The Vision for U.S. Community Solar:
A Roadmap to 2030

Prepared For:

VOTE SOLAR

FULL REPORT

July 2018

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Acknowledgements

The Vision for U.S. Community Solar: A Roadmap to 2030 and Beyond **was prepared by Wood Mackenzie and GTM Research on behalf of Vote Solar**

VOTE SOLAR

With special thanks to our project partners Coalition for Community Solar Access and GRID Alternatives

COALITION FOR COMMUNITY SOLAR ACCESS

GRID ALTERNATIVES

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Community Solar Advisory Committee

- Jeff Cramer — Coalition for Community Solar Access
- Tom Figel — Grid Alternatives
- Joel Henri — ForeFront Power
- Tom Hunt — Clean Energy Collective
- Hannah Muller — Clean Energy Collective
- John Murphy — Nexamp
- Jennifer Spinosi — CleanChoice Energy
- Joel Thomas — Community Energy Inc.

Low Income and Equity Advisory Committee

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- Michael DiRamio — Department of Energy
- Ariel Drehobl — American Council for an Energy-Efficient Economy
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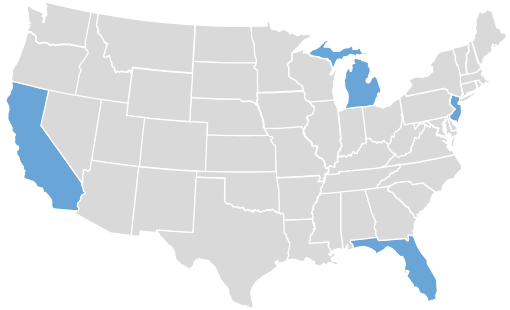
1. Executive Summary

A Vision for Community Solar: Study Overview

We establish a vision for a market where community solar is a mainstream option for consumers to choose and control their own energy generation — especially for those lacking access to traditional solar options, such as renters and the low- and moderate-income community.

This Vision for Community Solar:

- Outlines Benefits of Community Solar and Subscriber Preferences
- Addresses Key Bottlenecks to the Expansion of Community Solar
- Provides Strategies to Enhance Inclusivity of Low- and Moderate-Income Populations
- Walks through National Market Potential and Forecasts for Community Solar along with Deep Dives in 4 States:
  - California
  - Florida
  - Michigan
  - New Jersey
- Presents the National Impacts of Community Solar Market Transformation



Community Solar Makes Solar an Option for Everyone with an Electric Bill

U.S. consumers want solar…

The number of solar energy systems purchased by U.S. homeowners and businesses has grown tenfold since 2010. By the end of 2018, nearly 2 million homeowners and businesses will produce their own solar energy.

…and solar is getting more affordable

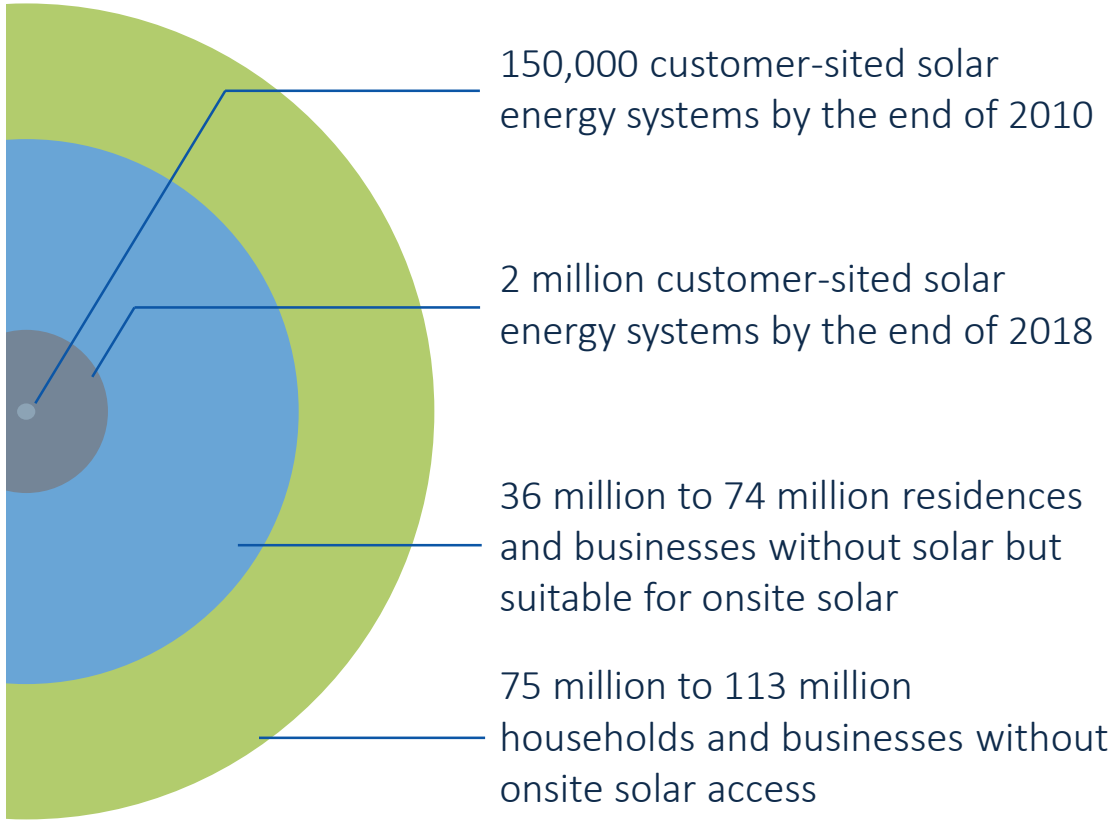
The price of rooftop solar has fallen by 40% in the past five years and currently beats the average retail price of electricity in 27 states and Washington, D.C.

…but access to solar is limited.

Between 50% and 75% of U.S. consumers cannot access traditional rooftop solar, either because they do not own their roof or due to technical restrictions. Community solar gives all 151 million electricity customers in the U.S. an opportunity to directly participate in solar.

Community solar gives all customers the ability to choose local clean electricity that can support local economic development, resiliency and healthier communities.

Community Solar Can Reach All Potential U.S. Customers



Source: GTM Research Wood Mackenzie, GTM Research/SEIA, NREL, EIA, U.S. Census

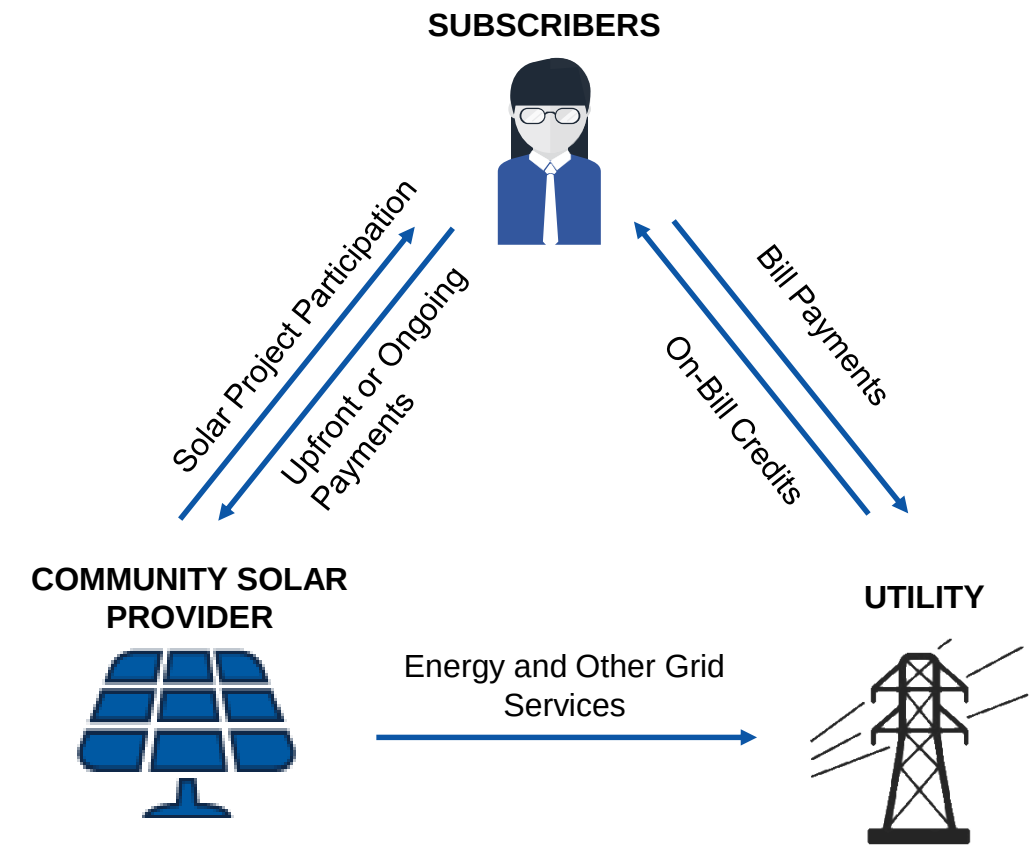
Defining Community Solar

Community solar – also called shared solar or solar gardens – refers to local solar facilities shared by multiple subscribers that receive credit on their electricity bills for their share of power produced.

Over the years, many projects have been labeled community solar, but we define **community solar** as a solar project with **multiple subscribers that receive on bill benefits directly attributable to the community solar project**.

- Subscribers must be credited with the benefits of community solar on their electric utility bills, either in the form of a monetary or energy (kWh) credit
- Subscribers must be tied to a specific solar project of which they are direct subscriber, not generic renewable certificates

The Community Solar Model



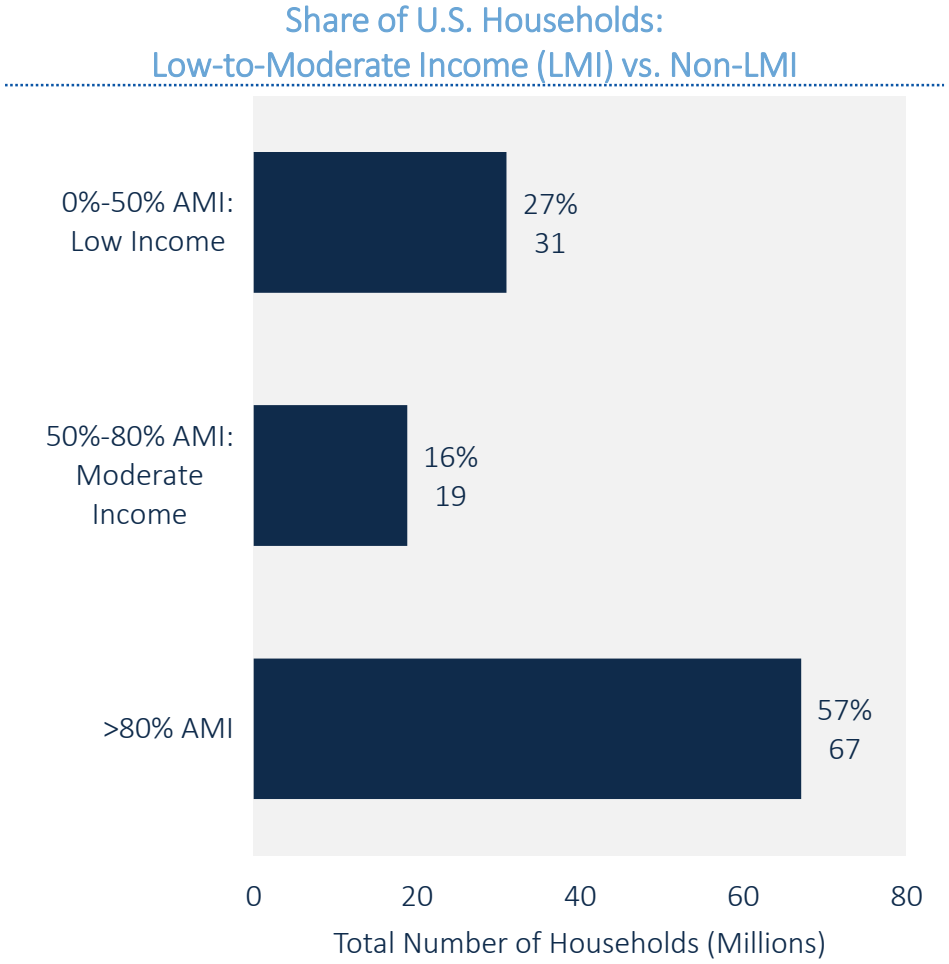
Source: GTM Research Wood Mackenzie

Community Solar Can Empower Communities Most in Need

50 million reasons why community solar needs to tap into the low-to-moderate income customer segment

Why community solar is the key to unlocking 50 million low-to-moderate income (LMI) households' access to clean, affordable energy solutions…

- The LMI subscriber opportunity is massive, accounting for approximately 43% of U.S. households. Of that total, there are 31 million low-income households, 19 million moderate-income households, and 5.78 million affordable housing properties across the U.S. that would benefit from cost-saving community solar solutions.
- Community solar provides the flexibility to deliver clean energy access to all LMI customers, including renters and multifamily housing – which LMI households are more likely to occupy.
- Community solar also offers significant benefits to low-income customers, including opportunity for bill savings and energy burden reduction, targeted, flexible value propositions tailored to LMI customers' unique needs, and local economic opportunity to drive the clean energy transition.
- At the same time, the LMI subscriber opportunity remains untapped, in large part due to higher costs to acquire LMI subscribers and limited access to capital for community solar projects involving LMI subscribers.
- But with the right combination of policy solutions, incentives, consumer protections, business model innovations, financing and programmatic support, there's an opportunity for community solar to play a critical role in creating an equitable clean energy future.
  - Targeted policy, financing and subscriber management solutions can reduce the perceived risk of serving LMI households and deliver significant benefits to LMI customers.



Source: NREL, 2018

An Equitable Transition to Serve Communities of Color and Environmental Justice Communities

Communities of color and environmental justice communities must also have equitable access to clean energy solutions

- LMI households are not the only customer segment that must proactively be included in solar markets moving forward. This work must also extend to communities of color and environmental justice communities. Community solar can be used as a tool to target benefits to communities who have historically been at the front lines of environmental pollution and negative impacts from traditional energy generation.
  - Fossil fuel power has disproportionately impacted the health and well-being of low-income communities, particularly communities of color and indigenous communities. Emissions from power plants sited in these communities contribute to high rates of asthma and cancer, and the presence of heavy industry contributes to a cycle of poverty and public disinvestment in neighborhoods that can least afford it.
  - Approximately 68% of African Americans live within 30 miles of a coal-fired power plant and nearly 40% of communities of color breathe polluted air. Meanwhile, environmental justice communities are disproportionately affected by public health effects of traditional generation.

Policymakers can target the benefits of community solar to communities of color and environmental justice communities through a number of strategies. Support can include program carve outs, job training programs, project ownership, siting preferences and incentives specifically focused on communities who have been disproportionately impacted by the electric system to date.

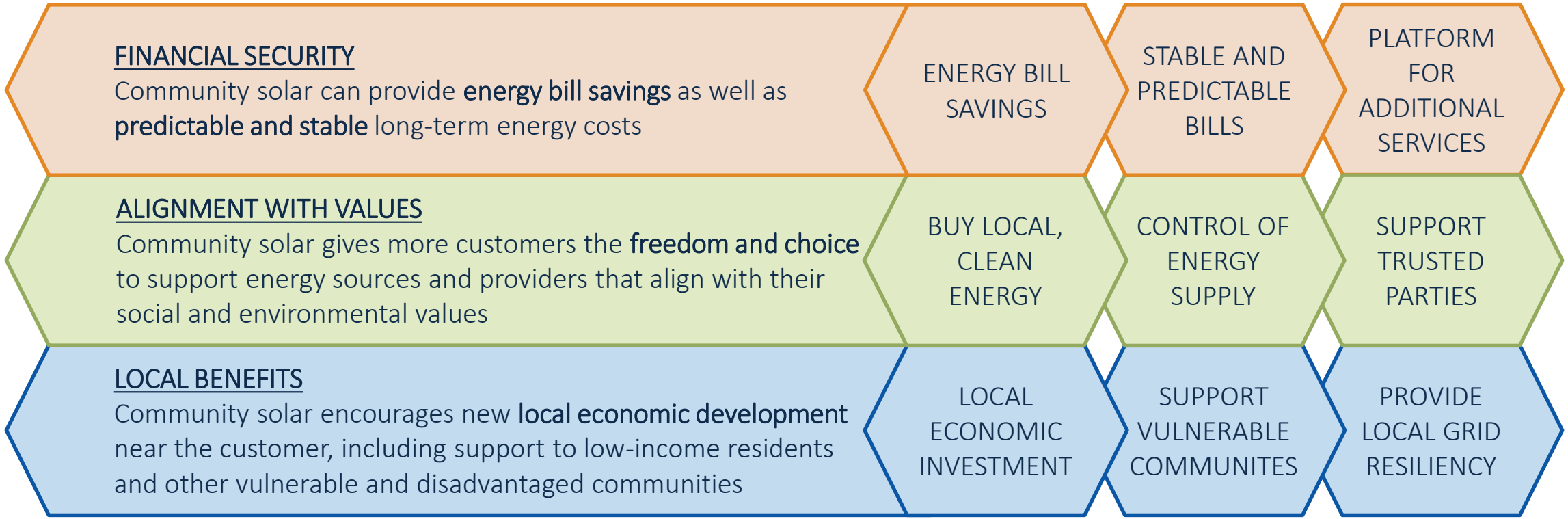
- Such solutions would not only provide workforce development opportunities, but also enable legislators and regulators to better quantify and measure public health benefits of community solar that displaces the need for fossil fuel generation.
- This report acknowledges that environmental justice communities and communities of color are critical to serve in the nation's transition to a low-carbon electricity system. Analysis of community solar's addressable market focuses on low and moderate income households, affordable housing owners and affordable housing tenants.

Source: Low-Income Solar Policy Guide, 2018

Community Solar Can Be an Attractive Solution for All Electric Customers

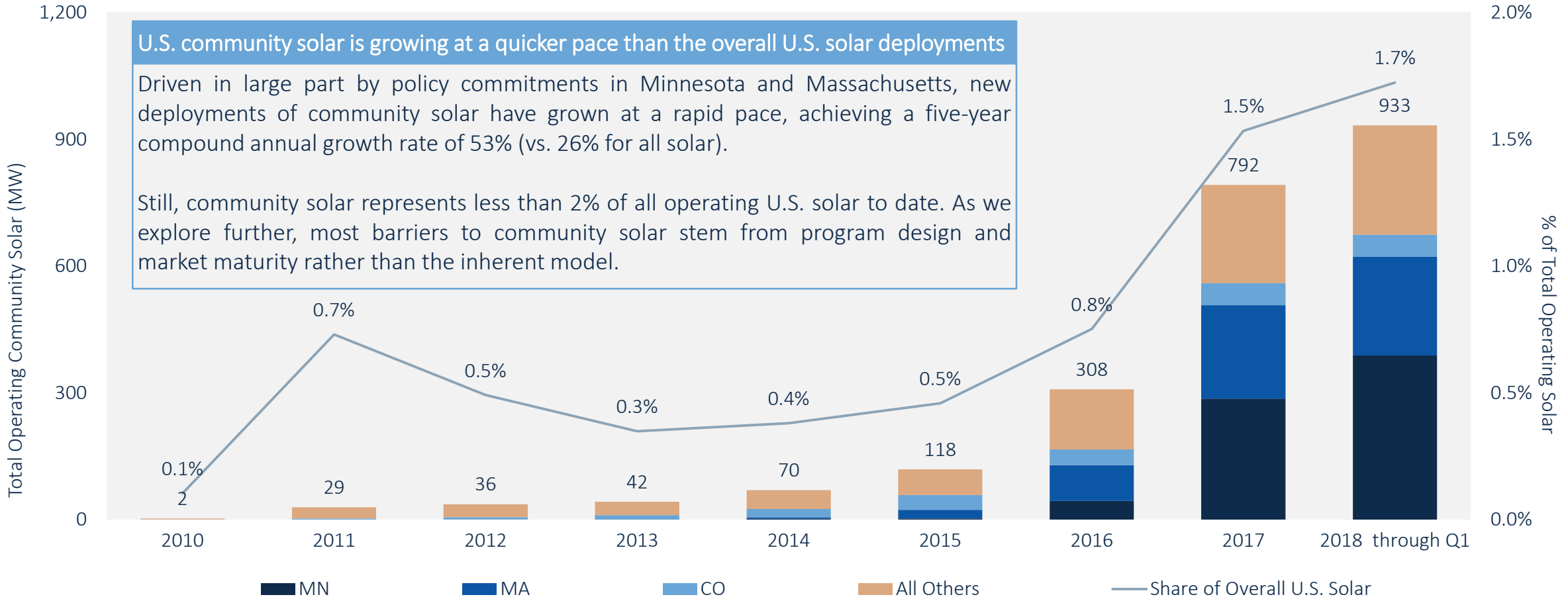
Community solar expands the important benefits of distributed solar to a much broader set of consumers, while also bringing unique solutions to physical, financing and equity challenges of onsite solar and current competitive retail electricity offerings.

Community solar is an energy source that ultimately provides:



U.S. Community Solar Nears 1 GW of Total Capacity Operating Nationwide

Cumulative U.S. Community Solar Installed Capacity by State



Source: GTM Research Wood Mackenzie

Community Solar Is Small Today — but It Can Rapidly Become a Mainstream Energy Source

If all states enabled community solar and adopted market rules that recognize the benefits community solar brings to subscribers and broader stakeholders – it could transform the energy landscape.

New programs can benefit by learning from early pioneers, leveraging solar's significantly reduced costs and drawing upon best practices—ultimately giving customers of all types, income-levels and geographies access to the rapidly growing clean energy economy.

U.S. Community Solar Market Potential by 2030

Total Community Solar Capacity Operating: **57 GW to 84 GW**

Annual Electricity Generated: **72 TWh to 107 TWh**

- Share of National Electricity Consumption: **1.6%-2.6%**

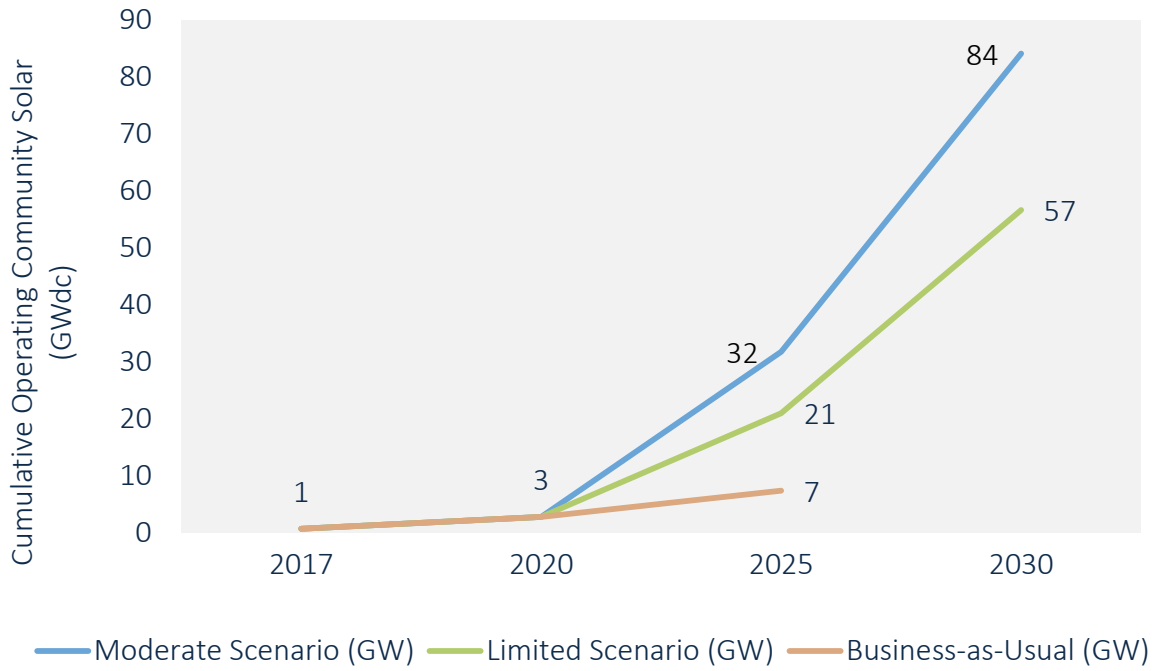
Subscribers Served: **6.4 million to 8.8 million**

- Low- and Moderate-Income Households Supported: **3.5 million to 4.0 million**

Cumulative Capital Invested*: **$81 billion to $121 billion**

*Cumulative capital invested represents total initial costs to build community solar plants, including all installation materials, labor, upfront supply chain, development and financing costs. Does not include ongoing operating costs

U.S. Community Solar through 2030: Market Potential



Source: GTM Research Wood Mackenzie

"Limited Scenario" and **"Moderate Scenario"** refer to the set of grid and environmental benefits included in the compensation for community solar. Neither reflect a full account of all costs and benefits, especially more difficult to calculate economic development and societal health benefits. Adoption forecast also includes assumptions of strong community solar and LMI adoption policy and continued subscription product innovations

Key Solutions to Unlock Community Solar's Potential

- Enabling policy to open viable new markets
  - Bill introduction & passage of ***legislation to open the community solar market*** in states where it is not yet enabled.
  - Program implementation that provides ***stable, fair rates and market participation structures*** that recognize and compensate community solar facilities for the full range of their grid, environmental and societal benefits.

- Expanding existing programs to support sustainable and scalable markets

- Improvements in program design to support meaningful participation by underserved communities with *the* ***inclusion of low- and moderate-income (LMI) communities*** in mind, recognizing the societal benefits and overall market opportunity that full LMI participation represents

- Product innovation by community solar providers and financiers around costs, technology and the services offered

Resources to guide a sustainable and scalable community solar future:

1. Shared Renewables Guiding Principles (Interstate Renewable Energy Council):

http://www.irecusa.org/publications/guiding-principles-for-shared-renewable-energy-programs/

2. Low Income Solar Policy Guide – Community Solar:

http://www.lowincomesolar.org/best-practices/community-solar/

3. Policy Decision Matrix and Model Legislation (Coalition for Community Solar Access):

http://www.communitysolaraccess.org/resources/

4. Smart Electric Power Alliance Community Solar Program Designs 2018:

https://sepapower.org/resource/community-solar-program-designs-2018-version/

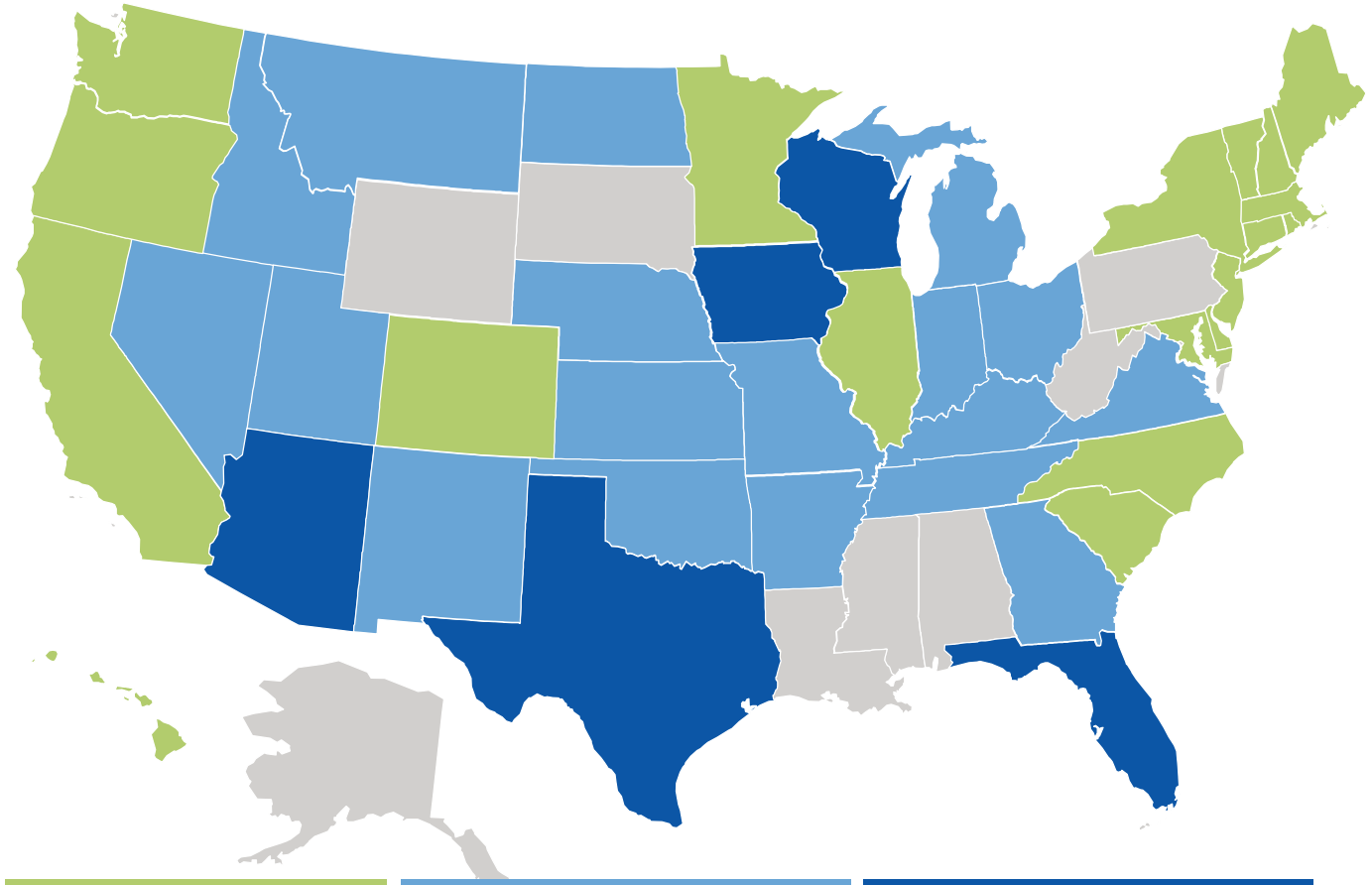
Today: A Patchwork of State-Level Policies and Utility Pilots Drive Community Solar

42 states and Washington, D.C. currently have community solar projects, but only 19 states and D.C. have statewide programs that provide an early opportunity for community solar to scale.

Voluntary utility-led community solar programs—including those initiated by investor-owned utilities, municipal utilities and rural cooperatives—provide limited access in states without state-wide policy.

Community solar is both enabled and encumbered by individual program rules and regulations on who can participate and how community solar projects and subscribers are compensated.

Although nearly every state has a community solar project, policy-enabled markets account for 71% of all currently operating community solar capacity.



Four Early Community Solar Markets in Focus

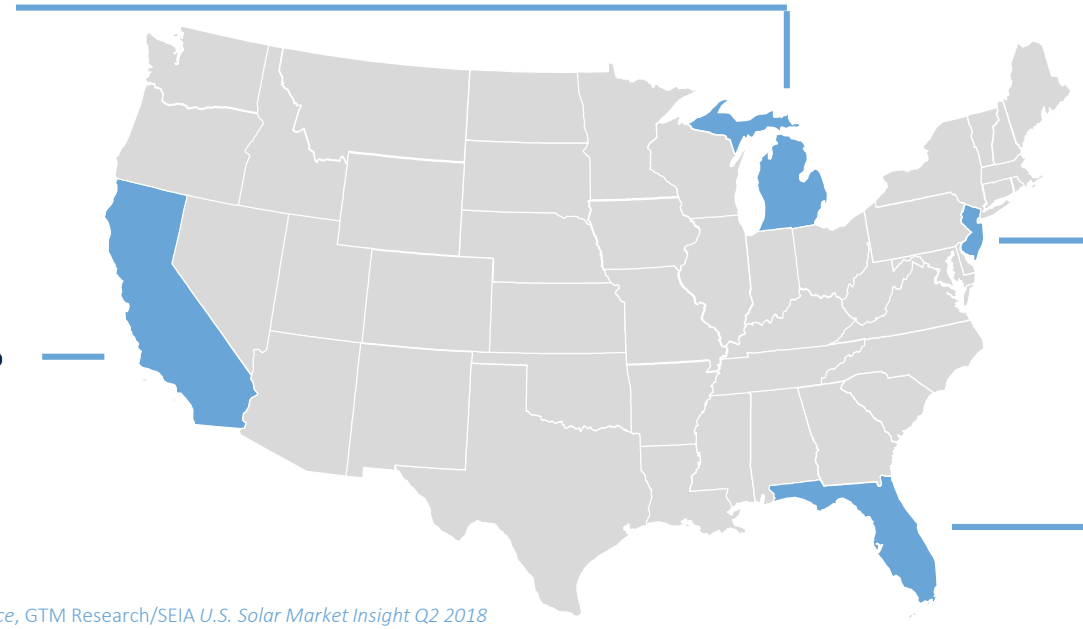
We examine four state markets in different regions with different makeups: California, Florida, Michigan and New Jersey

Two leading distributed solar states (CA, NJ) and two lagging distributed solar states (FL, MI). Each state differs in its current level of experience with community solar. NJ recently passed legislation and has yet to begin program implementation. CA also passed legislation back in 2013, but only two community solar projects from that program are under development. All operating community solar capacity in CA comes from voluntary utility-led programs administered by municipal utilities. Meanwhile, MI and FL have several voluntary utility-led programs among their investor-owned utilities, rural-electric cooperatives, and municipal utilities but lack statewide enabling legislation.

Solar Deployments in States-in-Focus as of 2017 Year End

Michigan
Total solar: **0.1 GW**
Solar as % of total load: **0.2%**
Community solar: **8.3 MW**

California
Total solar: **19.8 GW**
Solar as % of total load: **16.7%**
Community solar: **21.2 MW**



New Jersey
Total solar: **2.4 GW**
Solar as % of total load: **3.9%**
Community solar: **0 MW**

Florida
Total solar: **1.3 GW**
Solar as % of total load: **0.7%**
Community solar: **41.8 MW**

Source: Wood Mackenzie *North American Power and Renewables Service*, GTM Research/SEIA *U.S. Solar Market Insight Q2 2018*

Community Solar in California: Market Potential

California is undergoing a significant energy transition, with a 50% renewables target for 2030 and solar already providing nearly 17% of total electricity consumption — over 6% from distributed generation alone. High deployments of solar have already sparked the transition to rates that reflect the temporal value of energy with the consideration of locational benefits. Meanwhile, major load pockets are shifting away from traditional load-serving entities to community-choice aggregators, which could use distributed and community solar as a means to meet clean energy goals.

By 2030, with strong enabling policies, community solar could reach half a million subscribers, supporting hundreds of thousands of renters, LMI individuals, and businesses that have so far been left with few options in the California energy transition.

Community Solar Market Potential in California, 2030 Vision Scenarios

Total Addressable Market: **15.6 million customers**

Total Community Solar Capacity Operating: **6.3 GW to 8.2 GW**

Annual Electricity Generated: **9.4 TWh to 12.4 TWh**

- Share of State Electricity Consumption: **3.4% to 4.4%**

Subscribers Served: **747,000 to 964,000**

- Low- and Moderate-Income Households Supported: **440,000 to 550,000**

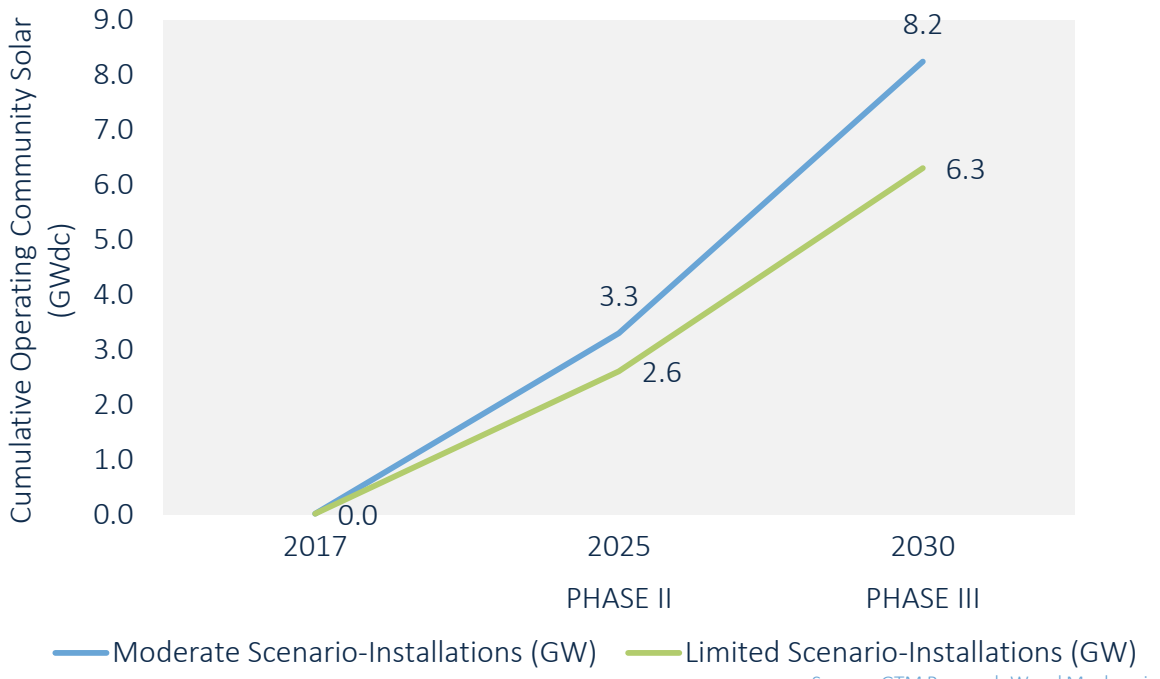
Cumulative Capital Invested*: **$9.8 billion to $12.8 billion**

Annual Spend on Operations, Leases and Taxes: **$125 million to $165 million**

Further Details on California Market Potential

*Cumulative capital invested represents total initial costs to build community solar plants, including all installation materials, labor, upfront supply chain, development and financing costs. Does not include ongoing operating costs

Community Solar in California: Market Potential



Source: GTM Research Wood Mackenzie

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Community Solar in Florida: Market Potential

Community solar in Florida could provide critical economic relief and local resiliency to vulnerable communities. By 2030, low income, moderate income and affordable housing subscribers could make up nearly half of subscriptions and one-third of electricity generated as, according to our modeling, community solar could eventually provide 25%-30% savings on LMI household bills.

Community solar's ability to be paired with energy storage and microgrids could be a key driver in also assuring that the state and utilities can ensure clean, reliable electricity to communities during hurricanes and other disasters.

Community Solar Market Potential in Florida, 2030 Vision Scenarios

Total Addressable Market: **8.9 million customers**

Total Community Solar Capacity Operating: **2.3 GW to 3.6 GW**

Annual Electricity Generated: **3.2 TWh to 5.1 TWh**

- Share of State Electricity Consumption: **1.1% to 1.8%**

Subscribers Served: **287,000 to 384,000**

- Low- and Moderate-Income Households Supported: **141,000 to 189,000**

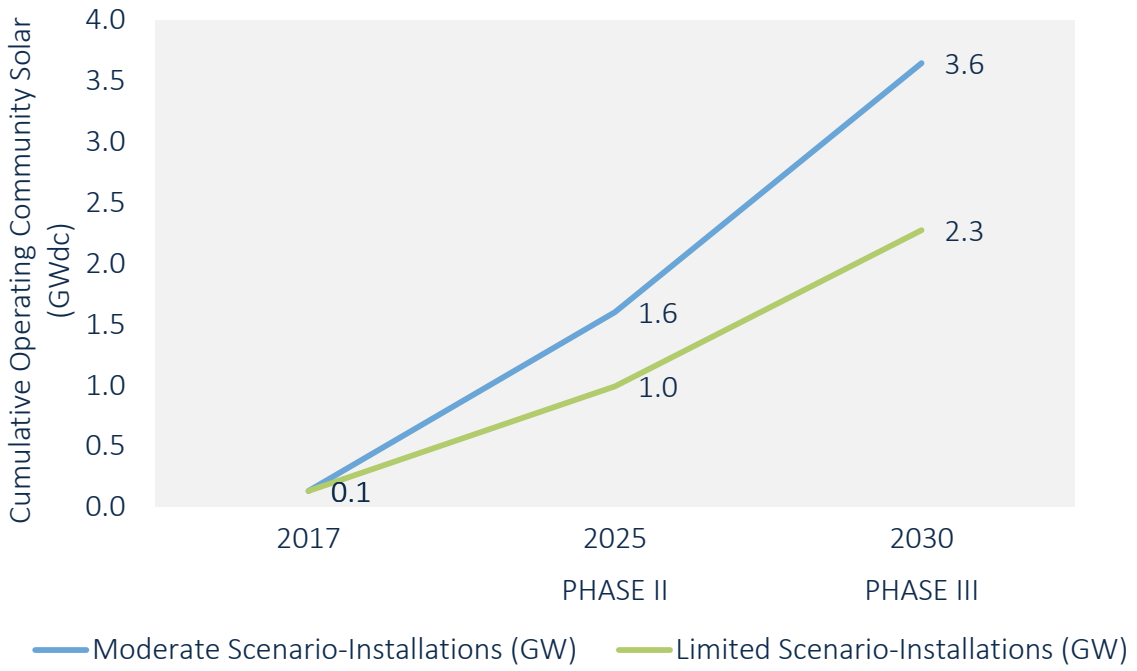
Cumulative Capital Invested*: **$3.3 billion to $4.0 billion**

Annual Spend on Operations, Leases and Taxes: **$34 million to $55 million**

Further Details on Florida Market Potential

*Cumulative capital invested represents total initial costs to build community solar plants, including all installation materials, labor, upfront supply chain, development and financing costs. Does not include ongoing operating costs

Community Solar in Florida: Market Potential



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Community Solar in Michigan: Market Potential

Community solar in Michigan could be a significant boost for distributed generation in the state. With just over 100 MW of solar installed to date and few supportive statewide policies for solar, Michigan lags nationally in the deployment of distributed generation. In the current regulatory debate around the compensation for the little distributed solar that does exist, policymakers could also look to community solar as a critical resource for ensuring all customer segments can access local clean electricity.

