribution
- No developer/operator
- Direct production to consumer
- *Limited by physical hosting requirements: onsite use*

Estimating Technically Potential Supply

Utility-Scale Solar

- System size (5+ MW)
- Interconnects to transmission
- Requires developer/operator
- PPA and retail sales
- *Limited by physical hosting requirements: open lands (> 0.1163 km²)*

DeSoto Next Generation Solar Energy Center (25 MW)
Desoto County, Florida

AES Lawai Solar Project – Kauai (28.2 MW)
Kauai County, Hawaii

Estimating Technically Potential Supply

Community Solar

- System size (38+ kW)
- Interconnects to substation or distribution
- Requires developer/operator
- Customer subscriptions
- Limited distance from production to consumer
- *Limited by virtual hosting requirements*

Community solar supply must be co-located in same electricity utility service territory as potential subscribers and community solar electricity generation cannot exceed maximum potential market share of gross electricity sales.

(Above) 600 kW PV arrays at the Minneapolis Convention Center
Hennepin County, Minnesota

(Right) 2 MW PV arrays U.S. Army Fort Carson base
El Paso County, Colorado

Estimating Technically Potential Supply

(Above) Residential rooftop solar array
Santa Clara County, California

(Right) Commercial rooftop solar array
Waldo County, Maine

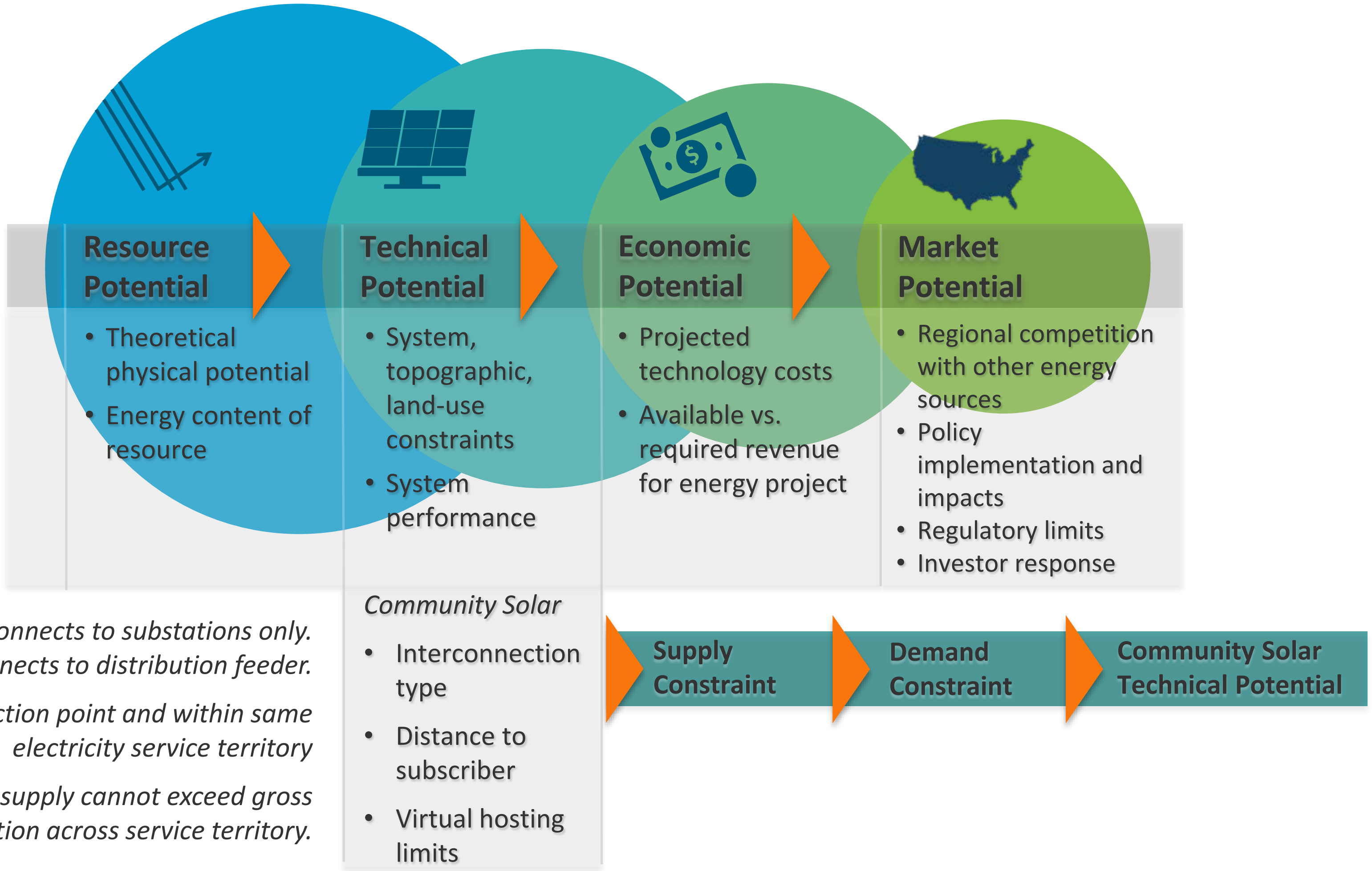
Behind-the-Meter Solar

- System size (< 500 kW)
- Interconnects to distribution
- No developer/operator
- Direct purchase by customer
- Direct production to consumer
- *Limited by physical hosting requirements -- buildings*

Estimating Community Solar Technical Potential

- In contrast to other forms of solar, community solar is defined by how it is used rather than how it is generated.
- As a result, unlike other technical potential estimates that disregard end use, our method for estimating community solar technical potential accounts for both technically-potential supply *and* demand.
- Our technical potential estimation therefore proceeds in three steps:
  1. Estimate technically-potential supply (similar to previous studies on technical potential)
  2. Estimate technically-potential demand, e.g., the serviceable market
  3. Estimate community solar technical potential based on both supply and demand constraints.

Community Solar Technical Potential



Ground-mount PV interconnects to substations only. Rooftop PV interconnects to distribution feeder.

1–2 miles from interconnection point and within same electricity service territory

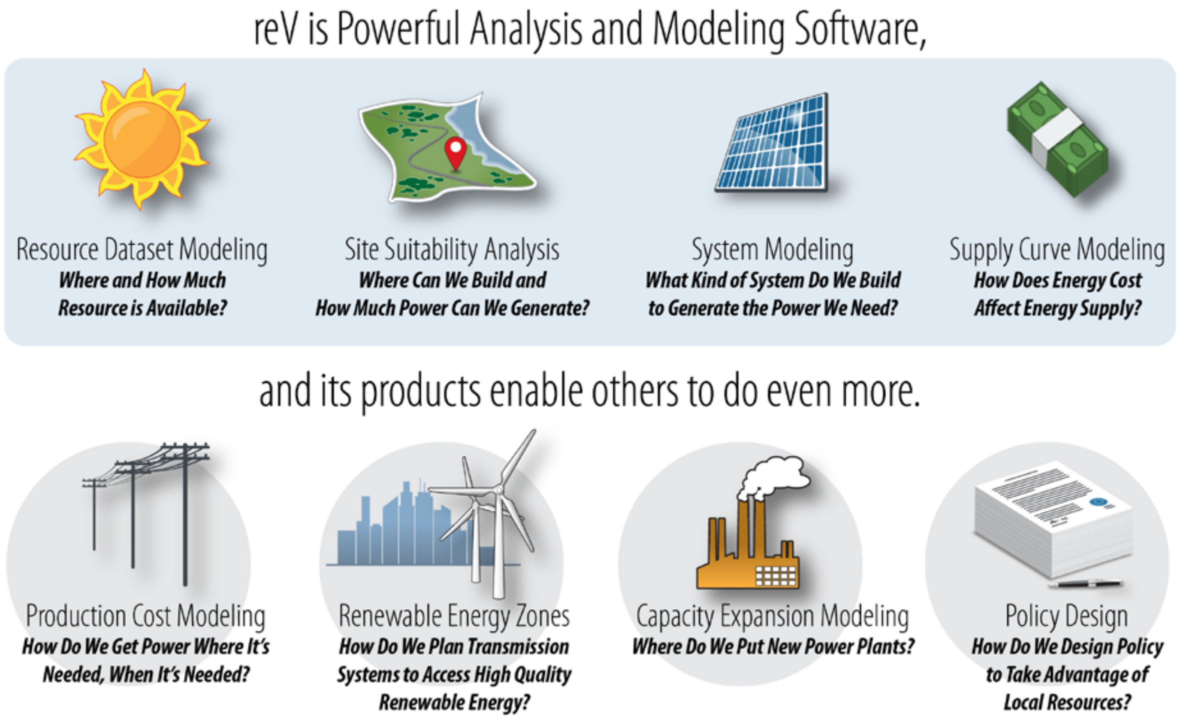
Community solar supply cannot exceed gross electricity consumption across service territory.

Modified for community solar: Brown, Austin, Philipp Beiter, Donna Heimiller, Carolyn Davidson, Paul Denholm, Jennifer Melius, Anthony Lopez, Dylan Hettinger, David Mulcahy, and Gian Porro. 2016. *Estimating Renewable Energy Economic Potential in the United States: Methodology and Initial Results*. Golden, CO: National Renewable Energy Laboratory. NREL/TP 6A20-64503. https://www.nrel.gov/docs/fy15osti/64503.pdf

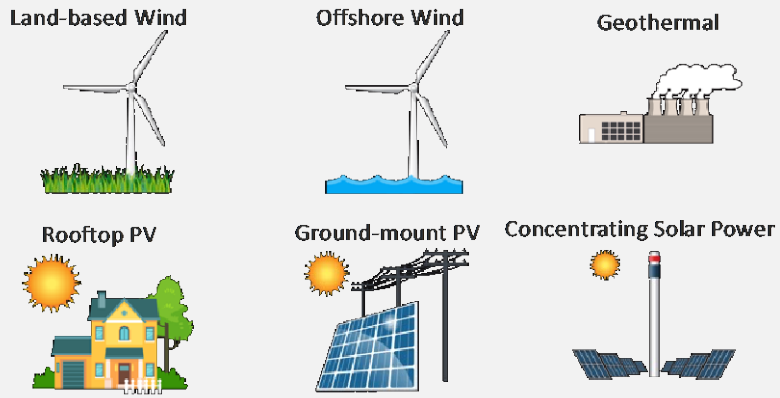
Renewable Energy Potential (V) Model

2023 R&D 100 WINNER

A Best-In-Class Model for Estimating Renewable Energy Supply



Modeled renewable energy technologies:



https://github.com/NREL/reV

reV

A Best-In-Class Model for Estimating Renewable Energy Supply

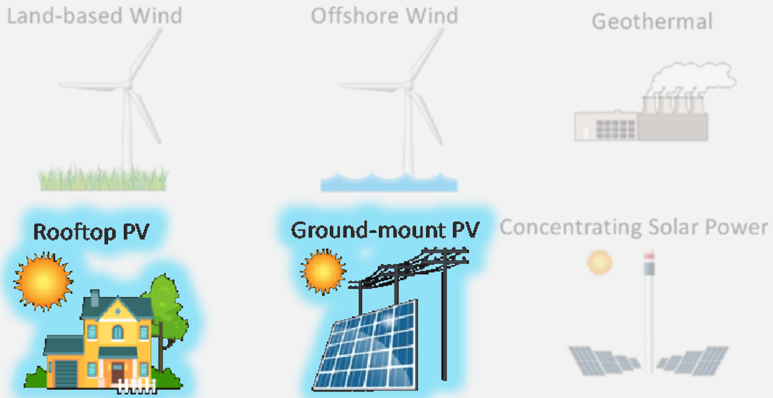
Renewable Energy Potential (V) Model

2023 R&D 100 WINNER

For community solar technical potential, reV calculated:

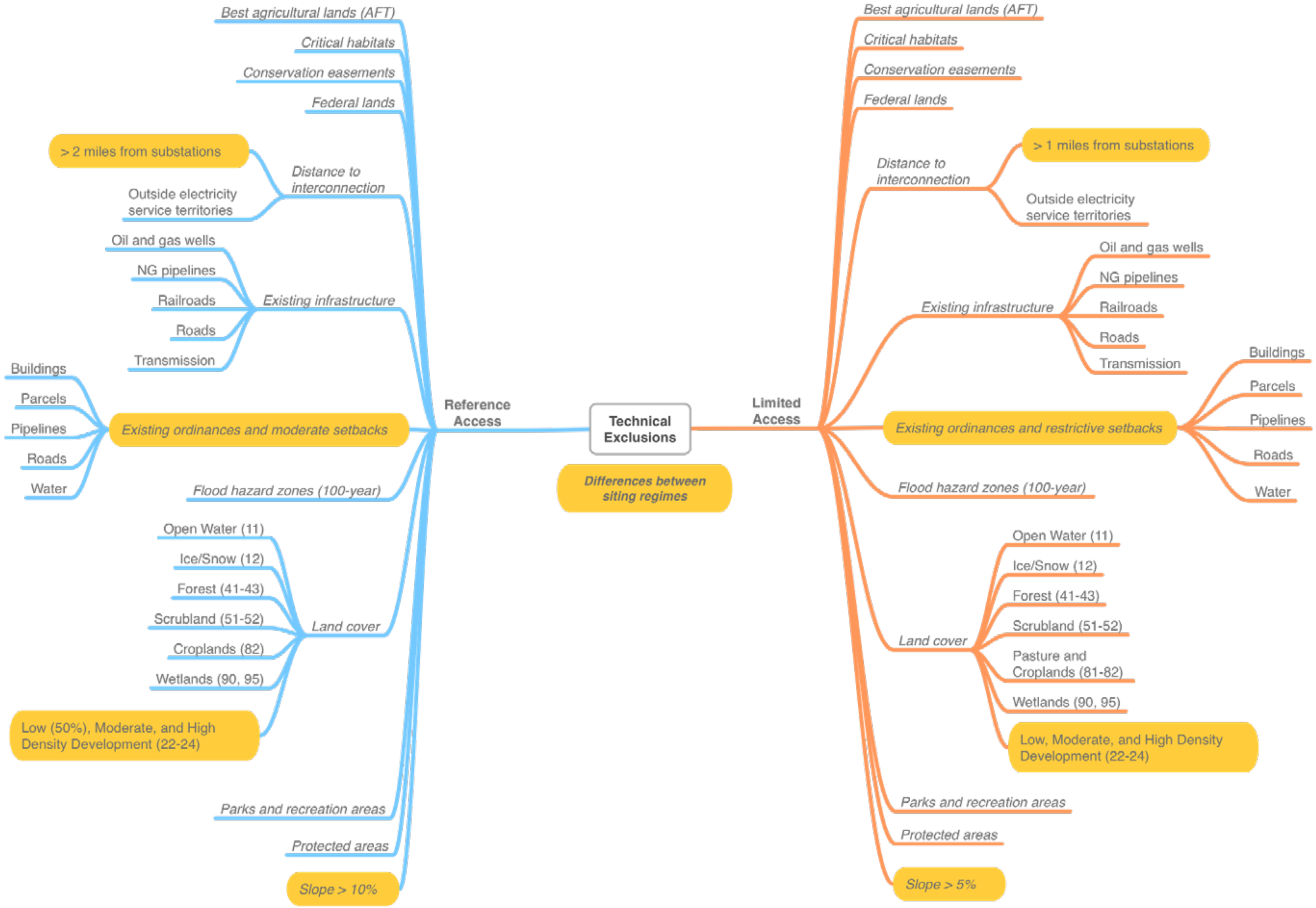
- Capacity factor profiles for ground-mount and rooftop PV arrays
- Site-based levelized costs of energy
- Developable area and capacity using ground-mount PV siting constraints

Modeled renewable energy technologies:



https://github.com/NREL/reV

Land Availability Scenarios



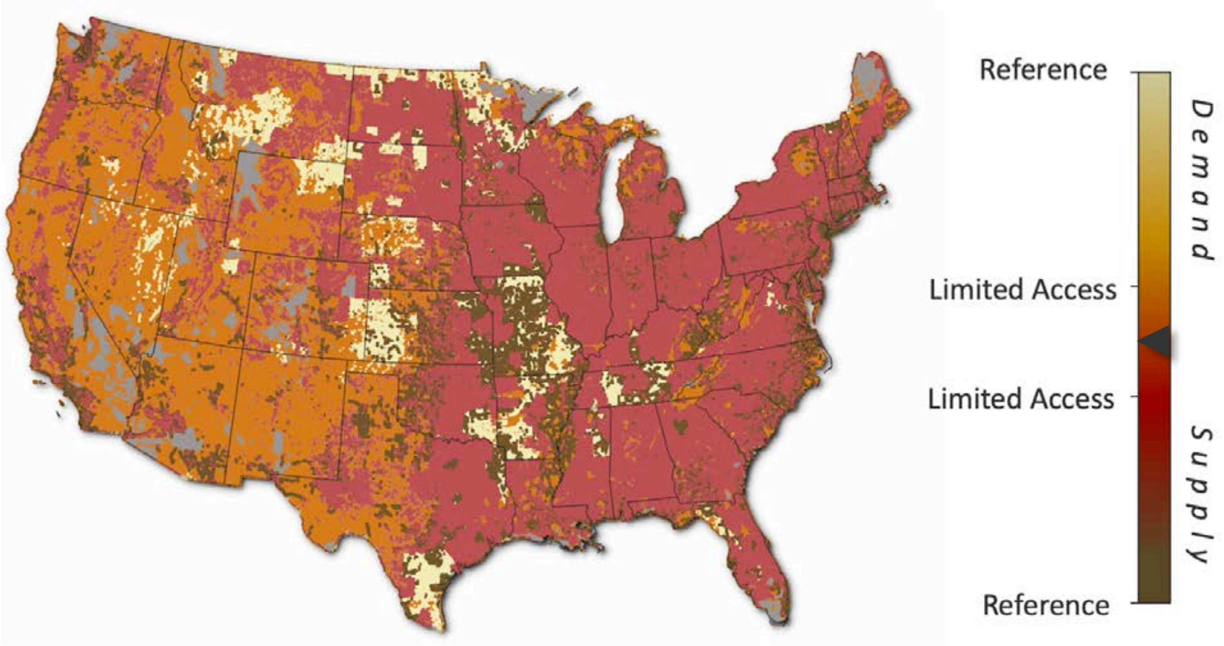
More on solar siting ordinances and setbacks: [Lopez et al. 2023 (doi.org/10.1038/s41560-023-01319-3)](https://doi.org/10.1038/s41560-023-01319-3)

Balancing Supply and Demand Constraints

- Every service territory is either supply-constrained or demand-constrained:
  - **Supply-constrained**: Technically potential demand exceeds technically potential supply in the service area.
  - **Demand-constrained:** Technically potential supply exceeds technically potential demand in the service area.

- Total technical potential estimates are based on technically potential supply in supply-constrained areas and technically potential demand in demand-constrained areas.

Community Solar Supply and Demand Constraints Across the United States



Technical potential tends to be supply-constrained in densely populated urban areas or areas with weaker solar resources, and demand-constrained in sparsely populated rural areas or areas with stronger solar resources.

Technical Potential Results

Community Solar Technical Potential Results

- Technical potential of community solar capacity in the United States: **967-2,862 GW_{AC}**
  - 570-2,465 GW of ground-mount solar
  - 397 GW of rooftop solar
- Technical potential of community solar annual energy production in the United States: **1,710-5,203 TWh**
- Technical potential of community solar capacity in *Justice40 Initiative* disadvantaged communities: **167-468 GW_{AC}**

Can Community Solar Technical Potential Offset Electricity Consumption?

Community solar has sufficient technical potential to offset electricity consumption for households that cannot access BTM solar in aggregate.

- 69% of community solar capacity under Limited Access
- 13% of community solar capacity under Reference Access

	Households	Annual Demand (GWh)	Percent of Community Solar Supply *(Limited Access)*
Single-family buildings	24,161,423	261.61	27%
Multifamily buildings	20,879,176	115.75	12%
Mobile dwellings	8,290,619	126.00	13%
Low- to moderate-income (LMI) households	25,025,771	156.50	16%

Residential Electricity Consumption and Community Solar Potential

Residential electricity consumption by income, tenure, and dwelling type (MWh)

	Very Low	Low	Moderate	Mid	High
Owner Occupied, Single Family	65,350,294	43,536,741	95,785,401	252,458,022	365,500,349
Owner Occupied, Multi-Family	932,641	1,364,245	2,499,454	6,401,835	12,061,394
Renter Occupied, Single Family	44,816,169	17,700,346	29,342,621	84,211,171	28,605,584
Renter Occupied, Multi-Family	34,796,418	19,427,293	26,679,484	48,757,529	30,033,638
Mobile Dwelling	2,976,650	5,504,750	19,239,550	59,869,800	38,406,300
Total	**148,872,172**	**87,533,375**	**173,546,510**	**451,698,358**	**474,607,265**

Percent of modeled community solar supply (Limited Access) needed to offset residential electricity consumption by income, tenure, and dwelling type

	Very Low	Low	Moderate	Mid	High
Owner Occupied, Single Family	3.3%	2.2%	4.8%	12.6%	18.2%
Owner Occupied, Multi-Family	<1%	<1%	<1%	<1%	<1%
Renter Occupied, Single Family	2.2%	<1%	1.5%	4.2%	1.4%
Renter Occupied, Multi-Family	1.7%	1.0%	1.3%	2.4%	1.5%
Mobile Dwelling	<1%	<1%	<1%	3.0%	1.9%
Total	**7.4%**	**4.4%**	**8.6%**	**22.5%**	**23.6%**

Total residential electricity consumption could theoretically be met by community solar if 67% (935 MW) of modeled community solar technical potential was built. Meeting electricity demand for households where access to BTM solar is limited by either tenure or building type would require build-out of 51% of modeled community solar potential (495 MW).

Income bins (of area median income defined by HUD):

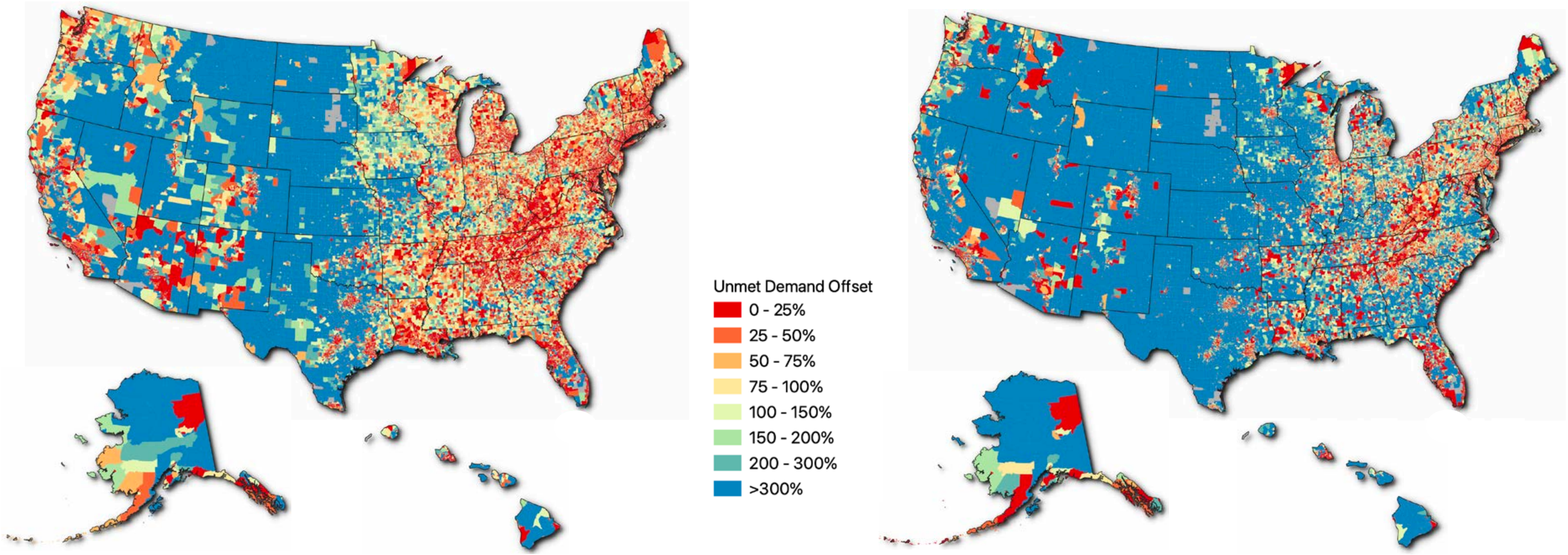
Very low: 0%–30%, Low: 30%–50%, Moderate: 50%–80%, Middle: 80%–120%, High: >120%

Data for the Low-Income Energy Affordability Data (LEAD) Tool comes from the U.S. Census Bureau's American Community Survey 2020 Public Use Microdata Samples

Community Solar Technical Potential in Context

- Our conservative estimated community solar technical potential capacity is roughly equal to the total solar capacity projected to be deployed by 2050 in the NREL Solar Futures Study (1,191 GW compared to 1,710-5,921 GW).
- Realistically, community solar is likely to represent a subset of actual future solar deployment.
- The actual amount of community solar deployed will depend on numerous policy, economic, and technological factors.

Community Solar Ability To Offset Electricity Consumption Unmet by BTM PV Within Tract



Limited Access

Reference Access

Maps show the proportion of unmet BTM PV demand (809 TWh) in each U.S. Census Bureau tract (2020) that can be met with community solar sited within the same tract. Tracts with low offsetable demand need to rely on community solar sited in the same utility service territory with excess community solar supply.

Strategically Siting Community Solar

Community solar technical potential follows a clear urban/rural divide.

Primary factors in developable areas for community solar: *population density, land cover, regulatory requirements*

Community solar is less affected by ordinances and setbacks for ground-mount PV.

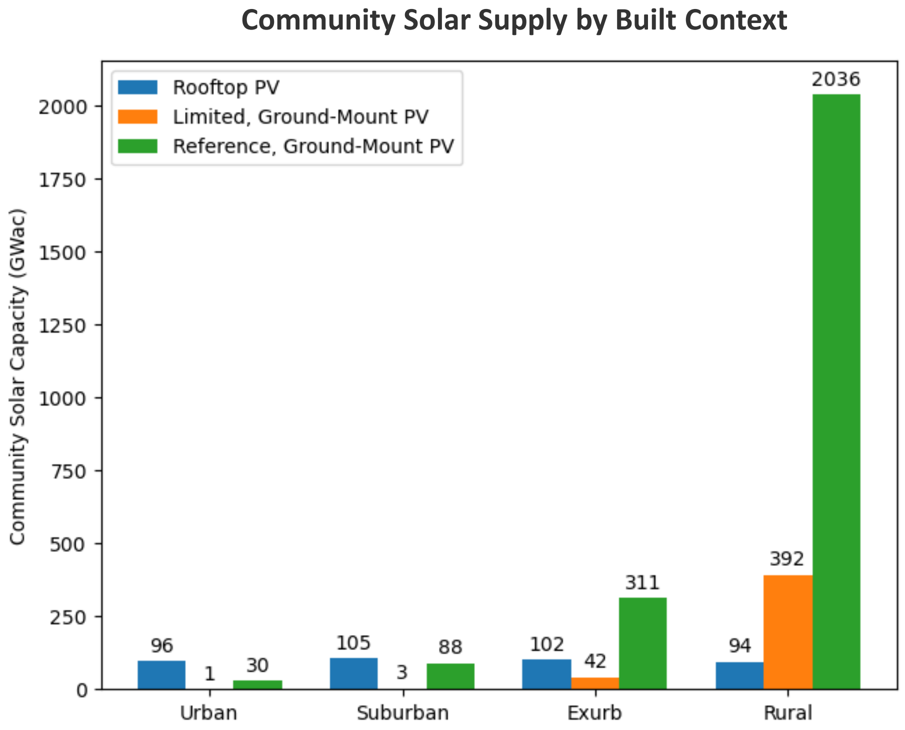
- 19% reduction in capacity vs. 38% reduction for utility-scale PV

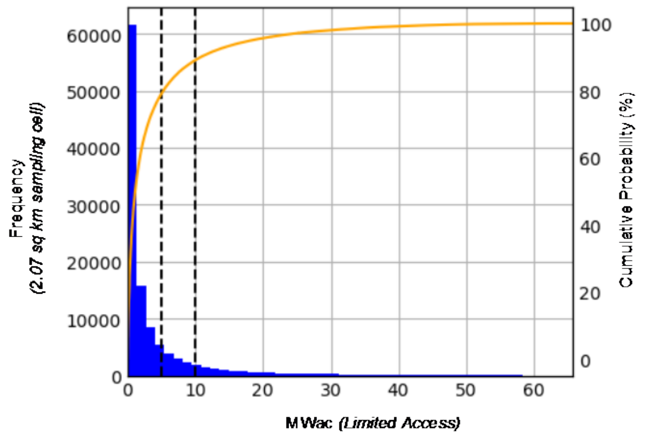
The largest opportunity for community solar siting is in smaller systems within infill spaces.

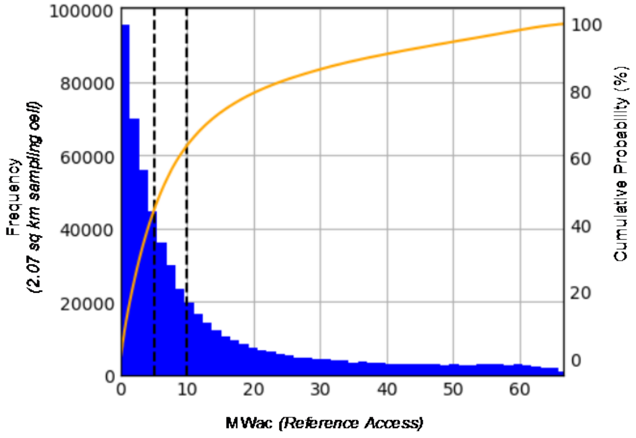
- Underutilized or vacant lots within urban and suburban contexts, marginal lands near interconnection

Most of the ground-mount community solar systems that have been modeled are small.

- 80% < 5 MW aggregated; 91% < 10 MW aggregated *(Limited Access)*
- 47% < 5 MW aggregated; 63% < 10 MW aggregated *(Reference Access)*



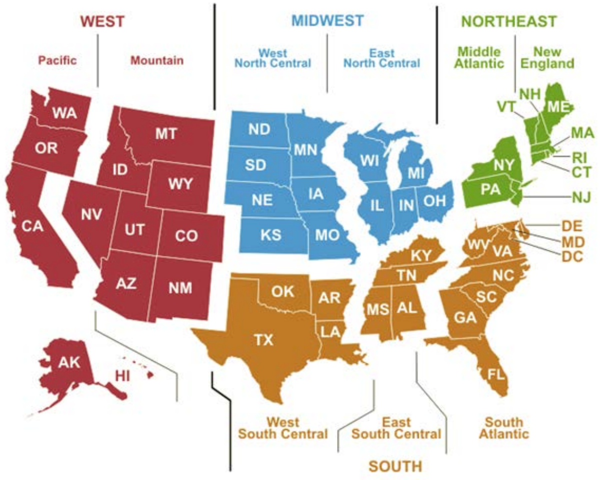




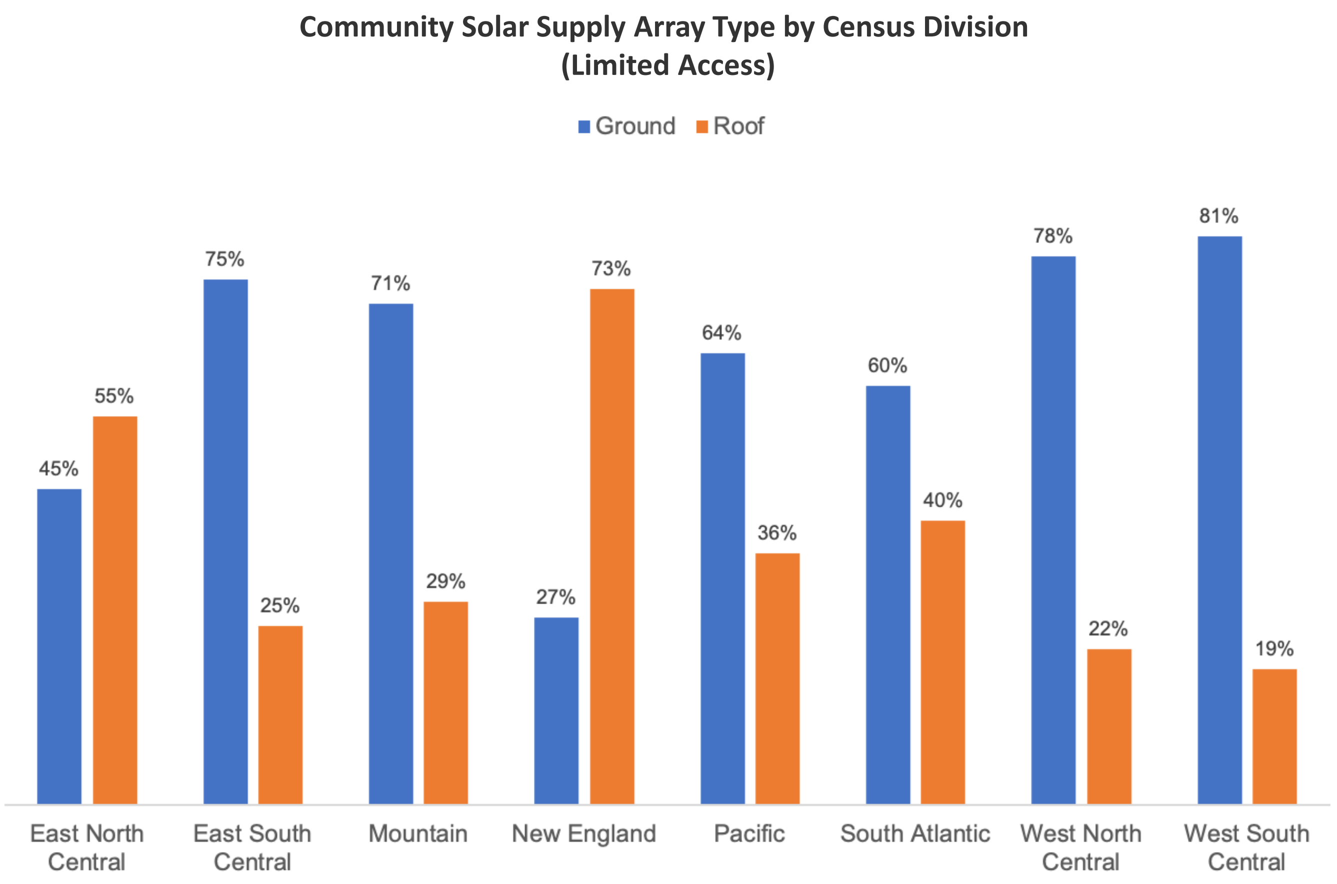
Strategically Siting Community Solar

Regions with low open lands (excluding federal lands), high-density development, and/or an older building stock will need to rely more on rooftop PV.