Community Solar Market Potential in Michigan, 2030 Vision Scenarios

Total Addressable Market: **3.9 million customers**

Total Community Solar Capacity Operating: **1.4 GW to 2.3 GW**

Annual Electricity Generated: **1.5 TWh to 2.5 TWh**

- Share of State Electricity Consumption: **1.5% to 2.4%**

Subscribers Served: **177,000 to 288,000**

- Low- and Moderate-Income Households Supported: **92,000 to 176,000**

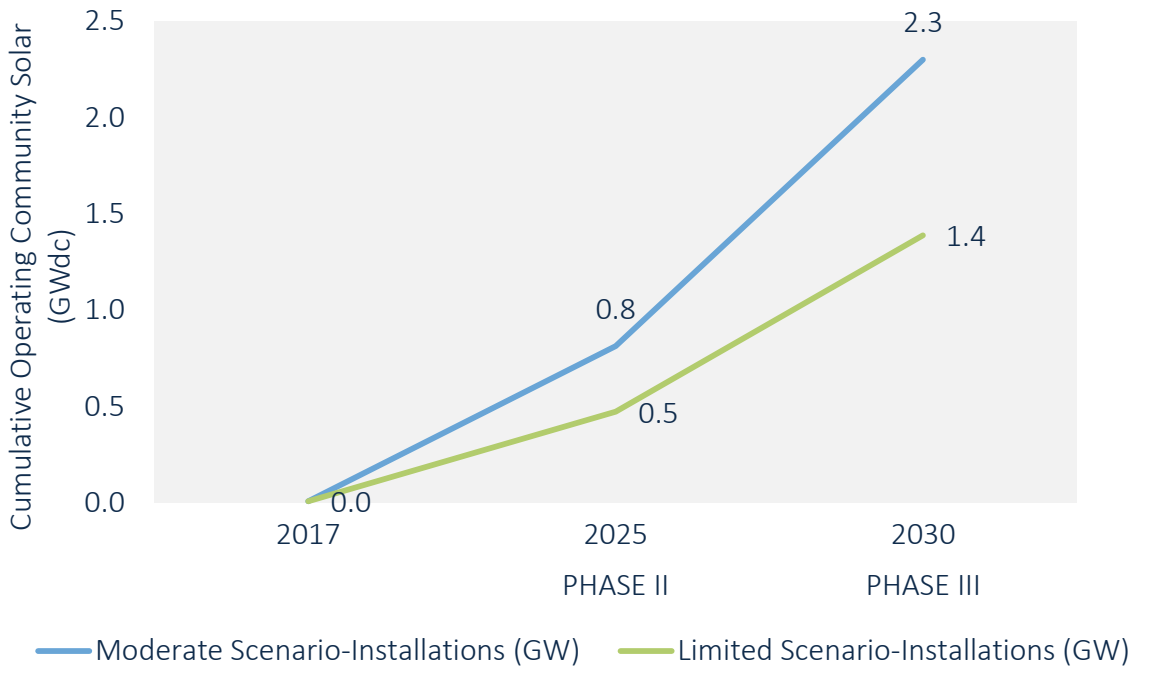
Cumulative Capital Invested*: **$2.0 billion to $3.0 billion**

Annual Spend on Operations, Leases and Taxes: **$21 million to $35 million**

Further Details on Michigan Market Potential

*Cumulative capital invested represents total initial costs to build community solar plants, including all installation materials, labor, upfront supply chain, development and financing costs. Does not include ongoing operating costs

Community Solar in Michigan: Market Potential



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Community Solar in New Jersey: Market Potential

New Jersey is in the beginning stages of incorporating community solar into its portfolio. A leader in distributed energy deployment, New Jersey recognizes the importance of setting strong solar policy. Robust design of pilots and sustained community solar programs would help residents and businesses thus far locked out of New Jersey's solar success. For example, by 2030, community solar could serve over 250,000 LMI households, including 25%-35% of all affordable housing tenants in the state.

Community Solar Market Potential in New Jersey, 2030 Vision Scenarios

Total Addressable Market: **3.6 million customers**

Total Community Solar Capacity Operating: **2.3 GW to 3.3 GW**

Annual Electricity Generated: **2.6 TWh to 3.6 TWh**

- Share of State Electricity Consumption: **3.3% to 4.5%**

Subscribers Served: **219,000 to 410,000**

- Low- and Moderate-Income Households Supported: **119,000 to 255,000**

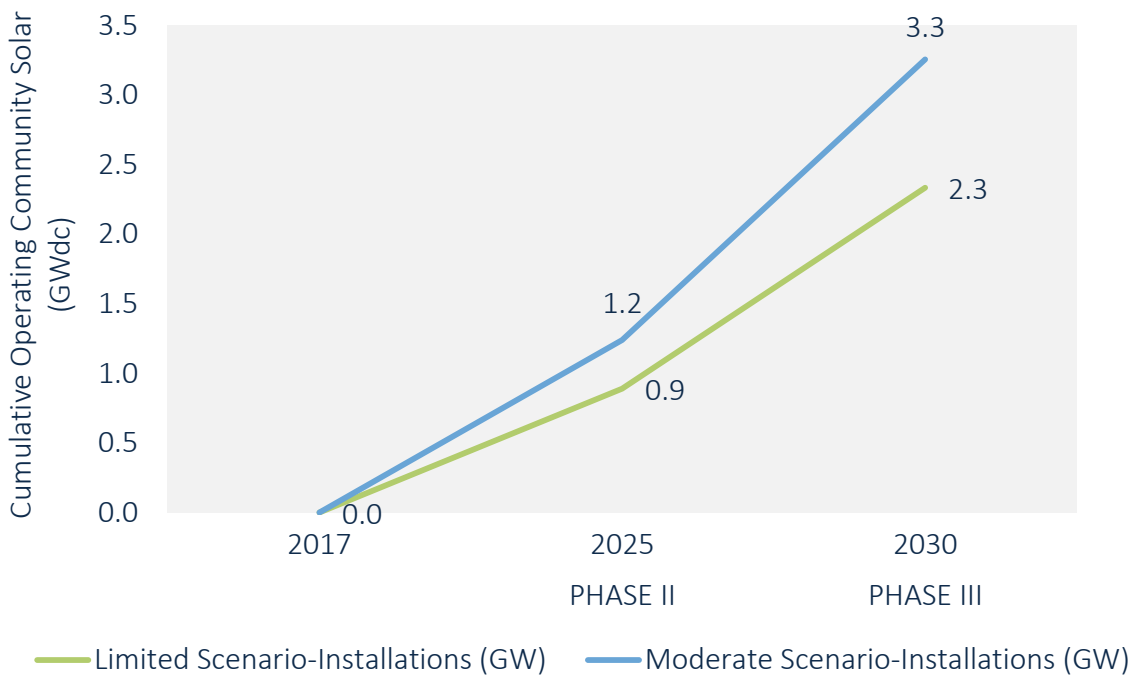
Cumulative Capital Invested*: **$2.8 billion to $4.9 billion**

Annual Spend on Operations, Leases and Taxes: **$47 million to $65 million**

Further Details on New Jersey Market Potential

*Cumulative capital invested represents total initial costs to build community solar plants, including all installation materials, labor, upfront supply chain, development and financing costs. Does not include ongoing operating costs

Community Solar in New Jersey: Market Potential



Source: GTM Research Wood Mackenzie

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Upfront Community Solar Investment in the Four States Could Top $24.3 billion by 2030

Community solar could add $1.5 billion to $2.0 billion in upfront capital investment per year in the four studied states combined through 2030. This represents private sector investment in the electricity infrastructure of the future.

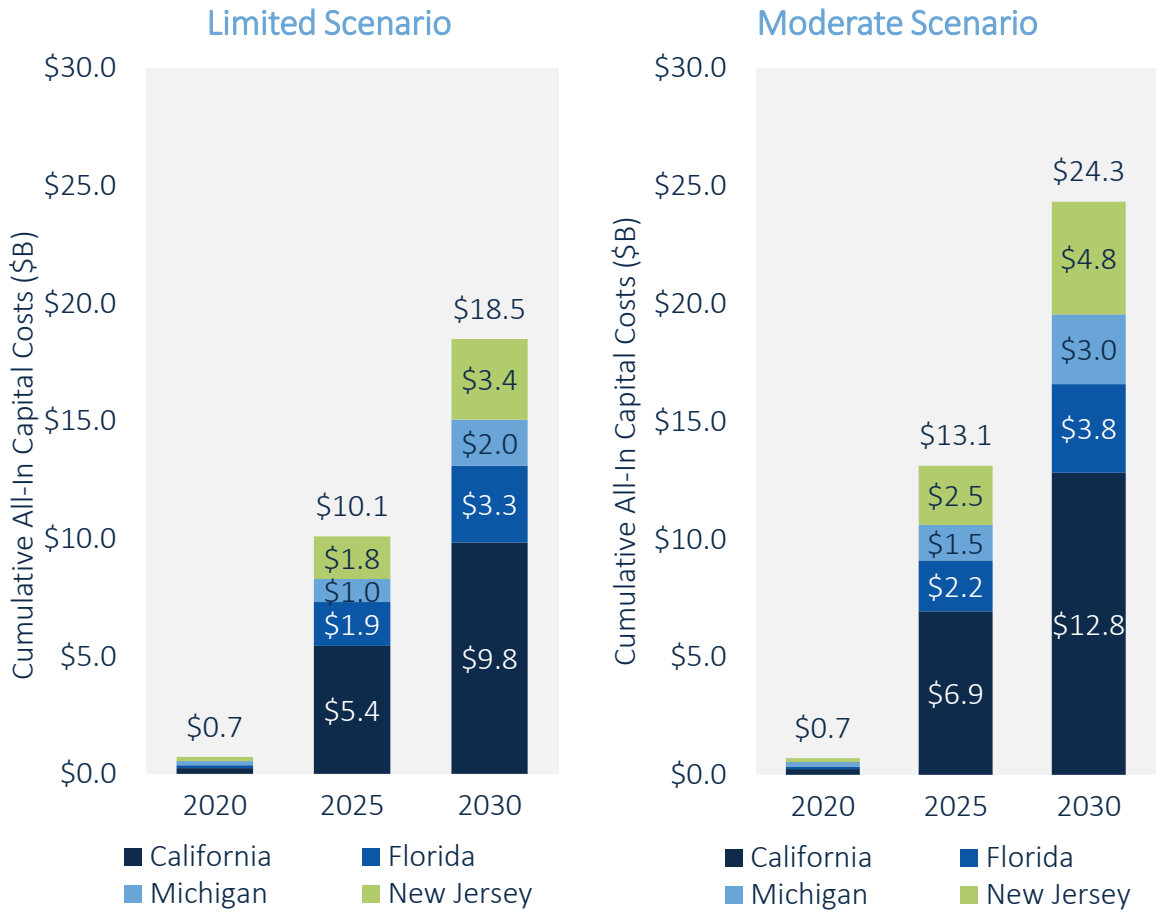
This estimate accounts for only capital expenditures for new solar installations and does not include payments from subscribers, nor ongoing costs such as land lease and property taxes.

Even in our low projection, over $18.5 billion ($1.5 billion per year) would be invested into community solar.

California leads the way, with $9.8 billion to $12.8 billion invested by 2030, triple the spend of Florida, the next highest ranked state.

Despite falling solar costs, Michigan's investment in community solar accelerates from $1.3 billion between 2020 and 2025 to $1.5 billion between 2025 and 2030.

Cumulative Community Solar Upfront Capital Expenditures



Source: GTM Research Wood Mackenzie

What If Every State Opened Its Doors to Community Solar?

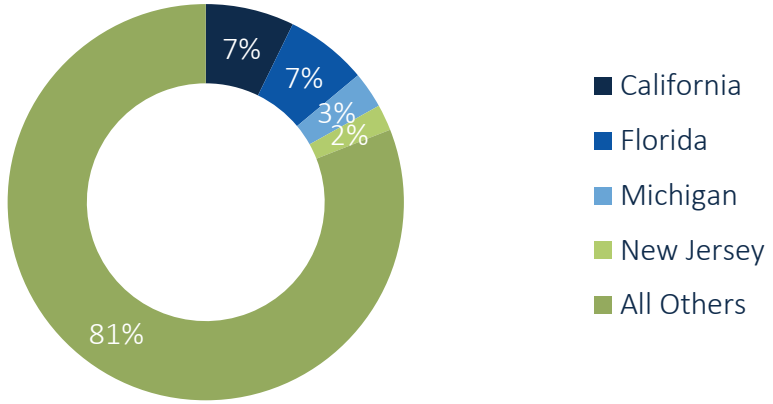
Contribution from community solar rises from a negligible share to as much as 3.1% of total energy consumption in the four states examined in the span of a decade.

The four states in focus represent one-fifth of all electricity sales nationally. Even the 19 states with current statewide community solar programs in place represent only 40% of total energy customers.

If over the next decade, every state were to adopt policies that similarly supported and valued community solar for an expanded array of customer, environmental, grid and social benefits, community solar could exceed 84 GW by the end of the next decade.

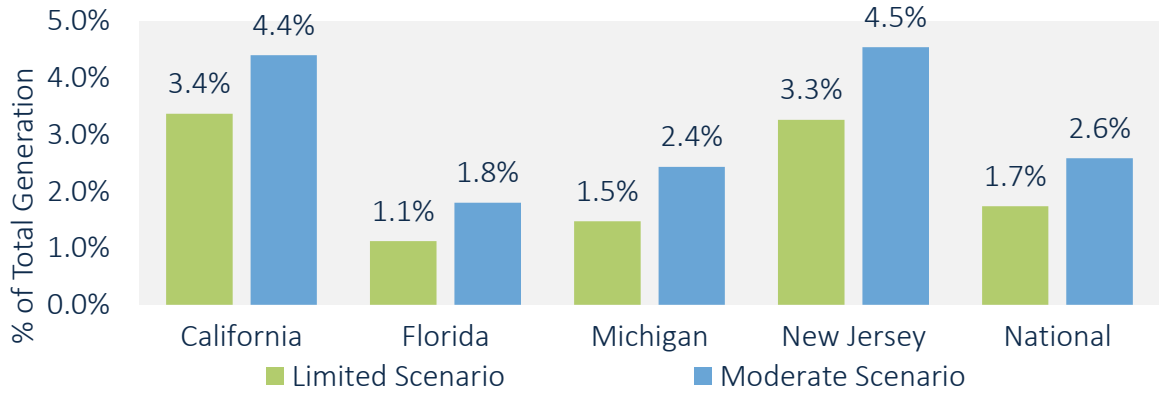
In other words, if all states were to see similar adoption rates as the four states examined (accounting for differences in state load and solar resource), community solar could supply 1.7%-2.6% of all electricity consumed in the U.S. by 2030.

State-Level Electricity Consumption as Share of National Total



Source: EIA

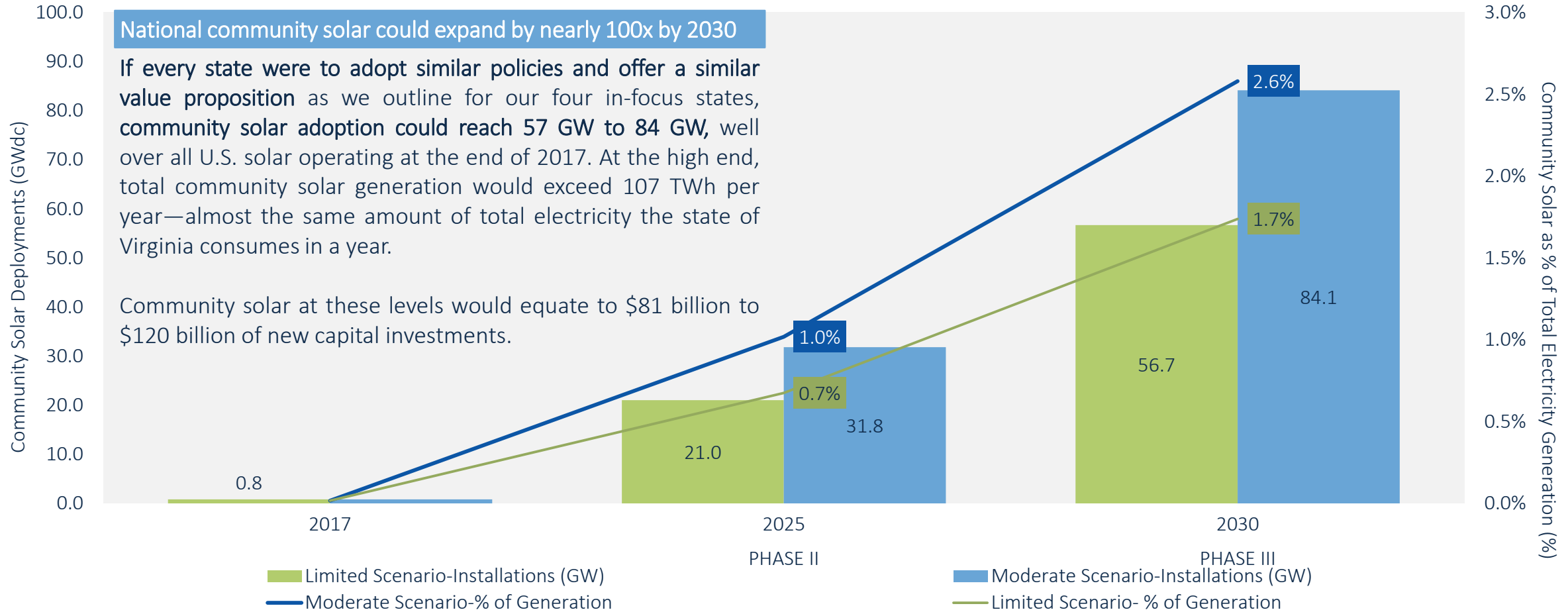
Forecasted Electricity Contribution From Community Solar by Scenario, 2030



Source: GTM Research Wood Mackenzie

Community Solar Could Reach Over 2.6% of U.S. Electricity by 2030 Equaling 57 GW to 84 GW

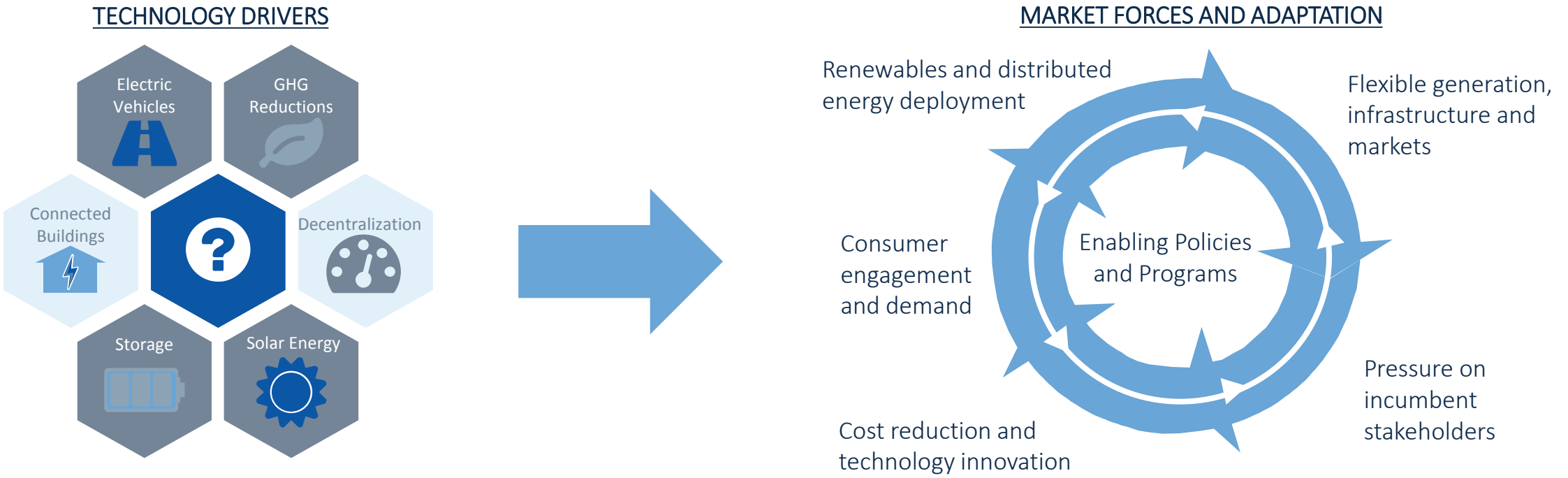
National Community Solar Installations by Scenario (Assuming All States Adopt Forward-Looking Community Solar Policies)



Source: GTM Research Wood Mackenzie

The Next Decade: The Power Sector is Changing – and Invites Community Solar Innovation

Community solar can be a foundational pillar in the ongoing and future power market transformation — one driven by more engaged customers that demand decentralized and decarbonized energy. In this future, distributed solar — including community solar — becomes a platform for a holistic clean, local, reliable and flexible energy service that opens up opportunities for flexible investment and business models in combination with other onsite and co-located distributed energy resources.



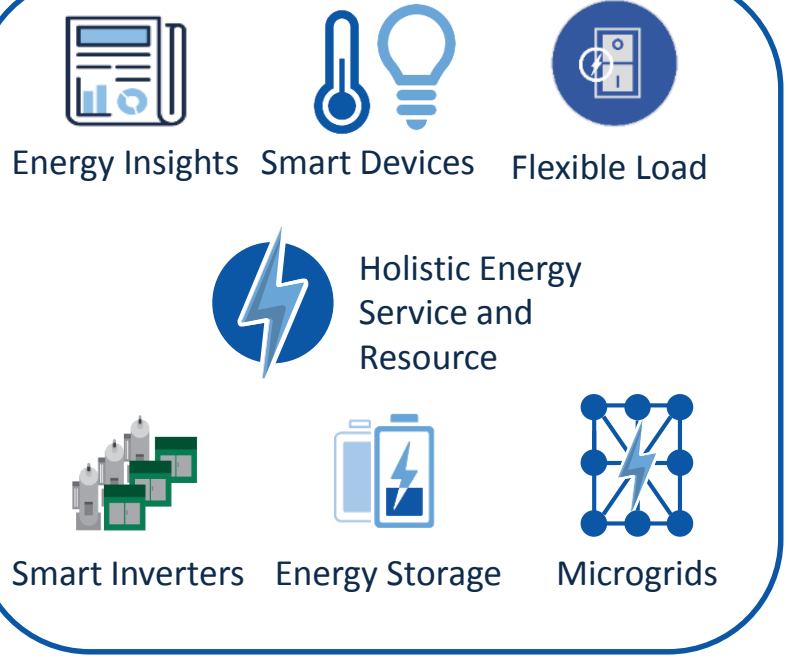
Embracing New Distributed Energy Technology Will Increase the Value of Community Solar

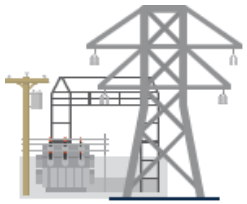
Community solar facilities will evolve, both as a virtual interactive energy platform and as a physical energy resource.

Community Solar Subscribers

Community solar operators will need to interact with subscribers beyond a bill, forming a holistic energy service.

Subscribers will receive tailored insights into their energy use, resulting in adoption of new devices and services that further increases the efficiency and lowers the cost of their energy use.





Utilities and the Electricity Grid

Community solar will create value beyond the energy generated — initially from offsetting new generation capacity, transmission and distribution assets, and longer term, in the form of flexibility and resiliency as community solar facilities are co-located with other distributed energy hardware.

A Market Transformation in Three Phases

Transformative growth of community solar will not happen overnight. Improvements in program design and implementation, financing solutions, and customer-focused offerings can expand solar access to all customer types. Proper valuation methodologies are critical to support community solar in a changing market landscape, and inclusive policies are essential to ensure equitable access for underserved communities

We envision a path through three phases: **1) Market Emergence, 2) Market Transition** and **3) Market Maturity**

PHASE I: Market Emergence

Community solar is still in pilot or early stages, driven primarily by early programs or virtual net metering programs with shifting compensation mechanisms. Community solar is proving itself to regulators, customers and investors.

PHASE II: Market Transition

Lessons from Phase I are incorporated. Community solar benefits from cost reductions through product innovations, streamlined program administration and investor trust. Improved program design and financing solutions encourage and increase LMI participation. Regulators, utilities and community solar stakeholders negotiate the benefits and the compensation for community solar.

PHASE III: Market Maturity

Community solar is an attractive offering to customers that delivers recognized benefits in the forms of cost savings, cost visibility, environmental attributes, grid value, local societal and economic support, and energy resiliency.

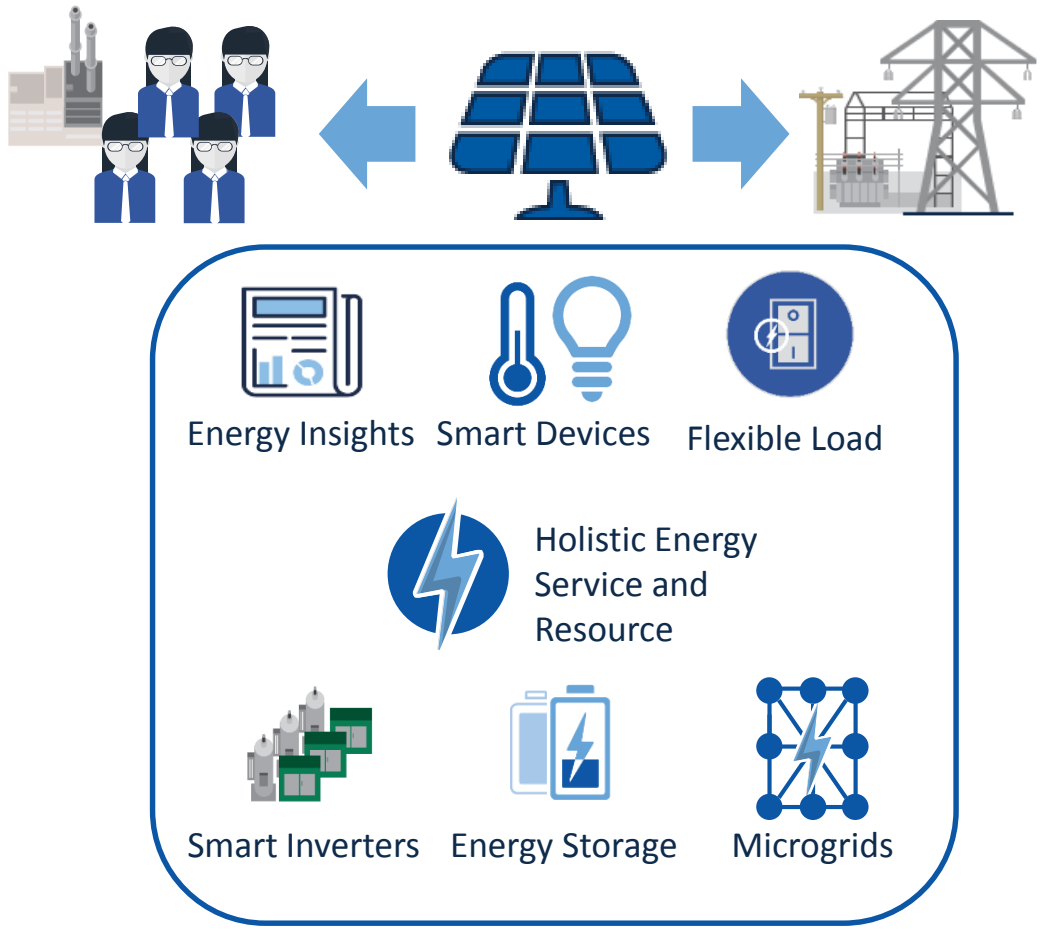
Community Solar at Scale: Looking Beyond 2030

Our 2030 Vision Represents an Early Milestone

Even though it is already supplying millions of new adopters of solar, community solar is just starting its journey as a mainstream energy source. Even under our most ambitious adoption forecast for 2030, community solar serves just 8.8 million out of the 75 million to 113 million households and businesses that lack access to onsite solar.

As community solar operators continue to innovate on the service offering by packaging energy insights and smart energy devices for their subscribers and incorporating physical grid assets like smart inverters and energy storage into their facilities, community solar will transition into a holistic energy service and resource.

As policymakers, utilities and the solar industry continue to deliberate the evolution of electricity rates and energy value, community solar can play a central role in providing benefits for all parties: predictable cost savings for consumers, financial value for operators, grid resilience, local environmental benefits and economic development — as long as policy and innovation evolve to meet these goals.



2. Introducing the Vision for Community Solar

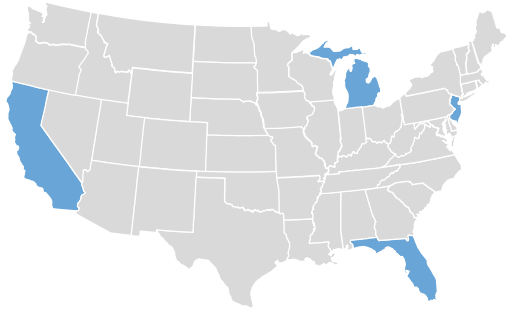
Realizing the Value of Community Solar

A Vision for Community Solar: Study Overview

We establish a vision for a market where community solar is a mainstream option for consumers to choose and control their own energy generation — especially for those lacking access to traditional solar options, such as renters and the low- and moderate-income community.

This Vision for Community Solar:

- Outlines Benefits of Community Solar and Subscriber Preferences
- Addresses Key Bottlenecks to the Expansion of Community Solar
- Provides Strategies to Enhance Inclusivity of Low- and Moderate-Income Populations
- Walks through National Market Potential and Forecasts for Community Solar along with Deep Dives in 4 States:
  - California
  - Florida
  - Michigan
  - New Jersey
- Presents the National Impacts of Community Solar Market Transformation



Community Solar Makes Solar an Option for Everyone with an Electric Bill

U.S. consumers want solar…

The number of solar energy systems purchased by U.S. homeowners and businesses has grown tenfold since 2010. By the end of 2018, nearly 2 million homeowners and businesses will produce their own solar energy.

…and solar is getting more affordable

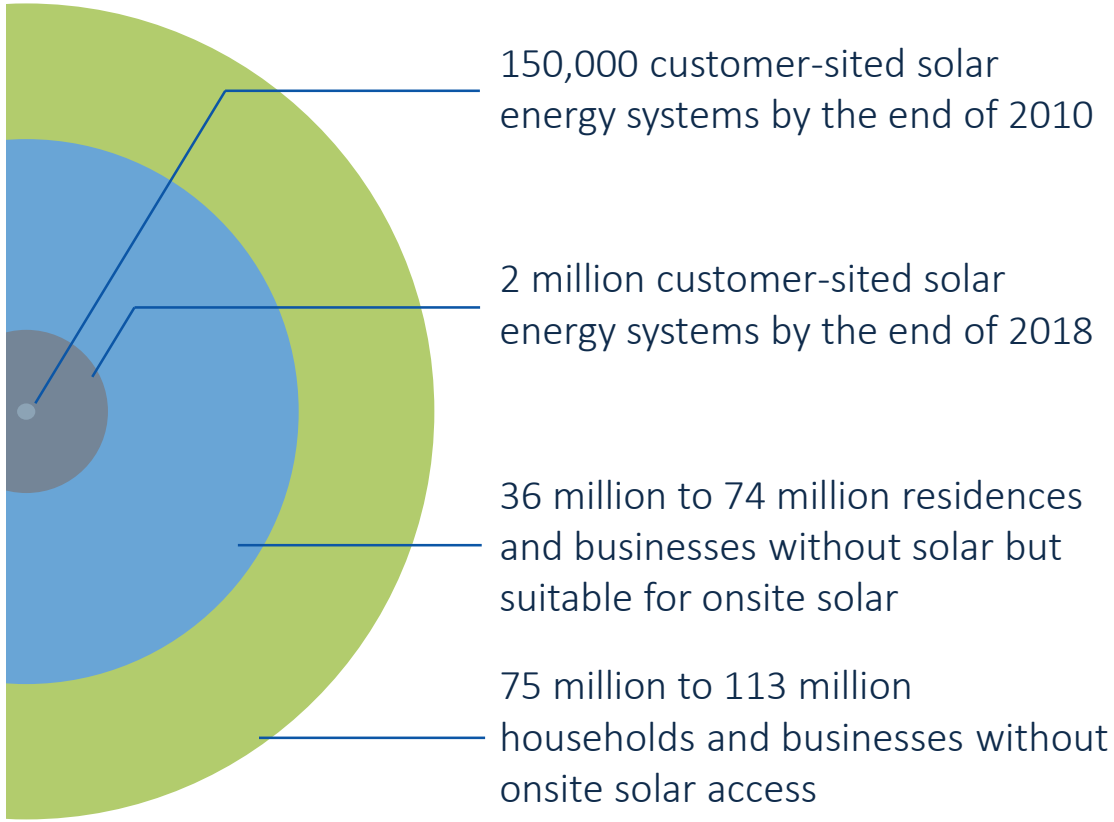
The price of rooftop solar has fallen by 40% in the past five years and currently beats the average retail price of electricity in 27 states and Washington, D.C.

…but access to solar is limited.

Between 50% and 75% of U.S. consumers cannot access traditional rooftop solar, either because they do not own their roof or due to technical restrictions. Community solar gives all 151 million electricity customers in the U.S. an opportunity to directly participate in solar.

Community solar gives all customers the ability to choose local clean electricity that can support local economic development, resiliency and healthier communities.

Community Solar Can Reach All Potential U.S. Customers



Source: GTM Research Wood Mackenzie, GTM Research/SEIA, NREL, EIA, U.S. Census

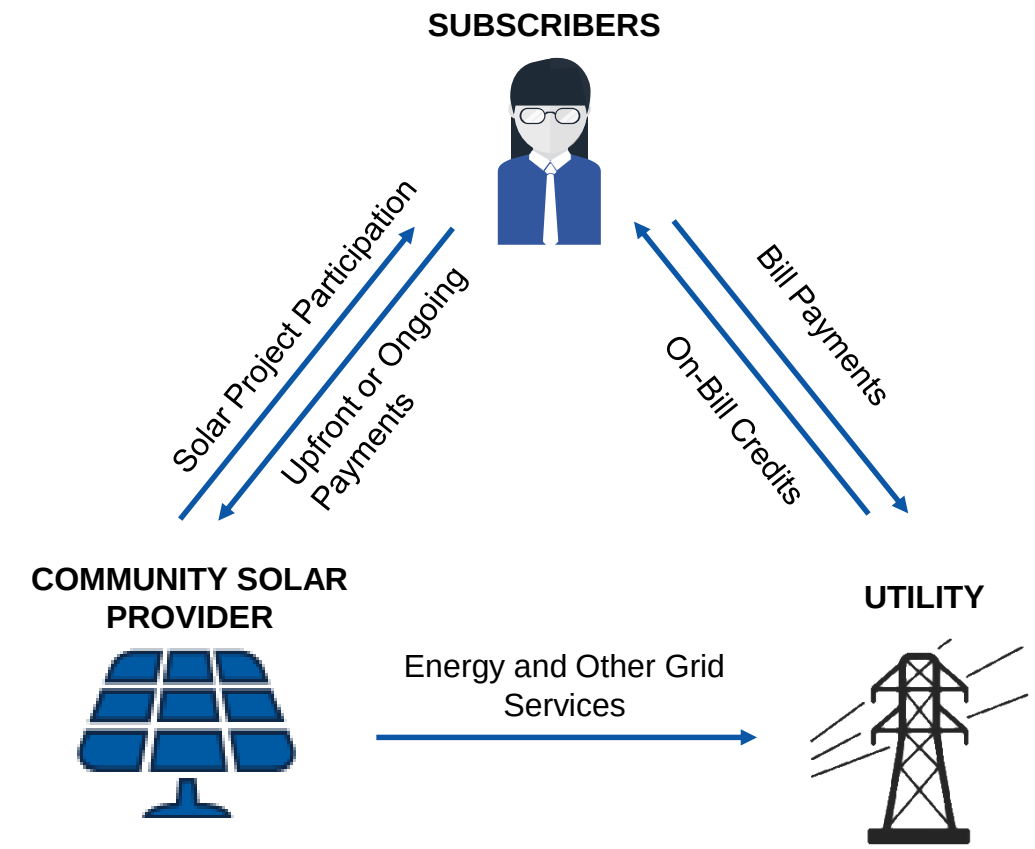
Defining Community Solar

Community solar – also called shared solar or solar gardens – refers to local solar facilities shared by multiple subscribers that receive credit on their electricity bills for their share of power produced.

Over the years, many projects have been labeled community solar, but we define **community solar** as a solar project with **multiple subscribers that receive on bill benefits directly attributable to the community solar project**.

- Subscribers must be credited with the benefits of community solar on their electric utility bills, either in the form of a monetary or energy (kWh) credit
- Subscribers must be tied to a specific solar project of which they are direct subscriber, not generic renewable certificates

The Community Solar Model

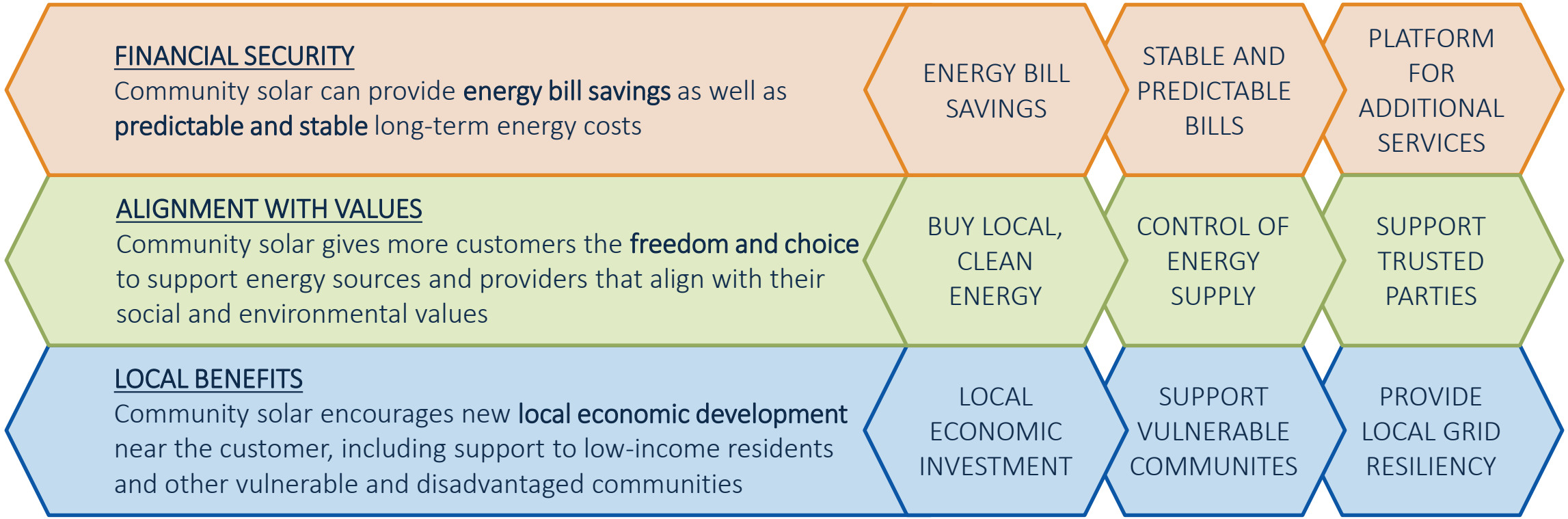


Source: GTM Research Wood Mackenzie

Community Solar Extends Key Benefits of Distributed Solar to a Broader Set of Consumers

Community solar expands the important benefits of distributed solar to a much broader set of consumers, while also bringing unique solutions to the physical, financing and equity barriers of on-site solar and retail electricity.