Regions with complicated roof architectures (high latitude, high precipitation) have less rooftop capacity per building, relying on more buildings for the same capacity.



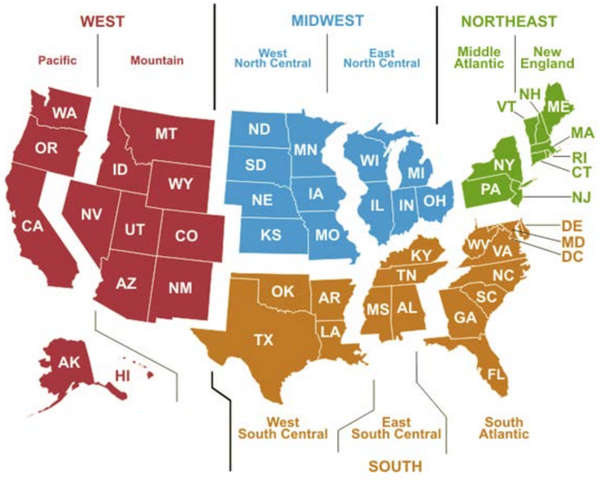
States Within Census Divisions



Rooftop Capacity By Occupancy

Commercial buildings for professional services, retail, wholesale trade, industrial buildings for light industrial, and grade schools contribute more to overall community solar rooftop potential than other buildings within their respective sectors.

Few residential buildings are large enough to support community solar systems (38+ kW).



States within Census divisions

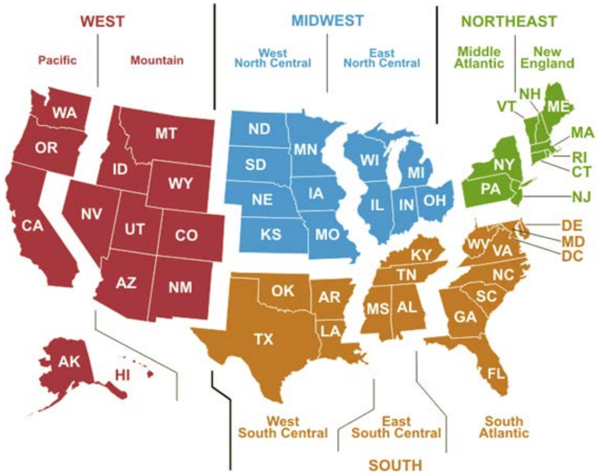
Sector	Occupancy	Building Count (thousands)	GW_{AC}	Percent of Developable Buildings	Percent of Developable Rooftop Capacity
COMMERCIAL	Banks	29.894	3.0807	0.77%	0.76%
	Entertainment/Recreation	192.435	15.6608	4.94%	3.88%
	Medical Office/Clinic	144.872	11.4305	3.72%	2.83%
	Personal and Repair Services	230.815	18.1668	5.93%	4.50%
	Professional Services	768.993	64.1048	19.74%	15.87%
	Retail	382.722	43.3017	9.83%	10.72%
	Temporary Lodging	66.403	5.6214	1.70%	1.39%
	Theater	7.491	0.9048	0.19%	0.22%
	Wholesale	290.726	43.3146	7.46%	10.72%
INDUSTRIAL	Construction	181.745	11.8024	4.67%	2.92%
	Food/Drug/Chemical	20.903	3.5166	0.54%	0.87%
	Heavy Industrial	90.28	16.9353	2.32%	4.19%
	High Technology	51.158	5.2413	1.31%	1.30%
	Light Industrial	377.466	48.1256	9.69%	11.91%
	Metals/Minerals Processing	20.086	2.9456	0.52%	0.73%
RESIDENTIAL	Single Family Residential	127.499	10.4291	3.27%	2.58%
	Multi-Family Residential (2)	125.268	7.1505	3.22%	1.77%
	Multi-Family Residential (3)	37.725	2.2521	0.97%	0.56%
	Multi-Family Residential (5)	59.997	3.2425	1.54%	0.80%
	Multi-Family Residential (10)	45.605	2.4720	1.17%	0.61%
	Multi-Family Residential (20)	40.809	2.6205	1.05%	0.65%
	Multi-Family Residential (50)	27.253	2.6839	0.70%	0.66%
OTHER	Church/Non-profit	172.181	13.6366	4.42%	3.38%
	College/University	10.663	1.9304	0.27%	0.48%
	Emergency Response	17.348	1.6529	0.45%	0.41%
	Government Services	135.88	14.3447	3.49%	3.55%
	Grade School	105.538	23.9871	2.71%	5.94%
	Hospital	22.114	3.3789	0.57%	0.84%
	Institutional Dormitory	45.837	10.7090	1.18%	2.65%
	Nursing Home	47.405	6.5353	1.22%	1.62%
	Parking	17.893	2.8628	0.46%	0.71%

Rooftop community solar supply by occupancy

Regional Rooftop PV Potential by Occupancy

The highest-performing buildings for maximizing community solar developable area are wholesale trade, heavy industrial, light industrial, metals/minerals processing, multifamily dwellings with 50+ units, and schools. The lowest-performing buildings include temporary lodging, single-family dwellings, duplexes, institutional dormitories, and nursing homes.

The highest proportion of developable areas per building are in the Southeastern United States, while the lowest proportions are in the Mountain and New England divisions.



States within Census divisions

Sector	Building Occupancy	East North Central	East South Central	Middle Atlantic	Mountain	New England	Pacific	South Atlantic	West North Central	West South Central
COMMERCIAL	Banks	63%	65%	54%	51%	50%	58%	60%	58%	64%
	Entertainment and recreation	58%	60%	50%	47%	50%	54%	57%	55%	59%
	Medical office/clinic	60%	59%	50%	44%	49%	55%	56%	56%	63%
	Personal and repair services	62%	62%	53%	48%	49%	57%	58%	56%	64%
	Professional/technical services	57%	58%	49%	44%	44%	53%	52%	51%	60%
	Retail trade	61%	65%	57%	52%	52%	60%	62%	59%	65%
	Temporary lodging	53%	62%	52%	41%	43%	46%	56%	50%	59%
	Theaters	64%	77%	56%	54%	63%	53%	58%	61%	70%
	Wholesale trade	67%	68%	59%	58%	53%	62%	66%	60%	71%
INDUSTRIAL	Construction	58%	60%	50%	43%	45%	54%	52%	51%	61%
	Food/drug/chemicals	73%	62%	63%	57%	55%	61%	65%	64%	69%
	Heavy industry	70%	70%	63%	56%	56%	62%	66%	53%	71%
	High technology	63%	66%	52%	53%	49%	57%	56%	61%	58%
	Light industrial	68%	68%	62%	56%	58%	60%	62%	64%	68%
	Metals/minerals processing	75%	64%	65%	60%	62%	61%	65%	53%	64%
RESIDENTIAL	Single family dwelling	39%	34%	33%	28%	31%	40%	35%	33%	35%
	Multi-family dwelling (2)	43%	41%	37%	30%	34%	43%	38%	37%	40%
	Multi-family dwelling (3)	45%	43%	38%	31%	35%	44%	40%	37%	45%
	Multi-family dwelling (5)	51%	44%	39%	34%	40%	45%	44%	43%	49%
	Multi-family dwelling (10)	53%	49%	42%	35%	46%	49%	43%	42%	51%
	Multi-family dwelling (20)	50%	60%	47%	32%	48%	50%	43%	47%	42%
	Multi-family dwelling (50)	58%	54%	51%	36%	39%	42%	48%	53%	55%
OTHER	Church/non-profit	58%	55%	47%	43%	45%	55%	54%	56%	61%
	College/universities	61%	62%	51%	58%	65%	62%	56%	49%	56%
	Emergency response	66%	67%	59%	55%	51%	59%	60%	61%	66%
	General services	64%	62%	50%	52%	46%	57%	61%	58%	67%
	Grade schools	66%	64%	63%	55%	59%	59%	65%	65%	67%
	Hospitals	56%	58%	53%	49%	52%	59%	60%	58%	70%
	Institutional dormitory	54%	60%	47%	43%	48%	48%	54%	49%	64%
	Nursing home	57%	60%	53%	40%	45%	48%	53%	50%	58%
	Parking	57%	67%	52%	52%	48%	52%	55%	61%	65%

Community solar supply array type by Census division

Analysis of Meaningful Benefits

Meaningful Benefits of Community Solar

The U.S. Department of Energy's (DOE's) National Community Solar Partnership (NCSP) has identified five benefits that can be delivered by community solar programs or projects.

EQUITABLE ACCESS & CONSUMER PROTECTIONS

- Contract terms that support strong consumer protections
- Inclusive outreach and engagement
- Financial products that are accessible to all households

Justice40 Priority 3:
Increase Clean Energy Parity

MEANINGFUL HOUSEHOLD SAVINGS

- Guaranteed bill and/or household savings
- Wealth building opportunities
- Indirect multifamily affordable housing tenant benefits

Justice40 Priority 1:
Reduce Energy Burden

RESILIENCE, STORAGE, AND GRID BENEFITS

- Household and community level resilience strategies
- Grid strengthening properties
- Improved health outcomes through reduced or shortened power outages

Justice40 Priority 7:
Increase Energy Resilience

COMMUNITY-LED ECONOMIC DEVELOPMENT

- Opportunities for community ownership
- Community benefits agreements
- Support for entrepreneurship and local and minority and women-owned businesses

Justice40 Priority 8:
Increase Energy Democracy

SOLAR WORKFORCE DEVELOPMENT

- Strategies that ensure jobs are accessible to workers of all backgrounds, offer competitive wages and union membership
- Training and apprenticeship programs

Justice40 Priority 6:
Increase Clean Energy Jobs

Source: NCSP. N.d. "Education and Outreach." Energy.gov. https://www.energy.gov/communitysolar/education-and-outreach.

Analyses at Two Levels

- **Deployment under NCSP target:** Analyzes meaningful benefits of incremental 14 GW of community solar installed from 2023 to reach DOE NCSP target (20 GW).
- **Technical potential:** Analyzes the accrual of meaningful benefits if all **technically-potential** community solar is developed

Greater Household Savings

- Projects today provide around 5-15% in bill savings; the NCSP target of 20% savings is ambitious but plausible
- Total estimated savings is the product of:
  - 20% assumed bill savings
  - The residential share of capacity
  - Community solar output
  - Retail electricity rates

Assumptions

- 15-45% residential shares
- Average zip code-level retail rates

Results

NCSP: $110-330M/year in household bill savings ($8-24M/GW)

Technical: $7-21B/year in household bill savings

Equitable Access

- LMI households will likely already account for around ~30% of subscribers in planned capacity*, again the NCSP target (40% LMI) is ambitious but plausible
- Estimate depends on assumed residential shares of project capacity, average subscription sizes

Assumptions

- 15-45% residential shares
- Average subscription = 4 kW**

Results

NCSP: 210,000-630,000 LMI subscribers (15,000-45,000/GW)

Technical: 13-38M LMI subscribers

* Based on state policy requirements reported in: Connelly, C. 2023. Demystifying LMI incentives for community solar projects. Wood Mackenzie.; ** Consistent with subscription size assumptions in the NCSP Target.