Community solar is an energy source that ultimately provides:

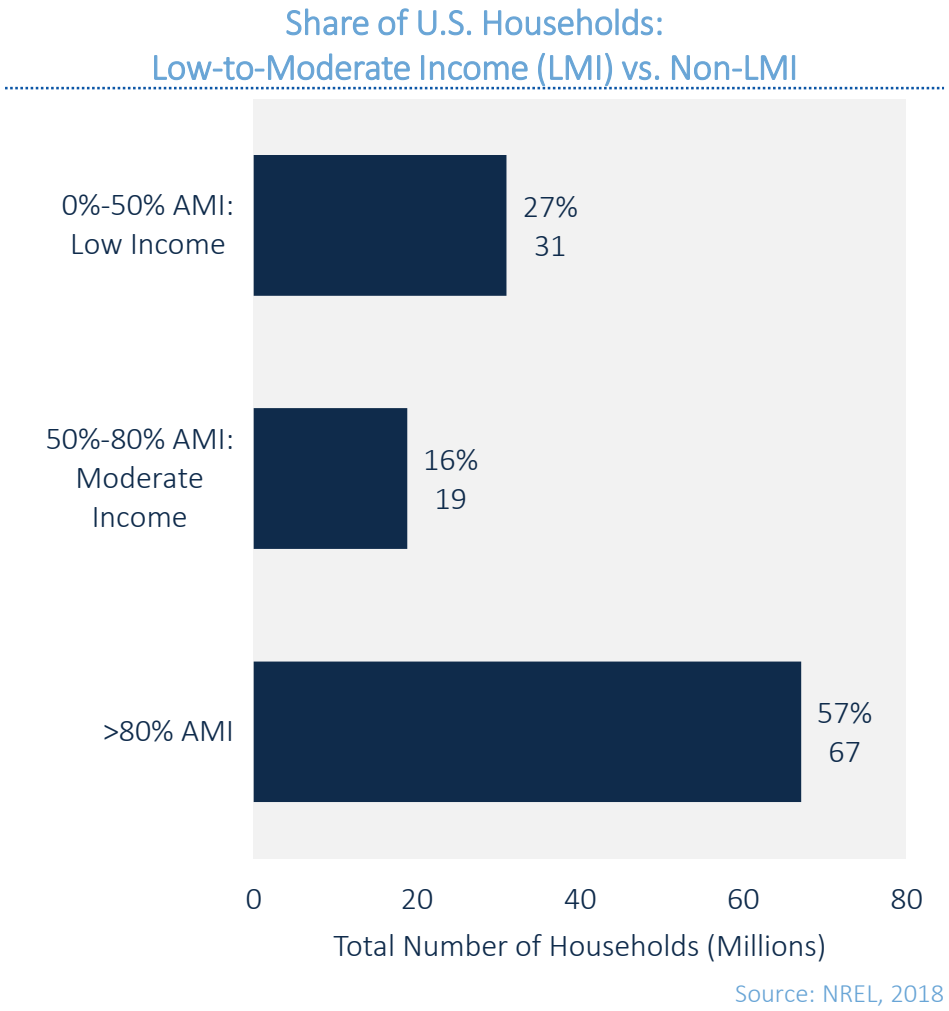


Community Solar Can Empower Communities Most in Need

50 million reasons why community solar needs to tap into the low-to-moderate income customer segment

Why community solar is the key to unlocking 50 million low-to-moderate income (LMI) households' access to clean, affordable energy solutions…

- The LMI subscriber opportunity is massive, accounting for approximately 43% of U.S. households. Of that total, there are 31 million low-income households, 19 million moderate-income households, and 5.78 million affordable housing properties across the U.S. that would benefit from cost-saving community solar solutions.
- Community solar provides the flexibility to deliver clean energy access to all LMI customers, including renters and multifamily housing – of which LMI households are more likely to occupy.
- Community solar also offers significant benefits to low-income customers, including opportunity for bill savings and energy burden reduction, targeted, flexible value propositions tailored to LMI customers' unique needs, and local economic opportunity to drive the clean energy transition.
- At the same time, the LMI subscriber opportunity remains untapped, in large part due to higher costs to acquire LMI subscribers and limited access to capital for community solar projects involving LMI subscribers.
- But with the right combination of policy solutions, incentives, consumer protections, business model innovations, financing and programmatic support, there's an opportunity for community solar to play a critical role in creating an equitable clean energy future.
  - Targeted policy, financing and subscriber management solutions can reduce the perceived risk of serving LMI households and deliver significant benefits to LMI customers.



Source: NREL, 2018

An Equitable Transition to Serve Communities of Color and Environmental Justice Communities

Communities of color and environmental justice communities must also have equitable access to clean energy solutions

- LMI households are not the only customer segment that must proactively be included in solar markets moving forward. This work must also extend to communities of color and environmental justice communities. **Community solar can be used as a tool to target benefits to communities who have historically been at the front lines of environmental pollution and negative impacts from traditional energy generation.**
  - Fossil fuel power has disproportionately impacted the health and well-being of low-income communities, particularly communities of color and indigenous communities. Emissions from power plants sited in these communities contribute to high rates of asthma and cancer, and the presence of heavy industry contributes to a cycle of poverty and public disinvestment in neighborhoods that can least afford it.
  - Approximately 68% of African Americans live within 30 miles of a coal-fired power plant and nearly 40% of communities of color breathe polluted air. Meanwhile, environmental justice communities are disproportionately affected by public health effects of traditional generation.

Policymakers can target the benefits of community solar to communities of color and environmental justice communities through a number of strategies. Support can include program carve outs, job training programs, project ownership, siting preferences and incentives specifically focused on communities who have been disproportionately impacted by the electric system to date.

- Such solutions would not only provide **workforce development opportunities**, but also enable legislators and regulators to better quantify and measure **public health benefits** of community solar that displaces the need for fossil fuel generation.
- This report acknowledges that environmental justice communities and communities of color are critical to serve in the nation's transition to a low-carbon electricity system. Analysis of community solar's addressable market focuses on low and moderate income households, affordable housing owners and affordable housing tenants.

Source: Low-Income Solar Policy Guide, 2018

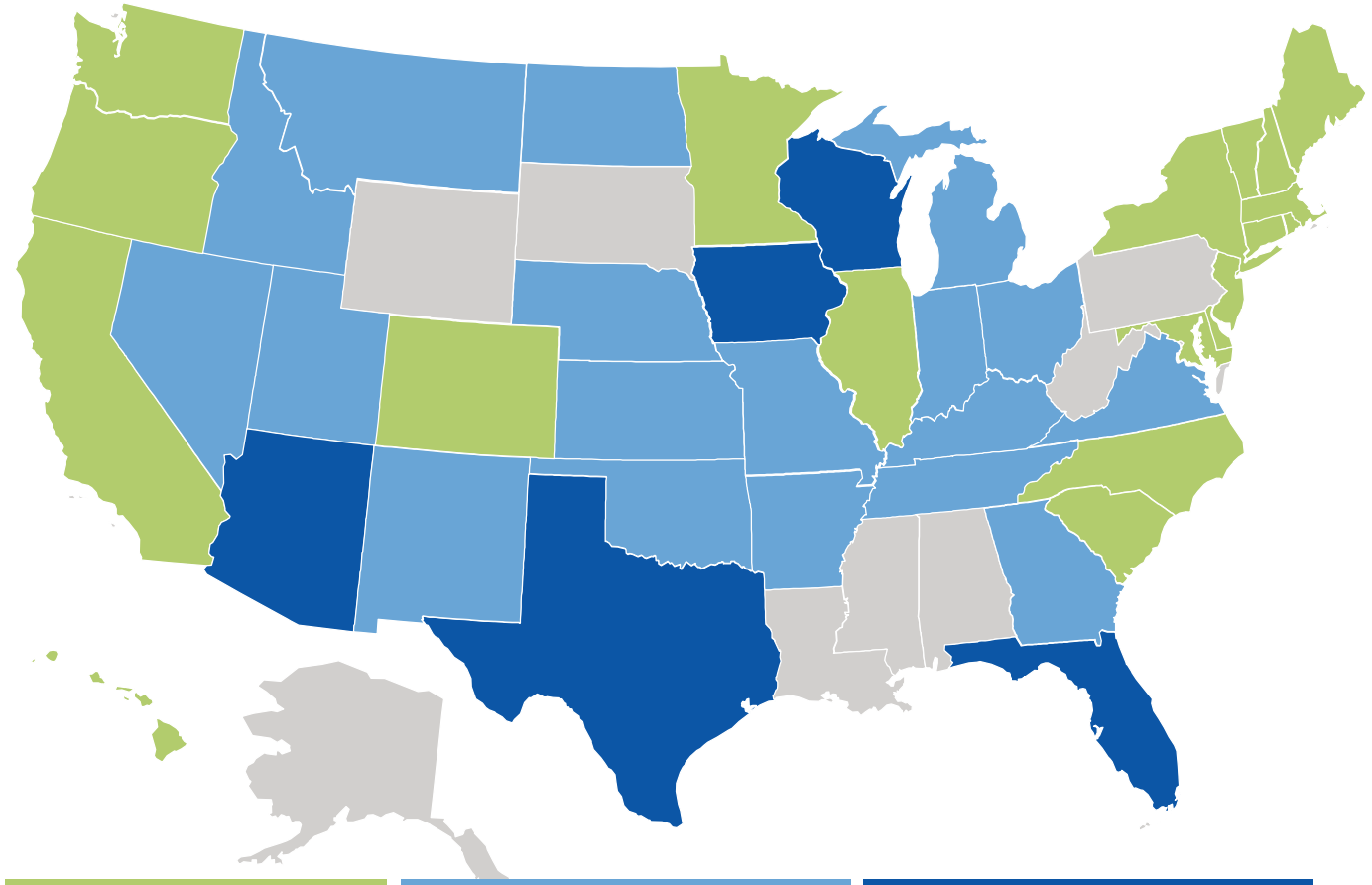
Today: A Patchwork of State-Level Policies and Utility Pilots Drive Community Solar

42 states and Washington, D.C. currently have community solar projects, but only 19 states and D.C. have statewide programs that provide an early opportunity for community solar to scale.

Voluntary utility-led community solar programs—including those initiated by investor-owned utilities, municipal utilities and rural cooperatives—provide limited access in states without state-wide policy.

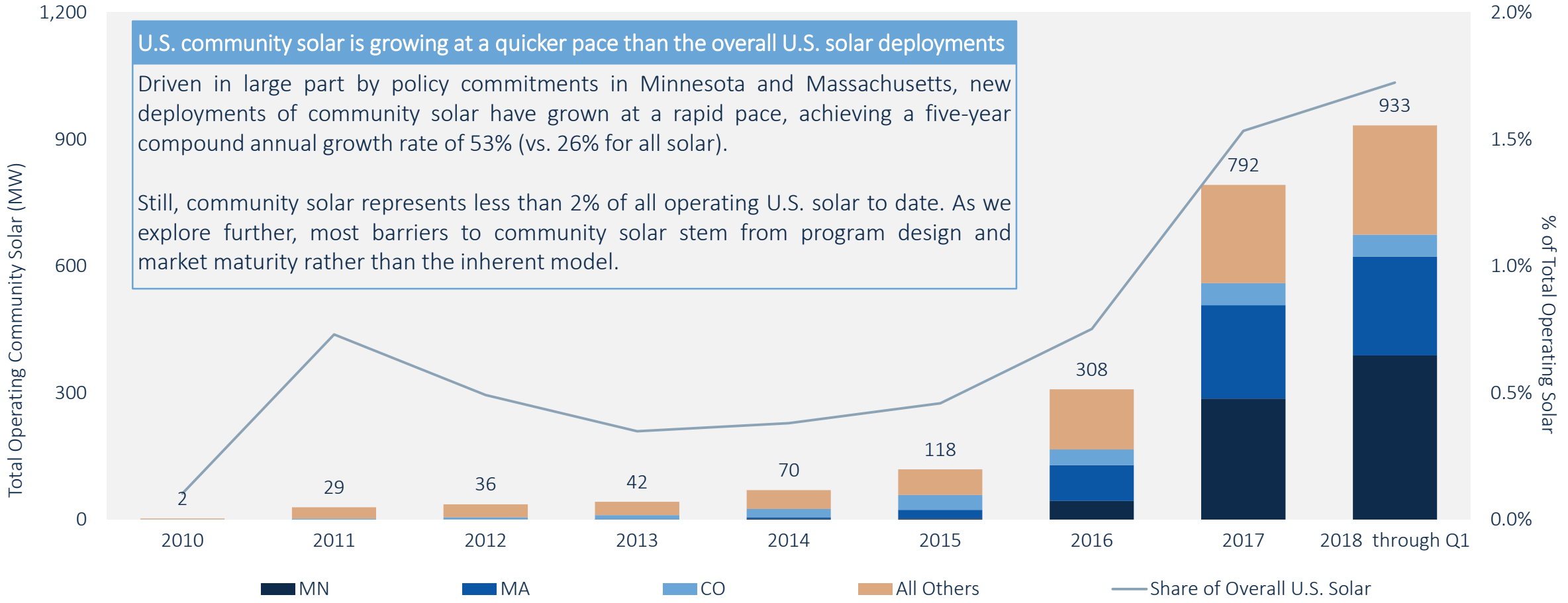
Community solar is both enabled and encumbered by individual program rules and regulations on who can participate and how community solar projects and subscribers are compensated.

Although nearly every state has a community solar project, policy-enabled markets account for 71% of all currently operating community solar capacity.



U.S. Community Solar Nears 1 GW of Total Capacity Operating Nationwide

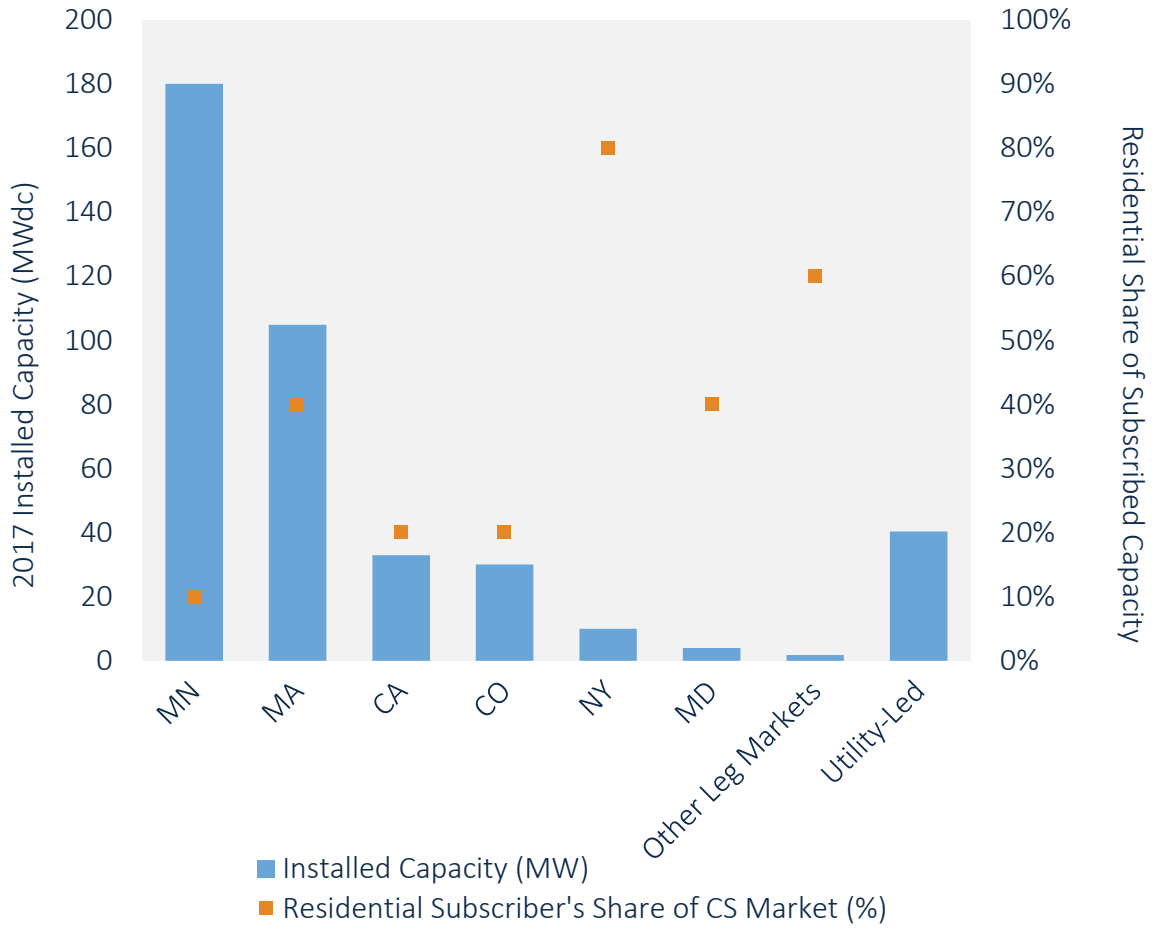
Cumulative U.S. Community Solar Installed Capacity by State



Source: GTM Research Wood Mackenzie

Community Solar Subscriber Mixes Vary Between Markets

Estimated Subscriber Mix of Community Solar by Subscription Size, 2017



Source: GTM Research Wood Mackenzie

Non-residential (e.g., commercial, nonprofits, government) entities made up 73% of all community solar subscribed capacity in 2017

- Program design and local rates strongly influence the participation mix. For example, the high national non-residential mix is in large part driven by Minnesota's large volume and policy that results in high participation of commercial entities. **Excluding Minnesota, the national residential subscription share rises to 36%.**
- All other variables held equal, non-residential subscribers tend to be more attractive to community solar providers due to creditworthiness and large subscription size. Policymakers seeking subscriber diversity must craft a balance between supporting a mix and being overly prescriptive.
- Expect increasing residential participation in 2018 as new programs come online and policymakers realize the importance of increasing residential participation.

Because program design and subscription features can strongly influence subscriber mix, we explore motivations of various subsets of residential and non-residential subscribers so that programs can more aptly address consumer needs.

Key Solutions to Unlock Community Solar's Potential

- Enabling policy to open viable new markets
  - Bill introduction & passage of ***legislation to open the community solar market*** in states where it is not yet enabled.
  - Program implementation that provides ***stable, fair rates and market participation structures*** that recognize and compensate community solar facilities for the full range of their grid, environmental and societal benefits.

- Expanding existing programs to support sustainable and scalable markets

- Improvements in program design to support meaningful participation by underserved communities with *the* ***inclusion of low- and moderate-income (LMI) communities*** in mind, recognizing the societal benefits and overall market opportunity that full LMI participation represents

- Product innovation by community solar providers and financiers around costs, technology and the services offered

Resources to guide a sustainable and scalable community solar future:

1. Shared Renewables Guiding Principles (Interstate Renewable Energy Council):

http://www.irecusa.org/publications/guiding-principles-for-shared-renewable-energy-programs/

2. Low Income Solar Policy Guide – Community Solar:

http://www.lowincomesolar.org/best-practices/community-solar/

3. Policy Decision Matrix and Model Legislation (Coalition for Community Solar Access):

http://www.communitysolaraccess.org/resources/

4. Smart Electric Power Alliance Community Solar Program Designs 2018:

https://sepapower.org/resource/community-solar-program-designs-2018-version/

Introducing the Vision for Community Solar

What Subscribers Want

Motivations for Boosting Distributed Solar Translate to Community Solar

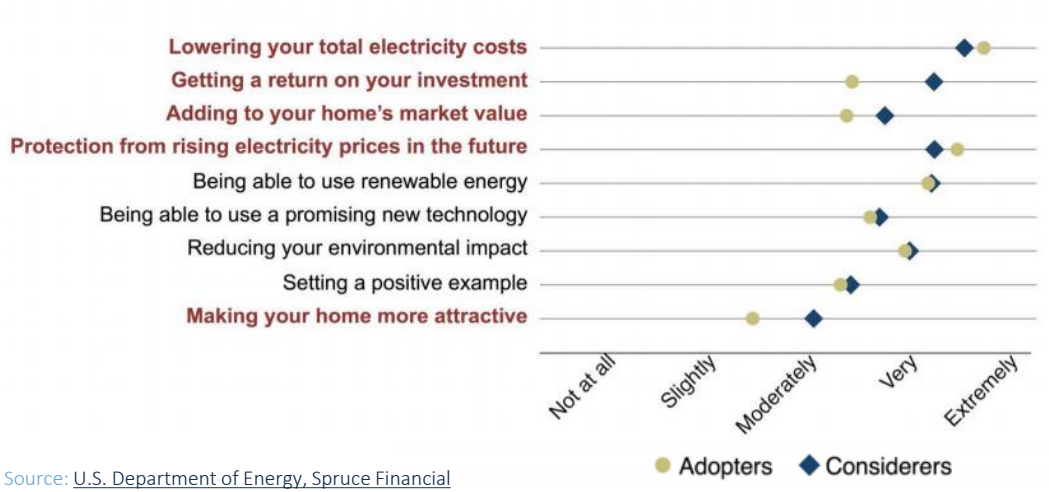
Community solar offers several benefits of distributed solar generation, including:

- Electricity cost savings and predictable long-term energy costs
- Environmental benefits from clean energy, including healthier communities and climate change mitigation
- Locally produced generation

In addition, community solar mitigates some key customer concerns about rooftop solar:

- How much maintenance will be required
- Risk of damaging the roof during installation and operation
- Aesthetics, for those who do not prefer the look of rooftop solar
- Reduces the steps and potentially lag between customer sign up and receiving solar benefits
- Costs, as greater economies of scale can help to deliver a lower cost of solar energy

Motivations for Rooftop Solar by Adopters and Considerers



Source: U.S. Department of Energy, Spruce Financial

Economic motivations dominate decision-making, but other motivators should not be discounted

- A Department of Energy SEEDS program survey of 3,600 households found that solar economics were the primary motivating factors, but also that reduction of environmental impacts and use of renewables ranked highly.

GTM Research interviews with developers and customers reveal a similar set of economic and environmental motivations for community solar subscriptions

Community Solar Subscribers Value a Breadth of Financial and Non-Financial Benefits

Average Score to "Rate the Importance of the Following Attributes to You / Customer Constituencies You Work With"—All Subscriber Segments

Source: GTM Research Wood Mackenzie

From a survey of over two dozen community solar operators and subscriber organizations, we find that:

Community solar economics are important…

Subscribers overwhelmingly chose community solar due to financial options and benefits:

- Over 60% of responses ranked "tangible economic savings" as the most important factor of a community solar subscription
- The second and third most important factors were, respectively, a predictable cost of electricity and compelling finance options (e.g., zero-down leases and pay-as-you-go models)

…but non-financial benefits need to be included

- Simplicity is the highest rated non-financial benefit identified, referencing an easy-to-subscribe and intuitive process to procure solar energy
- Subscribers also care about *who* is administering the program, meaning trust is important. But that can mean local organizations, private developers or a local utility, depending on the party.
- While subscribers may not universally value economic co-benefits highly (e.g., workforce development), other stakeholders, such as community leaders, policymakers and regulators, will.

Residential Customer Segments Universally Value the Simplicity of Community Solar

TYPICAL RESIDENTIAL

LOW- AND MODERATE-INCOME

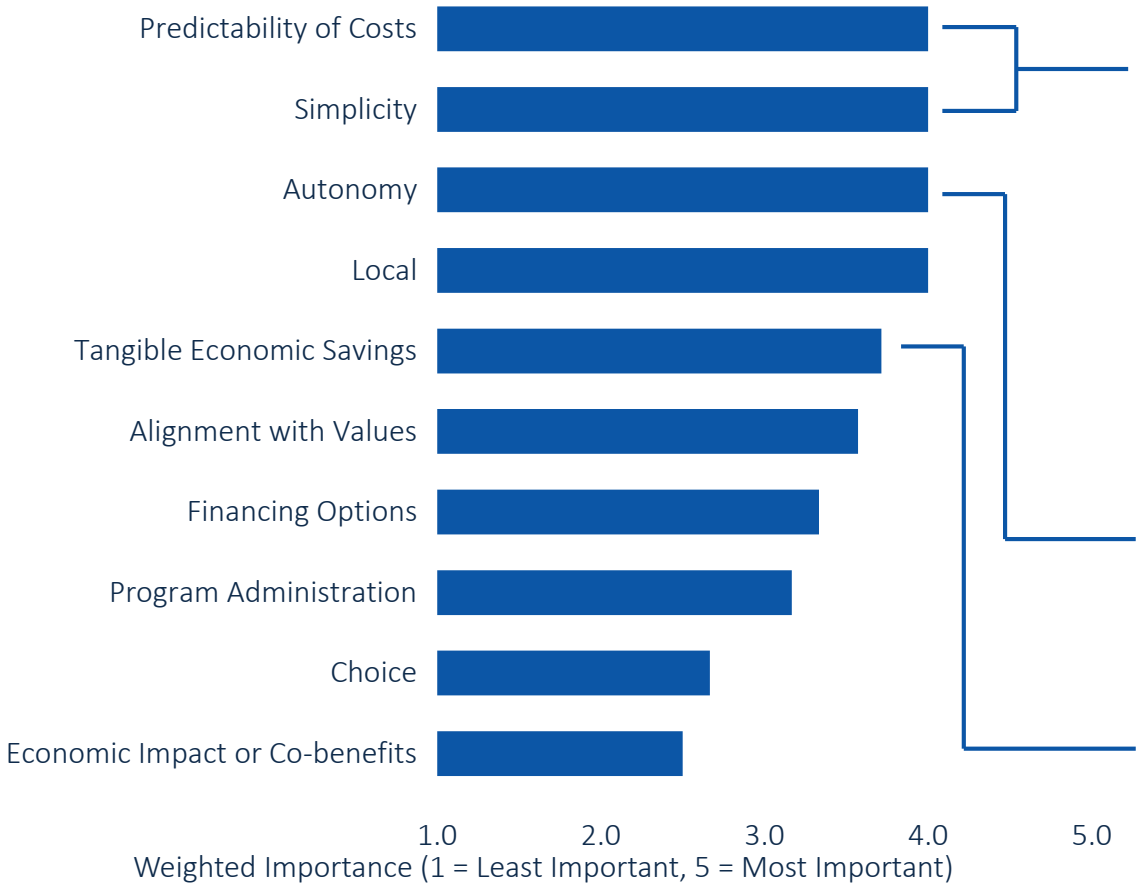
AFFORDABLE HOUSING

Unsurprisingly, economic and financial benefits bubble to the top — tangible savings are key for LMI customers and affordable housing operators, while predictability is key for traditional residential subscribers. Simplicity is universally strongly valued, as most residential customers lack tools and patience to digest complex energy concepts.

LMI subscribers require greater savings, but less-tangible community solar benefits such as alignment with personal values and local impacts are still rated as important and shouldn't be ignored.

Residential Subscribers Are Looking for Simplicity and Predictability of Costs

Average Score to "Rate the Importance of the Following Attributes to Potential Residential Customers"



Source: GTM Research Wood Mackenzie

Residential subscribers are primarily looking for predictable energy costs where the benefits and terms are simple to understand. Interviews indicate that:

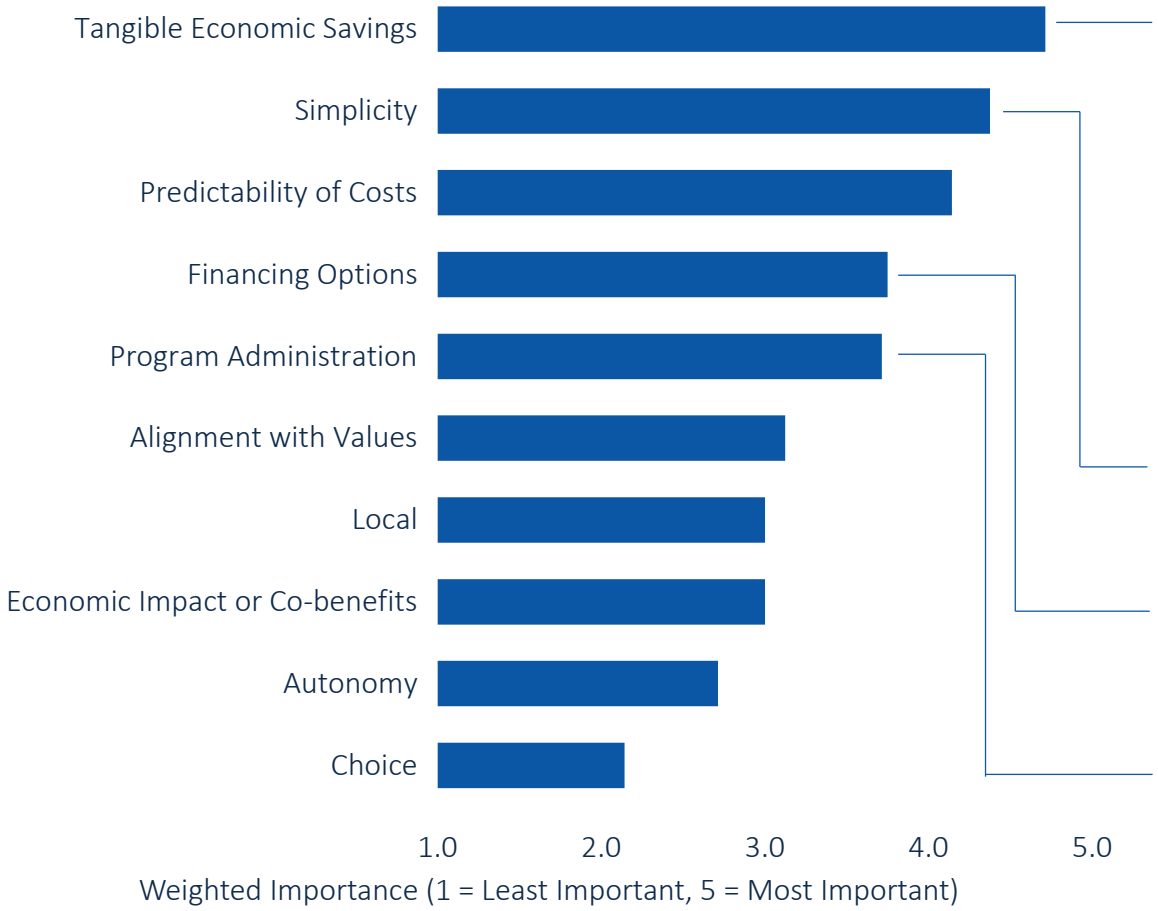
- Rate escalators and double bills (one from utility and another from community solar operator) result in more difficult communication around savings
- Short-term contracts may be needed to attract renters, who may not be willing to sign up for 15- to 25-year contracts that include exit fees

Residential subscribers are looking for more independence in their supply and consumption of energy — something that a mature community solar subscription offering can increasingly provide

While not the primary motivator, residential subscribers still want savings on their energy bills. Community solar operators and lead generators indicate that 5%-15% savings is typically considered desirable

Low- and Moderate-Income Subscribers Require Significant Cost Savings

Average Score to "Rate the Importance of the Following Attributes to Potential Low- and Moderate-Income Customers / Constituents You Work With"



Source: GTM Research Wood Mackenzie

Low- and moderate-income subscribers put top priority on tangible economic savings from community solar, and given their relatively lower energy use, often need higher relative discounts on their energy bill—sometimes at least 20%-50%--to see the same dollar savings. In order to decrease the cost of a subscription, community solar operators could build an engagement platform that provides subscribers with:

- Energy efficiency services that reduce their energy costs
- Controllable energy devices that allow community solar operators and energy aggregators to optimize subscribers' energy use for various retail rate structures and future aggregated grid services programs

Streamlined Billing: Additional bills are a significant barrier for low-income customers. Billing needs to be as streamlined as possible, for example, by being integrated into a single platform or on-bill (per recommendation on Slide 63), or by allowing benefits to be transferred through an intermediary purchaser or service provider.

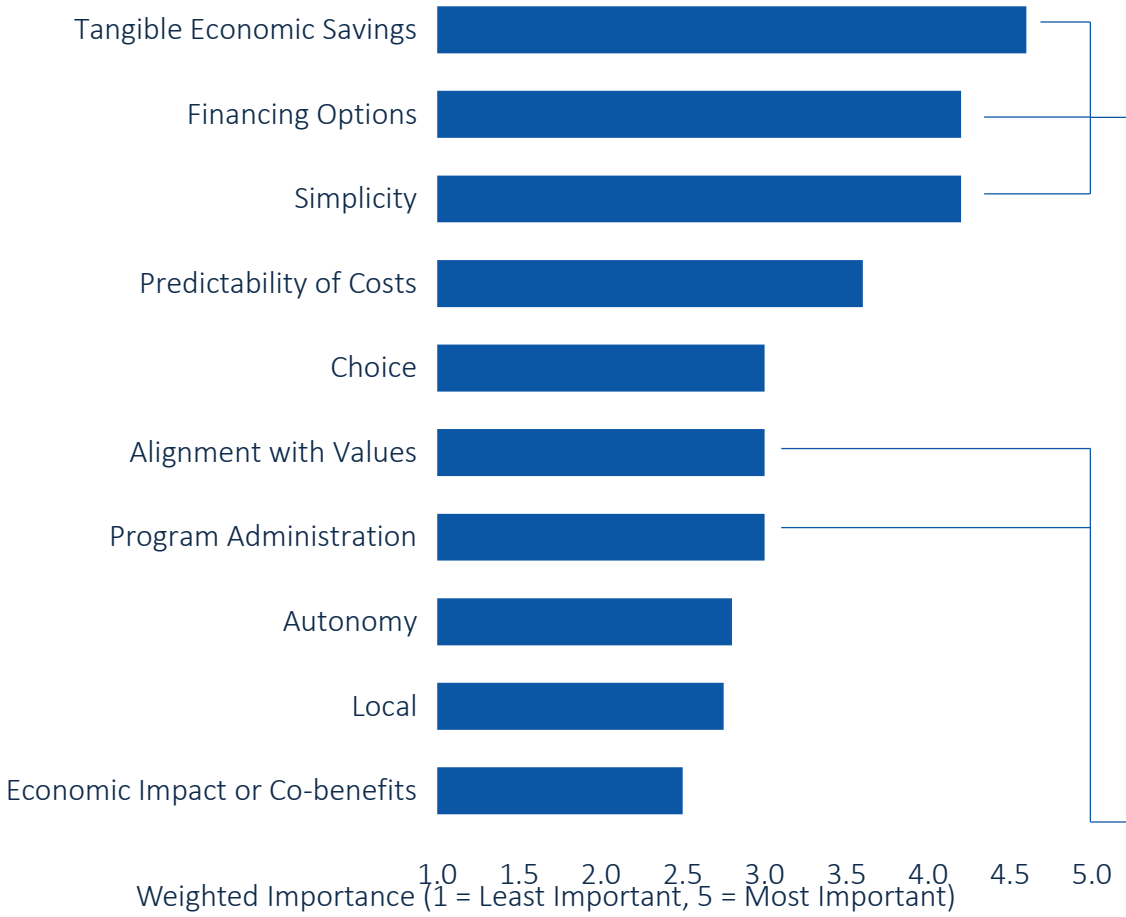
LMI subscribers typically cannot afford subscriptions with upfront payments

Program administration is an important component for low-income subscribers as trust can be a major issue. Many representatives of LMI subscribers indicated that these customers often look at community solar as being "too good to be true."

Community solar operators will need to work through local organizations. Programs can be designed with targeted market education in mind.

Affordable Housing Operators Require Clear Savings and Simplicity

Average Score to "Rate the Importance of the Following Attributes to Potential Affordable Housing Owners / Constituents You Work With"



Source: GTM Research Wood Mackenzie

Economic savings and financial components rise as the top motivators for affordable housing operators.

Savings are key, as affordable housing operators are looking to lower operating costs as much as possible. From GTM Research interviews, operators are often looking for energy bill discounts of 20% or more.

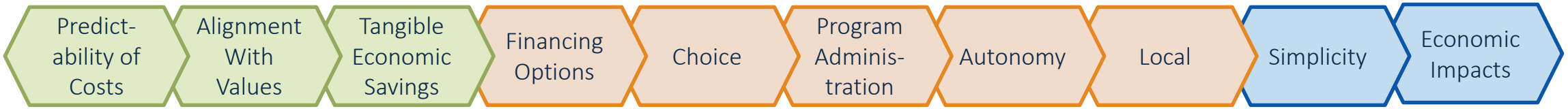
In contrast with non-residential subscribers, simplicity is important for affordable housing representatives who often have fewer resources and more pressing priorities than energy costs.

Some affordable housing operators have been advised against locking into long-term energy contracts, creating an impetus for short-term contracts or significant market education and assurances of long-term savings.

Property managers are looking for organizations they can trust and with similar goals of supporting the LMI community.

Non-Residential Customers Are Looking for Savings and Choice

SMALL NON-RESIDENTIAL



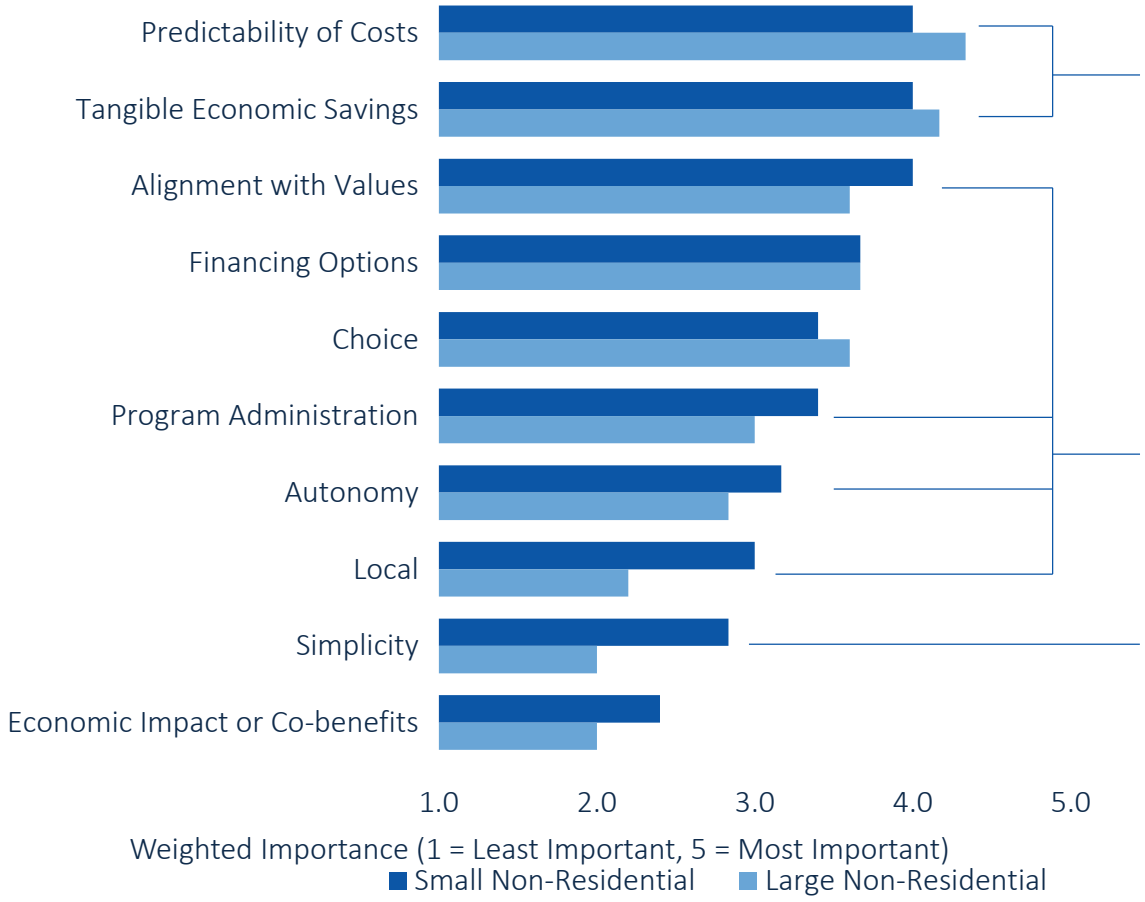
LARGE NON-RESIDENTIAL

Like traditional residential subscribers, predictability around costs is the most important community solar benefit for non-residential subscribers (e.g., commercial, industrial, government and nonprofit).

In contrast with residential subscribers, non-residential customers are comfortable with complexity — typically because there are larger resources and economic incentives to spend time understanding and addressing energy costs.

Non-Residential Subscribers Are Focused on Economics and Less Sensitive to Complexity

Average Score to "Rate the Importance of the Following Attributes to Potential Non-Residential Customers You Work With"



Source: GTM Research Wood Mackenzie

Motivations for community solar subscriptions generally match between small and large non-residential subscribers, with predictability of energy bills and savings the two highest-rated items.

Generally 10%-15% savings are required to attract commercial and non-residential customers. While these are similar to savings targets for residential subscribers, commercial and industrial electricity rates tend to be significantly lower than residential rates. This necessitates a lower subscription price to achieve the same discount.