Resilience, Storage and Grid Benefits

- Community solar co-located with storage can provide additional resilience and grid value
- **Resilience value** is the product of the # of avoided outages, storage capacity (GWh), and the value of lost load
- **Grid service value** is calculated based on remaining share of available storage capacity

Assumptions

- Share of projects co-located with storage = 30%
- Storage is 60% of solar capacity
- 50% of storage reserved for backup
- Damages* from service disruptions = $30/kWh
- Grid service** value = $50/kW

Results

NCSP:	Technical:
Backup: $30-100M/year ($2-7M/GW)	Backup: $2-6B/year
Grid services: $20-60M/year ($1-4M/GW)	Grid services: $1.3-3.8B/year

* Refers to monetary value of damages caused by blackouts, such as lost economic activity, thermal discomfort, and food spoilage. ** Revenues from sales of energy, capacity, and ancillary services.

Community-Led Economic Development

- Community ownership of community solar—meaning community members have equity stakes in projects—is uncommon, though numerous corporate structures have emerged to facilitate community ownership*
- Community benefit agreements (CBA) are an alternative to community ownership that can drive economic benefits into host communities
- Estimates based on assumed shares of community ownership and economic multipliers from the literature and NREL's Jobs and Economic Development Indicator model

* See Grimley, M., G. Chan. 2023. *Community Ownership in Community Solar Projects.* University of Minnesota.

Assumptions

- All projects include CBAs; CBA value is 5% of annual profits
- 1-25% are community-owned; ownership doubles local economic impacts

Results

NCSP: \$20M-160M/year in incremental economic benefits (\$1-11M/GW)

Technical: \$1.2-9.8B/year in incremental economic benefits

Solar Workforce Development

- The solar workforce is generally more diverse than the U.S. workforce, pays industry-competitive wages, and is unionized at comparable rates to broader workforce
- Including additional workforce benefits is compatible with NCSP deployment targets.*

Assumptions

- 21 temporary 1-year positions per MW during construction**
- 0.3 permanent jobs per MW
- Wages vary from current industry average to the 75th percentile wage. Based on wage data from Bureau of Labor Statistics

Results

NCSP:

290,000 temporary positions (20,000/GW)

7,000 permanent jobs (300/GW)

$200-230M/year in ongoing wages ($15M/GW)

Technical:

24M temporary positions

340,000 permanent jobs

$16-18B/year in ongoing wages

* Previous research shows that workforce development initiatives do not significantly reduce solar deployment (Mayfield, E., J. Jenkins. 2021. "Influence of high road labor policies and practices on renewable energy costs, decarbonization pathways, and labor outcomes." Environmental Research Letters 16:124012.). ** Assumptions based on NREL Jobs and Economic Development Indicator model.

Meaningful Benefits of Community Solar

	EQUITABLE ACCESS & CONSUMER PROTECTIONS	MEANINGFUL HOUSEHOLD SAVINGS	RESILIENCE, STORAGE, AND GRID BENEFITS	COMMUNITY-LED ECONOMIC DEVELOPMENT	SOLAR WORKFORCE DEVELOPMENT
NCSP Goal	40% LMI subscribers goal is ambitious but plausible	20% bill savings goal is ambitious but plausible (currently 5%-15%)	Additional resilience and grid value when paired with storage	Community members have equity stakes in projects	Additional workforce benefits are compatible with NCSP deployment targets
Assumptions	15-45% residential shares 4 kW average subscription	15-45% residential shares Mean retail rates (zip code)	$30/kWh service disruptions $50/kW grid service value	5% annual profits community benefit agreement 1%-25% are community-owned	21 temp 1-year jobs and 0.3 permanent jobs per MW 75th percentile wages
NCSP Target Estimate	210k-630k LMI subscribers 15k-45k/GW	$100M-$330M/year $8M-$24M/GW	*Backup:* $30M-$100M/year, $2M-$7M/GW *Grid services:* $20M-$60M/year, $1M-$4M/GW	$20M-$160M/year $1M-$11M/GW	290k temp jobs (20k/GW) 7k permanent jobs (300/GW) $200M-$230M/year ongoing wages ($15M/GW)
Technical Potential Estimate*	13M-38M LMI subscribers	$7B-$21B/year	*Backup:* $2B-$6B/year *Grid services:* $1.3B-$3.8B/year	$1.2B-$9.8B/year	24M temp jobs 340k permanent jobs $16B-$18B/year ongoing wages

* Assuming Limited Access technical potential results

Questions?

www.nrel.gov

NREL/PR-6A20-88841

This work was authored in part by the National Renewable Energy Laboratory, operated by Alliance for Sustainable Energy, LLC, for the U.S. Department of Energy (DOE) under Contract No. DE-AC36-08GO28308. Funding provided by the U.S. Department of Energy Office of Energy Efficiency and Renewable Energy Solar Energy Technologies Office. The views expressed in this presentation do not necessarily represent the views of the DOE or the U.S. Government. The U.S. Government retains and the publisher, by accepting the presentation for publication, acknowledges that the U.S. Government retains a nonexclusive, paid-up, irrevocable, worldwide license to publish or reproduce the published form of this work, or allow others to do so, for U.S. Government purposes.

NREL Transforming ENERGY

Appendix: Technical Potential Methodology

Ground-Mount and Rooftop Arrays

Community Solar Footprint

80% of installed community solar system sizes range from 38kW to 4.9MW. This analysis assumes system sizes 38 kW or greater. 38 kW minimum size was determined by the minimum representation of ground-mount solar capacity via NREL's Renewable Energy Potential (reV) model's native 90-meter technical exclusions grid.

System size	Ground-Mount PV Minimum developable area		Rooftop PV Minimum developable area	
38 kW	*4,953 m^2*	*53,317 ft^2*	*202 m^2*	*2,171 ft^2*
100 kW	14,568 m^2	156,815 ft^2	593 m^2	6,386 ft^2
1 MW	145,686 m^2	1,568,156 ft^2	5,933 m^2	63,858 ft^2
5 MW	*733,433 m^2*	*7,894,599 ft^2*	*29,663 m^2*	*319,290 ft^2*
10 MW	*1,466,866m^2*	*15,789,198 ft^2*	*59,326 m^2*	*638,580 ft^2*

PV System Assumptions

Ground-Mount

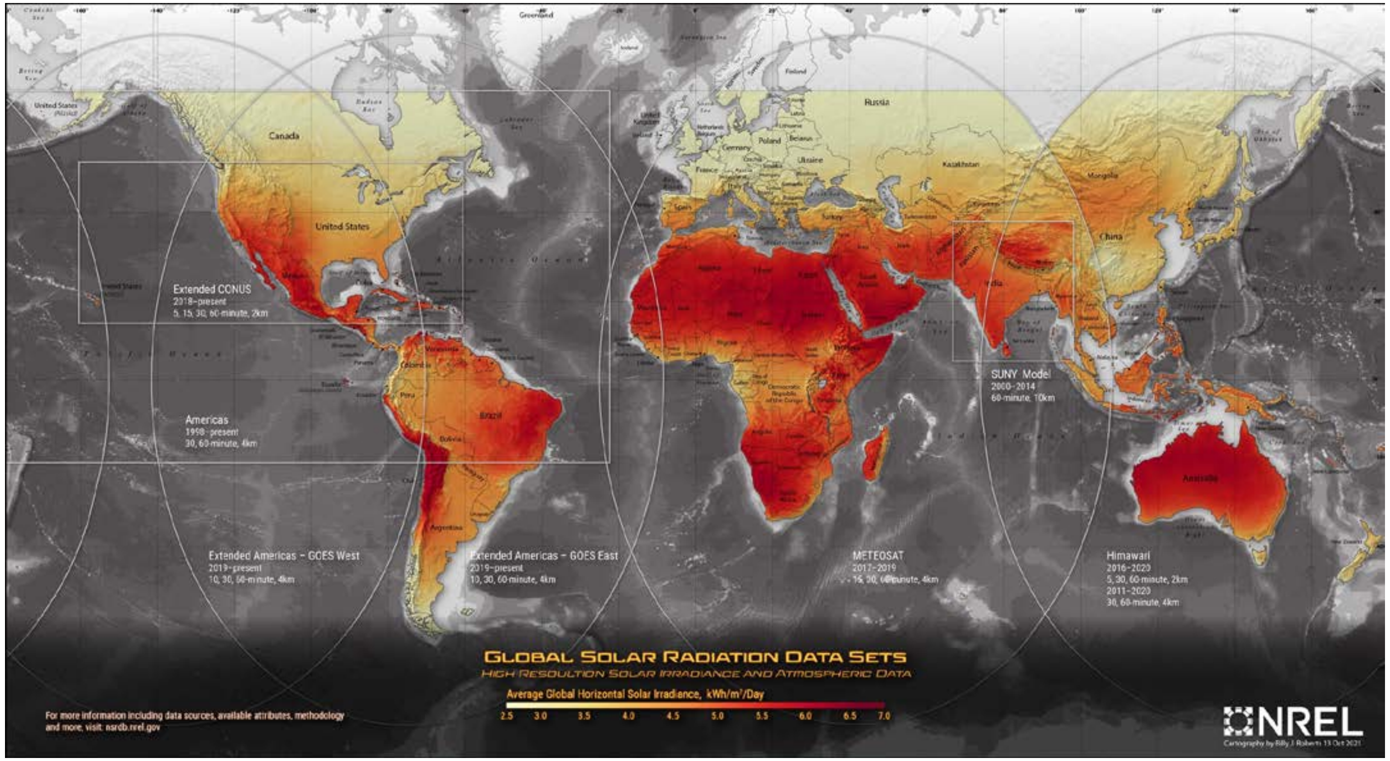
- Array type: 1-axis tracking
- Module type: mono-c-Si
- Module efficiency: 20.8%
- Ground cover ratio: 0.3
- **Capacity density:**
  - **48 MW_{DC}/km^2 | 37 MW_{AC}/km^2**

Rooftop

- Array type: roof mounted
- Module type: mono-c-Si
- Module efficiency: 20.3%
- Packing density: 88%
- **Capacity density:**
  - **172 W/m^2**

Based on Commercial PV Model from [2] Ramasamy, Vignesh, Jarett Zuboy, Eric O'Shaughnessy, David Feldman, Jal Desai, Michael Woodhouse, Paul Basore, and Robert Margolis. 2022. *U.S. Solar Photovoltaic System and Energy Storage Cost Benchmarks, With Minimum Sustainable Price Analysis: Q1 2022.* Golden, CO: National Renewable Energy Laboratory. NREL/TP-7A40-83586. https://www.nrel.gov/docs/fy22osti/83586.pdf.

Solar Resource Data



A combination of multiple solar resource sets from the National Solar Radiation Database[1] as well as the European Centre for Medium-Range Weather Forecasts' ERA5[2] were used to calculate PV system performance across the study area.