Non-residential subscribers, especially smaller entities, still strongly value intangible benefits, such as alignment with values (e.g., meeting corporate sustainability and social responsibility goals) and autonomy.

Non-residential customers tend to be less sensitive to complex energy services and comfortable with long-term contracts, rate escalators and termination fees. In combination with volume purchasing, this reduces the cost of acquiring non-residential subscribers. Large organizations may also have more resources directed toward energy procurement, further decreasing the importance of a simple service to large non-residential customer.

Introducing the Vision for Community Solar

The Potential Evolution of Community Solar

Community Solar Can Be Further Improved to Expand Its Availability and Reach

Subscription Cost and Subscriber Value

- Maximize economies of scale and reduce customer acquisition costs to reach subscribers' target savings and create competitive offerings compared to alternative energy sources
- Package with other devices to maintain and increase subscriber and societal value as energy sector changes
- Ensure regulations around compensation are stable and predictable over the long term

Simplicity, Availability, Access and Transparency

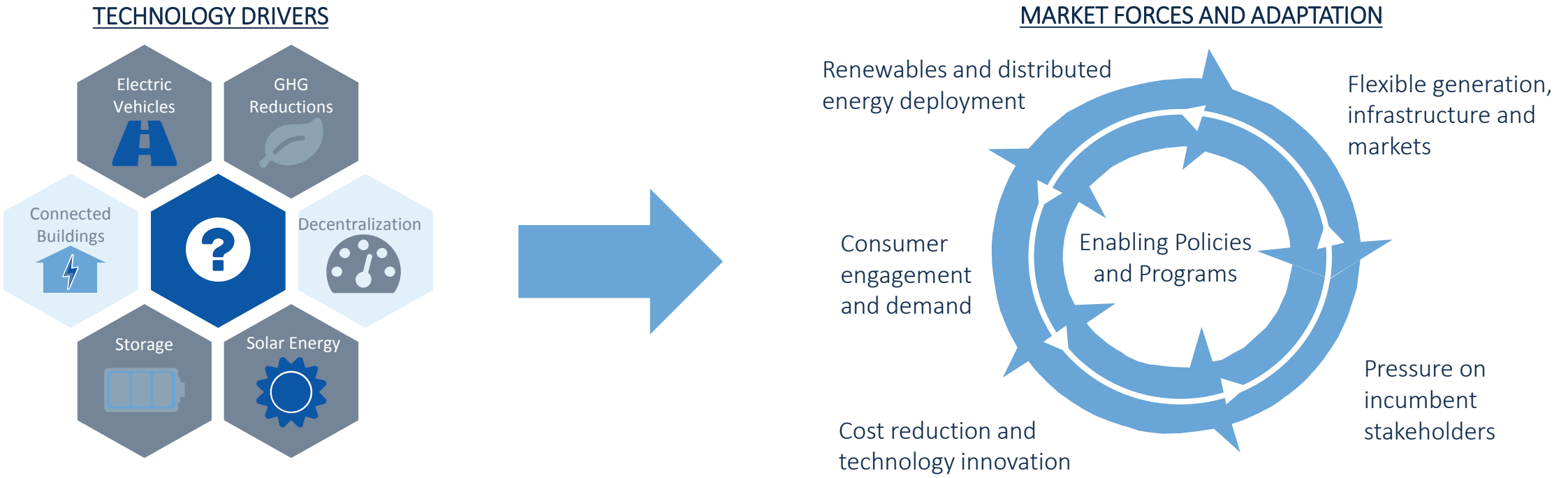
- Focus on streamlining project and subscriber qualification requirements and ease of processing subscriber changes
- Ensure accurate, timely bill crediting and ease of accessing necessary subscriber information
- Reduce contract lengths, escalators, exit fees and hard credit checks that reduce subscriber qualification and interest
- Create platforms that allow subscribers and operators to quickly assess net energy and bill savings (e.g., via a single bill)

Local Investment and Resilience

- Prioritize community influence via direct engagement with potential subscribers and local organizations
- Package with co-located distributed energy storage and microgrids to provide local energy resilience
- Increase economic support for local affordable housing and low- and moderate-income households
- Target local workforce for training and employment

The Next Decade: The Power Sector is Changing – and Invites Community Solar Innovation

Community solar can be a foundational pillar in the ongoing and future power market transformation — one driven by more engaged customers that demand decentralized and decarbonized energy. In this future, distributed solar — including community solar — becomes a platform for a holistic clean, local, reliable and flexible energy service that opens up opportunities for flexible investment and business models in combination with other onsite and co-located distributed energy resources.



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Community solar facilities will evolve, both as a virtual interactive energy platform and as a physical energy resource.

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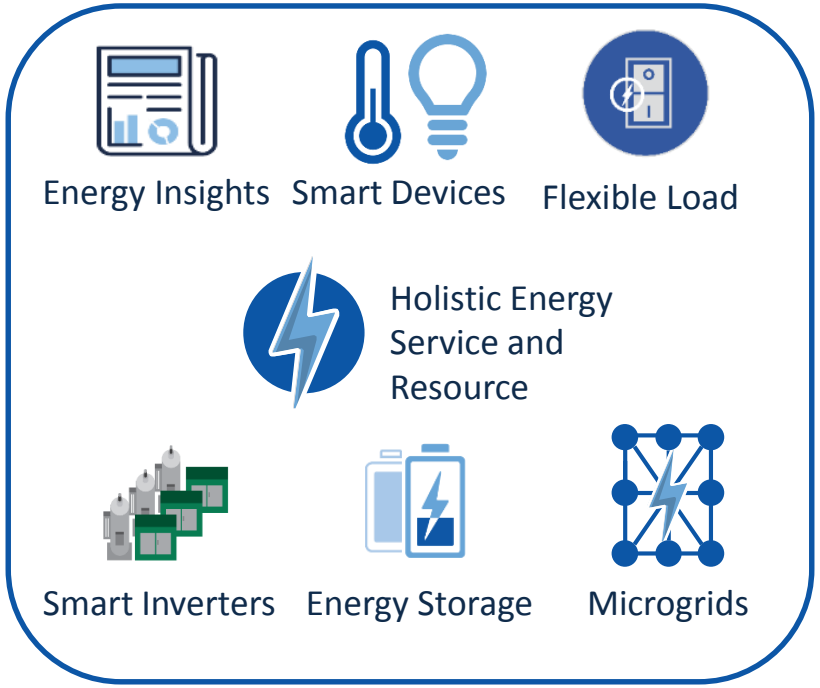
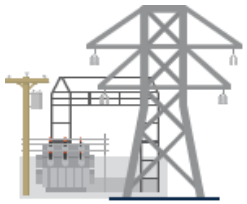
Subscribers will receive tailored insights into their energy use, resulting in adoption of new devices and services that further increases the efficiency and lowers the cost of their energy use.





Utilities and the Electricity Grid

Community solar will create value beyond the energy generated — initially from offsetting new generation capacity, transmission and distribution assets, and longer term, in the form of flexibility and resiliency as community solar facilities are co-located with other distributed energy hardware.

Community Solar's Potential to Be an Attractive Service for Homes and Businesses

As community solar proves itself in leading markets, improvements to program design and implementation, subscriber acquisition and project finance will proliferate with concentrated efforts to innovate the community solar model beyond business-as-usual improvements.

Our vision for community solar addresses three principles for the ideal, mature community solar market:

I. Community solar providers must engage in ***deep product innovation*** around costs, technology and the services offered in order to substantially improve the individual and communal economic, environmental and social attractiveness and benefits of community solar.

II. Policymakers and utilities must enable access to community solar by crafting scalable markets through ***stable, fair rates and market participation structures*** that recognize and compensate community solar facilities for the full range of their grid, environmental and societal benefits.

III. All stakeholders must craft programs and products with *the* ***inclusion of low- and moderate-income communities*** in mind, recognizing the societal benefits and overall market opportunity that full LMI participation represents.

A Market Transformation in Three Phases

Transformative growth of community solar will not happen overnight. Improvements in program design and implementation, financing solutions, and customer-focused offerings can expand solar access to all customer types. Proper valuation methodologies are critical to support community solar in a changing market landscape, and inclusive policies are essential to ensure equitable access for underserved communities.

We envision a path through three phases, while noting that the starting point and transition will vary by state and market maturity

PHASE I: Market Emergence

Community solar is still in pilot or early stages, driven primarily by early programs or virtual net metering programs with shifting compensation mechanisms. Community solar is proving itself to regulators, customers and investors.

PHASE II: Market Transition

Lessons from Phase I are incorporated. Community solar benefits from cost reductions through product innovations, streamlined program administration and investor trust. Improved program design and financing solutions encourage and increase LMI participation. Regulators, utilities and community solar stakeholders negotiate the benefits and the compensation for community solar.

PHASE III: Market Maturity

Community solar is an attractive offering to customers that delivers recognized benefits in the forms of cost savings, cost visibility, environmental attributes, grid value, local societal and economic support, and energy resiliency.

Four Early Community Solar Markets in Focus

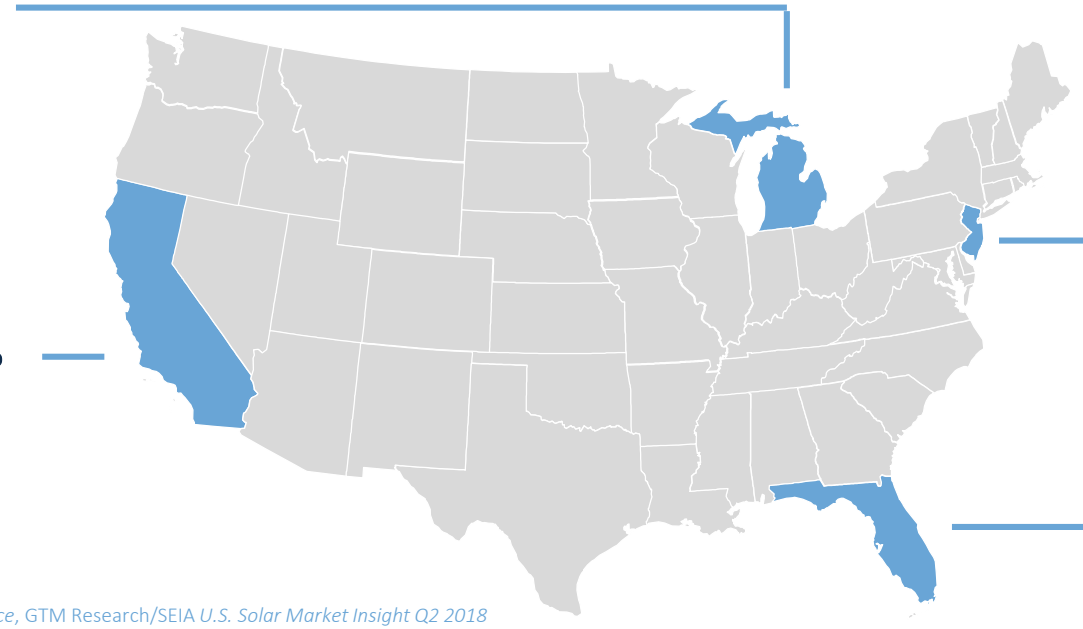
We examine four state markets in different regions with different makeups: California, Florida, Michigan and New Jersey

Two leading distributed solar states (CA, NJ) and two lagging distributed solar states (FL, MI). Each state differs in its current level of experience with community solar. NJ recently passed legislation and has yet to begin program implementation. CA also passed legislation back in 2013, but only two community solar projects from that program are under development. All operating community solar capacity in CA comes from voluntary utility-led programs administered by municipal utilities. Meanwhile, MI and FL have several voluntary utility-led programs among their investor-owned utilities, rural-electric cooperatives, and municipal utilities but lack statewide enabling legislation.

Solar Deployments in States-in-Focus as of 2017 Year End

Michigan
Total solar: **0.1 GW**
Solar as % of total load: **0.2%**
Community solar: **8.3 MW**

California
Total solar: **19.8 GW**
Solar as % of total load: **16.7%**
Community solar: **21.2 MW**



New Jersey
Total solar: **2.4 GW**
Solar as % of total load: **3.9%**
Community solar: **0 MW**

Florida
Total solar: **1.3 GW**
Solar as % of total load: **0.7%**
Community solar: **41.8 MW**

Source: Wood Mackenzie *North American Power and Renewables Service*, GTM Research/SEIA *U.S. Solar Market Insight Q2 2018*

3. Expanding the Reach of Community Solar

Community Solar's Evolution in Three Phases

Phase I: Building the Foundation to Further Community Solar Innovation

PHASE I: Market Emergence	PHASE II: Market Transition	PHASE III: Market Maturity
Potential customers see clear economic benefits — including savings and predictable costs — while community solar operators reduce costs and build engagement platforms that simply and transparently communicate benefits to all customer segments.	The economic benefits of community solar are preserved and expanded through a combination of cost reduction and stable policies that value grid benefits of distributed solar. Access to community solar continues to expand as industry and policy matures to support access for LMI and other underserved communities.	Subscribers receive community solar as a component of a broad, holistic energy service that delivers lower cost to subscribers; resilient, flexible energy to the grid; and clean energy to all members of the local community.

Improving community solar subscription attractiveness starts with strong programs and targeting simplicity and costs

- Strong and ambitious program design is necessary to ensure that community solar starts off in the right direction
- In the early stages, market education is critical, as subscriber acquisition depends on dispelling general myths about solar and explaining the community solar model. Working through local organizations and community partners will help establish trust, especially with LMI communities.
- While clean, local and independent supply of energy is a key motivator for subscribers, project operators must continue to improve on the transparency and attractiveness of community solar's economic proposition.
- Operators will need robust virtual interfaces to ensure that cost savings and other benefits are simply and transparently communicated to subscribers.

Phase II: Continuing to Expand Community Solar's Value in a Changing Power Market

PHASE I: Market Emergence	PHASE II: Market Transition	PHASE III: Market Maturity
Potential customers see clear economic benefits — including savings and predictable costs — while community solar operators reduce cost and build engagement platforms that simply and transparently communicate benefits to all customer segments.	The economic benefits of community solar are preserved and expanded through a combination of cost reduction and stable policies that value grid benefits of distributed solar. Access to community solar continues to expand as industry and policy matures to support access for LMI and other underserved communities.	Subscribers receive community solar as a component of a broad, holistic energy service that delivers lower cost to subscribers, resilient, flexible energy to the grid, and clean energy and development to all members of the local community.

With a simple, transparent and attractive community solar product established in Phase I, the focus in Phase II shifts to expand subscriber and societal value in the context of broader changes to the electricity industry

- Cost reduction will continue, but utilities will develop tools or be incentivized to limit stubborn interconnection equipment costs.
- Policymakers and industry representatives will establish a stable, long-term value for distributed solar generation, which must ultimately reflect the full breadth of community solar's benefits.
- Flexible subscription offerings more tailored to different customer preferences are the norm, and when coupled with further reduced subscription costs, lead to a step function increase in low- and moderate-income subscribers as financiers grow more comfortable with subscriber retention platforms.

Phase III: Community Solar as a Holistic Energy Service

PHASE I: Market Emergence	PHASE II: Market Transition	PHASE III: Market Maturity
Potential customers see clear economic benefits — including savings and predictable costs — while community solar operators reduce cost and build engagement platforms that simply and transparently communicate benefits to all customer segments.	The economic benefits of community solar are preserved and expanded through a combination of cost reduction and stable policies that value grid benefits of distributed solar. Access to community solar continues to expand as industry and policy matures to support access for LMI and other underserved communities.	Subscribers receive community solar as a component of a broad, holistic energy service that delivers lower cost to subscribers, resilient, flexible energy to the grid, and clean energy to all members of the local community.

Community solar must be seen as a holistic energy service, not just a policy-dependent bill savings opportunity

- Community solar platforms serve as a primary interface of customers to a deeper connection and involvement in their energy choices.
- Community solar becomes a key tool for ensuring equitable participation in the clean energy economy, regardless of income level or housing type.
- Community solar assets coupled with distributed equipment like energy storage provides services beyond virtual energy.
- By building community solar into microgrids and decentralized energy markets, community solar can provide energy for critical services and be further valued for “softer” local social and economic benefits typically left out of retail rate-based compensation.

Expanding the Reach of Community Solar

Addressing Policy and Customer Engagement Barriers

Addressing the Immediate Barriers to Community Solar

The primary barrier to adoption is the lack of policy that enables a broadly attractive community solar subscription

- Only 19 states and Washington, D.C. have statewide policies for community solar. While these states represent 41% of total electricity customers nationally, these state programs can be further limited due to program caps, limits on facility and subscriber qualification or otherwise unattractive bill crediting mechanisms.

We outline several key challenges faced by community solar facilities and operators when building an attractive subscription offering.

Program Design and Implementation Challenges

- Lack of control over full customer experience
- Limited pilot programs and capped program sizes
- Limitations to facility size, reducing economics of scale
- Restrictions on subscription sizes
- Restrictions on project siting or where credits can be allocated
- Insufficient bill credit/compensation levels
- Inaccurate or late bill credits
- Insufficient incentives or programmatic support for low- and moderate-income subscribers to overcome financial barriers
- Lag time between subscriber signup and facility connection due to permitting or regulatory restrictions
- Limited windows or long delays for transferring subscribers, leading to difficulties adding or swapping subscribers

Customer Engagement and Product Offering Challenges

- Low level of market awareness on the part of customers
- Unattractive or difficult-to-predict energy bill savings due to project economics
- Overly restrictive subscriber vetting and contract terms due to nascence of innovative metrics, market education and track record for lenders
- Lag time between subscriber signup and delivery of benefits due to lender restrictions on when a project can begin construction
- Little focus on low- and moderate-income customers and affordable housing tenants due to perceived repayment risks
- Difficulty showing economic benefits due to multiple bills or bills that do not show overall energy generation and consumption
- Insufficient consumer protection, especially for vulnerable communities

Addressing Key Initial Policy Barriers for Community Solar

Program Design and Implementation Challenges

Attractive, sustainable community solar starts with strong program design. Many policy best practices have already been outlined in the Coalition for Community Solar Access's Community Solar Policy Decision Matrix. Key initial hurdles brought forth in GTM Research's conversations with community solar subscribers and operators are outlined here.

- **Limited or insufficient bill crediting:** For community solar programs to be successful, they must offer a clear economic value proposition to subscribers. A bill credit should be stable, long-term and high enough to ensure that subscribers reach their primary targets, whether it's predictable costs, modest (5%-15%) savings for typical residential and commercial customers or a deeper discount (20%-50% at minimum) for low- and moderate-income customers.
- **Customer Qualification and Subscriber Mixes**: Depending on the specific policy goals, a customer carve-out may be appropriate. But if carve-outs are implemented, they must be examined closely so that targets can feasibly be reached. For example, clear qualification processes and support for low-income participation can advance community solar inclusiveness without hindering economic feasibility.
- **Lag time between customer sign up and project availability:** Policymakers and utilities should ensure that interconnection queue management and other approval processes do not cause undue delays between customer signup and facility connection. Operators must also work with lenders to reduce the hurdles and time between customer signup and the start of construction.
- **Ability to quickly move or remove subscription:** Community solar can be ideal for renters and affordable housing tenants who may not intend to stay in their residence long-term. Programs should allow community solar operators and subscribers to move or remove subscriptions on a monthly basis to reduce customer confusion and increase community solar's availability.

Source: Community Solar Policy Decision Matrix, 2016

Community Solar Subscriptions: Key Features of a Consumer-Focused Subscription

Community solar offers key economic benefits to subscribers, but a key barrier is the simplicity, transparency and reliability of these benefits.

Improving community solar subscriptions will require better execution and communication of the following subscription features:

- **Discount to or security of electricity service costs**: Community solar should offer a discount to a customer's existing electricity service and provide secure long-term visibility on energy costs. Typical residential and non-residential consumers require a 5%-15% discount before subscriptions are considered attractive, whereas LMI subscribers may need upward of 20%-50% before consideration. Where possible, a long-term fixed or guaranteed discount would also increase the attractiveness to potential subscribers.
- **Short-term contracts**: The long length of the contract can give customers pause and reduce customer interest. Increasing access to renters—a key potential benefit of community solar—can be more easily realized with contracts that are five years in length or less. For LMI subscribers, the contract itself may be a barrier that need to be creatively addressed.
- **Simple contracts:** Contracts that have high termination fees or rate escalators make it more difficult for customers to accept the economic benefits, ultimately raising the cost of subscriber acquisition.
- **Fewer limits to credit requirements**: High FICO scores and investment ratings are typically required to minimize risk to financiers, but credit checks and lengthy underwriting processes can cause customers to lose interest. Furthermore, alternatives to FICO scores, such as electricity bill payment history, may prove a stronger correlation between risk to energy bill repayment.[1] Moving to quicker, more inclusive and more predictive metrics could reduce risk, lower cost and increase access to community solar — especially for LMI customers.
- **Transparent billing and engagement**: In states where community solar is provided by a non-utility organization, customers must deal with two electric bills: their traditional one and one from the community solar provider. Ideally, customers would receive a single bill reflecting the net cost of electricity service to minimize confusion and increase transparency of costs. Furthermore, community solar operators should provide a platform where subscribers can easily view the performance and benefits of their subscription. As the electricity sector moves toward more complex electricity rates, customers will need to easily track their net energy profile and the temporal and locational value of their solar subscription.

[1]Solstice, EnergyScore: An Alternative to FICO Credit Requirements for Low- to Moderate-Income Community Solar.

An Integrated Billing and Customer Engagement Portal Is Critical for Innovation

For community solar operated by third parties, regulators and utilities will need to address current billing issues, as existing utility billing capabilities and customer engagement infrastructure are not well suited for products like community solar. Integrating community solar payments onto the utility bill or allowing single bill platforms would:

- **Reduce customer confusion** from needing to pay two distinct energy bills that may be on different billing cycles and help reduce inaccurate/late bill credits.
- **Improve transparency** of community solar benefits as subscribers could more easily compare the performance of their community solar share against their own consumption and avoided utility billing costs. In addition, an integrated platform could smooth the process of accessing critical customer information.

As retail rates grow more complex in response to changing energy market dynamics, an integrated billing and customer consumption platform is the first step toward deep community solar product innovation. For example:

- With monthly updates on its subscribers' energy usage, community solar operators **could better tailor subscription sizes** to match ongoing consumption.
- As a trusted provider, community solar operators could better **assist subscribers with efficiency products, weatherization and eventually grid services.** A bundled product offering could be an effective strategy to ensure sufficient bill savings when marketing to LMI subscribers with higher energy burdens.
- Community solar operators with periodic — and eventually real-time — visibility into their subscribers' energy consumption could optimize community solar design (and eventually generation) to match its subscribers' consumption trends in the case of time-of-use rates or demand charges.

As discussed previously, these changes need to coupled with regulations that encourage product innovation with bill crediting that reflects these services and the ability to easily swap subscriber lists.

Expanding the Reach of Community Solar

Reducing the Cost of Community Solar

Delivering a Lower-Cost Community Solar Subscription

Customers clearly want cost savings, so this report explores several approaches to reducing community solar subscription costs to provide stable, long-term savings for customers. Reduced community solar costs can provide:

- **A better value proposition for the subscribers**: Whether community solar is being weighed against a bill credit, the value to the grid, the utility cost of service, or simply alternative forms of procuring solar, lower costs are crucial to realizing a larger benefit.
- **More headroom for packaging other technologies:** Lower solar costs make it easier to package in energy storage and grid support technologies, and ultimately to deliver more grid and social value at similar costs.
- **Greater focus on inclusion and local development:** Lower costs give operators more space to focus on broad adoption, including the LMI segment or price-sensitive non-residential customers, as well as other local benefits (e.g., workforce development), while still meeting targeted financial performance and returns.

Current community solar costs fall between rooftop residential and small-scale utility solar projects.

Projects benefit from larger scale (typically between 1-5 MW) and the ability to choose locations with fewer land, shading and interconnection constraints. As a result, community solar projects are typically:

- **Easier to scale**: Community solar can target larger tracts of land and potentially locate on adjacent parcels, enabling larger systems with greater cost efficiencies
- **Simpler to maintain**: Projects can be built in close proximity to reduce fixed costs of preventative and corrective maintenance
- **Better performance:** Instead of conforming to rooftop constraints, projects can be optimized to deliver better performance through technologies like single-axis tracking or simply more optimized tilt angles and orientation

All-In Costs to Build Community Solar Could Fall by 42% by 2030

Community solar costs are driven by a combination of industry-wide improvements and community-solar-specific activity

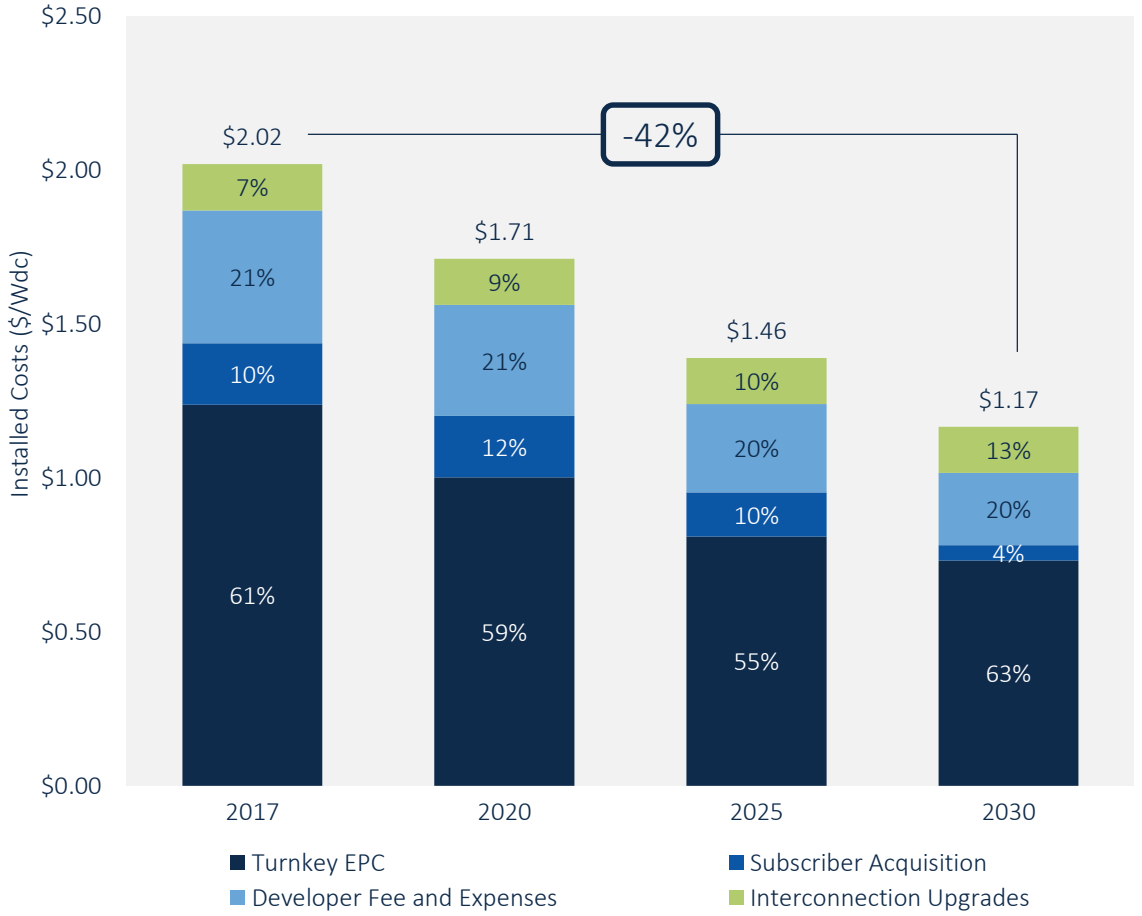
The cost to build 1 to 5 MW ground-mount solar arrays is expected to drop by 41% between 2017 and 2030, which is slower than historical declines of 40% between 2012 and 2017. Improvements are driven by:

- Solar module cost reduction, including expiration of the Section 201 tariff, silicon cost reduction, shift to higher-efficiency monocrystalline technologies, and further automation of production facilities.
- Balance-of-system improvements will be incremental, with small gains from lower material usage, reduced labor costs and operational efficiency focus.

Development costs may increase as share of costs

- Development fees, overhead and margins could fall as community solar grows more competitive and project developers become more efficient.
- Legal fees, land acquisition and permitting costs will be tougher to reduce, especially as competition forces developers to explore suboptimal sites.
- Interconnection fees and equipment costs could rise as distributed solar deployment increases and optimal feeders become more saturated.

National All-In Cost Projections for Community Solar by Major Component Cost



Source: GTM Research Wood Mackenzie

Subscriber Acquisition and Management Are Key Targets for Lowering Costs

Community solar stakeholders generally have more direct control over subscription acquisition and management costs, leading to greater opportunities for cost reduction

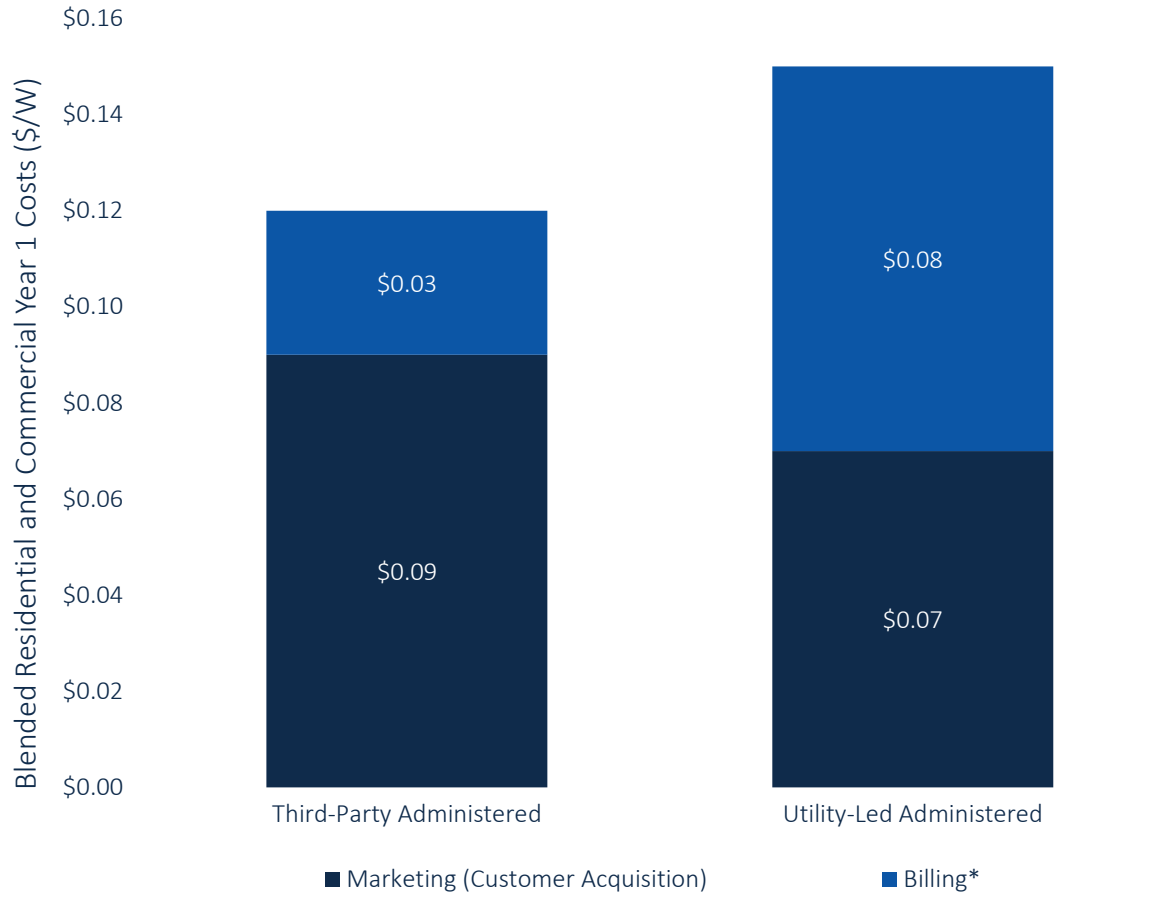
As a virtual product, community solar has the advantage of not requiring customer-specific site studies, permitting fees and interconnection.

Subscriber acquisition costs range from $0.06/W to $0.25/W, based on anecdotal information.

- Acquisition costs generally reflect a blend of residential and non-residential
- Due to fixed costs, small subscription sizes and failed leads, residential subscriptions typically have higher acquisition and billing costs
- Ongoing billing and subscriber management (including subscriber replacement costs) generally range between $0.12/W and $0.35/W
- But subscriber acquisition costs are typically less than residential rooftop acquisition costs, which currently total around $0.57/W

A survey conducted by the Smart Electric Power Alliance found that median first-year customer marketing and billing costs for mixed residential and commercial subscriptions ranged between $0.12/W and $0.15/W.

Median First-Year Subscriber Acquisition and Management Costs of Surveyed Programs by Smart Electric Power Association



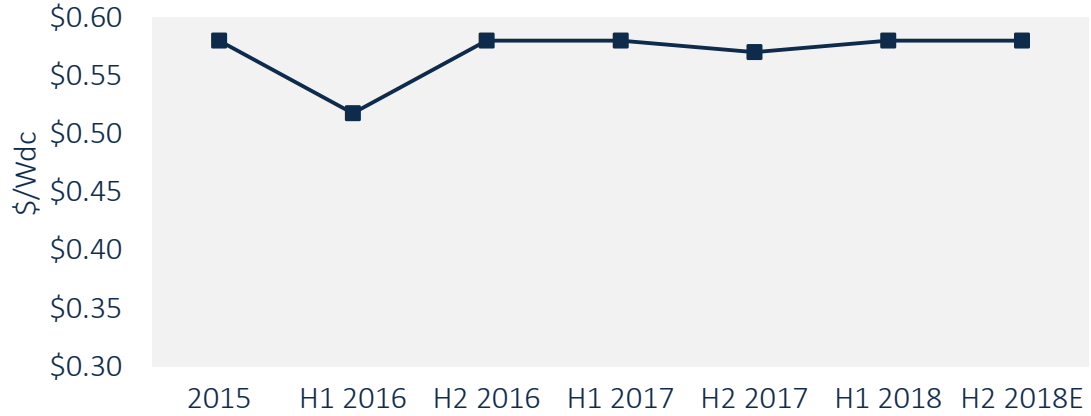
Source: Smart Electric Power Alliance/Coalition for Community Solar Access *Community Solar Program Design Models*

Lowering the Cost of Subscription Acquisition

Customer acquisition costs do not automatically decrease as the industry scales

- As volumes grow, installers turn from referrals to more expensive sales channels and sources for customer leads
- Despite residential solar doubling in terms of annual installations from 2015 to 2018, average customer acquisition costs have remained the same
- While non-residential acquisition costs tend to be much smaller, attrition rates on non-residential leads result in difficulties in reducing costs

National Average Residential Solar Rooftop Customer Acquisition Costs ($/Wdc)



Source: GTM Research *U.S. PV System Pricing H1 2018: Forecasts and Breakdowns*

Community solar must simultaneously make strides on two paths to reduce subscriber acquisition costs

I. Find greater efficiencies in sales channels and sales strategies

- Partnerships with local community organizations can both leverage trusted relationships to educate potential community solar customers and help streamline the vetting process to identify qualified participants.
- Historically, rooftop solar lead generators have kept a tight rein on disqualified leads — but these could be a source of low-cost leads.

II. Build more consumer-friendly customer offerings

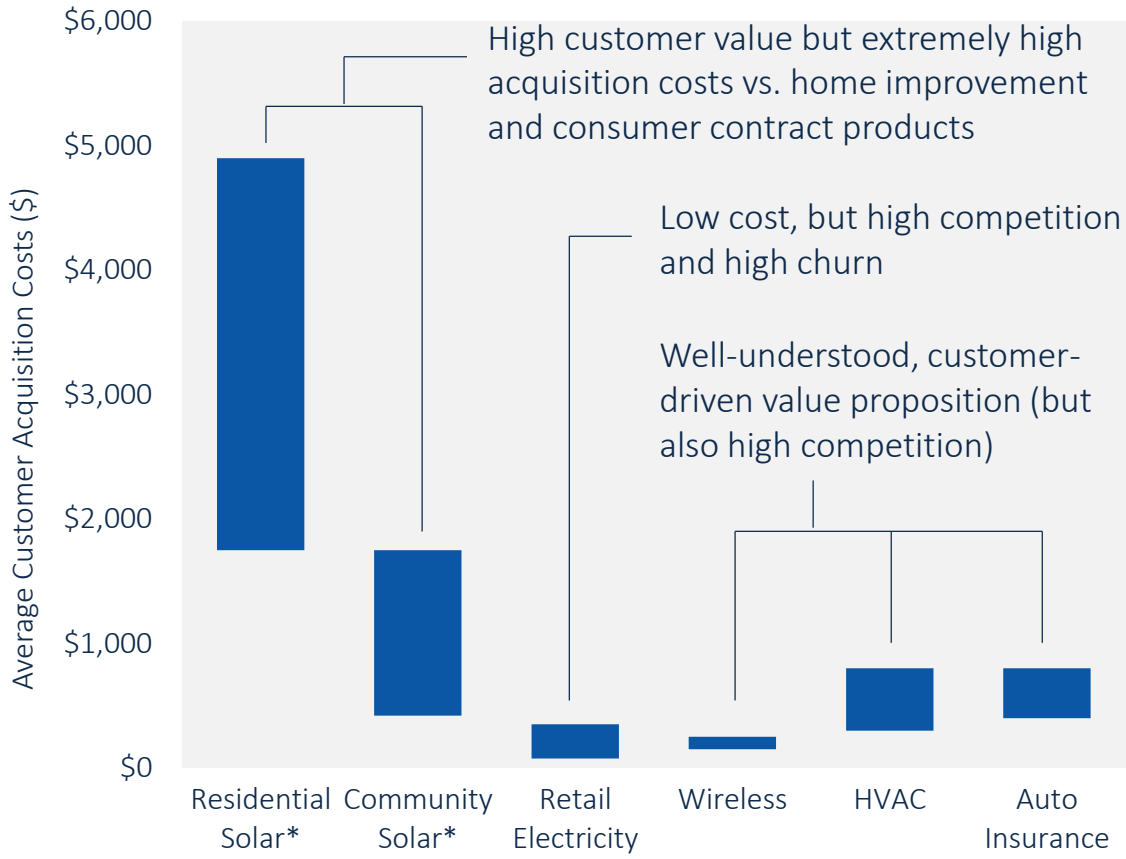
- Community solar operators must tackle key obstacles that give subscribers pause, including escalators, large exit fees and lengthy contracts, although these are typically requirements from financiers, not operators.
- Community solar operators can couple other service offerings on top of solar generation, including weatherization, energy efficiency, time-of-use benefits and local resiliency.

Creating Consumer-Focused Offerings to Lower Subscription Acquisition Costs

Customer and financier education can help create consumer-focused offerings and lower subscription acquisition costs.

- **Options for shorter contract lengths:** Current community solar contract lengths are typically similar to rooftop solar contracts, requiring customers to lock themselves in for 15 to 25 years. While these may work for some residential and commercial subscribers, some customer segments (e.g., renters, affordable housing) desire shorter commitments.
- **Low or refundable termination fees:** In order to minimize financier risk, especially in markets where regulators or utilities limit the transferability of community solar subscriptions, operators may require termination fees. Better policies around subscription transfers and having more robustly qualified customers on waiting lists can help reduce the need for exit fees.
- **Low or no rate escalators:** Rising subscription costs can turn off subscriber interest. Reducing build costs will help operators provide fixed-price products at a desirable savings target for subscribers.
- **Robust subscriber management:** Additional innovation to subscriber management platforms could reduce the need for stringent terms on individuals, relying instead on the platform's ability to maintain and replace subscribers through continued community engagement and waiting lists.

Customer Acquisition Costs of Solar vs. Other Products



* Assumes 7 kW rooftop solar array or 7 kW community solar subscription

Source: GTM Research , Sunrun

The Evolution of Community Solar Finance: Chasing a Lower Cost of Capital

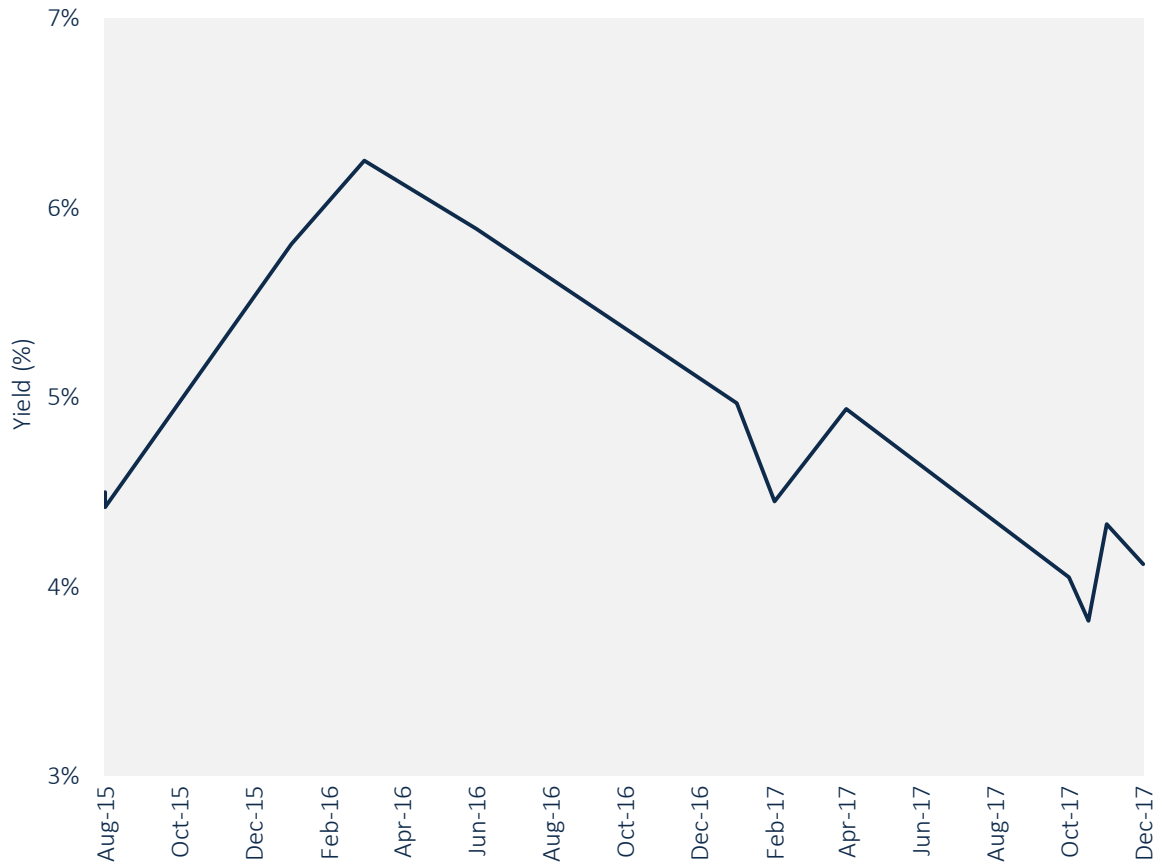
Long-term cash flows could be sold to lower cost of capital providers, potentially lowering subscription costs or increasing the space to finance other services alongside community solar.

For example, as of early 2018, over $2 billion of capital has been raised through asset-backed securitizations of distributed solar assets. Yields have fallen as low as 4%—a marked discount from typical equity returns between 8% and 12%. Other low-cost capital providers are also interested in solar as an investment vehicle, representing a significant opportunity for community solar operators to reduce overall costs.

In today's conservative case, long contracts and sizable exit fees are required to reduce the perceived risk of subscriber payment and cancellation. LMI subscribers are typically not specially considered because of preconceived notions of being higher risk.

In the near future, investors and lenders may evaluate the risk of a subscriber management "platform" — not necessarily contract terms — to determine the risk to the subscriber base (i.e., subscribers are quickly replaced without loss to the overall cash flows). Alternative credit scoring, such as utility payment history, may also help to qualify additional subscribers — especially LMI subscribers — while reducing overall portfolio risk.

Average Yield Rate of Securitized Distributed Solar Assets (%)



Source: GTM Research, Standard and Poor's, Kroll Bond Rating Agency

Expanding the Reach of Community Solar

Building a Holistic, Consumer-Focused Subscription

Community Solar as a Foundation for Participation in the Energy Future

Community solar's role in a decentralized, clean energy future

The year is 2030. The electricity grid is dominated by efficient, clean and low-cost energy. Millions of people are producing their own energy with on-site solar generation. In fact, most homes and businesses across America have some form of generation, energy storage, electric transportation or connected load control and are actively participating in new markets and services that help balance the time-variant and locational complexities of a massively electrified economy. In the background, utilities and decentralized service providers are able to operate consumer and distribution-level resources with minimal intrusion and impact to customers, thus maximizing savings, ensuring grid balance and providing local social and economic benefits.

At its core, community solar provides its subscribers with stable, low-cost, clean, sustainable and locally produced energy. But community solar also provides significant local development, including jobs for construction and management, opportunities for workforce development and economic support to LMI and other underserved communities. Furthermore, community solar plays the important role of ensuring that all residents are able to contribute to services and markets for distributed energy resources.

Community solar starts first as an engagement tool — a way for customers to more actively participate in how and what they consume for energy — but can evolve into a portal for more holistic energy services such as energy efficiency, energy analytics and active load control for flexible demand. In parallel to virtual engagement, community solar also provides a physical location and equipment with which to pair other distribution infrastructure, including smart inverters and energy storage. These assets can be shared between the community solar operator and the grid operator to maximize community solar's contribution.

Finally, as a modular and local generation resource, community solar can be a key asset for clean energy-based microgrids that can support local resiliency. By pairing community solar with other microgrid necessities like switch/protection equipment, advanced power electronics and high-speed communication, community solar-based microgrids can ensure critical services remain up and running during minor grid disruptions and in times of disasters.

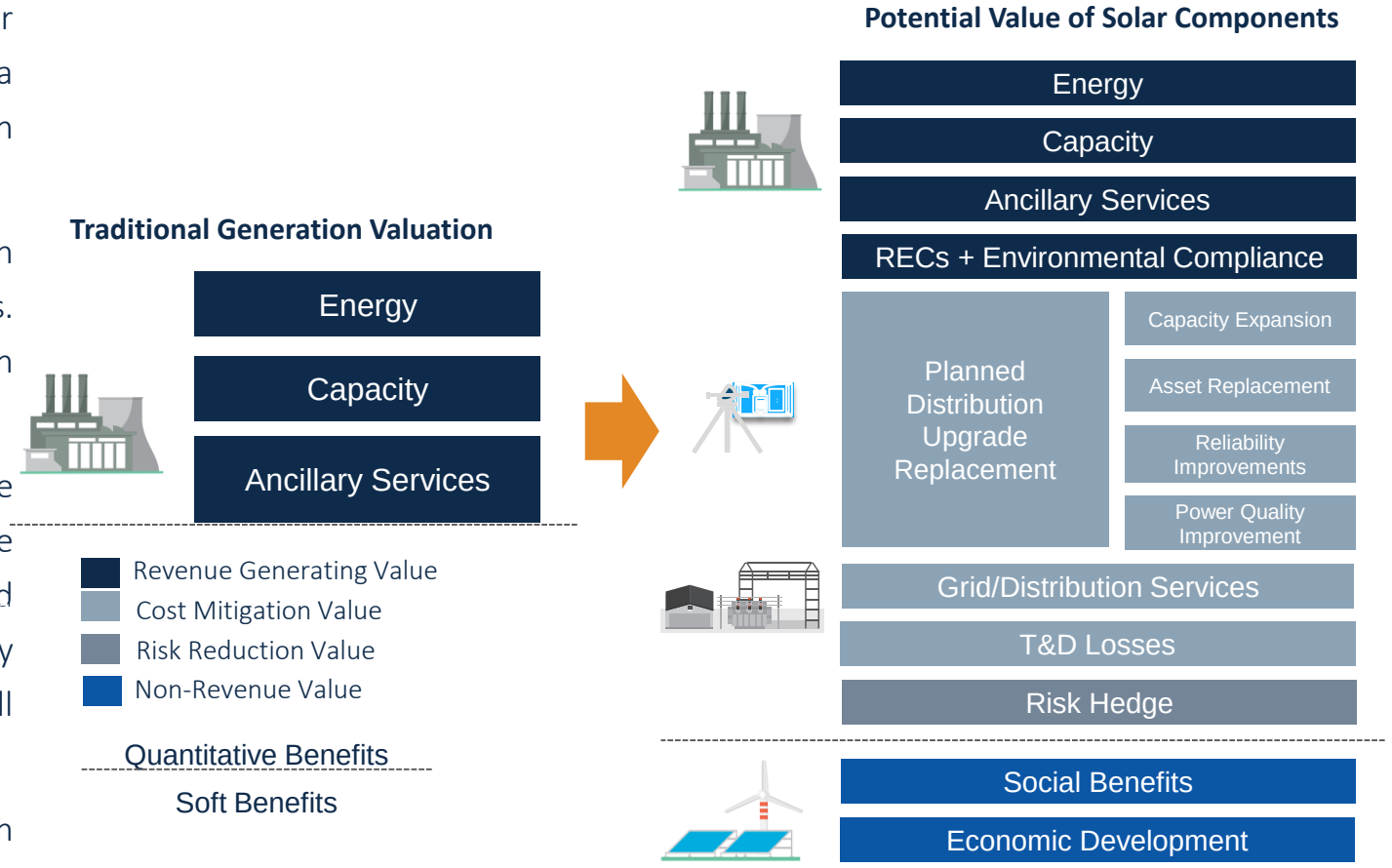
The Compensation and Valuation of Community Solar will Evolve

At low penetration rates, "the cost-shift from distributed solar is negligible,"[1] meaning that net metering may serve as a convenient near-term basis for community solar valuation in most territories.

Even at low penetration rates, utilities and regulators may push back against retail-rate-based bill compensation mechanisms. Some have pressed for a traditional model of generation valuation—only including immediate marginal energy costs.

However, some regulators are looking toward calculated "value of distributed energy" tariffs to more "fairly" compensate distributed solar for its benefits and costs, such as avoided grid investments due to its proximity to load. While community solar is not located at the point of consumption, it can still offset grid costs and provide locational grid resources.

As industry, utilities and regulators seek a compensation mechanism beyond standard retail rates, a negotiated value of solar methodology and calculation could serve as the basis for onsite and community solar bill credits.



Source: GTM Research Wood Mackenzie, Pacific Gas & Electric

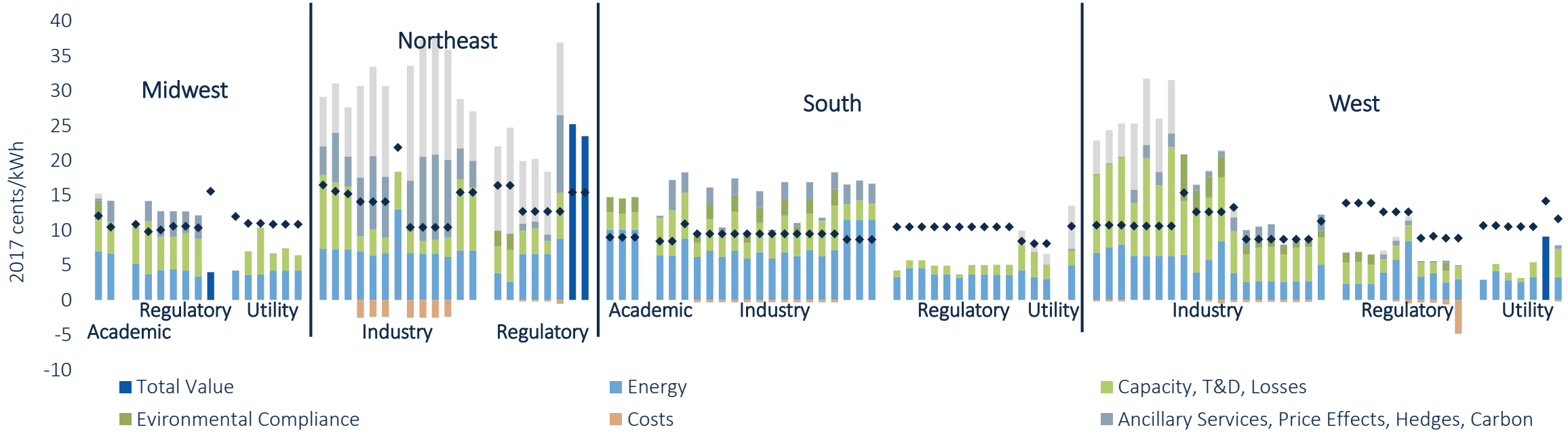
[1]Net Metering and Rate Reforms for Distributed Solar, Lawrence Berkeley National Laboratory

A Review of the Value of Solar Literature Shows Incredibly Varied Results

GTM Research's literature review of 40 value-of-solar studies show estimates that typically fall between 60% to 150% of average retail rates (including all segments). Values vary due to differences in locational inputs and the breadth of studied components. More discussion can be found in the Appendix.

Even beyond the variances in the results, the studies inherently portray different breadth of studied values and may also include inaccurate or simply incomplete assumptions. As there remains significant work for deriving appropriate and accurate value of solar figures, **our goal for introducing value of solar is to create proxy values for our customer adoption forecast, not to prescribe or create definitive values for community solar or distributed energy as a whole.**

Review of Value of Solar by Component From 40 Value of Solar/Value of Distributed Energy Studies vs. Average EIA Retail Rates



Source: GTM Research, EIA (average retail rates in study year) Various Regulatory Filings and Studies (See References for Full List of Studies)

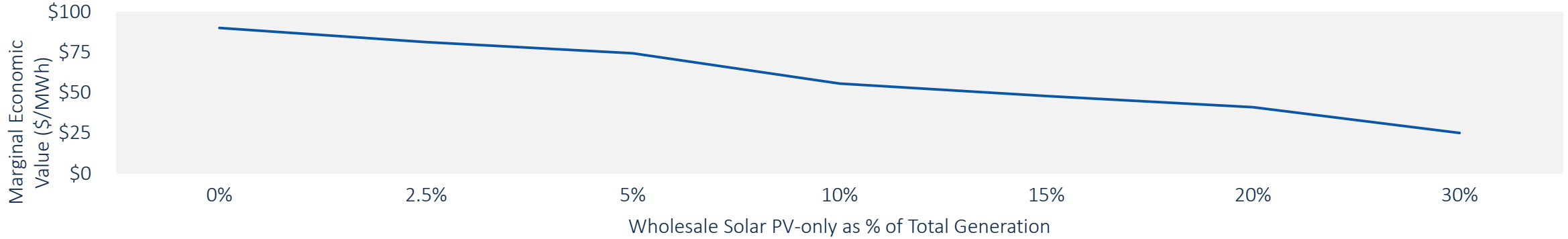
The Value of Energy Is Not Static

Electricity prices will change, potentially resulting in a shifting economic value for both subscribers and the grid.

For subscribers, if the underlying retail rates change or increase without a corresponding increase in community solar bill crediting, the relative savings from community solar will erode. These utility rate increases can come with increased utility and energy costs or a shift to fixed charges, demand charges and time-varying rates that aren't offset by solar generation.

For utilities and the grid, future rates are always influenced by changes in energy input costs (e.g., natural gas prices) and grid infrastructure investment. With light solar volumes, distribution infrastructure investment can be offset by generation closer to load (i.e., distributed solar). However, at higher penetration levels, marginal solar additions will have diminishing impacts on grid investments — and some argue, could even increase costs from integration.

Lawrence Berkeley National Laboratory: Marginal Economic Value of Wholesale/Utility Solar PV-only as Percentage of Total Generation in Simulated 2030 Grid



Source: Lawrence Berkeley National Laboratory, *"Changes in the Economic Value of Variable Generation at High Penetration Levels: A Pilot Case Study of California"*

For example, looking only at wholesale solar, marginal energy and capacity values fall with increasing share of pure solar. As discussed previously, distributed solar value needs to include a full set of benefits, including avoided grid infrastructure costs as well as social and environmental benefits. ***But community solar also requires deep product innovation — and regulations and program design that will allow that innovation to flourish.***

Community Solar Value Can Grow through Innovation

Community solar can evolve in response to changing rate and market dynamics, preserving and adding value — even as solar penetration increases. We discuss two interwoven tracks, both of which will need significant enabling policy.

Virtual engagement and advanced market participation

Subscribers see community solar operators as trusted energy advisers. Using online portals or in-person/phone-based customer advocates that link to the subscriber's energy use, bills and all the rates and services available, subscribers can find ways to further reduce their energy costs.

Community solar operators can start with advice, such as energy efficiency tips or weatherization, but can evolve into a more active relationship. Subscribers can lower their costs by procuring efficiency and load control devices — such as smart thermostats, electric water heaters, batteries and EV chargers — from operators.

Eventually subscribers may even allow operators to optimize and control these devices to lower their bills through rate optimization and services like aggregated demand response.

Distributed Infrastructure Co-Location and Grid Services

In many markets, community solar operators already bear the burden of grid upgrades. These could be better targeted and utilized to ensure that operators, utilities and consumers are all seeing a net benefit.

For example, utilities could help operators site community solar more optimally and target congested feeders. Or utilities could help operators install telemetry devices, smart inverters, batteries and other equipment that grant utilities greater visibility into the distribution grid and a better ability to balance voltage and power.

Eventually, community solar operators can aggregate their subscribers' flexible load devices while controlling the community solar facility output to help utilities better respond to changing energy demand.

Subscribers Can Optimize Their Energy Use With a Holistic Community Solar Platform

Subscribers can use an integrated billing and engagement platform to make better energy choices and lower their costs.

The billing and engagement platform for community solar could serve as:

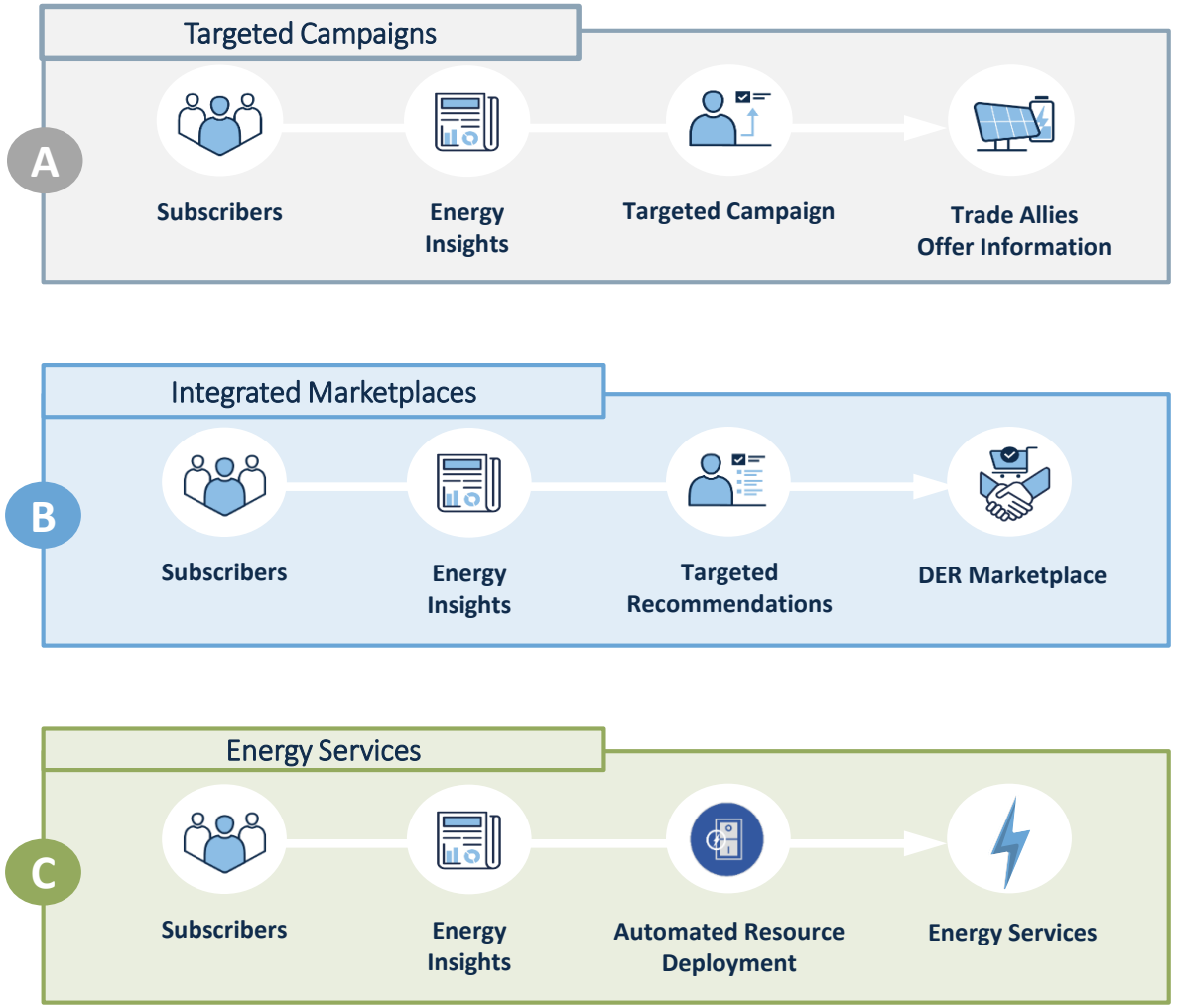
A) A warehouse of information that connects subscribers with targeted campaigns to reduce energy costs and local initiatives

B) A marketplace from which to buy products like smart thermostats and EV chargers or services like weatherization and energy storage-as-a-service.

With energy storage and controllable local energy management devices, community energy facilities could deliver a full breadth of services, further lowering and stabilizing subscribers' costs.

With controllable loads (e.g., EV chargers, smart thermostats) and energy storage located at subscribers' site, community solar providers could aggregate and sell flexible demand resources for utilities and markets.

Depending on the cost and values, these services could offset potential distributed resource integration costs or reduce subscription costs.



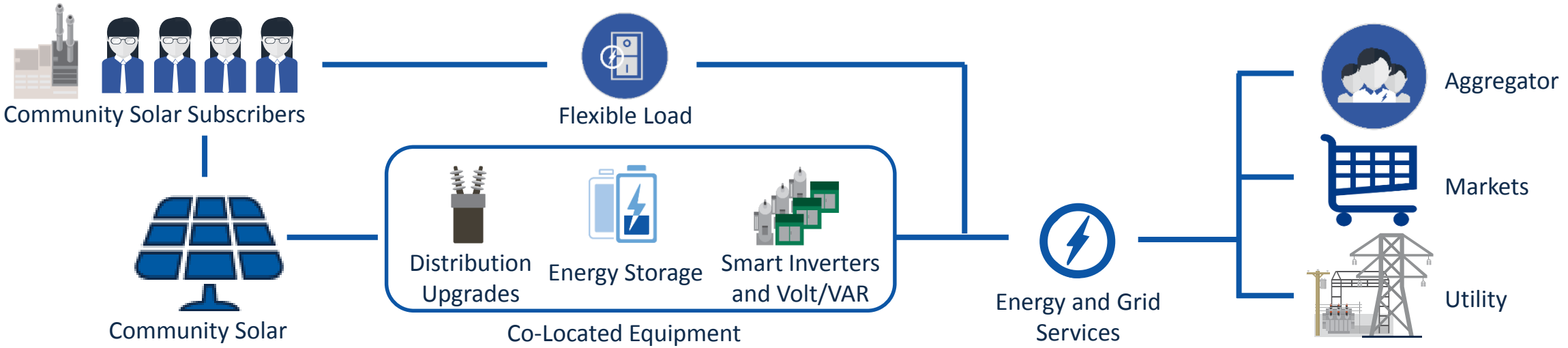
Utilities and Operators Can Leverage Community Solar for Greater Grid Benefits

To preserve and increase community solar's value to the grid, facilities can help utilities, grid operators and energy aggregators by layering on co-located distributed hardware.

Beyond energy, community solar platforms could provide:

- A virtual platform and management system to interface with and control subscriber loads, either through direct control or price signals
- A physical asset with which to co-locate distribution system upgrades, energy storage and smart power electronics for grid support

These assets can either be packaged and sold to energy markets (or otherwise compensated by regulators) for the benefit of the grid and subscribers. These services will ultimately help community solar maintain its grid value — and potentially offer more revenue streams that can be shared with subscribers.



Using Community Solar to Enhance Local Resilience

As a distributed generation source, community solar can be the primary generation source for microgrids for local resilience.

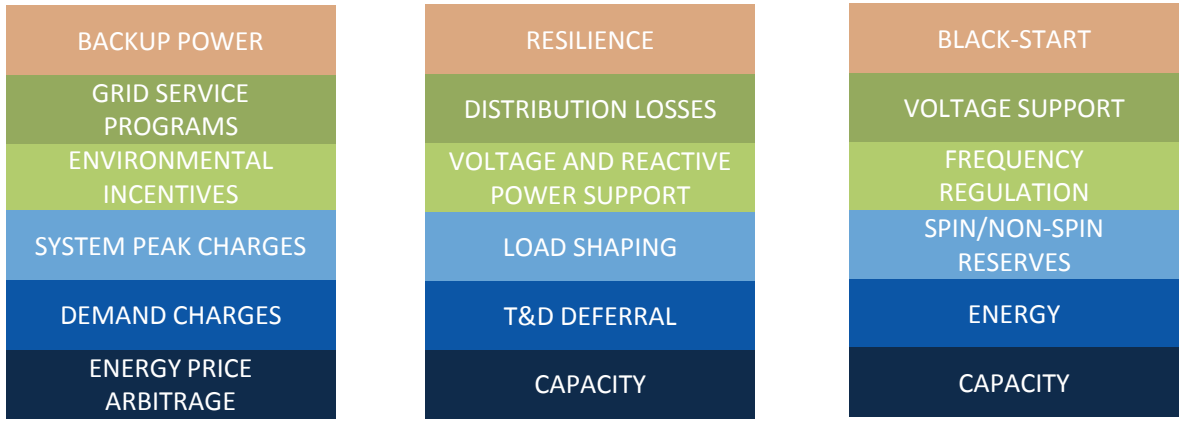
Businesses and governments are quickly realizing the importance of local grid resilience, especially in the case of disaster relief, to keep critical infrastructure powered during disasters or other outage events.

- During normal operation, community solar-based microgrids continue to provide all the benefits of community solar to subscribers and the grid.
- During grid disruptions and disasters, community solar facilities can provide the necessary generation component for critical and emergency services — or simply ensure that local consumers have backup generation.

Community-solar-based microgrids can be sited near underserved communities, including remote neighborhoods that are typically last to be serviced during a large disaster or in low-income and vulnerable neighborhoods that may have fewer resources to weather long power outages.

In order to assure deployment and optimal performance of community solar in microgrids, policy must be carefully constructed to allow and incentivize all the services and value streams these assets can provide.

Representative Value Streams for Microgrids



Source: GTM Research, *U.S. Microgrids 2017: Market Drivers, Analysis and Forecast*

Solar-based microgrid deployments are growing quickly

Operational microgrid capacity in the U.S. currently stands at 3.3 GW. Microgrids for critical infrastructure will grow most rapidly with increasing solar PV adoption, combined heat and power incentives, state resilience programs and commercial interest in keeping power on during disasters.

GTM Research expects a total of nearly 1 GW of solar-based microgrids to be deployed over the next five years — a 29% annual growth rate.

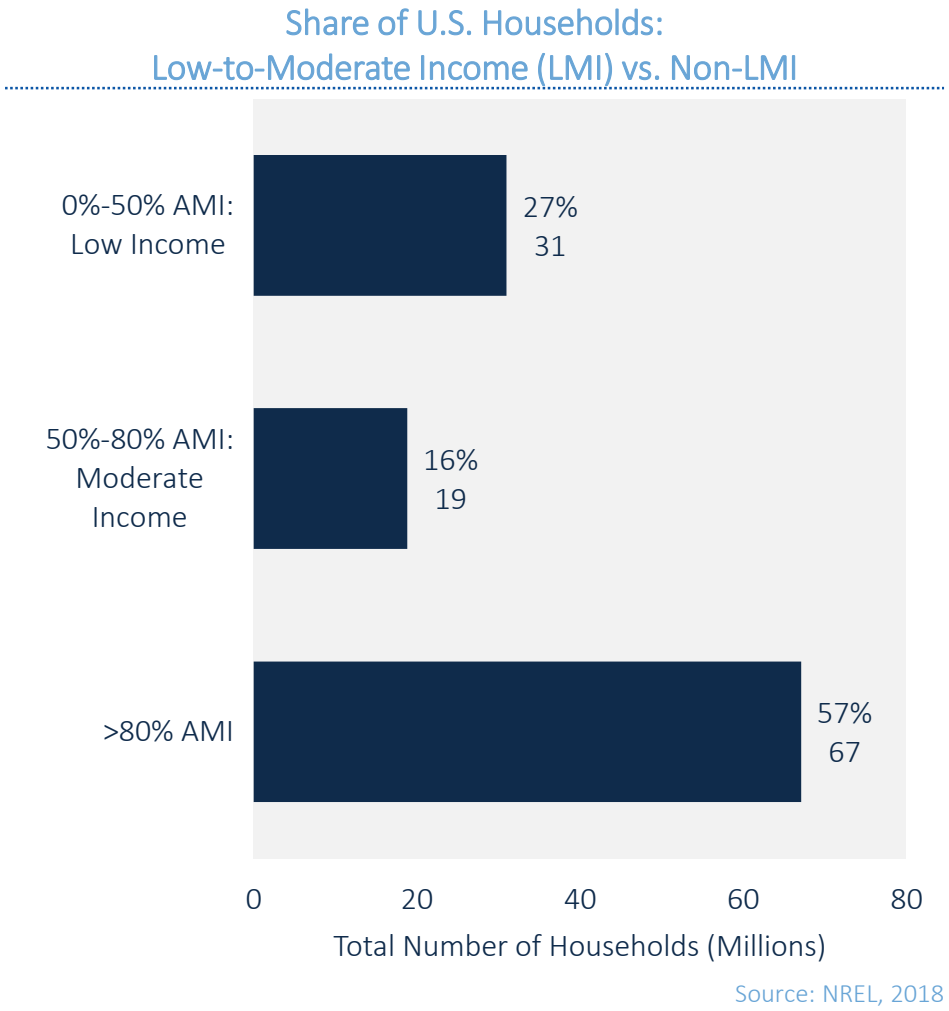
4. Realizing the Low- and Moderate-Income Opportunity

The Low-to-Moderate Income Community Solar Market

50 million reasons why community solar needs to tap into this customer segment

Why community solar is the key to unlocking 50 million low-to-moderate income (LMI) households' access to clean, affordable energy solutions…

- The LMI subscriber opportunity is massive, accounting for approximately 43% of U.S. households. Of that total, there are 31 million low-income households, 19 million moderate-income households, and 5.78 million affordable housing properties across the U.S. that would benefit from cost-saving community solar solutions.
- Community solar provides the flexibility to deliver clean energy access to all LMI customers, including renters and multifamily housing – of which LMI households are more likely to occupy. While 40% of the LMI household addressable market lives in multi-family housing, rental and multi-family housing together comprise nearly 60% the total LMI addressable market.
- Community solar also offers significant benefits to low-income customers, including opportunity for bill savings and energy burden reduction, targeted, flexible value propositions tailored to LMI customers' unique needs, and local economic opportunity to drive the clean energy transition.
- But the LMI community remains relatively untapped due to a number of challenges that can be bucketed into three overarching bottlenecks.
  - Program design, subscriber acquisition and project finance challenges have resulted in insufficient incentive levels, higher soft costs and limited access to capital for community solar projects involving LMI subscribers.



Source: NREL, 2018

Key Barriers Holding Back LMI Participation in Community Solar

These challenges are evaluated in greater detail in subsequent sections of this report

Program Design Challenges

- **Carve-Outs:** At best, these result in community solar providers meeting, not exceeding, LMI subscription requirements.
- **Incentives:** Incentive funding is insufficient and other forms of program support are not available to address subscriber acquisition and project finance challenges.

Subscriber Acquisition Challenges

- **Consumer Product Design:** Rigid contract terms may not align with LMI customer preferences and struggle to generate sufficient savings.
- **Lead Generation and Sales:** Community solar providers may lack internal capabilities and resources to scale up LMI-oriented sales channels.
- **Streamlined Billing:** Additional bills are a significant barrier for low-income customers. Billing needs to be as streamlined as possible, for example, by being integrated into a single platform or on-bill (per recommendation on Slide 63), or by allowing benefits to be transferred through an intermediary purchaser or service provider.

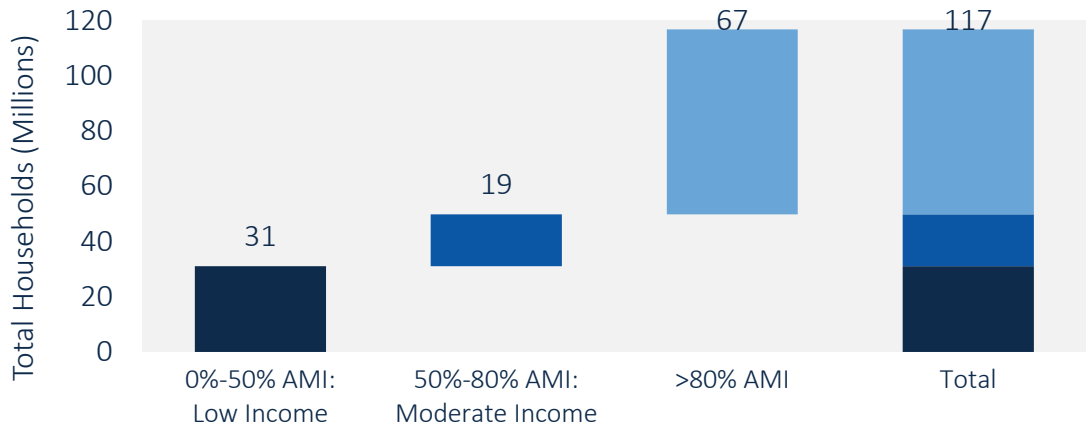
Project Finance Challenges

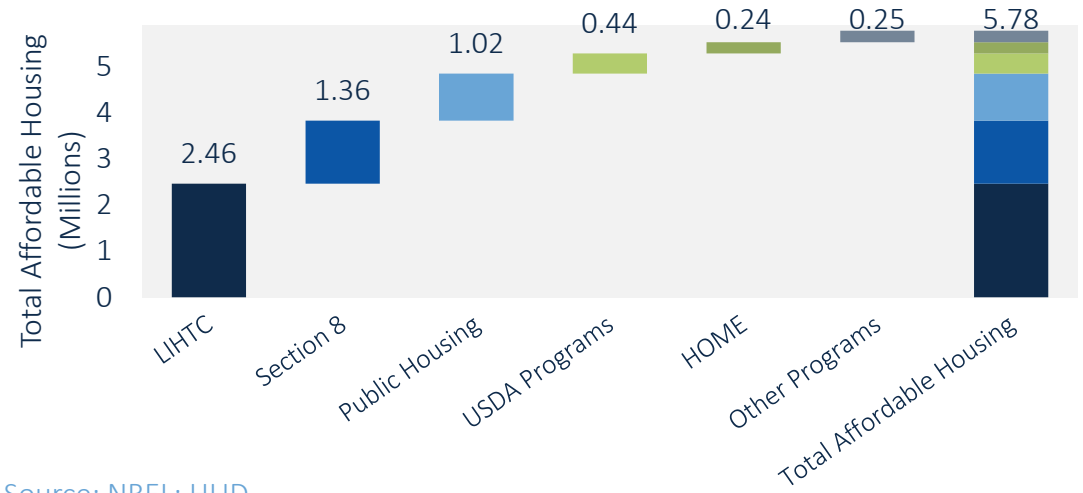
- **Access to Capital:** LMI customers may lack sufficient capital and/or adequate credit scores for community solar providers to raise capital at the same cost of financing as projects backed by residential subscribers with high credit scores and investment-grade C&I subscribers.

Assessing the LMI Addressable Market

Low Income vs. Moderate Income vs. Affordable Housing

U.S. Single Family and Multi-Family Households and Affordable Housing Buildings (2017)





Source: NREL; HUD

Low Income vs. Moderate Income vs. Affordable Housing

- **Low Income:** Per the U.S. Department of Housing and Urban Development (HUD), a household whose income does not exceed 50% of the area median income
- **Moderate Income:** A household whose income ranges between 50% and 80% of AMI
- **Affordable Housing:** Households that receive financial support or direct rental assistance from a federally supported program that targets low-income households offered by HUD and U.S. Department of Agriculture and Rural Development (USDA)
  - Includes Low Income Housing Tax Credit (LIHTC), Section 8 (also called the Housing Choice Voucher Program), HOME Investment Partnerships Program (HOME), public housing, USDA programs and all other smaller programs
- In total, there are 31 million low-income households, 19 million moderate-income households and 5.78 million affordable housing properties across the U.S. that could benefit from cost-saving community solar solutions.

(Affordable housing is treated as a separate segment from low income for three key reasons outlined on the following slide)

Additional Challenges Unique to Affordable Housing Customers

With impacts on subscriber acquisition and raising project finance

1. Who pays the electricity bill impacts who is the actual subscriber and financiers' risk assessment

- Approximately 55% of affordable housing is in a master metered building, where the property owner pays the electricity bill instead of the tenant. This means that a community solar provider only has to sell a subscription to the property owner when the affordable housing building is master metered, as opposed to tenant metered.
  - With master metered buildings, issues of low credit scores, LMI targeted sales channels and other challenges involving LMI subscribers are not relevant, which typically means a lower cost of subscriber acquisition for the community solar provider and easier access to capital for projects that do not rely on individual tenants. However, this also means that property owners in master metered buildings typically do not pass through the benefits and savings of community solar to the tenant.

2. Community solar bill savings can be zeroed out by corresponding increases in rent

- In most types of affordable housing, there is a "utility allowance," which means that rent plus utilities must equal 30% of a household's adjusted monthly income. If the utility allowance is based on actual tenant bills (i.e., is site-specific), then a tenant receives no community solar bill savings because any savings that lower a utility allowance is paired with a corresponding increase in rent. Meanwhile, alternative methodologies that estimate electricity bill costs can allow a tenant to still receive some or all community solar bill savings.
  - It's worth noting that Low-Income Housing Tax Credit properties typically are not required to adopt a specific utility allowance methodology (although rules vary state-by-state). However, most LIHTC property owners use a methodology that allows tenants to capture 100% of community solar bill savings without any increase in rent.

3. HUD approval of community solar subscription agreements can increase soft costs and limit savings for public housing authorities

- If a public housing authority or its tenants subscribe to community solar via a power purchase agreement (PPA), then the subscriber is only eligible for 50% of the bill savings, although requests to receive 100% of the bill savings have been approved by HUD. Second, if the PPA lasts longer than five years, then the PPA must also be approved by HUD via its Rate Reduction Incentive Program.
  - The majority of today's community solar subscription agreements are structured in a $/kWh PPA contract that lasts longer than five years. This means that all public housing authorities are likely to only receive 50% of bill savings, and must go through a HUD approval process that can last upward of 12 to 18 months. However, if the subscriber directly owns a community solar subscription, then the subscriber receives 100% of the savings and no additional approval is required by HUD.

Source: NREL, HUD

Realizing the Low- and Moderate-Income Opportunity

Policy and Market Barriers in Depth

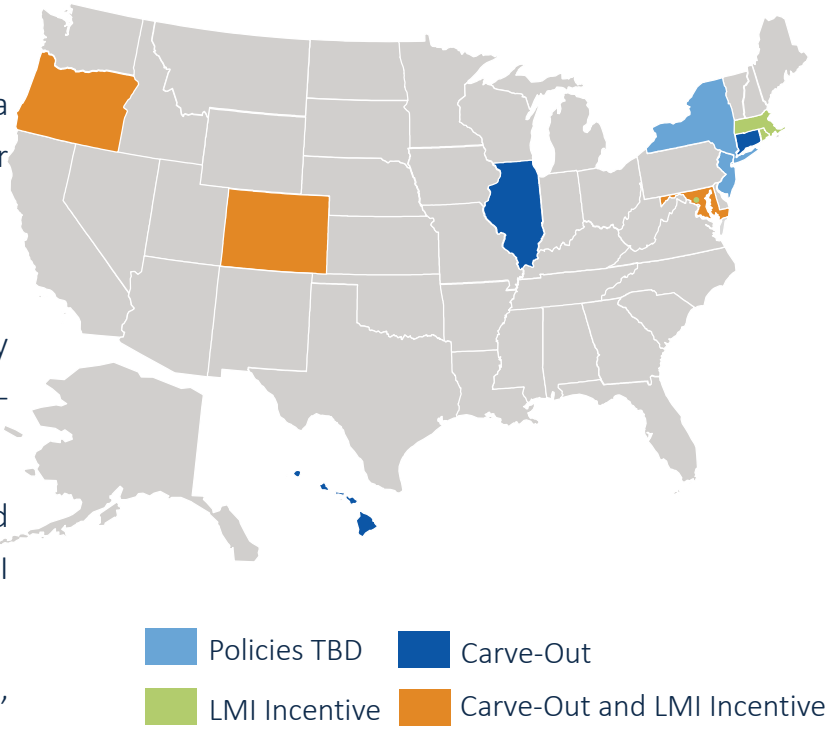
Today's LMI Market: Primarily Driven by Carve-Outs and Incentives

11 states with policies in place or development to support LMI adoption of community solar

- **Incentives or Incentive Adders:** Targeted performance-based incentives, adders to performance-based incentives or grants to support LMI subscriptions in community solar projects.
- **Notable Carve-Outs:** Require a certain share of a community solar program or individual project capacity to be subscribed by LMI customers.