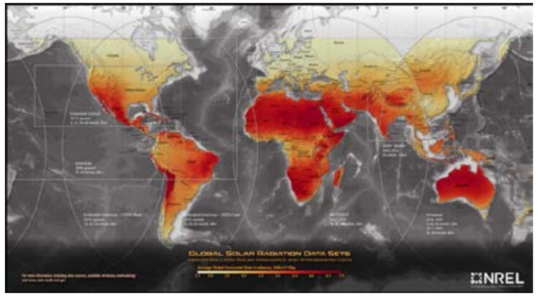
Geographic Area	Solar Resource Data Source and Years	
Continental US	NSRDB - Extended CONUS	2018-2021
Alaska	ERA5	2018-2021
Hawai'i	NSRDB - Extended CONUS	2018-2021
Puerto Rico	NSRDB - Extended CONUS	2018-2021

[1] Sengupta, M., Xie, Y., Lopez, A., Habte, A., Maclaurin, G., Shelby, J., 2018. The National Solar Radiation Data Base (NSRDB). Renew. Sustain. Energy Rev. 89, 51-60. https://doi.org/10.1016/j.rser.2018.03.003.

[2] Hersbach, H., Bell, B., Berrisford, P., Biavati, G., Horányi, A., Muñoz Sabater, J., Nicolas, J., Peubey, C., Radu, R., Rozum, I., Schepers, D., Simmons, A., Soci, C., Dee, D., Thépaut, J-N. (2023): ERA5 hourly data on single levels from 1940 to present. Copernicus Climate Change Service (C3S) Climate Data Store (CDS), DOI: 10.24381/cds.adbb2d47.

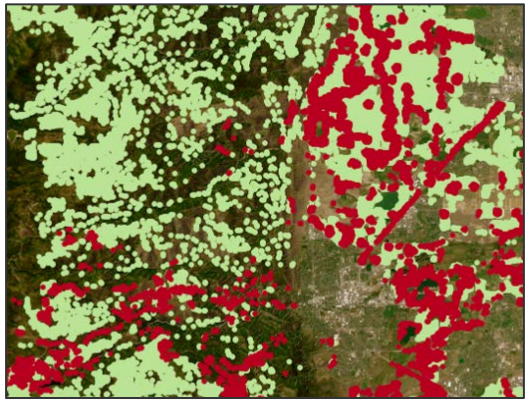
Ground-Mount PV Supply Constraints

Ground-mount PV supply constraints are based on the achievable energy capacity and generation of ground-mounted PV systems on developable lands.



Solar Resource Data

Capacity Density

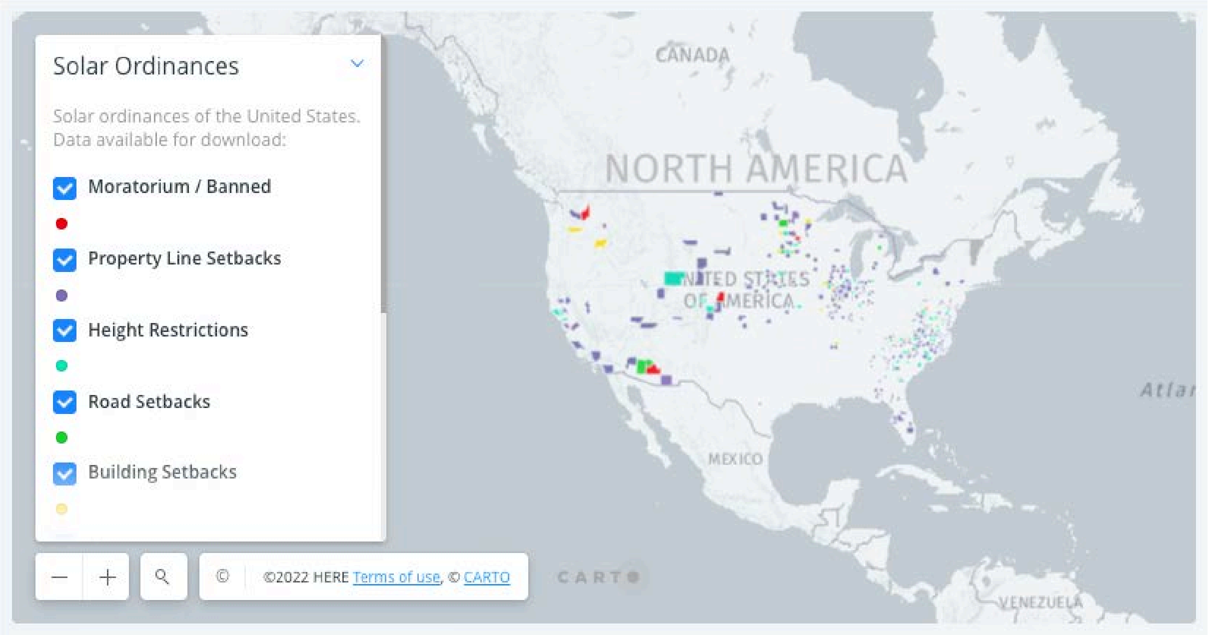


Developable Area

Interconnection

NREL Solar Energy Siting Ordinances and Setbacks

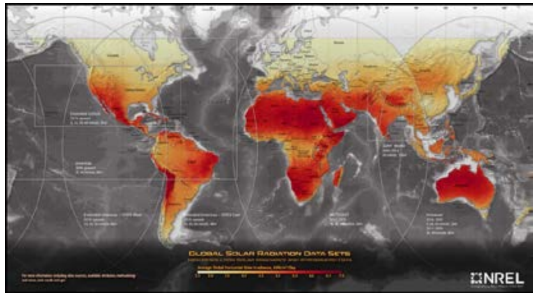
- State and county-level zoning laws that influence how and where solar resources can be sited and deployed
- Differing severity of setbacks and ordinances between limited, reference, and open access siting regimes
- Available on Open Energy Data Initaitive (OEDI)
- Ordinances included:
  - Moratoria, property and building setbacks, minimum and maximum lot sizes
- Does not include:
  - Noise limits, road setbacks, height restrictions



Web map: https://nrel.carto.com/u/alopez/builder/8b7d6765-1ee0-4b5e-bf7a-742d34551ca8/embed

Rooftop PV Supply Constraints

Based on the achievable energy capacity and generation of roof-mounted PV systems given roof plane orientation and shading.



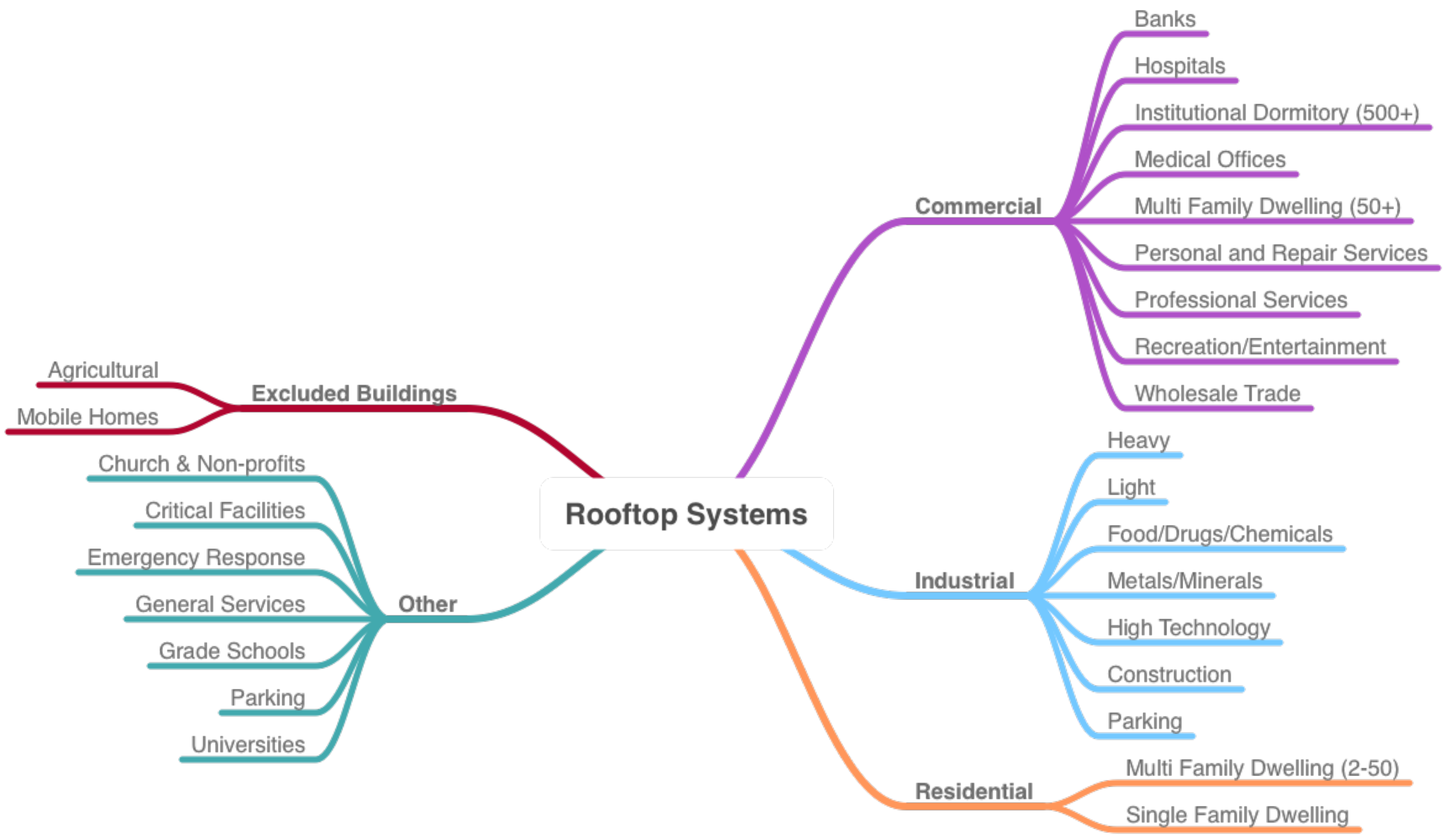
Resource Data

Capacity Density

Developable Area

Interconnection

Developable Area: Building Types



These building occupancies were assessed for suitable rooftop developable area for community solar except for excluded occupancies noted (agricultural, mobile homes).

Including building occupancy allows us to report out on rooftop suitability findings useful for community solar development.

Source: National Structures Inventory, (occupancy and height), USA Structures (building geometry)

Characterizing Rooftop Developable Area

This study used NREL's [PV Rooftop Database]() of buildings modeled for rooftop PV technical potential to extrapolate rooftop PV developable areas across the United States.

PV Rooftop data were used to apply a geographically weighted regression to estimate developable areas per building based on tree canopy and topographic position index.

CONUS: Gagnon et al. 2016

Puerto Rico: Mooney and Waechter 2020

Hawai'i: Grue et al. 2021

OEDI

Direct Downloads:
https://data.openei.org/s3_viewer?bucket=oedi-data-lake&prefix=pv-rooftop%2F

How does the PV Rooftop Database work?

LiDAR or photogrammetric digital surface models are used to delineate **roof planes suitable for PV array installation**. Suitable planes are combined with outputs from the reV model to create rooftop PV data products.