Notable Carve-Out and Incentive Programs

- **Colorado:** Xcel Energy used to have a 5% project level carve-out. For 2017 to 2019, Xcel's program shifted to a program carve-out, which includes 13.5 MW of third-party-led and 5.25 MW of utility-led community solar that must be 100% subscribed by LMI. These projects are eligible for higher incentives for the sale of RECs.
- **Connecticut:** 20% of a 6 MW pilot program is dedicated to LMI subscriber participation.
- **Illinois:** In the Illinois Solar for All Program, more than 60% of REC incentive funding is dedicated to community solar. Incentive levels vary by system size range, and each project must partner with at least one community-based organization.
- **Maryland:** 30% of a 200 MW pilot program must serve LMI, with one-third of that program carve-out required to serve low-income households. On top of SREC incentives, there are grants available for projects with LMI subscribers.
- **Massachusetts:** The current SMART incentive program has incentive adders for projects with LMI subscribers, which vary for projects with LMI customers and affordable housing property owners.
- **Oregon:** There is a 5% carve-out for every project, plus an additional 5% target for the entire program, with incentive program design to be determined.



Source: NREL; Low-Income Solar Policy Guide, Vote Solar, Grid Alternatives

LMI Carve-Outs Are an Important Policy Tool but Not a Panacea to Scale LMI Adoption

Key Benefit of Carve-Outs: Carve-out requirements are a straightforward policy that guarantee a percentage of a program will ultimately serve the LMI segment.

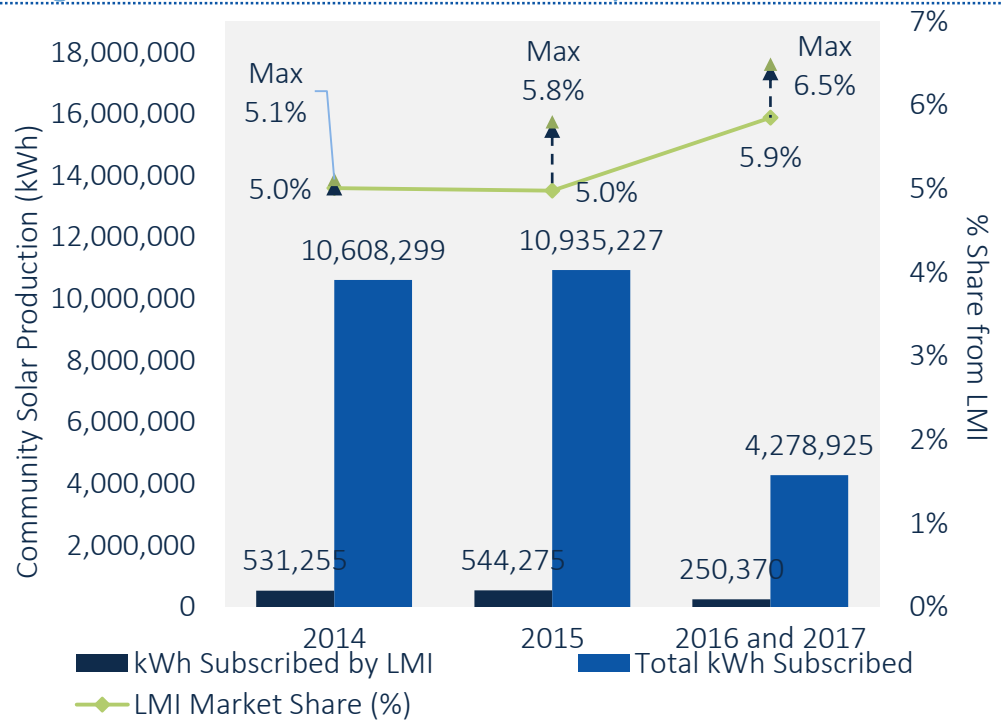
Key Challenges of Carve-Outs

- **Without additional/adequate incentives and programs**, community solar providers often just meet the minimum carve-out requirement when set at the project level. As a result, carve-outs can act as an artificial cap on LMI participation.
- A number of LMI carve-outs **do not set additional targets within the LMI segment**. As a result, community solar providers primarily or exclusively focus on master-metered affordable housing authorities that financiers view as less risky subscribers than low-income homeowners and renters.

Colorado case study: Why hasn't the longest-standing LMI program for community solar achieved scale?

- For projects with a 5% LMI subscription requirement, community solar providers have consistently hovered around that 5% target, and have sometimes given LMI subscriptions away for free in tenant-metered buildings.
- **Key Reason:** Carve-outs alone do not directly address any of the financing or subscriber acquisition challenges associated with LMI subscriptions.

Annual Community Solar Installations in Xcel Energy Colorado's Programs: kWh and % share subscribed by LMI



Source: NREL, Xcel Energy

Why Subscriber Acquisition Is a Challenge in the LMI Customer Segment

Consumer Product Design

- *Rigid contract terms may not align with LMI customer preferences*
- *Subscription offerings may not generate sufficient savings for LMI customers*

- **Rigid Contracts That Do Not Align With LMI Customer Preferences:** Many low-income subscribers are tenants of multifamily buildings and are more likely to move every few years. But today's subscription terms are often structured as 20- to 25-year subscription agreements, which do not align with the needs of LMI customers who tend to be more mobile than residential homeowners.
  - **Note on Affordable Housing Customers:** As mentioned, certain affordable housing buildings that are tenant-metered face additional constraints of utility allowance methodologies that can limit or zero out community solar bill savings, while PPAs with public housing customers (master- or tenant-metered) may only be allowed to claim 50% of bill savings and may not even be granted approval for PPAs with durations greater than five years. Given that, there is a major misalignment between today's 20- to 25-year pay-as-you-go subscription agreements and the needs of tenant-metered affordable housing customers and most public housing customers.
- **Inability to Generate Sufficient Savings:** The majority of community solar subscriptions offer residential customers between 5% and 20% year 1 savings. However, for LMI customers, it has been found that even 10% to 20% percent savings is not sufficient because of the higher energy burden of low-income households (discussed further in a subsequent section of this report).
  - **Note on LMI Retail Rate Schedules:** A number of utilities offer LMI customers alternative, lower retail rates via ratepayer assistance programs. These retail rate discounts pose an unintended challenge of lowering community solar bill credits when subscribers are compensated via net metering.

Source: Low-Income Solar Policy Guide, 2018; Lotus Engineering and Sustainability, 2015; Colorado Energy Office, 2017; GTM Research and Wood Mackenzie

Why Subscriber Acquisition Is a Challenge for the LMI Customer Segment (Cont.)

Lead Generation and Sales

- *Community solar providers may lack internal capabilities and resources to scale up LMI-oriented sales channels*

- **Identifying and Verifying Which Customers Qualify as "LMI" is Challenging:** Community solar providers lack standardized processes to identify which households qualify as low or moderate income, and must pay additional soft costs to partner with outside organizations to support the customer identification process.
- **Challenges of LMI Customer Oriented Marketing:**
  - **High Trust Barrier to Overcome When Selling Subscriptions to LMI Households:** Without possessing a pre-existing relationship with LMI customers, and even in some cases with those relationships, it takes multiple conversations to gain trust from an LMI household to sign up for a deal that when structured correctly (i.e., at least 20% to 50% year 1 bill savings) may be viewed as too good to be true.
    - **Note on Affordable Housing Customers:** Affordable housing property owners can be hesitant to disclose information on tenants, so the community solar provider sometimes must overcome an additional trust barrier with the property owner in order to secure leads in the first place.
  - **Community Solar Providers Tend to Lack Internal Expertise to Tap Into Necessary Sales Channels:** Marketing collateral and sales channel strategies are not a one-size-fits-all approach when seeking to tap into households that are multicultural and multilingual, lack internet access and/or are already enrolled under other affordable energy assistance programs. Such factors impact the degree of consumer awareness an LMI customer has entering an initial sales pitch and the diversity of sales channels required to increase the funnel of high-quality leads.
- **The Challenge of Multiple Bills:** Oftentimes, a subscriber must pay a separate bill to the community solar provider in addition to the customer's remaining bill owed to the utility. This requirement has been a challenge in the subscription acquisition process for LMI customers with burdensome preexisting financial obligations.

Source: Low-Income Solar Policy Guide, 2018; Lotus Engineering and Sustainability, 2015; Colorado Energy Office, 2017; Wood Mackenzie

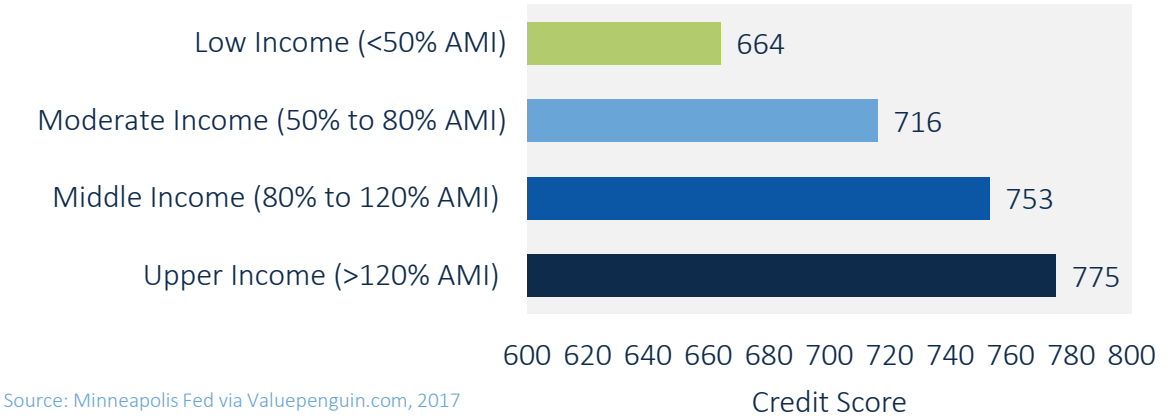
Project Finance Challenges

Why it is currently more difficult and expensive to raise capital for projects backed by LMI subscribers

Project Finance Challenges

- *LMI customers may lack sufficient capital and/or adequate credit scores for community solar providers to raise capital at the same cost of financing as projects backed by residential subscribers with high credit scores and investment-grade C&I subscribers.*

National Median Credit Score by Income Bracket



Source: Minneapolis Fed via Valuepenguin.com, 2017

- **Credit and Income — The Lifeblood of Distributed Solar Project Finance:** Both credit score and income are key elements of a consumer credit underwriting process. For rooftop and community solar, investors across the capital stack typically seek credit scores of at least 680 for any project involving a residential customer.
  - However, LMI customers often lack sufficient capital to prepay subscriptions (which community solar providers sometimes require LMI customers to do to mitigate perceived risk of customer default). Also, LMI subscribers — especially those with credit scores below 680 — can fail to meet the minimum credit scores required for lenders to finance a project. ***However, it is important to note that while there might be overlap, there is not a 100% correlation between low credit scores and low income levels.*** High-income customers can have low credit scores as well.
- **Different Needs for Low Income vs. Moderate Income:** Given that moderate income customers might have higher credit scores, conversations with market participants suggest that certain financing solutions to attract capital for LMI community solar projects, such as credit enhancements administered by green banks, have proven more successful at tapping into moderate-income customers. Additional strategies, such as incentives or leveraging existing LMI subsidies/programs, to improve the affordability of subscriptions may still need to be paired with project-level financing solutions to access the low-income segment.

Source: IREC, 2016; GTM Research and Wood Mackenzie, Sustainable Capital Advisors

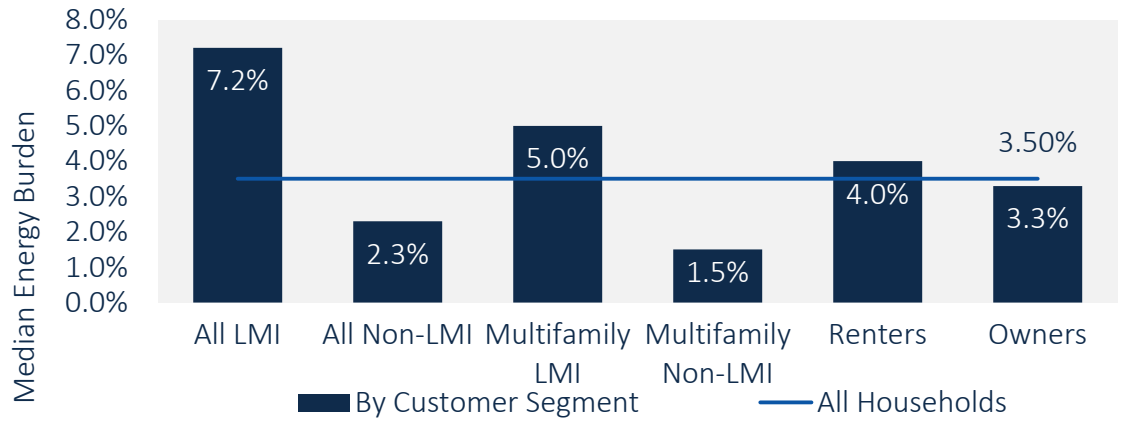
Realizing the Low- and Moderate-Income Opportunity

Policy & Market Solutions to Scale LMI Adoption of Community Solar

Key Elements of a Compelling LMI Offering

Higher % annual savings paired with shorter contract terms and minimal upfront investment

National Median Energy Burden for Electricity and Heating Fuels: All Households vs. Customer Segments

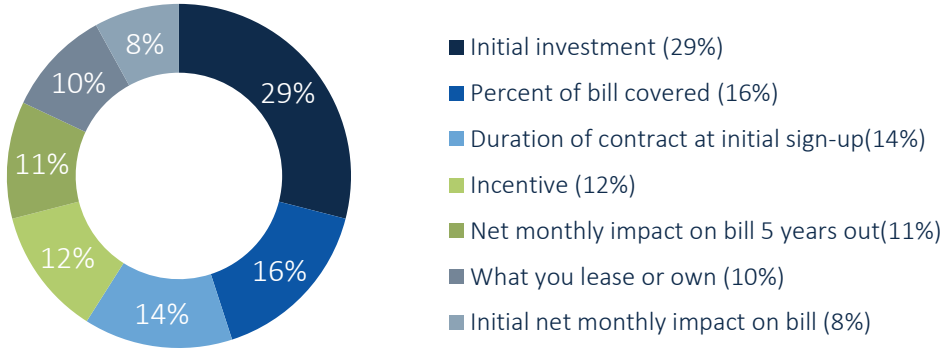


Higher Energy Burdens for LMI Subscribers Require Higher % Bill Savings

- The concept “energy burden" refers to the percent of income spent on energy bills. Given that household electricity consumption does not vary as widely as household incomes, the energy burden is greater for low-income households. In fact, on a national basis, all LMI households have more than three times the energy burden of non-LMI households.
- **Expected Savings:** Conversations with market participants validate the fact that higher energy burdens mean that community solar subscriptions need to offer anywhere between at least 20% and upwards of 50% year 1 bill savings in order to secure commitments from LMI subscribers. The lower end of that range is more viable for master-metered affordable housing property owners, where bill savings are not always directly passed through to the tenants.
  - One notable exception to that range is in Colorado, where much of the initial community solar capacity installed that serves LMI subscribers offers greater than 50% bill savings.

Source: Pacific Consulting Group 2017, SEPA Webinar; ACEEE, 2016; GTM Research and Wood Mackenzie

Considerations for LMI Subscribers’ Participation in Community Solar



Leading Considerations for LMI Customers When Assessing a Subscription

- **Initial Investment:** Market participants note that higher energy burdens make pay-as-you-go subscription offerings with zero or minimal upfront payments especially attractive subscription offerings for LMI customers.
- **Percent of Bill Covered:** Given that LMI subscribers may be on a retail-rate schedule or enrolled in an energy assistance program that lowers their electricity bills, it is critical that a community solar subscription covers as close to 100% of a customer’s electricity consumption as possible to ensure sufficient bill savings.
- **Subscription Length:** Since LMI renters are more likely to move every few years, flexible subscription terms that allow for a subscriber to opt out of the contract in less than 20 to 25 years (i.e., the current industry range for subscriptions) are another key differentiator.
- **Streamlined Billing:** Additional bills are a significant barrier for low-income customers. Billing needs to be as streamlined as possible, for example, by being integrated into a single platform or on-bill (per recommendation on Slide 63), or by allowing benefits to be transferred through an intermediary purchaser or service provider.

Evolving Program Design to Address Major Barriers to LMI Adoption of Community Solar

Current State of Program Design

- *Today's LMI program designs primarily include carve-outs and incentives that at best result in community solar providers meeting, not exceeding, LMI subscription requirements.*

Source: Low-Income Solar Policy Guide, 2018; Lotus Engineering and Sustainability, 2015; Colorado Energy Office, 2017; Wood Mackenzie

Menu of Market and Policy Solutions

- **Carve-Outs:** Tailored LMI carve-out requirements could be created for affordable housing and all other LMI subscribers, including distinct carve-outs for master-metered and tenant-metered affordable housing buildings. Providing carve-outs at the program level may also be useful to provide program administrators with flexibility to implement 100% LMI programs.
- **Incentives:** Performance-based and upfront incentives and incentive adders could be set for different types of LMI customers, such as varying incentives for affordable housing, low income and moderate income participation.
- **Flexible Subscription Rules for Affordable Housing Customers:** Affordable housing property owners typically own multiple properties across a utility service territory. Allowing affordable housing subscribers across multiple load zones to subscribe to the same community solar project is a key program design feature to increase the funnel of leads and support subscriber acquisition efforts.
- **Organizational Backstops and Intermediaries:** Program administrators could also allow housing authorities, state energy offices, cities and nonprofits to serve as financial backstops in the event that LMI customers default, and/or serve as intermediaries to purchase and pass through community solar benefits and savings to LMI customers.

Program Design Evolutions

- *Community solar providers possess sufficient incentive funding and revenue stream certainty from projects with LMI subscribers to lower the cost of LMI subscriber acquisition and lower the cost of capital for projects with LMI subscribers as well.*

Evolving Program Design to Address Major Barriers to LMI Adoption of Community Solar (Cont.)

Current State of Program Design

- *Today's LMI program designs primarily include carve-outs and incentives that at best result in community solar providers meeting, not exceeding, LMI subscription requirements.*

Source: Low-Income Solar Policy Guide, 2018; IREC, 2016; Lotus Engineering and Sustainability, 2015; Colorado Energy Office, 2017; Wood Mackenzie

Menu of Market and Policy Solutions (Continued)

- **Allow Subscriptions to Exceed 100% of Customer Load:** Given the relatively lower energy consumption profiles of LMI subscribers, along with utility allowances and energy assistance programs that can reduce community solar bill savings, allowing LMI customers to subscribe to more than 100% of their customer load can help ensure sufficient bill savings.
- **Removing Caps for Large C&I Anchor Subscribers' Share of Community Solar Projects:** This strategy can enable investment-grade anchor subscribers to provide a backup guarantee to increase its subscription if any LMI subscribers default.
- **Guaranteed Bill Credit Values for Low-Income Subscribers:** Given the higher energy burden that LMI customers face, it is that much more important for LMI subscribers to have predictability in their energy costs. By leveraging ratepayer assistance funds or some other public funding source, program administrators could guarantee bill credit values for LMI subscribers.
- ***The next slide outlines key factors to consider when involving regulated utilities in community solar programs for LMI subscribers.***

Program Design Evolutions

- *Community solar providers possess sufficient incentive funding and revenue stream certainty from projects with LMI subscribers to lower the cost of LMI subscriber acquisition and lower the cost of capital for projects with LMI subscribers as well.*

Factors to Consider When Involving Regulated Utilities in LMI Community Solar Programs

Involvement from regulated utilities should support competitive market development, while ensuring community solar programs are designed to be in the best interests of LMI subscribers and all ratepayers

- Utilities have resources that can be used to address subscriber acquisition and project finance challenges associated with LMI participation in community solar. Some of those resources include **customer information, access to cheap financing, a longstanding customer relationship and the utility brand itself.**
  - At the same time, **it is important to ensure that utility participation does not stifle the solar market's ability to drive down costs** through competition or edge out community-driven and nonprofit solutions. Also, if utilities build and own community solar projects with LMI subscribers, regulators must ensure such programs are designed in the best interest of LMI customers and ratepayers. More broadly, any utility-led program should be designed to ensure fair market competition, which should allow for the LMI community to benefit from the most attractive offerings.
- There are a number of **best practices that utilities could implement** to address both subscriber acquisition and project finance challenges. The below strategies are options that could be considered in tandem with all of the preceding program design solutions outlined in the prior two slides:
  - *Facilitate LMI subscriber enrollment, education and engagement*
  - *Facilitate on-bill payment and/or financing to increase low-income customers' access to solar*
  - *Facilitate siting for solar projects that will serve low-income customers*
  - *Serve as a backup subscriber in the event that LMI subscribers default*
  - *Facilitate the participation of other large entities as backup subscribers*

Source: *Working Draft -- Principles and Recommendations for Utility Participation in Solar Programs for Low-Income Customers, 2018*

Evolving Subscriber Acquisition to Address Barriers to LMI Adoption of Community Solar

Current State of Subscriber Acquisition

- *Community solar providers often lack internal capabilities and resources to scale up LMI-oriented sales channels, while offering standard subscriptions with rigid contract terms that may not align with LMI customer preferences and savings expectations.*

Menu of Market and Policy Solutions

- **Integrating community solar with energy efficiency and energy assistance programs:** By pairing community solar with energy efficiency and energy assistance programs, such as the Low Income Home Energy Assistance Program (LIHEAP), community solar subscriptions are more likely to reach at least 20%-50% savings via a bundled product offering. Certain states, such as Colorado and Minnesota, are also using LIHEAP to finance community solar projects, recognizing that community solar can serve as a long term, flexible solution to energy assistance.
- **Partnerships with organizations that already have established trust or have direct experience building trust with LMI communities:** By partnering with affordable housing property owners and other low-income-oriented community organizations, community solar providers can access customer data to more efficiently verify that a subscriber meets the definition of low or moderate income and design more tailored subscription offerings that meet the needs of LMI subscribers in that particular community.
- **Tailor marketing campaigns and sales channels to the needs of LMI customer preferences:** Conversations with market participants suggest that more than one sales channel and conversation are needed to secure an LMI subscriber. But in-person events, workshops or door-to-door campaigns that involve a trusted organization are particularly effective best practices for overcoming trust barriers among LMI leads.
- **Importance of building out a waitlist:** Given that LMI renters tend to move every few years, on average, it is critical to build out a pipeline of customers to manage LMI subscriber turnover.

Subscriber Acquisition Evolutions

- *Community solar providers tailor subscription offerings to be flexible, short term and eclipse 20% year 1 savings, while leveraging community partnerships to develop scalable LMI-oriented sales channels that lower the costs of subscriber acquisition and retention.*

Source: Low-Income Solar Policy Guide, 2018; IREC, 2016; Lotus Engineering and Sustainability, 2015; Colorado Energy Office, 2017; Wood Mackenzie

Evolving Project Finance to Address Barriers to LMI Adoption of Community Solar

Current State of Project Finance

- *Many LMI subscribers lack sufficient capital and/or adequate credit scores for community solar providers to raise capital at the same cost of financing as projects backed by residential subscribers with high credit scores and investment-grade C&I subscribers.*

Menu of Market and Policy Solutions

- **On-bill financing:** This financing tactic involves the LMI subscriber repaying the costs on his or her utility bill. Conversations with market participants suggest that this tactic could lead to lower default rates and a more compelling sales pitch if a subscription payment is structured as a line item on a customer's utility bill.
- **Rolling out green banks to provide credit enhancements:** Green banks can serve a critical role of providing low-cost public financing to attract private capital at cheaper financing terms. Key tactics include credit enhancements, such as loan loss reserves or loan guarantees, which set aside capital to cover losses incurred during the loan term. Such financing mechanisms can provide a pool of capital to provide lenders with a backstop against customer default, as community solar providers prove out subscriber retention strategies to reduce the perceived risk of customer default over time.
- **Moving beyond credit score to alternative underwriting assessments:** Given that a FICO score is not necessarily the most accurate indicator of an LMI customer's likelihood to pay a subscription, lenders could consider more tailored, alternative underwriting criteria, such as an LMI subscriber's utility bill payment history.
- **Layering on additional tax credits:** Market participants note that some community solar providers have been able to attract investors that can layer on additional tax credits, such as the LIHTC, to further defray upfront installation costs.

Project Finance Evolutions

- *By tapping into alternative consumer finance strategies and/or public sources of capital, community solar providers will have an opportunity to minimize the perceived risk of higher customer default across LMI subscribers that possess low credit scores.*

Source: Low-Income Solar Policy Guide, 2018; IREC, 2016; NREL, 2016; GTM Research and Wood Mackenzie

Putting the Vision Together: Scaling LMI Adoption of Community Solar

An Evolution in Program Design, Subscriber Acquisition and Project Finance

Current State of Program Design

Today's LMI program designs primarily include carve-outs and incentives that at best result in community solar providers meeting, not exceeding, LMI subscription requirements.

Current State of Subscriber Acquisition

Community solar providers often lack internal capabilities and resources to scale up LMI-oriented sales channels, while offering standard subscriptions with rigid contract terms that may not align with LMI customer preferences and savings expectations.

Current State of Project Finance

Most LMI subscribers lack sufficient capital and/or adequate credit scores for community solar providers to raise capital at the same cost of financing as projects backed by residential subscribers with high credit scores and investment-grade C&I subscribers.

Program Design Evolutions

Programs offer sufficient financial support and other resources for community solar providers to exceed program-level LMI carve-outs:

Community solar programs pair carve-outs with sufficient incentive funding that varies by customer type within the LMI segment, integrate with other energy assistance programs, support creative solutions that address LMI customer default risk for community solar providers, and include strong consumer protections for more financially vulnerable LMI subscribers.

Subscriber Acquisition Evolutions

Community solar providers design subscription offerings and invest in sales channels that are specific to LMI customers' preferences and needs:

Community solar providers tailor subscription offerings to be flexible, short term and eclipse 20% year 1 savings, while leveraging community partnerships to develop scalable LMI-oriented sales channels that lower the costs of subscriber acquisition and retention.

Project Finance Evolutions

Low-cost sources of private bank and institutional investor capital are willing to finance portfolios of projects with 20% to even up to 100% LMI subscribers:

Financing strategies, such as on-bill financing, alternative credit scoring or credit enhancement, loan loss reserves and green banks, enable community solar providers to access financing while proving out business models that erase perceived risk of higher customer default across LMI subscribers.

5. Charting Potential Adoption for Community Solar

Quantifying the Phases of Market Transformation

A Market Transition in Three Phases

PHASE I: Market Emergence

The business model for community solar is being proven out and tailored to fit local regulations and risk-averse investor sentiment.

Costs have a strong premium for interconnection upgrades, subscription acquisition and subscription management.

LMI adoption is limited to programs that pair carve-out requirements with sufficient incentive funding.

PHASE II: Market Transition

Community solar begins to flourish as policymakers and regulators see its economic and societal values. Programs are uncapped and solar is compensated based on negotiated or studied value.

Community solar costs fall rapidly through programmatic, policy and industry innovations, as well as specific improvements to subscription acquisition and management.

LMI adoption improves as regulators implement incentives and other support programs to exceed carve-out requirements.

PHASE III: Market Maturity

Community solar is an attractive default option as customers and policymakers recognize the broad grid, environmental and even socioeconomic values of solar.

Community solar costs have levelized but deliver cost-competitive energy with an accounting of environmental, societal and grid benefits.

Strong LMI support programs and improved subscriber retention models result in LMI customers being viewed similarly to medium- and high-income subscribers.

Building an Adoption Forecast for Our Envisioned Market Transformation

To forecast potential customer adoption, we assume that the necessary community solar policies and industry innovations previously described are in place, including inclusion of strong support for low- and moderate-income adoption.

Our forecast focuses on economic adoption based on pragmatic bill crediting and solar valuation outlooks via historically-observed and literature-based customer adoption curves for distributed solar. Constraints based on local distributed solar adoption, market resource mix and known near-term broad market policies are also applied.

Our analysis also attempts to quantify key inputs in the following categories:

Subscription costs

- Based on the costs to build and finance community solar, how much would subscribers pay for community solar?
- Key assumptions: System lifetime, all-in costs, operation costs, subscriber acquisition and management, interest rates, investor rate of returns

Customer benefit

- Based on assumed subscriber offerings, what is the economic benefit for subscribers compared to either a bill credit or valuation for community solar?
- Key assumptions: Compensation mechanism and rate for community solar

Market segment-specific adoption

- How does adoption differ between residential, non-residential (commercial, industrial, government and nonprofit) and low- and moderate-income market segments (including affordable housing tenants and property owners)?
- Key assumptions: Addressable market for each segment, desired benefits for each segment (residential, low- and moderate-income residential, affordable housing, small non-residential, and large non-residential, value comparison to adoption by onsite distributed solar options, assumption of LMI adoption-focused policies and subscription offerings

Charting a Path for the Cost of Community Solar Subscriptions

Collating the innovations and cost reductions identified in our Section on "Reducing the Cost of Community Solar", we chart potential community solar subscription costs

Our national roadmap for community solar costs and other asset parameters may be viewed as conservative:

- Most community solar assets have an expected functional lifetimes well beyond the typical 20- or 25-year subscription period.
- All-in prices for solar have fallen by over 40% in the past five years, whereas we expect only a 30% cost reduction over the next 12 years.
- All-in operation costs are held steady in our model although many industry stakeholders expect asset management and operations and maintenance costs to fall due to scale, focus on operational efficiencies and better software tools.

Meanwhile, we note that while project finance costs have dipped as new, low-cost of capital sources enter the market, rising interest rates, tax revisions and any number of macroeconomic factors could raise the cost to finance solar.

Even so, community solar holds a number of cards to reduce the cost of capital, including the asset securitization or reducing real and perceived payment risk with new qualification metrics. Shifting financiers' attention to "subscriber platform" risk rather than focusing on individual subscribers could also help keep the long-term cost of capital steady.

KEY ASSUMPTIONS (NATIONAL)	2018	2025	2030
Asset Life (years)	25	25	25
All-In Price, Not Including Subscription Acquisition ($/Wdc)	$1.95	$1.46	$1.36
All-In Operation Costs ($/kW/year)	$15.0	$15.0	$15.0
Subscriber Acquisition Costs ($/Wdc)	$0.20	$0.14	$0.05
Subscriber Maintenance Costs ($/W/year)	$0.02	$0.02	$0.01
Interest Rate (%)	5.0%	5.0%	5.0%
Equity IRR (%)	9.0%	9.0%	9.0%
Interest Rate (%)	5.0%	5.0%	5.0%
Debt Fraction (%)	40%	40%	40%

State-Level Differences in Community Solar Cost Inputs

We build state- and utility-level cost inputs by adjusting national level inputs based on proprietary forecasts and industry interviews. Differences include:

- **Capacity factor**: Primarily a function of solar resource and system type (single-axis tracking vs. fixed tilt PV). We use PVWatts to model local performance for each major state investor-owned utility.
- **Upfront costs**: While equipment costs are relatively even across state lines, local permitting, labor, taxes and other soft costs can vary considerably even for larger solar projects.
- **Operation costs**: O&M costs differ slightly between states. The primary differences are typically the result of property taxes, insurance and ongoing land leases.
- **Subscriber acquisition and management:** Given relatively low experience to date with community solar, acquisition costs are difficult to estimate. We believe that more competitive states with higher rates of solar deployment will have higher acquisition costs.
- **State-level incentives**: We do not model in any new incentives — especially important for New Jersey where the state is embarking on an SREC successor program.

KEY ASSUMPTIONS	CA	FL	MI	NJ
PV System Type	Single-Axis	Single-Axis	Fixed Tilt	Fixed Tilt
Capacity Factor (%)	21%-22%	18%-21%	13%-15%	14%-16%
Upfront Costs vs. National	+7%	-2%	+4%	+9%
Operation Costs vs. National	+50%	---	---	+25%
Subscriber Acquisition and Management Costs vs. National	+50%	---	---	+25%
Weighted Cost of Capital	7%	7%	7%	7%
State-Level Incentives	None	None	None	SRECs until program expiry

How Could Community Solar Be Valued in the Future?

PHASE I: Retail Rate | **PHASE II: Two Value of Solar Options** | **PHASE III: Moderate Value of Solar**

Based on recent policy action on compensation structures, we expect that community solar will evolve from full retail net metering in states with growing distributed solar deployments

- According to the Database of State Incentives for Renewables & Efficiency, 31 states and Washington, D.C. have introduced policy action on distributed generation compensation in 2017 alone.
  - At the time of writing, a value-of-solar methodology for community solar is currently implemented in three geographies: Austin Energy, Minnesota and New York.
  - Other geographies are in the process of considering a value-of-solar mechanism, including Illinois and Oregon, although the implementation has been stalled in Oregon due to Oregon Public Utility Commission concerns. In Illinois, the value of solar will determine a rebate paid to the project owner for community solar, not a bill credit rate.

Given the difficulty in predicting precisely where policy will land at a state—or even broad national—level, we make the following assumptions for community solar in each phase with solar estimates:

- Phase I: Retail net metering offsetting all volumetric charges
- Phase II: Two Scenarios —Limited Scenario (Limited Value of Solar) and Moderate Scenario (Moderate Value of Solar) - Explained more fully in "Phase II: What Might a Transitional Credit Look Like?"
- Phase III: Moderate Value of Solar that includes many though not all benefits from community solar

In addition to a fair compensation level, a sustainable community solar program requires stable and long-term credits and values to ensure attractiveness to the customer and financeability.

The Examined Community Solar Compensation Paths

While a movement away from full retail-rate net metering is likely, when and how this will occur remains in the realm of speculation

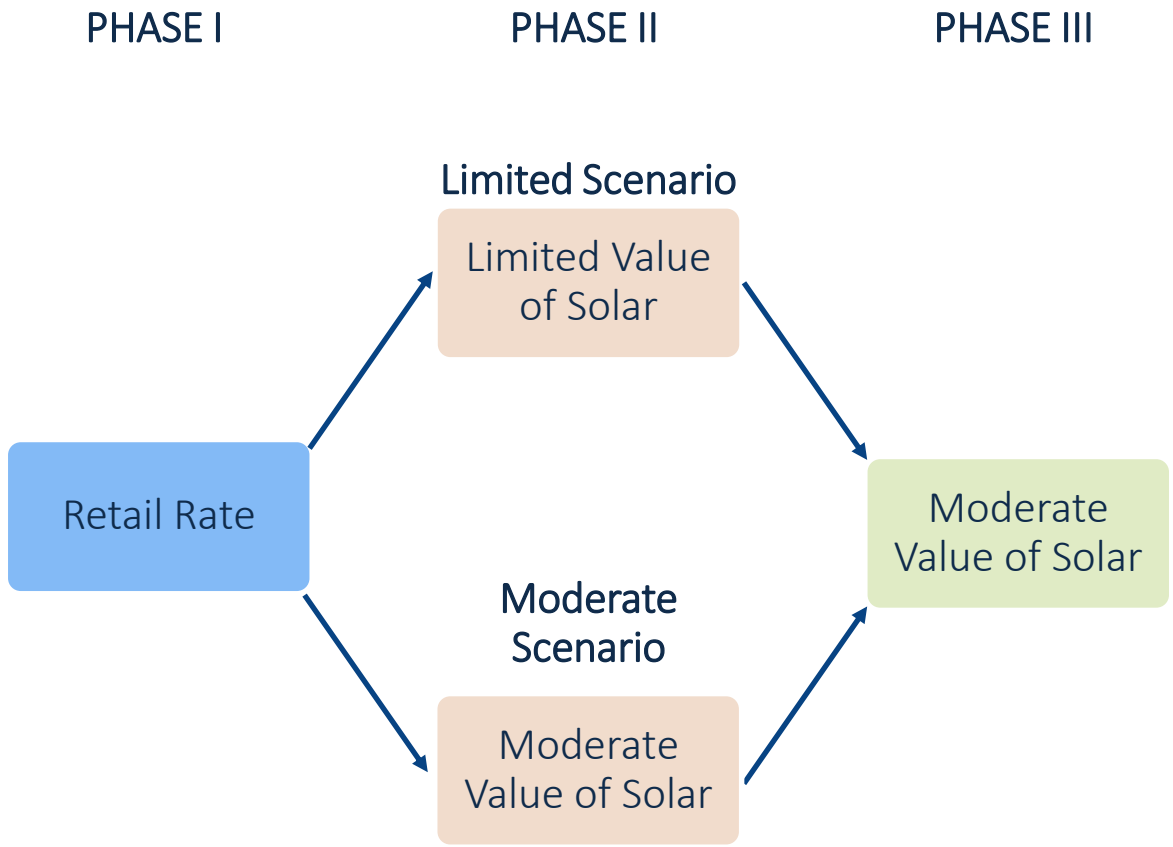
Every state is in a different place in terms of solar penetration and political atmosphere for a transition away from retail-rate net metering. Even in states undergoing a change (e.g., Michigan), the rates are still unknown.

Rather than make a predictive stance as to when the four profiled state markets move into new compensation structures, we use two scenarios in Phase II to help us model customer adoption in Phase II:

- **Limited Value of Solar**: An estimate based on the literature that includes only a narrow set of grid benefits (see Value of Solar Cost Categories and Components)
- **Moderate Value of Solar:** An estimate using an increased, though not full, set of grid and environmental benefits (see Value of Solar Cost Categories and Components)

By Phase III, we model the market to converge on the moderate value of solar methodology that takes into account a greater range of benefits that community solar provides the grid, customers and the environment. As noted previous, due to uncertainty, our modeled moderate value still excludes additional economic and societal values as described in "Value of Solar Cost Categories and Components"

Value of Community Solar Compensation Mechanism for Each Market Phase



Phase II: What Might a Transitional Credit Look Like?

Considering the nascence of community solar and the uncertainty of the future of solar valuation, we examine two different scenarios for a transitional valuation of community solar.

Limited Scenario: This scenario represents an early transition to an export tariff that reflects compromise or an otherwise reduced scope of components that field a full value-of-solar tariff. These components include the marginal value of generation, avoided capacity, transmission and distribution equipment build-out and environmental compliance. However, it lacks recognition of further grid (e.g., ancillary services and demand reduction-induced price effects), societal, environmental and economic benefits. Examples of implementation include:

- Austin Energy: Austin Energy had the first implementation of a value-of-solar tariff, using mostly core components plus a societal rate for carbon
- Minnesota: A value-of-solar tariff that encompasses core value-of-solar components with valueless placeholders for future costs and credits

Moderate Scenario: This scenario reflects an environment that accepts that distributed solar could provide additional grid and societal values. *An moderate value of solar credit may not be easily calculated for all markets nor will it necessarily capture every economic, societal and environmental benefit and cost.*

Practically, transitioning to an Moderate Value of Solar framework could take the form of either:

- A limited value of solar with a market transition credit (MTC), where the MTC is used to give credit for uncertain values without requiring a deeper methodology for valuation. An example includes:
  - New York: Community solar is granted an MTC on top of the "Value of DER" components that serves as the base of community solar bill credits
- "Retail minus" representing a continuation of legislative and regulatory stakeholders that look for a convenient compromise between advocates of full retail-rate net metering and those seeking a low compensation rate for distributed solar. Typically seen as a temporary transition, retail minus simply assumes a credit with a fixed discount off of prevailing retail rate, but finding the "right" number can be arbitrary or speculative. Examples of implementation include:
  - NV Energy: Residential solar bill credit for exported generation starts at 95% of retail rate and steps down to 75% of retail rate based on installation "blocks"
  - Rocky Mountain Power (Utah): Residential solar bill credit is set at 90% of retail rate for exported generation

Value of Solar: Overview of Methodology

In Phase II, we use "value of solar" estimates that represent an average of proxy values from an extensive review of existing studies. ***These values are meant to be illustrative and should not be interpreted as a prescription or prediction for the actual value of solar in the studied states nor applied more broadly.*** The studied literature provide a convenient result for modeling potential adoption but may be incomplete, inaccurate or inconsistent with best practices, current conditions and a full set of benefits.

We estimate the value of solar in the four states in focus via the following steps

1. Conduct an extensive literature review of various value-of-solar studies with a focus on studies that provide component-by-component estimates
   - Categorize value-of-solar component values into general buckets as described in the next slide
   - Compare value-of-solar component estimates against EIA average retail electricity rates at the time of the study to derive a net discount/benefit (in %)
2. Weight relevance of each study according to its recency (i.e., when study was conducted), state and wholesale market structure
   - Recent, in-state studies are given the most weight whereas older, out-of-state studies with a different market structure (i.e., regulated vs deregulated) are given the least weight
   - Aggregate and average the estimated net discount/benefit off average retail rate to derive a regional/state-proxy estimate
3. Apply resulting average value-of-solar discount/benefit off retail to utility-specific retail rates to derive utility-specific value-of-solar costs
   - Rates are escalated according to Wood Mackenzie projected retail rates for each state

For a more detailed description of our value-of-solar methodology, see our Value of Solar Methodology in the Appendix

Caveats for Our Value of Solar Methodology

Value-of-solar estimates vary due to the inherent locational and temporal details and a lack of commonly accepted core assumptions and methodologies

While various handbooks, white papers and initiatives seek to establish a common language and a set of methods to calculate the value of solar, an inherently balkanized utility and regulatory landscape results in very different sets of methods and values.

A bottom-up analysis of value of solar in each territory would be extensive, complex and no less controversial nor more valid than our top-down analysis, due to limited data for critical pieces of the analysis. Our intent is to convey the promise of community solar — not set a value-of-solar rate that warrants adoption.

Our purpose is not to prescribe a "value of community solar," but rather to use existing frameworks and literature to create proxy values we can couple with strong community solar policies, product innovation and LMI inclusivity to paint potential community solar adoption. In short, these are illustrative values only and should not be viewed as a proper valuation study nor used as robust, geography-specific estimates.

We accept that there are a number of shortcomings in our calculated value of community solar estimates, including but not limited to the small population of studies and variations to study methodologies on calculated components. We believe that a number of studies fall short in building in the true value of solar because of scope, data and calculation limitations. Similarly, a handful of broad studies incorporate values that may not be realistically employed.

In short, our values represent a simplistic proxy where further standardization, study and clarity is much needed.

Quantifying a Limited and Moderate Value of Solar for Our In-Focus States

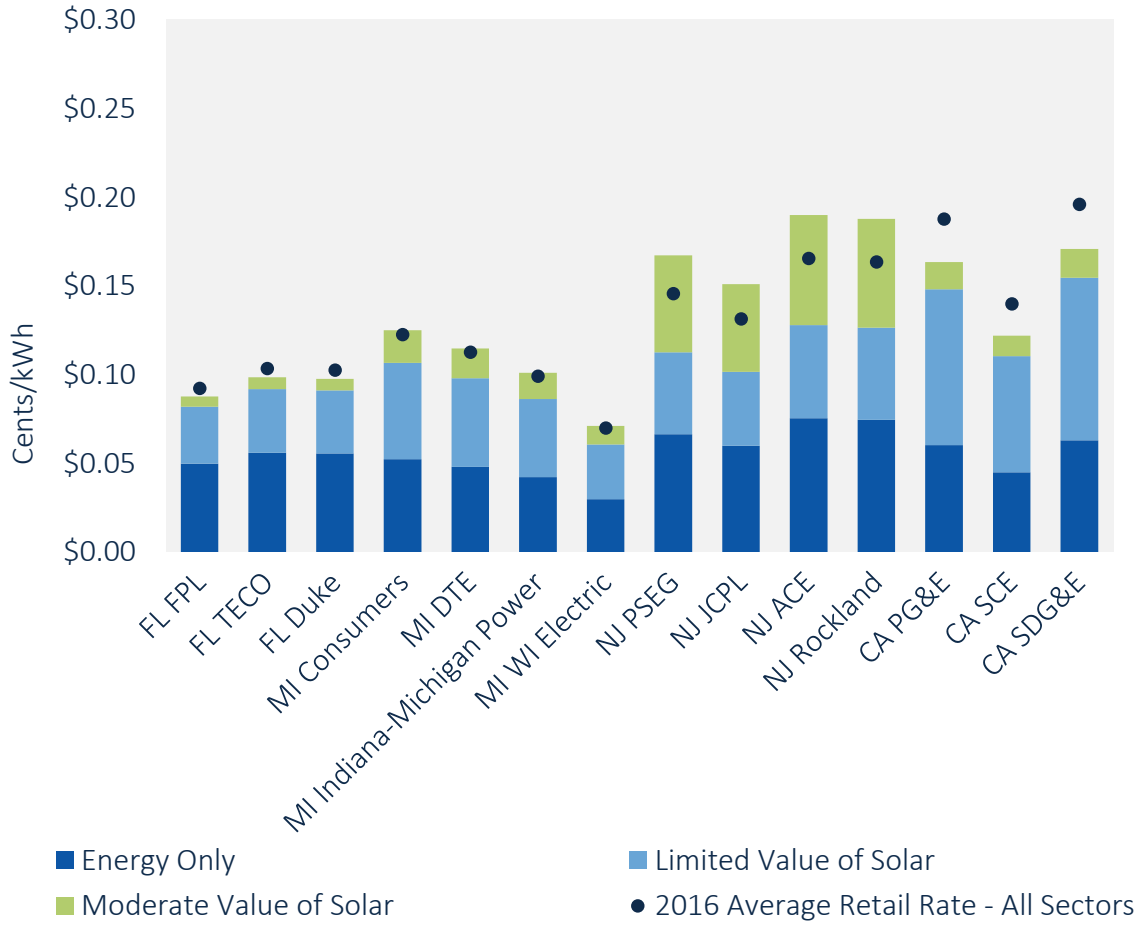
We build two value-of-solar estimates for each studied state

Despite differences in methodology, nearly all value-of-solar studies accept that distributed solar has value beyond the generated electrons (i.e., an energy-only value). However, adopted methodologies generally differ in which components are included and how these are calculated. Using our guide to different components, we come to two general categories of value of solar:

- **Limited value of solar:** Using only components that are more commonly calculated for value of solar in studies, including direct avoided costs and environmental credits that are directly monetizable (e.g., RECs)
- **Moderate value of solar:** Using a broader, but incomplete, set of components that pertain to grid value, excluding non-monetizable and more difficult-to-calculate societal benefits (e.g., social cost of emissions, jobs, low-income support).

Ultimately, our moderate value-of-solar averages range from a 13% discount to a 15% premium of average state-wide retail rates, with an average close to average retail rates. ***We also note that, due to the limitations of the literature reviewed, our moderate value of solar does not include a full benefit and cost accounting, including additional economic and societal benefits.***

Weighted Value of Solar vs. Average Retail Rate Based on Literature Review



Source: GTM Research

Identifying the Uncertainty and Potential Biases in Our Study

In addition to pragmatic differences in the reviewed studies' methodologies, we acknowledge the risk inherent to using a broad set of literature for values rather than a bottom-up calculation. The main risks to our utilized values include:

- **Bullish views on forward wholesale electricity prices:** Given the limitation of available data on the studied geographies and our intent for these estimates to be representatives rather than definitive, we employ a rough top-down average of existing studies rather than using best-in-class bottom-up calculations in each studied geography. Older studies may have more bullish views on natural-gas-driven wholesale energy prices, which would increase the long-term value of solar. We attempt to mitigate the impact of these factors by filtering out studies before 2010, as well as more heavily weighting recent studies with up-to-date views on energy and infrastructure costs.
- **Increasing solar deployment erodes the value of pure solar**: Our discount to average retail rate method could **overestimate the value of solar in high-penetration scenarios**, as concurrent solar generation does not mitigate all capacity costs and may increase certain integration costs. We assert that broad deployment of energy storage and flexible devices installed could mitigate the value erosion. These components will come at an additional cost but can also be utilized for services beyond mitigation of the effects of high solar penetration, adding value or potentially offsetting the costs of these additions.
- **Many value-of-solar studies take a limited view on broad values**: Our methodology averages in value-of-solar studies that ignore or cast aside best practice values, e.g., assuming capacity offset of solar is zero or assuming no ability to offset distribution equipment even at low solar penetration. In other circumstances, we look at estimates from regulatory filings in which the value-of-solar definition may be intentionally narrow, i.e., broader components are not even considered. Because these limited studies are also included in our averaged results, **our estimates may undersell the full value of solar**.

Overall, there is an inherent risk in mischaracterizing the value of distributed solar because current literature is incomplete or may otherwise inaccurately portray different component values. Significantly more work on a standard, agreed-upon framework and methodology should be implemented in markets that move towards a value of solar bill credit for community solar facilities.

Charting the Vision for Community Solar

California

California's Community Solar Market to Date

Community Solar in a Time of Transition

California has been a clear market leader in solar energy in nearly every aspect, making up just over 38% of overall U.S. solar deployed to date.

In 2016, California adopted time-of-use rates as mandatory for new net-metering customers as a first step toward reflecting the temporal costs and benefits of energy. Going forward, the California Public Utilities Commission committed to revisiting net metering in 2019 and in that context, consider export compensation, which takes into account locational- and time-differentiated values.

As the CPUC considers a change to the key tariff for distributed solar generators in the state, major changes in the composition of load-serving entities are occurring, with a majority of the state's load potentially transitioning to being served by community choice aggregators with ambitious clean energy goals. Community solar could be a means by which CCAs cost-competitively meet their goals for developing new local renewable energy resources and meet medium-term goals for being 100% renewable.

California by the Numbers

- Total Cumulative Solar: **19.8 GWdc**
- State Solar Rank*: **1**
- Solar % of Total Electricity: **13.2%**
- Community Solar: **21.1 MW**
- Community Solar Rank*: **3**

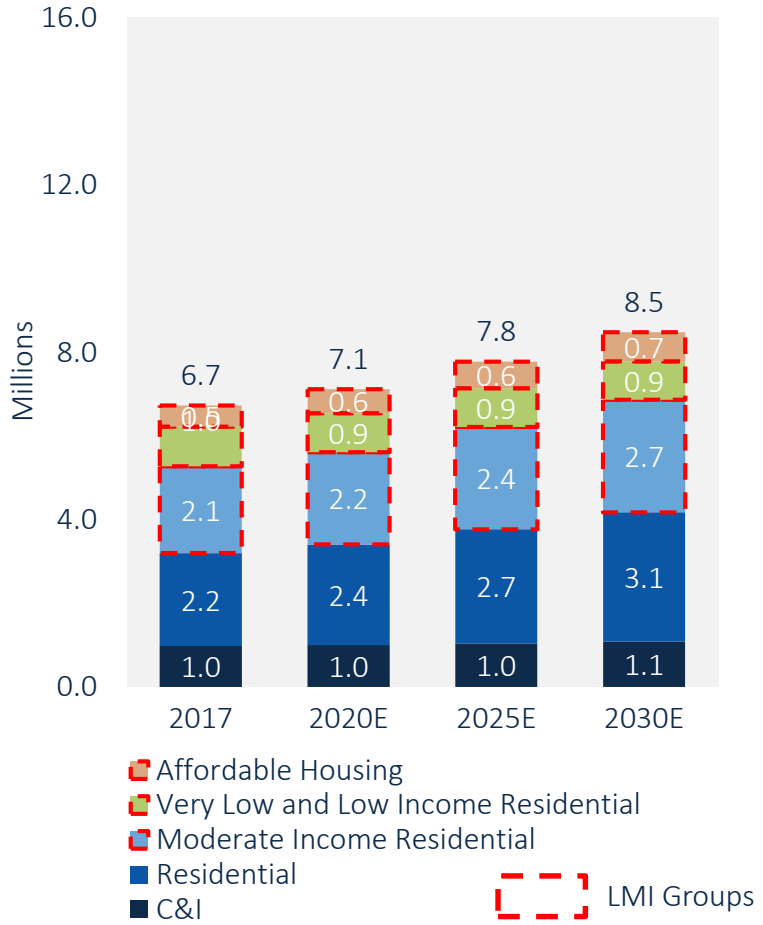
*By cumulative installed solar capacity

An Underwhelming Community Solar Program To Date

Under the Green Tariff Shared Renewables program enacted in 2013, the three CA IOUs are required to procure up to 600 MW of new renewables to which customers can subscribe. However, to date, only a few community solar projects are under development. In June 2018, the California PUC approved a program similar to the Green Tariff, where low-income customers living in polluted areas can receive a 20% overall bill discount from a local renewable project. However, these programs are not expected to drive significant amounts of capacity.

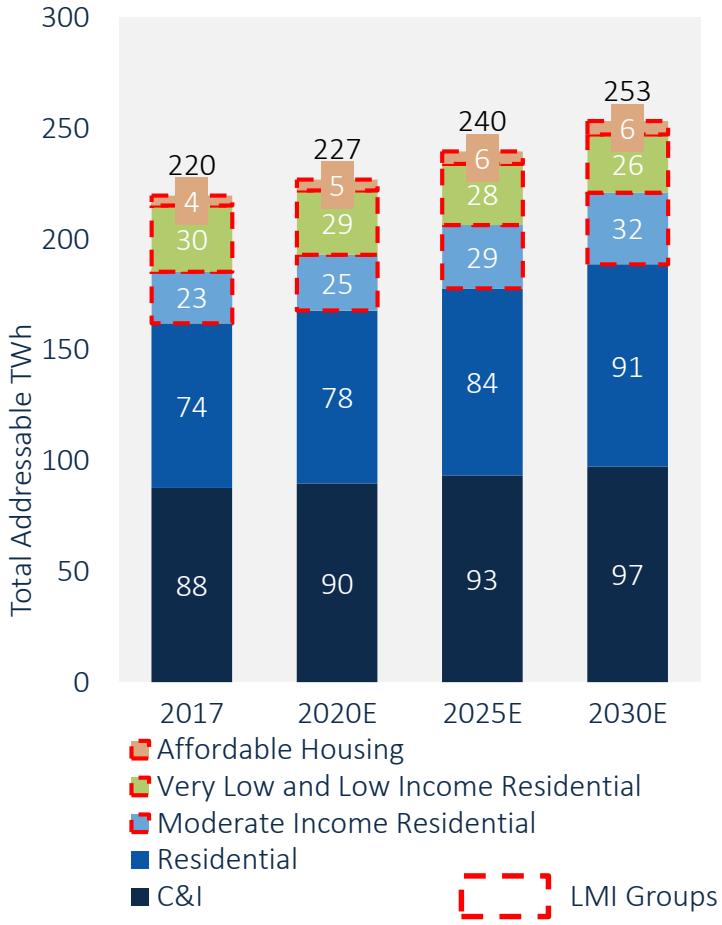
Total Addressable Market for Community Solar – California

Addressable Households and Organizations (#)



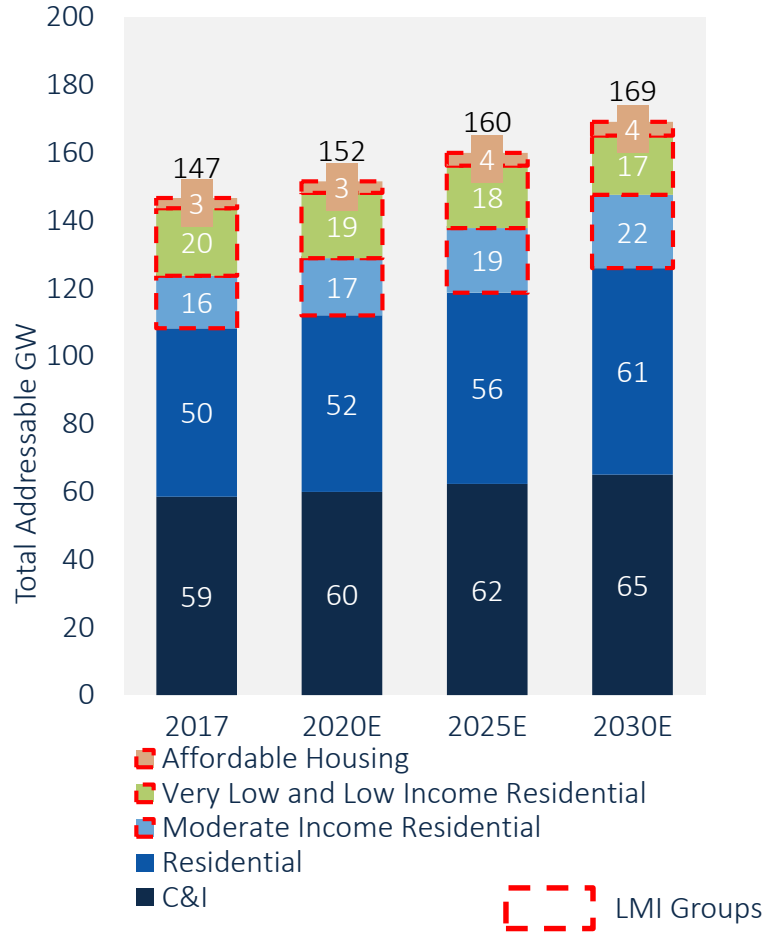
Source: GTM Research Wood Mackenzie, NREL, U.S. Census

Addressable Households and Organizations (TWh)



Source: GTM Research Wood Mackenzie, NREL, U.S. Census

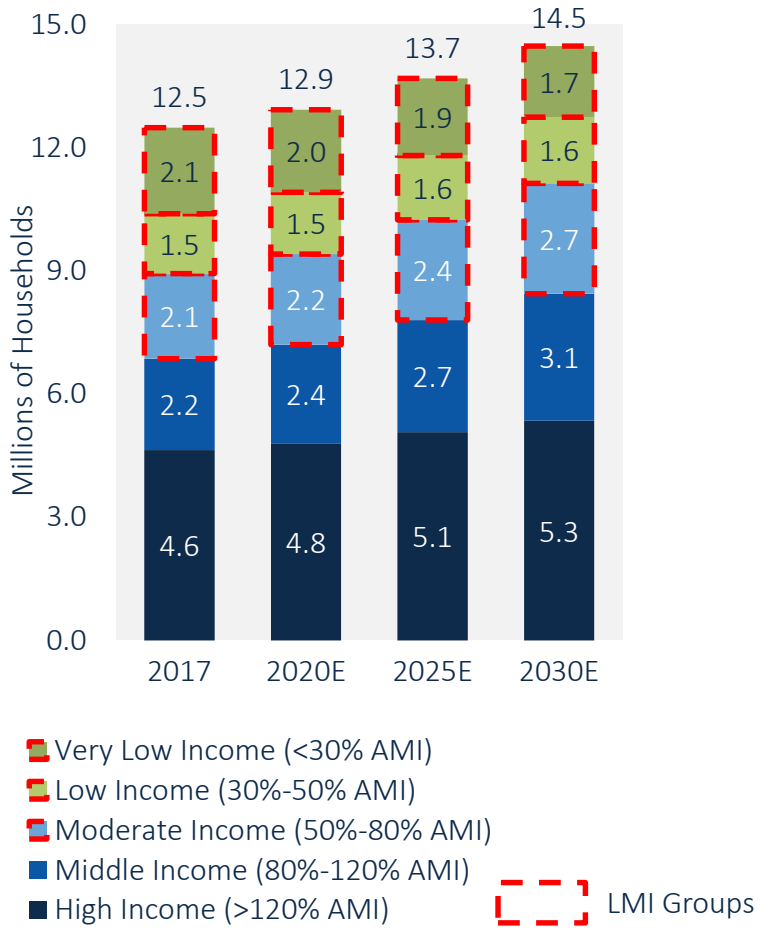
Addressable Households and Organizations (GW)



Source: GTM Research Wood Mackenzie, NREL, U.S. Census

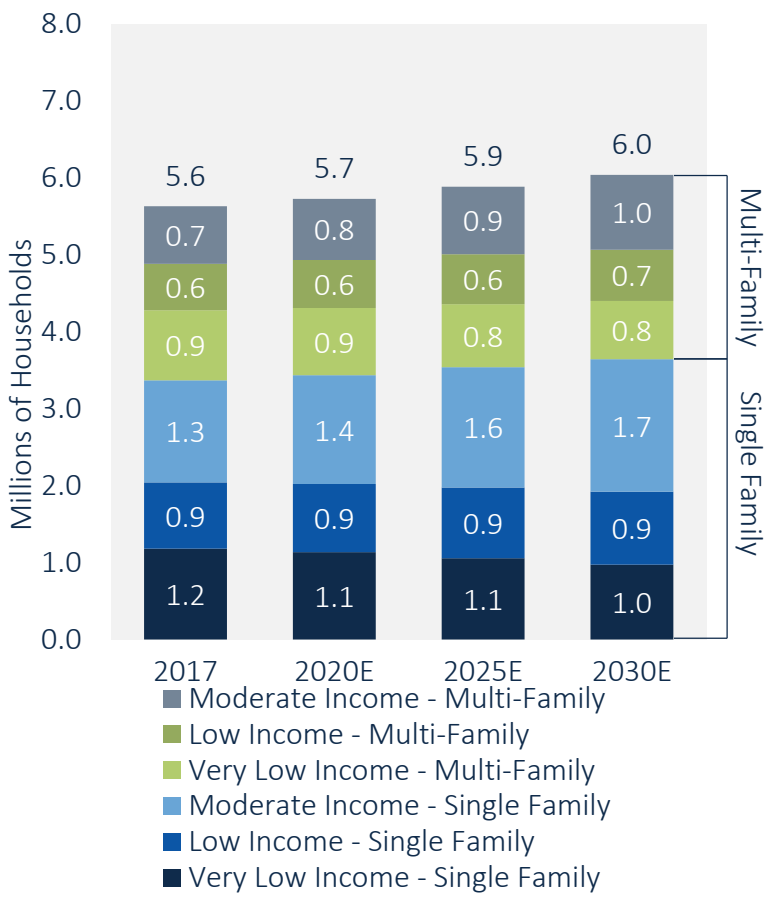
Low- and Moderate-Income Addressable Market – California

Residential Addressable Market by Income (# of HHs)



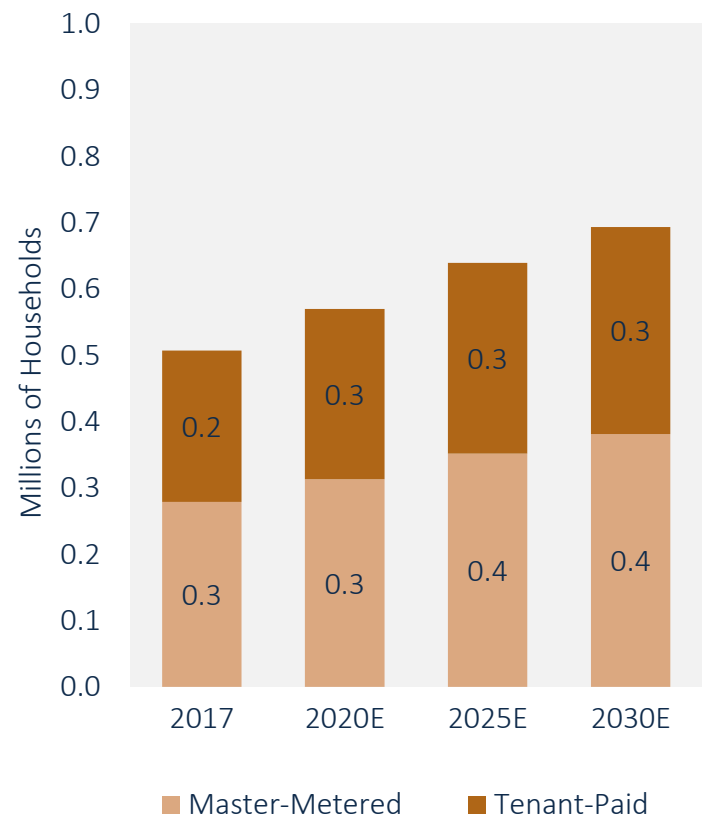
Source: GTM Research Wood Mackenzie, NREL, U.S. Census

LMI Households by Single- vs. Multi-Family Unit



Source: GTM Research Wood Mackenzie, NREL, U.S. Census

Affordable Housing Market by Type (# of HHs)



Source: GTM Research Wood Mackenzie, NREL, U.S. Census

Modeling Customer Benefits for Community Solar

Community solar in California could provide strong savings across the board for all customer segments, although shifting peak periods and planned net metering revisions will influence future savings for residential customers

- Our model of residential community solar subscriptions account for time-of-use generation and rates, although no shifts in relative rates nor applicable periods are projected in the model.
- The CPUC is currently developing locationally variant valuations of distributed energy, which could form the basis of a value-of-solar-based successor to net metering

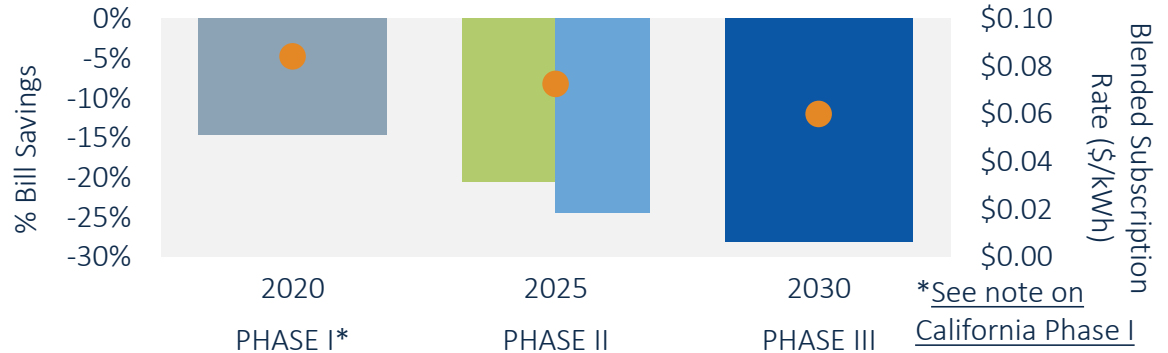
Growing penetration of utility solar has pushed peak generation periods into the evening. This shift is being seen in changing time-of-use (TOU) periods and would likely be reflected in time-variant value-of-solar rates.

- Shifts will likely affect solar-only community solar; pairing with energy storage may be able to shift solar toward more valuable periods.
- With single-axis systems, community solar captures a small addition of late afternoon, early evening peak that contributes to more savings.
- For co-location of storage components to shift generation to when it's most beneficial for the grid, community solar with storage could capture significant cost economies of scale. For example, 4-hour duration front-of-the-meter battery systems are currently 70% the cost of residential systems on a $/kW basis.

Potential Residential Community Solar Subscription Rate and Bill Savings by Compensation Mechanism and Value, PG&E Territory

Source: GTM Research, Wood Mackenzie

Potential Large Commercial & Industrial Community Solar Subscription Rate and Bill Savings by Compensation Mechanism and Value, PG&E Territory



[1]Modeled subscription rate utilizes assumptions in "Charting a Path for the Cost of Community Solar"

California's Community Solar Deployments Could Reach 6.3 to 8.2 GW by 2030

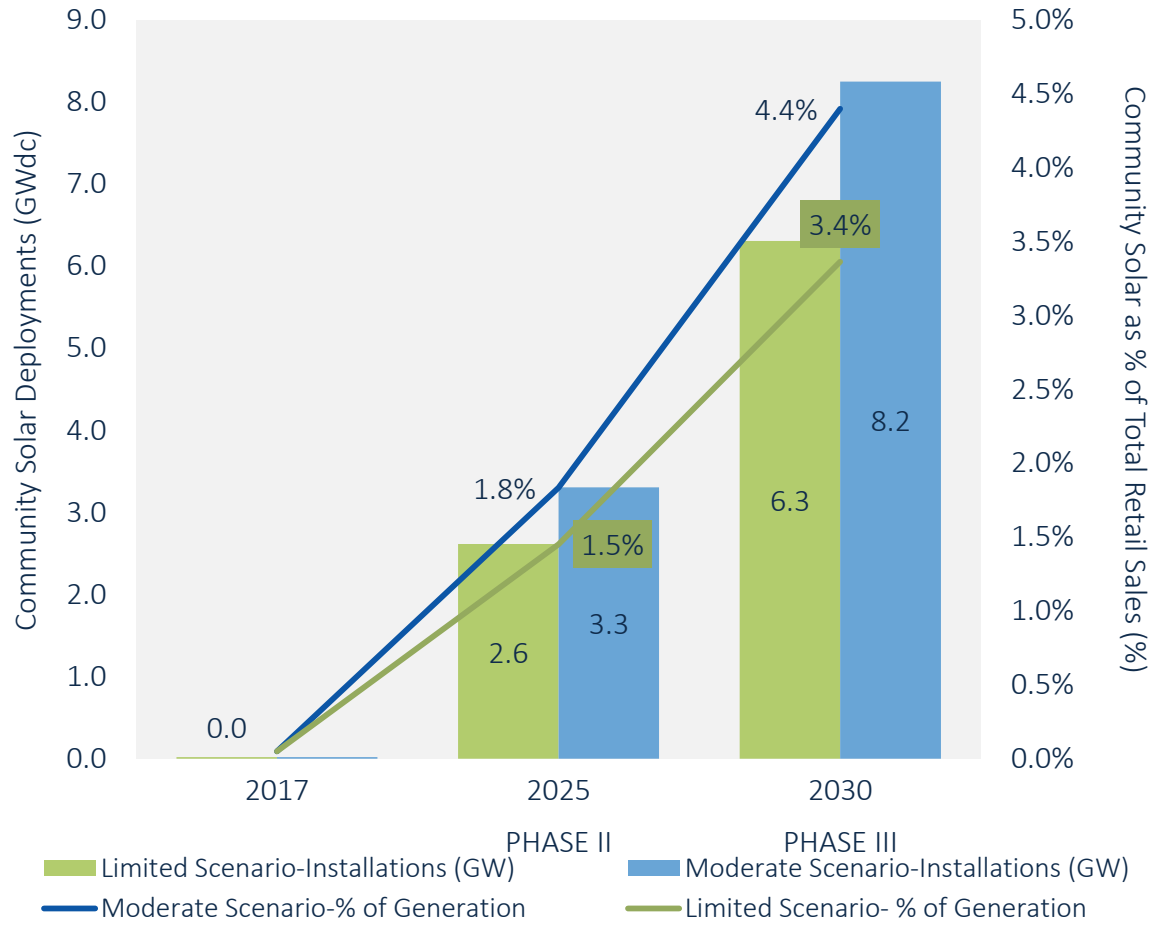
California could add a significant contribution to its diverse set of options for consumers with community solar.

While community solar may not be on the same growth path as utility solar — or even some segments of rooftop solar — it can provide a significant adder that uniquely serves renters and other residents that lack access to traditional rooftop options.

By 2030, community solar could contribute an additional 3.4% to 4.4% of solar to the state's electricity mix, serving nearly one million residents and businesses across the state.

Ensuring that community solar policy and facilities can respond to changing rates that look to temporal and locational values of energy will be critical in realizing these volumes.

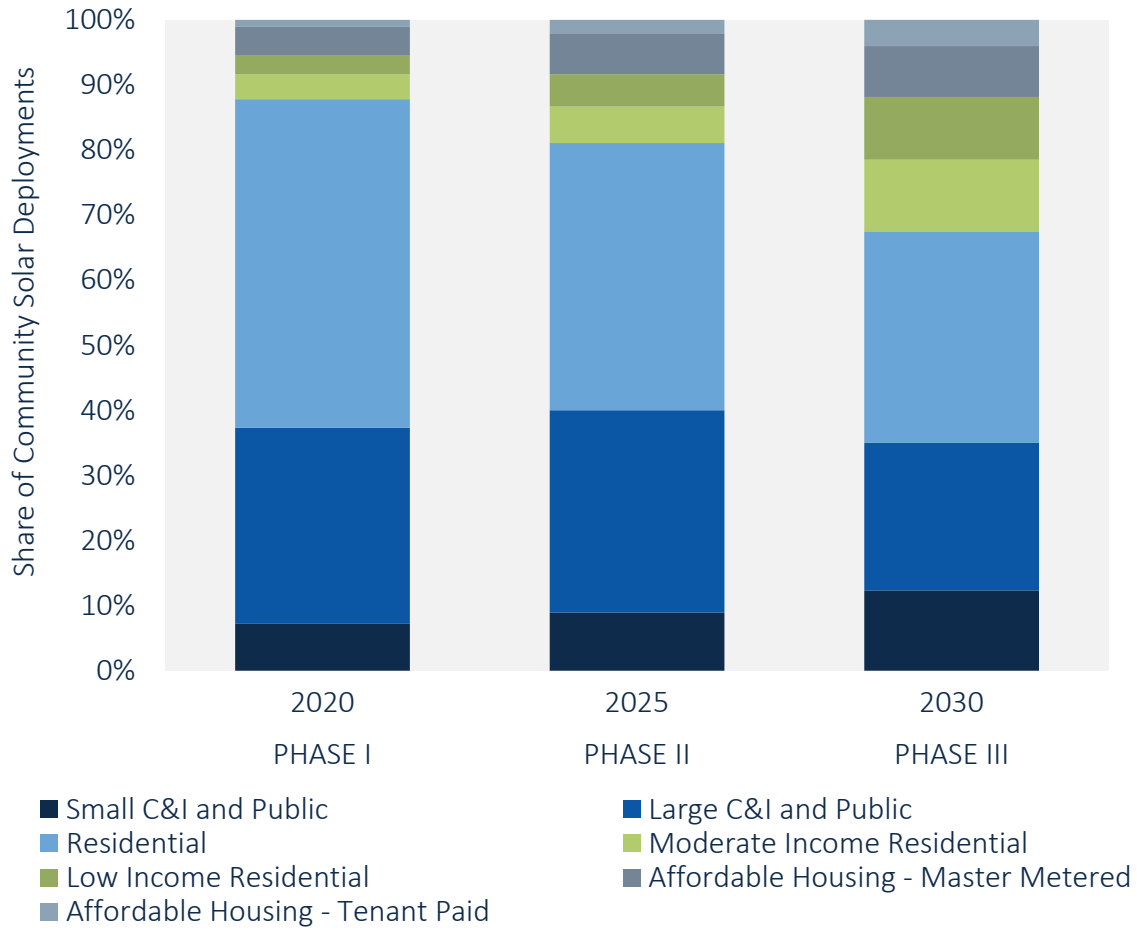
Cumulative Community Solar Market Potential: California



Source: GTM Research Wood Mackenzie

A Balanced Subscriber Mix for California Community Solar

California Community Solar Segmented Subscriber Adoption



Source: GTM Research Wood Mackenzie

With significant savings possible for all customer classes, California community solar could have a balanced subscriber mix

Although community solar does not necessarily compete directly with rooftop solar, community solar adoption needs to be considered against the backdrop of a large existing distributed solar base and the relative attractiveness of on-site generation — as well as changing rates due to the large volumes of utility-scale solar.

As such, community solar has relatively low total addressable market penetration — just 3%-4% of total residents and businesses, but the sheer size of California's market means that it's sure to be a community solar leader if a compelling program is created.

Community Solar in California: Market Potential

California is undergoing a significant energy transition, with a 50% renewables target for 2030 and solar already providing nearly 17% of total electricity consumption — over 6% from distributed generation alone. High deployments of solar have already sparked the transition to rates that reflect the temporal value of energy with the consideration of locational benefits. Meanwhile, major load pockets are shifting away from traditional load-serving entities to community-choice aggregators, which could use distributed and community solar as a means to meet clean energy goals.

By 2030, with strong enabling policies, community solar could reach half a million subscribers, supporting hundreds of thousands of renters, LMI individuals, and businesses that have so far been left with few options in the California energy transition.

Community Solar Market Potential in California, 2030 Vision Scenarios

Total Addressable Market: **15.6 million customers**

Total Community Solar Capacity Operating: **6.3 GW to 8.2 GW**

Annual Electricity Generated: **9.4 TWh to 12.4 TWh**

- Share of State Electricity Consumption: **3.4% to 4.4%**

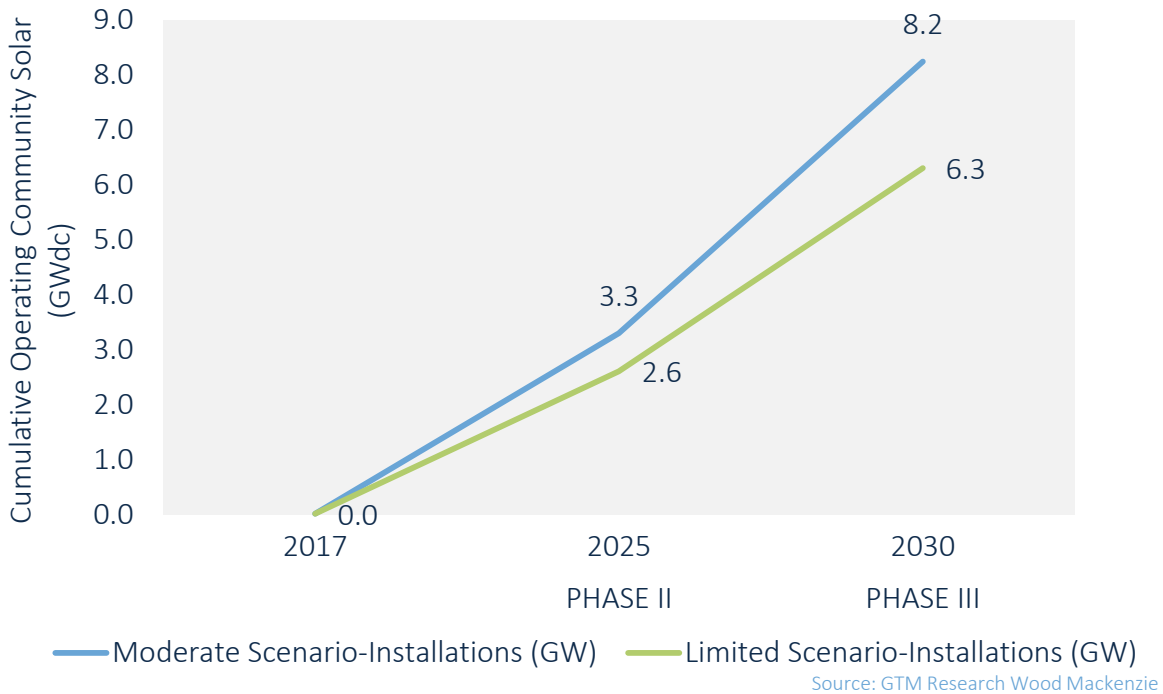
Subscribers Served: **747,000 to 964,000**

- Low- and Moderate-Income Households Supported: **440,000 to 550,000**

Cumulative Capital Invested*: **$9.8 billion to $12.8 billion**

Annual Spend on Operations, Leases and Taxes: **$125 million to $165 million]**

Community Solar in California: Market Potential



Source: GTM Research Wood Mackenzie

"Limited Scenario" and **"Moderate Scenario"** refer to the set of grid and environmental benefits included in the compensation for community solar. Neither reflect a full account of all costs and benefits, especially more difficult to calculate economic development and societal health benefits. Adoption forecast also includes assumptions of strong community solar and LMI adoption policy and continued subscription product innovations

*Cumulative capital invested represent total initial costs to build community solar plants, including all materials, installation materials and upfront supply chain, development and financing costs. Does not include ongoing operating costs

Charting the Vision for Community Solar

Florida

Florida's Community Solar Market to Date

Florida Overview

Florida does not have a statewide renewable portfolio standard in place, nor does it allow for third-party power-purchase agreements, both of which are often critical drivers for solar. Its recent growth comes primarily from utility solar installations – distributed solar makes up less than 20% of all statewide capacity.

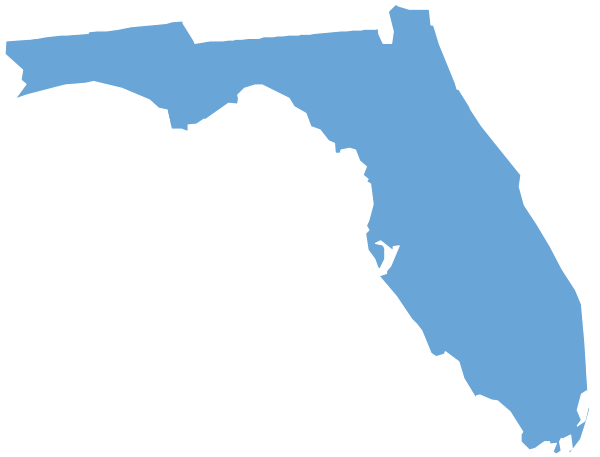
While several voluntary community solar programs have been approved by the Florida Public Service Commission or adopted by local municipal utilities, these generally present a limited value proposition to subscribers and almost universally charging a premium for subscriptions.

Nevertheless, solar's momentum is rapidly growing: Florida utilities are expected to install more than 4.6 GW of solar over the next five years, as solar costs in Florida are among the lowest in the country.

Community solar adds to the options for low-cost solar with resiliency to local businesses and the low- and moderate-income population as a key driver for its deployment.