PV Rooftop Database:

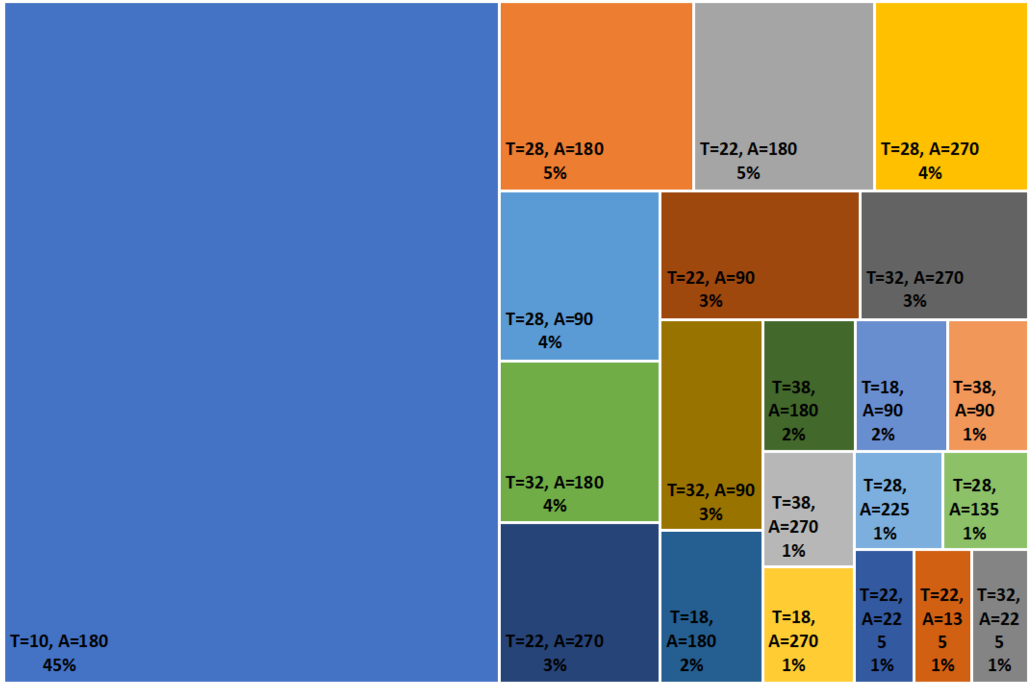
- Identifies obstructions to array placement and shading at sub-meter scale
- Handles customized array configurations per plane or building
- Does not assess roof condition, roof material, or code compliance

OEDI

Direct Downloads:
https://data.openei.org/s3_viewer?bucket=oedi-data-lake&prefix=pv-rooftop%2F

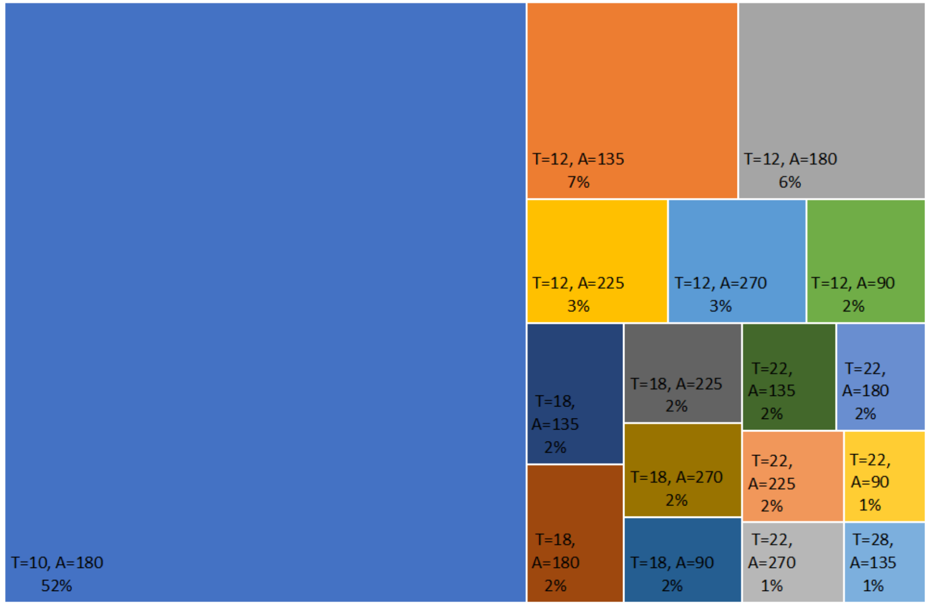
Examples PV Suitable Roof Planes Sample Distributions

Tilt and Azimuth Combinations for PV Suitable Roof Planes: Portland, Oregon



Tilt and Azimuth Combinations for PV Suitable Roof Planes: Albuquerque, New Mexico

Tilt and Azimuth Combinations for PV Suitable Roof Planes: Pierre, South Dakota



Tilts for developable roof planes in a city are indicated by ‘**T**’ while azimuths are indicated by ‘**A**’. The percent of the city’s developable roof planes for PV is listed below the tilt and azimuth specification.

Appendix: Detailed results

Limited Access Technical Potential by State (1 of 2)

State	ROOFTOP PV			GROUND-MOUNT PV			COMBINED		Percent of Unmet Demand That Community Solar Could Meet
	MW_{AC}	GWh	Percent of Capacity	MW_{AC}	GWh	Percent of Capacity	MW_{AC}	GWh	
Alabama	6,902.92	13,569.47	50%	6,868.42	13,718.28	50%	13,771.34	27,287.75	205%
Alaska	913.69	867.90	14%	5,721.24	3,959.14	86%	6,634.93	4,827.04	409%
Arizona	7,260.03	12,046.82	33%	14,848.47	27,487.46	67%	22,108.50	39,534.28	229%
Arkansas	4,751.76	9,053.68	51%	4,548.70	9,634.13	49%	9,300.46	18,687.80	220%
California	36,108.90	48,482.72	59%	25,526.20	48,085.89	41%	61,635.10	96,568.61	135%
Colorado	6,244.32	12,053.91	13%	41,931.34	66,523.84	87%	48,175.66	78,577.75	633%
Connecticut	3,785.22	7,582.67	96%	152.02	1,144.31	4%	3,937.24	8,726.98	90%
Delaware	1,114.71	2,215.48	92%	97.24	614.03	8%	1,211.95	2,829.52	116%
District of Columbia	465.94	813.37	100%	0	0	0%	465.94	813.37	32%
Florida	19,793.04	38,700.50	60%	13,083.21	23,506.29	40%	32,876.25	62,206.79	104%
Georgia	14,021.07	27,407.58	63%	8,319.16	19,263.69	37%	22,340.23	46,671.27	156%
Hawaii	909.85	1,917.18	16%	4,776.50	7,903.51	84%	5,686.35	9,820.69	425%
Idaho	2,467.49	4,077.45	21%	9,209.23	13,567.84	79%	11,676.72	17,645.29	474%
Illinois	16,059.99	29,760.69	78%	4,572.35	12,337.95	22%	20,632.34	42,098.64	162%
Indiana	11,369.99	21,486.53	77%	3,449.32	11,585.23	23%	14,819.31	33,071.76	250%
Iowa	5,889.18	11,703.23	46%	6,992.91	14,473.26	54%	12,882.09	26,176.49	428%
Kansas	5,756.81	11,118.37	19%	23,799.36	38,496.38	81%	29,556.17	49,614.75	795%
Kentucky	6,423.89	12,451.79	45%	7,710.42	15,057.25	55%	14,134.31	27,509.04	225%
Louisiana	5,454.37	10,165.71	71%	2,252.43	5,339.18	29%	7,706.80	15,504.88	118%
Maine	1,535.48	3,030.19	51%	1,501.99	3,184.27	49%	3,037.47	6,214.46	172%
Maryland	5,832.34	11,468.31	87%	851.20	2,833.26	13%	6,683.54	14,301.57	96%
Massachusetts	5,912.77	11,716.81	86%	955.45	3,228.71	14%	6,868.22	14,945.51	73%
Michigan	13,229.07	26,017.46	76%	4,247.53	11,030.59	24%	17,476.60	37,048.05	193%
Minnesota	8,153.74	15,947.15	40%	12,024.75	20,788.19	60%	20,178.49	36,735.34	354%
Mississippi	4,679.54	9,434.11	59%	3,302.27	8,194.76	41%	7,981.81	17,628.87	206%
Missouri	8,130.41	15,978.59	29%	19,722.64	30,988.59	71%	27,853.05	46,967.18	361%
Montana	2,483.39	4,497.56	8%	28,245.49	37,876.38	92%	30,728.88	42,373.94	1731%
Nebraska	3,306.50	6,460.66	9%	33,834.55	49,894.40	91%	37,141.05	56,355.06	1395%
Nevada	3,167.49	5,162.97	55%	2,575.43	5,108.61	45%	5,742.92	10,271.58	131%
Total	396,988.43	718,241.93	41%	570,508.78	991,984.70	59%	967,497.2	1,710,226.63	211%

Limited Access Technical Potential by State (2 of 2)

State	ROOFTOP PV			GROUND-MOUNT PV			COMBINED		Percent of Unmet Demand That Community Solar Could Meet
	MW_{AC}	GWh	Percent of Capacity	MW_{AC}	GWh	Percent of Capacity	MW_{AC}	GWh	
New Hampshire	1,461.15	2,765.28	87%	221.49	1,001.08	13%	1,682.64	3,766.35	106%
New Jersey	9,194.21	18,254.97	93%	743.38	3,606.23	7%	9,937.59	21,861.19	84%
New Mexico	2,113.58	4,113.80	14%	13,320.59	23,883.43	86%	15,434.17	27,997.23	532%
New York	17,824.25	35,651.05	74%	6,122.01	13,792.62	26%	23,946.26	49,443.67	69%
North Carolina	13,704.48	26,994.61	64%	7,706.27	19,629.06	36%	21,410.75	46,623.67	154%
North Dakota	2,909.93	5,523.16	11%	22,624.65	31,147.62	89%	25,534.58	36,670.78	2049%
Ohio	18,758.23	36,548.93	83%	3,769.81	14,344.36	17%	22,528.04	50,893.30	210%
Oklahoma	4,746.23	9,110.41	12%	33,236.52	51,728.27	88%	37,982.75	60,838.69	568%
Oregon	5,196.02	7,827.94	37%	8,866.04	14,355.43	63%	14,062.06	22,183.37	309%
Pennsylvania	17,215.14	26,171.05	87%	2,578.02	9,314.02	13%	19,793.16	35,485.07	104%
Rhode Island	1,093.39	2,068.43	86%	177.13	467.95	14%	1,270.52	2,536.39	77%
South Carolina	6,756.57	12,051.15	51%	6,430.68	12,731.36	49%	13,187.25	24,782.50	172%
South Dakota	2,450.72	4,123.75	7%	30,541.54	42,170.49	93%	32,992.26	46,294.24	2409%
Tennessee	8,946.30	14,987.29	69%	3,941.21	8,964.36	31%	12,887.51	23,951.64	131%
Texas	38,206.28	72,170.26	29%	93,404.97	159,795.16	71%	131,611.2	231,965.42	292%
Utah	3,857.97	7,291.37	33%	7,824.78	14,206.99	67%	11,682.75	21,498.35	349%
Vermont	814.66	1,173.54	39%	1,270.01	2,122.10	61%	2,084.67	3,295.64	194%
Virginia	8,907.26	14,833.24	57%	6,838.68	12,533.32	43%	15,745.94	27,366.56	124%
Washington	7,958.03	11,106.38	60%	5,251.94	8,739.27	40%	13,209.97	19,845.64	160%
West Virginia	2,292.32	3,470.90	75%	756.98	2,071.34	25%	3,049.30	5,542.23	116%
Wisconsin	9,422.49	14,934.50	69%	4,316.77	11,101.43	31%	13,739.26	26,035.93	218%
Wyoming	1,035.32	1,881.13	5%	19,445.52	28,453.41	95%	20,480.84	30,334.54	2293%
Total	396,988.43	718,241.93	41%	570,508.78	991,984.70	59%	967,497.2	1,710,226.63	211%

Reference Access Technical Potential by State (1 of 2)

State	ROOFTOP PV			GROUND-MOUNT PV			COMBINED		Percent of Unmet Demand That Community Solar Could Meet
	MW_{AC}	GWh	Percent of Capacity	MW_{AC}	GWh	Percent of Capacity	MW_{AC}	GWh	
Alabama	6,902.92	13,569.47	17%	33,213.00	58,019.78	83%	40,115.92	71,589.25	537%
Alaska	913.69	867.90	12%	6,562.94	5,048.77	88%	7,476.63	5,916.67	502%
Arizona	7,260.03	12,046.82	7%	99,617.77	223,185.86	93%	106,877.8	235,232.68	1365%
Arkansas	4,751.76	9,053.68	17%	23,651.51	40,524.10	83%	28,403.27	49,577.78	584%
California	36,108.90	48,482.72	22%	126,147.54	261,014.81	78%	162,256.4	309,497.53	432%
Colorado	6,244.32	12,053.91	7%	84,761.97	167,535.99	93%	91,006.29	179,589.90	1446%
Connecticut	3,785.22	7,582.67	54%	3,244.92	5,055.54	46%	7,030.14	12,638.21	130%
Delaware	1,114.71	2,215.48	34%	2,131.05	3,555.46	66%	3,245.76	5,770.94	237%
District of Columbia	465.94	813.37	88%	61.44	101.50	12%	527.38	914.87	36%
Florida	19,793.04	38,700.50	32%	42,219.23	79,807.93	68%	62,012.27	118,508.43	198%
Georgia	14,021.07	27,407.58	23%	48,084.29	85,723.38	77%	62,105.36	113,130.95	379%
Hawaii	909.85	1,917.18	9%	9,575.20	19,255.14	91%	10,485.05	21,172.32	915%
Idaho	2,467.49	4,077.45	5%	43,431.64	77,741.09	95%	45,899.13	81,818.54	2200%
Illinois	16,059.99	29,760.69	34%	31,188.59	51,325.23	66%	47,248.58	81,085.92	312%
Indiana	11,369.99	21,486.53	23%	37,313.98	60,194.58	77%	48,683.97	81,681.11	616%
Iowa	5,889.18	11,703.23	13%	38,857.06	63,872.96	87%	44,746.24	75,576.19	1237%
Kansas	5,756.81	11,118.37	8%	65,302.86	121,734.19	92%	71,059.67	132,852.55	2130%
Kentucky	6,423.89	12,451.79	13%	42,230.29	68,685.36	87%	48,654.18	81,137.14	664%
Louisiana	5,454.37	10,165.71	24%	17,509.21	31,229.28	76%	22,963.58	41,394.98	315%
Maine	1,535.48	3,030.19	18%	7,041.04	10,640.27	82%	8,576.52	13,670.46	378%
Maryland	5,832.34	11,468.31	43%	7,840.91	12,879.06	57%	13,673.25	24,347.37	163%
Massachusetts	5,912.77	11,716.81	43%	7,959.71	12,411.60	57%	13,872.48	24,128.40	117%
Michigan	13,229.07	26,017.46	26%	37,908.42	58,338.36	74%	51,137.49	84,355.81	440%
Minnesota	8,153.74	15,947.15	12%	59,333.37	93,638.75	88%	67,487.11	109,585.90	1056%
Mississippi	4,679.54	9,434.11	19%	19,784.86	34,617.25	81%	24,464.40	44,051.36	516%
Missouri	8,130.41	15,978.59	9%	87,446.17	148,193.63	91%	95,576.58	164,172.23	1262%
Montana	2,483.39	4,497.56	2%	105,005.89	168,873.48	98%	107,489.2	173,371.03	7084%
Nebraska	3,306.50	6,460.66	3%	115,212.13	205,610.45	97%	118,518.6	212,071.11	5251%
Nevada	3,167.49	5,162.97	14%	18,826.77	39,483.71	86%	21,994.26	44,646.69	568%
Total	396,988	718,241	14%	2,465,142	4,484,768	86%	2,862,130	5,203,010	643%

Reference Access Technical Potential by State (2 of 2)

State	ROOFTOP PV MW$_{AC}$	ROOFTOP PV GWh	ROOFTOP PV Percent of Capacity	GROUND-MOUNT PV MW$_{AC}$	GROUND-MOUNT PV GWh	GROUND-MOUNT PV Percent of Capacity	COMBINED MW$_{AC}$	COMBINED GWh	Percent of Unmet Demand That Community Solar Could Meet
New Hampshire	1,461.15	2,765.28	36%	2,639.28	4,000.94	64%	4,100.43	6,766.22	191%
New Jersey	9,194.21	18,254.97	50%	9,063.56	14,613.24	50%	18,257.77	32,868.21	127%
New Mexico	2,113.58	4,113.80	3%	77,693.73	171,659.57	97%	79,807.31	175,773.37	3340%
New York	17,824.25	35,651.05	36%	31,374.16	46,275.12	64%	49,198.41	81,926.17	114%
North Carolina	13,704.48	26,994.61	25%	41,224.14	71,894.42	75%	54,928.62	98,889.02	327%
North Dakota	2,909.93	5,523.16	3%	82,972.75	132,545.84	97%	85,882.68	138,069.00	7716%
Ohio	18,758.23	36,548.93	34%	36,095.95	55,703.73	66%	54,854.18	92,252.67	381%
Oklahoma	4,746.23	9,110.41	5%	87,938.20	165,656.50	95%	92,684.43	174,766.92	1631%
Oregon	5,196.02	7,827.94	11%	40,419.87	69,027.81	89%	45,615.89	76,855.75	1070%
Pennsylvania	17,215.14	26,171.05	40%	25,583.60	38,425.12	60%	42,798.74	64,596.17	190%
Rhode Island	1,093.39	2,068.43	49%	1,139.49	1,805.49	51%	2,232.88	3,873.92	118%
South Carolina	6,756.57	12,051.15	19%	28,927.86	51,408.35	81%	35,684.43	63,459.49	440%
South Dakota	2,450.72	4,123.75	3%	81,437.59	138,302.66	97%	83,888.31	142,426.41	7412%
Tennessee	8,946.30	14,987.29	22%	31,109.75	52,218.75	78%	40,056.05	67,206.04	368%
Texas	38,206.28	72,170.26	8%	434,960.38	860,080.43	92%	473,166.66	932,250.69	1174%
Utah	3,857.97	7,291.37	7%	48,923.03	97,114.81	93%	52,781.00	104,406.18	1693%
Vermont	814.66	1,173.54	13%	5,599.02	8,019.69	87%	6,413.68	9,193.23	540%
Virginia	8,907.26	14,833.24	21%	33,956.30	56,290.86	79%	42,863.56	71,124.09	322%
Washington	7,958.03	11,106.38	21%	29,572.40	46,854.17	79%	37,530.43	57,960.54	466%
West Virginia	2,292.32	3,470.90	30%	5,304.89	8,030.32	70%	7,597.21	11,501.21	240%
Wisconsin	9,422.49	14,934.50	18%	43,634.53	69,061.85	82%	53,057.02	83,996.34	705%
Wyoming	1,035.32	1,881.13	2%	64,107.76	117,481.78	98%	65,143.08	119,362.91	9023%
Total	396,988	718,241	14%	2,465,142	4,484,768	86%	2,862,130	5,203,010	643%

Rooftop Community Solar Technical Potential

State	Medium Buildings Count	Large Buildings Count	Developable Areas (sq km)	Mean Capacity Factor	MW_{AC}	Annual Energy Production (GWh)
Alabama	139457	14679	60.26	0.15	7255.83	9788.68
Alaska	16974	1594	4.98	0.09	856.64	705.73
Arizona	200392	14573	73.94	0.20	8902.33	15910.34
Arkansas	96029	9630	43.83	0.15	5277.57	6884.25
California	4967832	281358	749.63	0.19	229019.04	391102.34
Colorado	114327	12301	45.27	0.18	5449.95	8745.22
Connecticut	50128	7668	20.79	0.14	2503.06	3129.51
Delaware	21118	2394	9.32	0.15	1121.67	1473.91
District of Columbia	7951	1695	3.98	0.15	479.29	621.89
Florida	645245	42952	240.28	0.17	28929.50	43450.73
Georgia	227845	27881	97.10	0.16	11690.87	15944.39
Hawaii	4407	728	2.73	0.22	222.48	421.81
Idaho	44926	4696	17.96	0.16	2161.91	3098.67
Illinois	251660	33606	103.19	0.15	12423.78	15955.16
Indiana	155180	19356	62.82	0.14	7563.04	9461.38
Iowa	117686	11201	47.93	0.15	5771.33	7718.02
Kansas	75036	9210	30.00	0.16	3611.90	5201.80
Kentucky	105506	10482	42.78	0.14	5150.56	6427.25
Louisiana	127882	12327	50.23	0.16	6048.17	8359.45
Maine	22932	2761	9.39	0.14	1130.73	1419.93
Maryland	105933	13495	43.84	0.15	5278.48	6836.05
Massachusetts	74092	13474	32.01	0.14	3853.55	4844.12
Michigan	194438	26960	81.60	0.14	9824.99	12280.62
Minnesota	146093	17345	58.18	0.15	7005.34	9236.20
Mississippi	86277	9496	37.51	0.16	4516.58	6137.48
Missouri	138994	16350	56.84	0.15	6843.03	8979.16
Montana	34168	3039	13.42	0.15	1616.05	2113.29

State	Medium Buildings Count	Large Buildings Count	Developable Areas (sq km)	Mean Capacity Factor	MW_{AC}	Annual Energy Production (GWh)
Nebraska	56420	6754	22.90	0.16	2757.41	3976.74
Nevada	72309	6021	26.91	0.20	3240.32	5777.11
New Hampshire	20326	2883	8.42	0.14	1013.22	1261.47
New Jersey	129810	19400	54.46	0.14	6556.69	8296.24
New Mexico	59254	5455	23.01	0.20	2770.99	4916.72
New York	211341	35554	91.72	0.14	11043.21	13466.00
North Carolina	217461	26612	94.52	0.15	11380.02	15406.87
North Dakota	34551	3418	13.73	0.16	1653.64	2261.09
Ohio	247065	32451	100.60	0.14	12112.30	14600.13
Oklahoma	115424	11101	46.16	0.17	5557.80	8079.99
Oregon	86501	11082	35.12	0.15	4228.27	5405.81
Pennsylvania	252692	31919	106.97	0.14	12879.13	15426.55
Rhode Island	12280	2082	5.37	0.14	646.21	818.36
South Carolina	100451	13003	41.63	0.16	5012.10	6969.23
South Dakota	34676	3562	13.70	0.16	1649.35	2314.13
Tennessee	141279	17144	56.68	0.15	6823.86	8794.18
Texas	623821	69071	246.77	0.17	29711.53	44045.53
Utah	56953	7644	23.37	0.18	2814.34	4465.20
Vermont	14241	1420	5.80	0.13	698.50	823.54
Virginia	380047	29928	144.63	0.15	17413.55	22625.17
Washington	129535	16793	52.20	0.13	6284.73	7273.58
West Virginia	30879	3695	12.86	0.13	1548.56	1828.33
Wisconsin	167651	19110	67.48	0.15	8124.71	10537.35
Wyoming	19773	1733	7.82	0.18	941.51	1447.71
Total	**11,387,248**	**999,086**	**3,433**	**.16**	**541,370**	**817,064**

Based on statistical modeling of regional distribution of suitability per building footprint for 34kW-5MW system sizes (all sectors)
Medium buildings have footprint areas of 15,000– 25,000 square feet. Large buildings have footprint areas 25,000 square feet or more.