[1] Reuters. "With 7.4 million without power, utility workers get respect"

Florida by the Numbers



- Total Cumulative Solar: 1.3 GWdc
- State Solar Rank*: 10
- Solar % of Total Electricity: 0.7%
- Community Solar: 41.8 MW
- Community Solar Rank*: 5

*By cumulative installed solar capacity

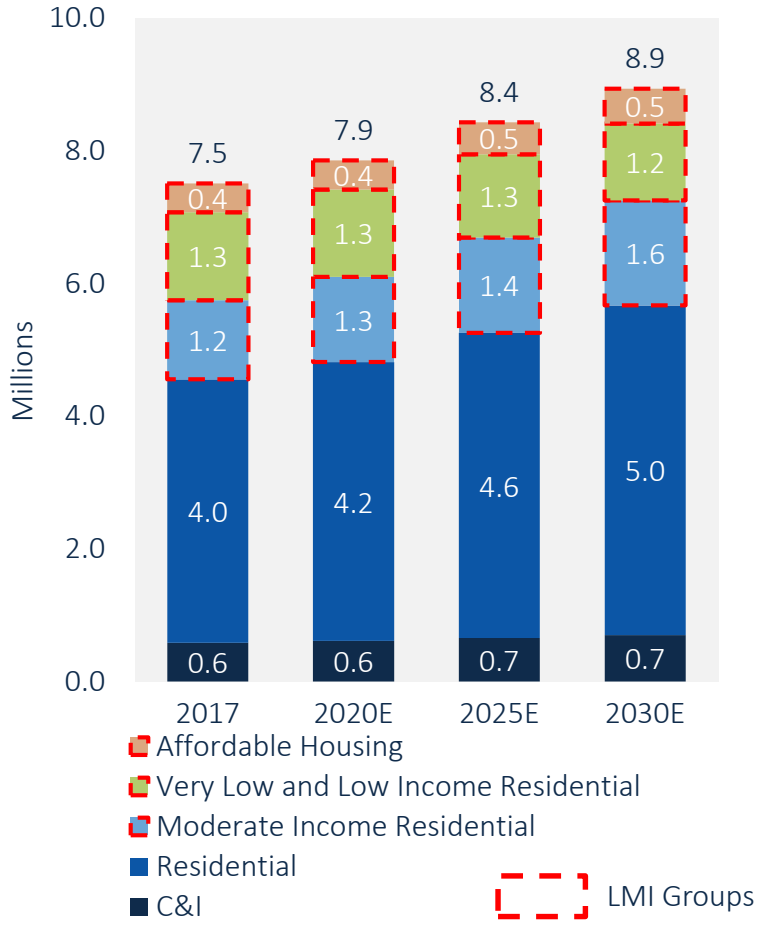
Building community solar with a focus on resilience

In September 2017, Hurricane Irma wrought $50 billion[1] of damage across Florida and left 7.4 million customers without electricity at shortly after the storm. While power was restored quickly to most neighborhoods, distributed generation could be deployed to increase grid resilience.

Solutions like community solar-paired-with-storage or community solar-based microgrids may not prevent every outage, but they could provide a generation resource near vulnerable communities to help support critical infrastructure and reduce system restoration times.

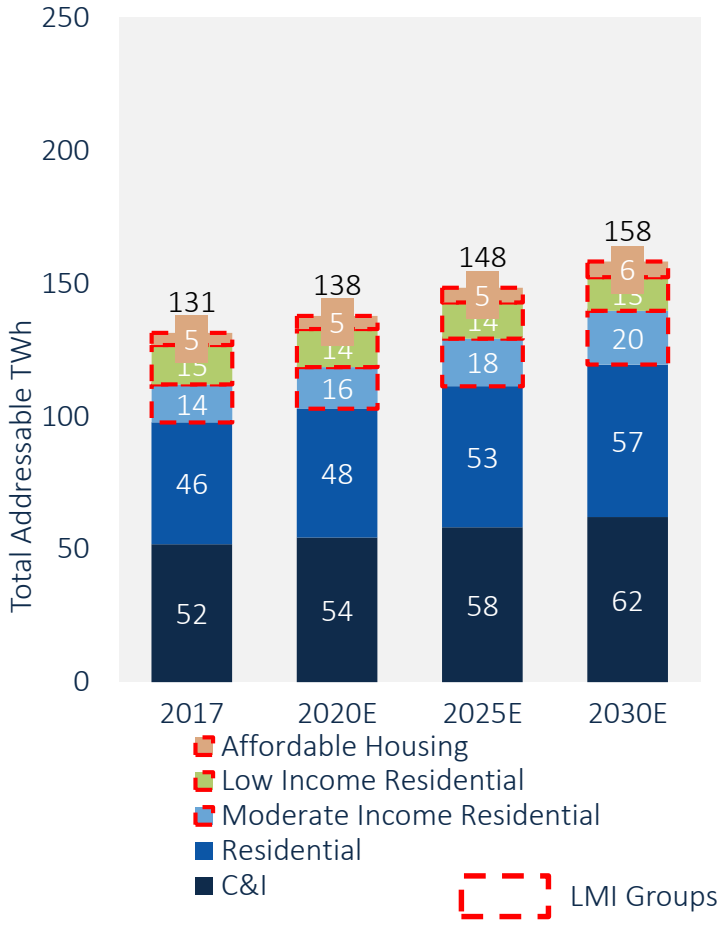
Total Addressable Market for Community Solar – Florida

Addressable Households and Organizations (#)



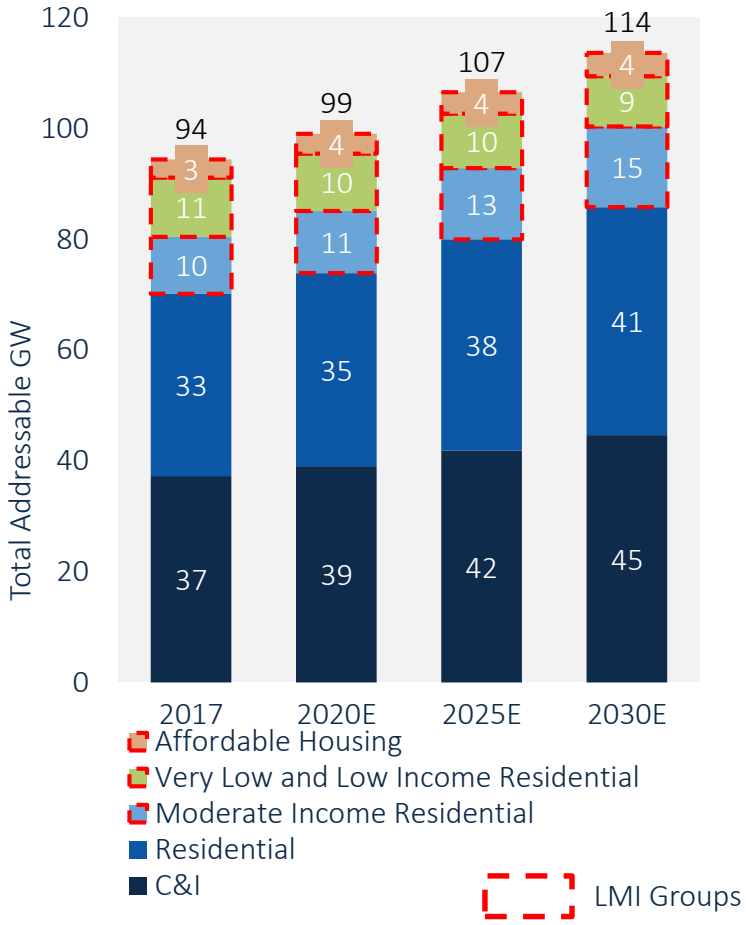
Source: GTM Research Wood Mackenzie, NREL, U.S. Census

Addressable Households and Organizations (TWh)



Source: GTM Research Wood Mackenzie, NREL, U.S. Census

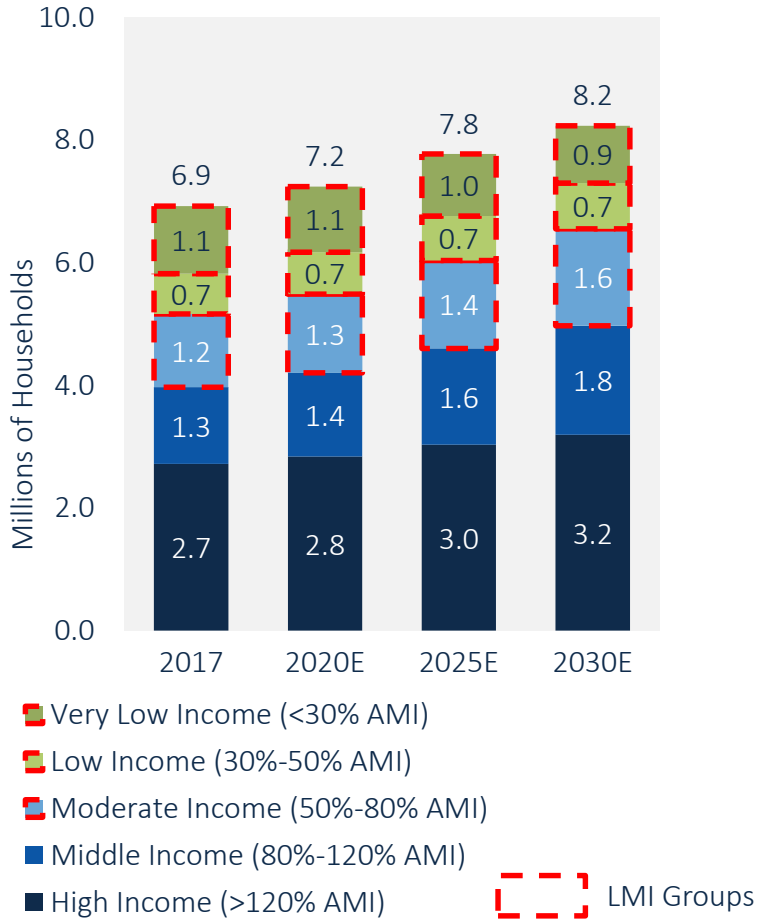
Addressable Households and Organizations (GW)



Source: GTM Research Wood Mackenzie, NREL, U.S. Census

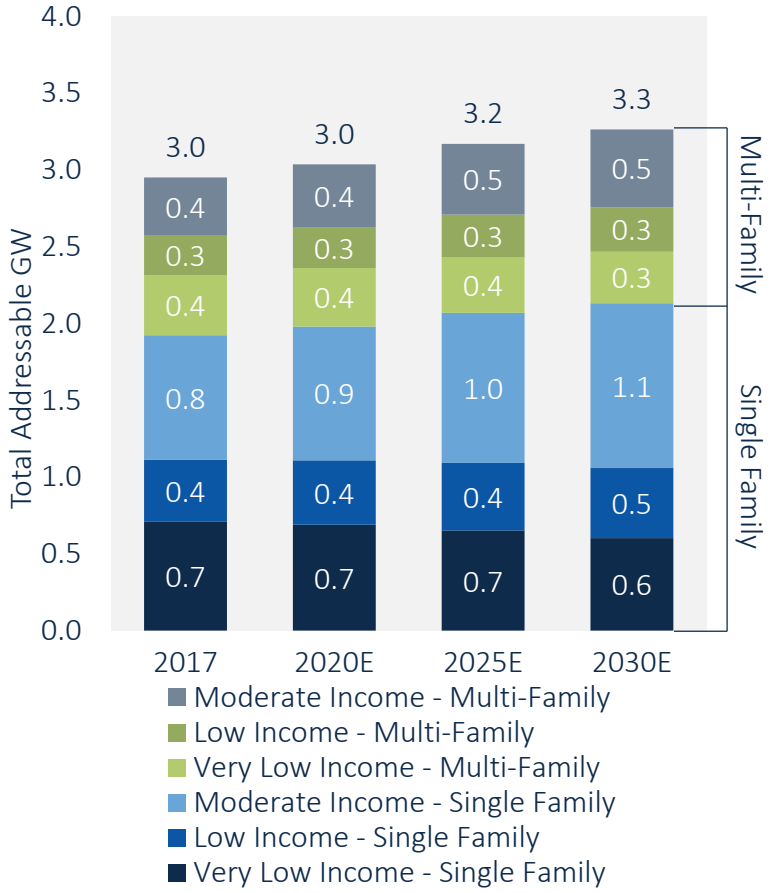
Low- and Moderate-Income Addressable Market – Florida

Residential Addressable Market by Income (# of HHs)



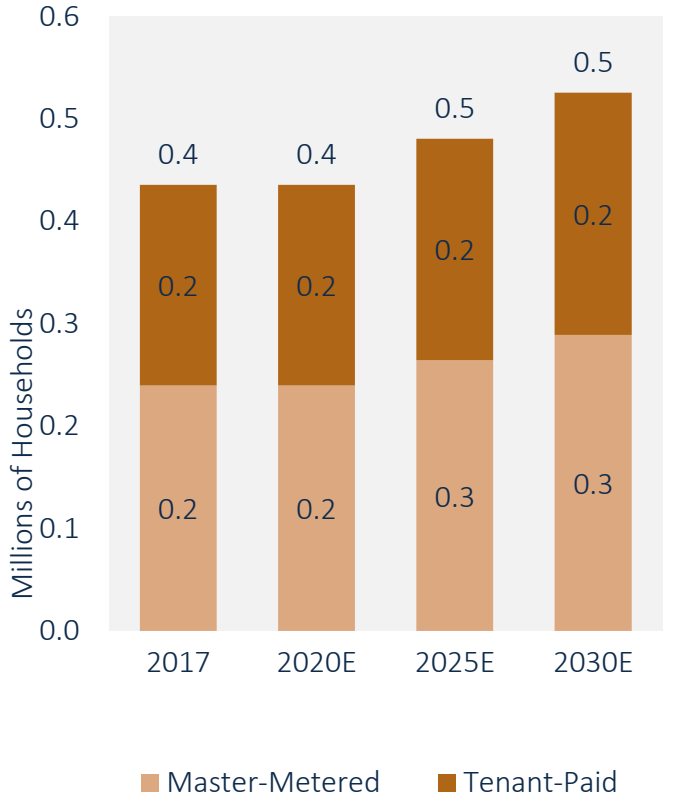
Source: GTM Research Wood Mackenzie, NREL, U.S. Census

LMI Households by Single- vs. Multi-Family Unit



Source: GTM Research Wood Mackenzie, NREL, U.S. Census

Affordable Housing Market by Type (# of HHs)



Source: GTM Research Wood Mackenzie, NREL, U.S. Census

Modeling Customer Benefits for Community Solar in Florida

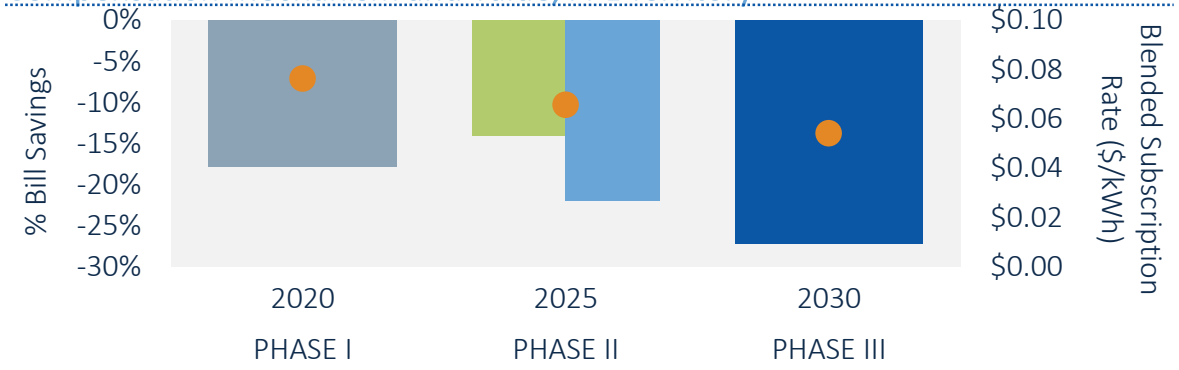
Current retail rates results in tight economics for commercial customers but improve as costs fall

In the three IOUs studied for Florida, the large C&I segment may have difficulties in getting off the ground under current retail rates, as 1) commercial rates are low in Florida and 2) the amount of volumetric charges that can be offset with community solar is limited. Strong reductions in community solar costs coupled with a meaningful distributed solar bill credit would need to be implemented for significant large commercial adoption.

Community solar could provide more than 10% in residential customer savings in both scenarios

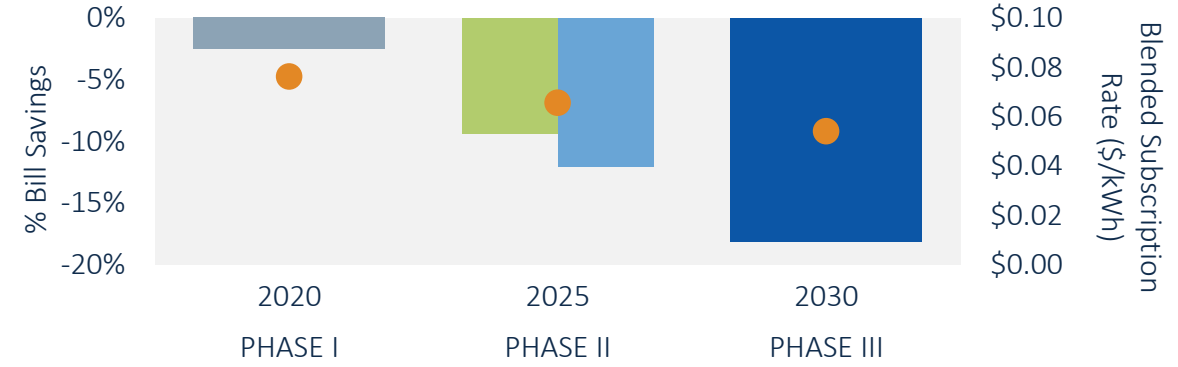
While retail electricity prices tend to much lower in Florida, blended community solar subscription rates are also the lowest of the four states we examined. In larger bill credit scenarios, residential subscription bill savings could be cut back to provide more savings to commercial customers while not affecting the return for the community solar project investor.

Potential Residential Community Solar Subscription Rate and Bill Savings by Compensation Mechanism and Value, FPL Territory



Source: GTM Research, Wood Mackenzie

Potential Large Commercial and Industrial Community Solar Subscription Rate and Bill Savings by Compensation Mechanism and Value, FPL Territory



[1]Modeled subscription rate utilizes assumptions in "Charting a Path for the Cost of Community Solar"

Florida Community Solar Deployments Could Reach 2.3 to 3.6 GW by 2030

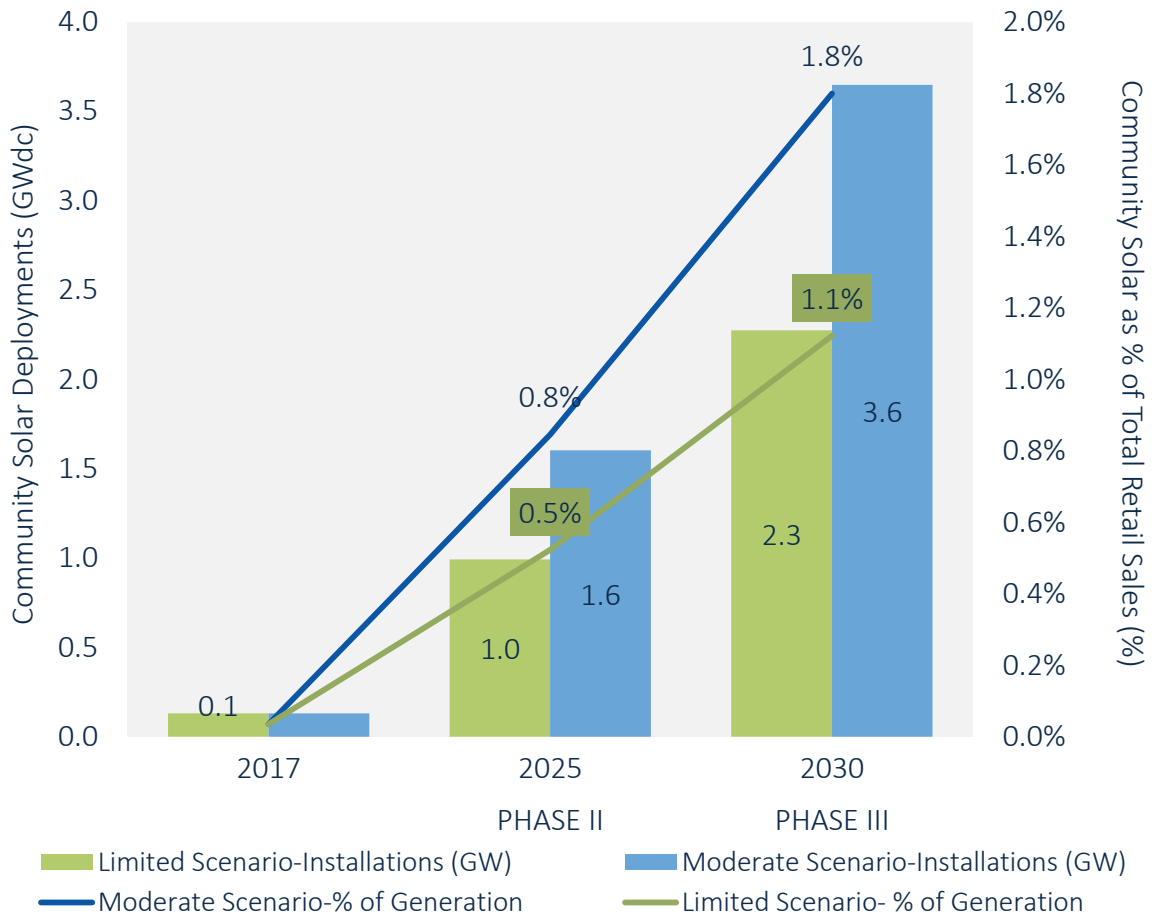
Florida could become one of the most promising community solar markets, accounting for 1.1% to 1.8% of all retail electricity sales

Community solar generation could be equal to or double the amount of current solar generation in Florida.

In general, solar and planned "community solar" projects have taken on more of a utility solar flavor. These projects are an important piece in building a cleaner grid at a low cost, but may not necessarily present end customers with other attributes they value, such as bill savings or autonomy.

Furthermore, an increased look toward resiliency may push customers to investigate more grid backup options. Community solar could serve as an important intermediary platform to provide local, district-level resiliency.

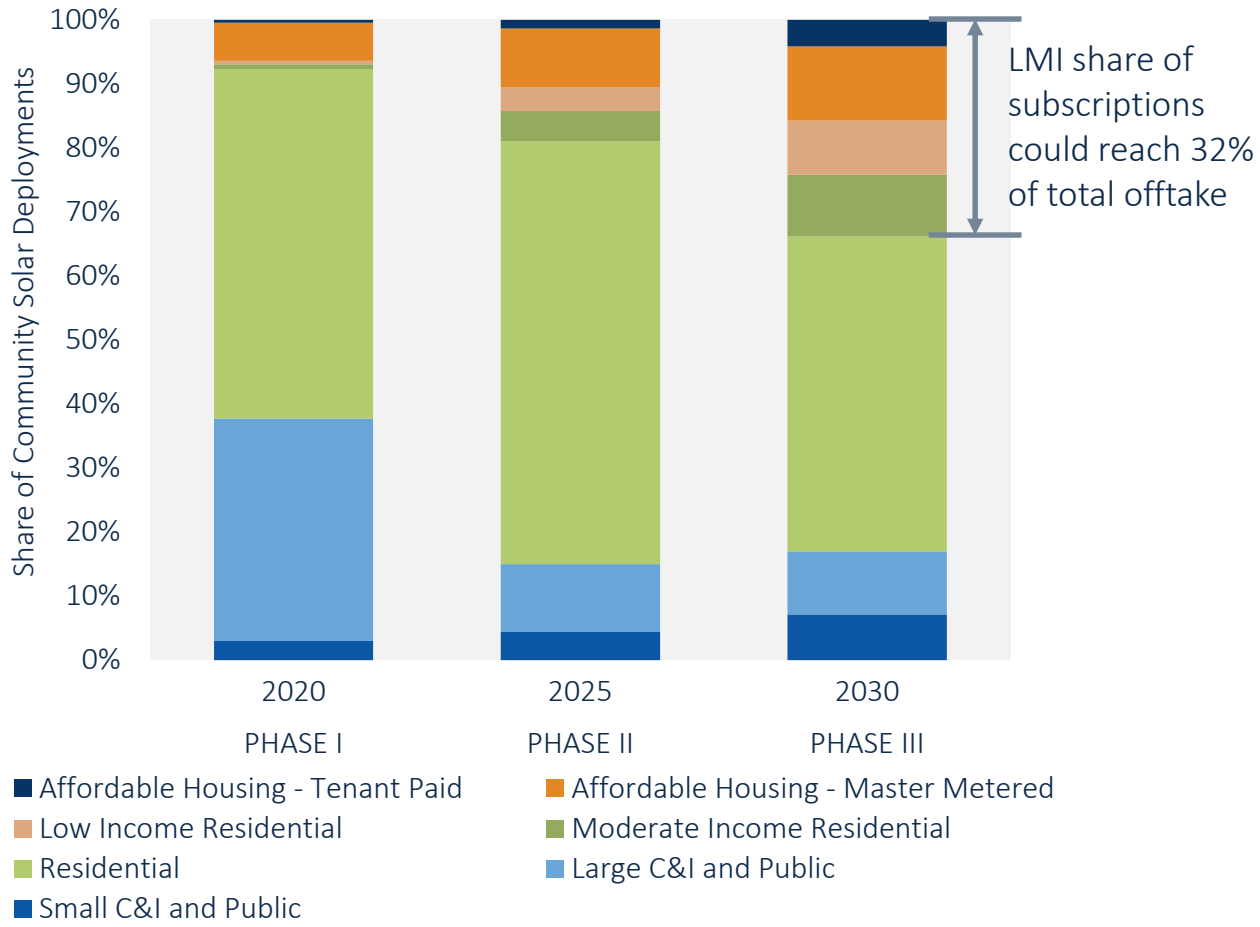
Cumulative Community Solar Market Potential: Florida



Source: GTM Research Wood Mackenzie

Residential and LMI Customers Should Be the Main Focus of Community Solar in Florida

Florida Community Solar Segmented Subscriber Adoption



Source: GTM Research Wood Mackenzie

With more muted economics for large commercial customers, residential and LMI subscribers should be the main focus for community solar programs in Florida

By 2030, the LMI sector could represent nearly one-third of total community solar capacity in Florida, equating to over 750 MW serving over 141,000 individuals.

Traditional residential community solar offtake makes up a small piece of the total addressable market for homeowners and renters (just 1%-2% of the total population) but could still serve nearly 100,000 residents with over a terawatt-hour of solar generation every year.

Community Solar in Florida: Market Potential

Community solar in Florida could provide critical economic relief and local resiliency to vulnerable communities. By 2030, low income, moderate income and affordable housing subscribers could make up nearly half of subscriptions and one-third of electricity generated as, according to our modeling, community solar could eventually provide 25%-30% savings on LMI household bills.

Community solar's ability to be paired with energy storage and microgrids could be a key driver in also assuring that the state and utilities can ensure clean, reliable electricity to communities during hurricanes and other disasters.

Community Solar Market Potential in Florida, 2030 Vision Scenarios

Total Addressable Market: **8.9 million customers**

Total Community Solar Capacity Operating: **2.3 GW to 3.6 GW**

Annual Electricity Generated: **3.2 TWh to 5.1 TWh**

- Share of State Electricity Consumption: **1.1% to 1.8%**

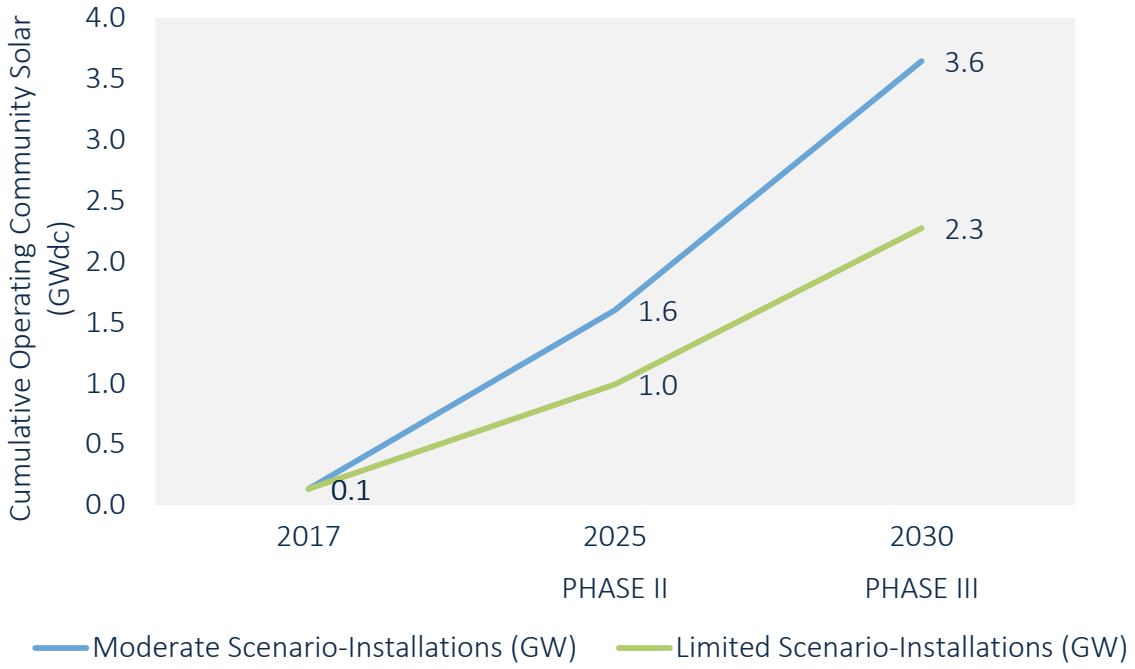
Subscribers Served: **287,000 to 384,000**

- Low- and Moderate-Income Households Supported: **141,000 to 189,000**

Cumulative Capital Invested*: **$3.3 billion to $4.0 billion**

Annual Spend on Operations, Leases and Taxes: **$34 million to $55 million**

Community Solar in Florida: Market Potential



Source: GTM Research Wood Mackenzie

"Limited Scenario" and **"Moderate Scenario"** refer to the set of grid and environmental benefits included in the compensation for community solar. Neither reflect a full account of all costs and benefits, especially more difficult to calculate economic development and societal health benefits. Adoption forecast also includes assumptions of strong community solar and LMI adoption policy and continued subscription product innovations

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Charting the Vision for Community Solar

Michigan

Michigan's Community Solar Market to Date

Michigan Overview

Michigan has significantly lagged behind other states, ranking 32nd in terms of total solar deployed and with just 0.1% of total electricity powered by solar at the end of 2017.

Despite low levels of distributed solar deployments, the Michigan Public Service Commission recently replaced its net metering policy with an "inflow/outflow" mechanism — moving to a potentially limited value-of-solar consideration for exported solar. All future rate cases filed by the state's utilities must now also include a proposed "Inflow/Outflow" with which to compensate exported on-site solar. How these rates influence any statewide community solar policy on bill crediting will likely be hotly contested.

Early community solar experiences in Michigan are mixed. A project developed for the Lansing Board of Water and Light offers a ~14-year payback on an upfront subscription payment. Meanwhile, other community solar programs, such as Consumers Energy's "Solar Gardens" program, offer no economic savings to their customers.

A fair bill crediting mechanism for community solar must be in place to enable a flourishing community solar market in Michigan.

Michigan by the Numbers

- Total Cumulative Solar: **133.5 MWdc**
- State Solar Rank*: **32**
- Solar % of Total Electricity: **0.2%**
- Community Solar: **8.3 MW**
- Community Solar Rank*: **13**

*By cumulative installed solar capacity

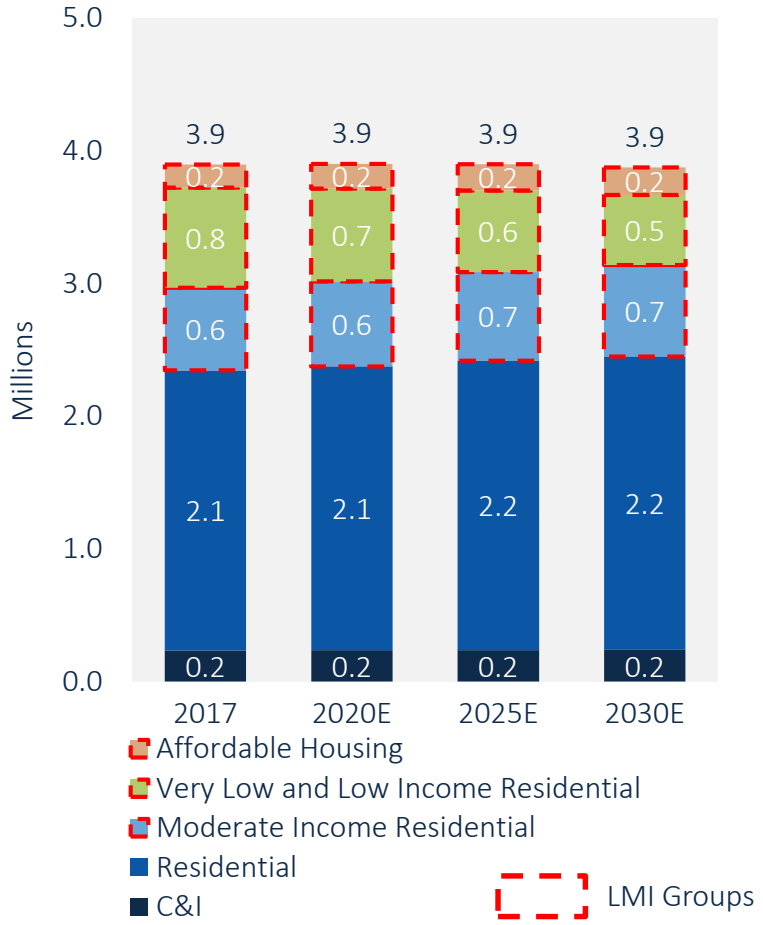
Community Solar that confers economic benefits

300 kW in East Lansing, Michigan

- First of two projects developed by Patriot Solar Group and promoted by Lansing Board of Water and Light, City of East Lansing, City of Lansing and Michigan Energy Options
- Bill credit of approximately 6.5¢/kWh yields small savings to customer
- Upfront payment of ~$1.33/W promises approx. 14-year payback

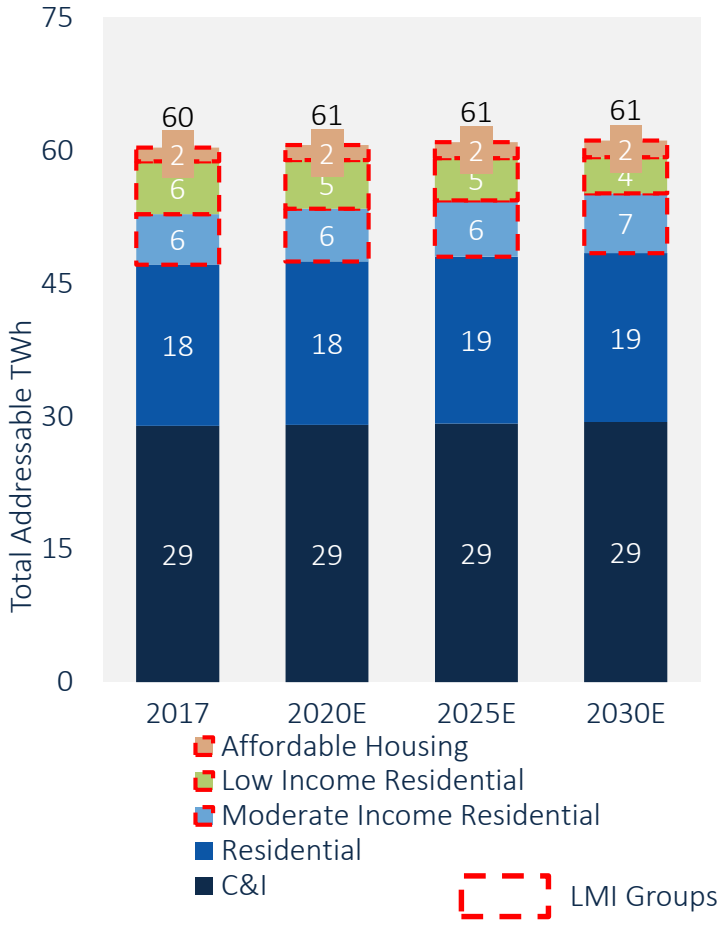
Total Addressable Market for Community Solar – Michigan

Addressable Households and Organizations (#)



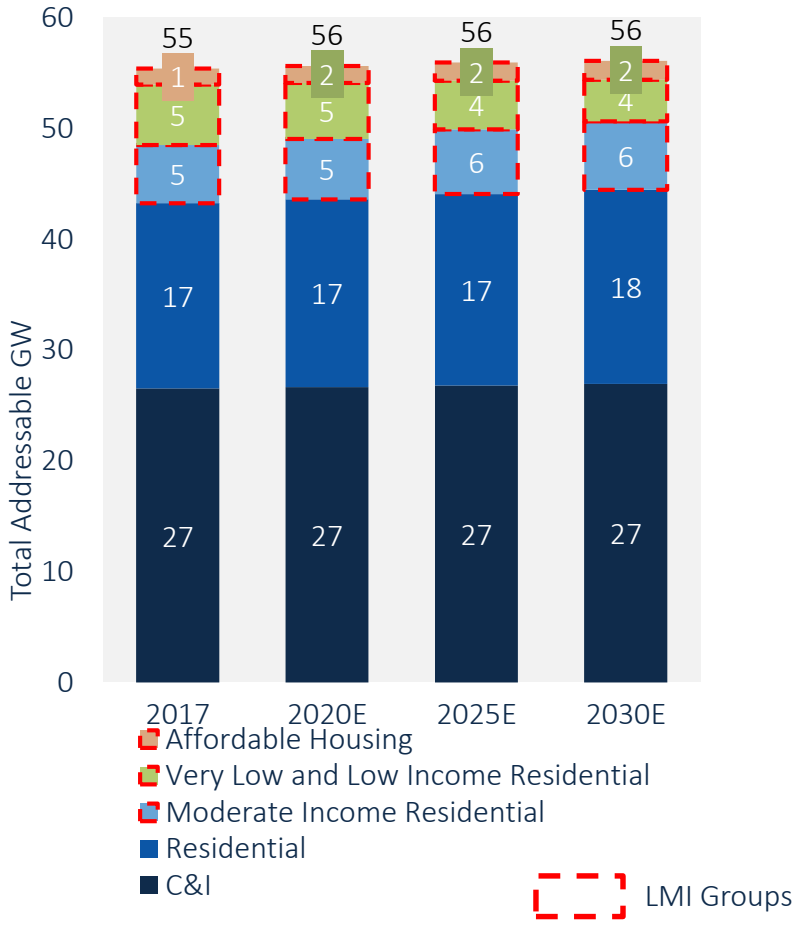
Source: GTM Research Wood Mackenzie, NREL, U.S. Census

Addressable Households and Organizations (TWh)



Source: GTM Research Wood Mackenzie, NREL, U.S. Census

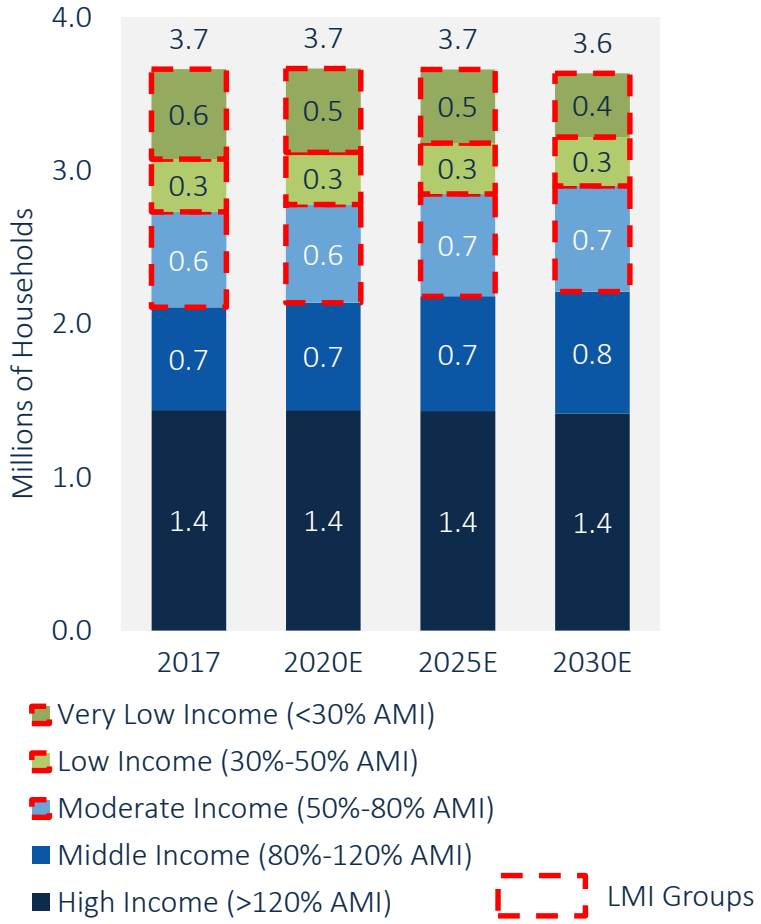
Addressable Households and Organizations (GW)



Source: GTM Research Wood Mackenzie, NREL, U.S. Census

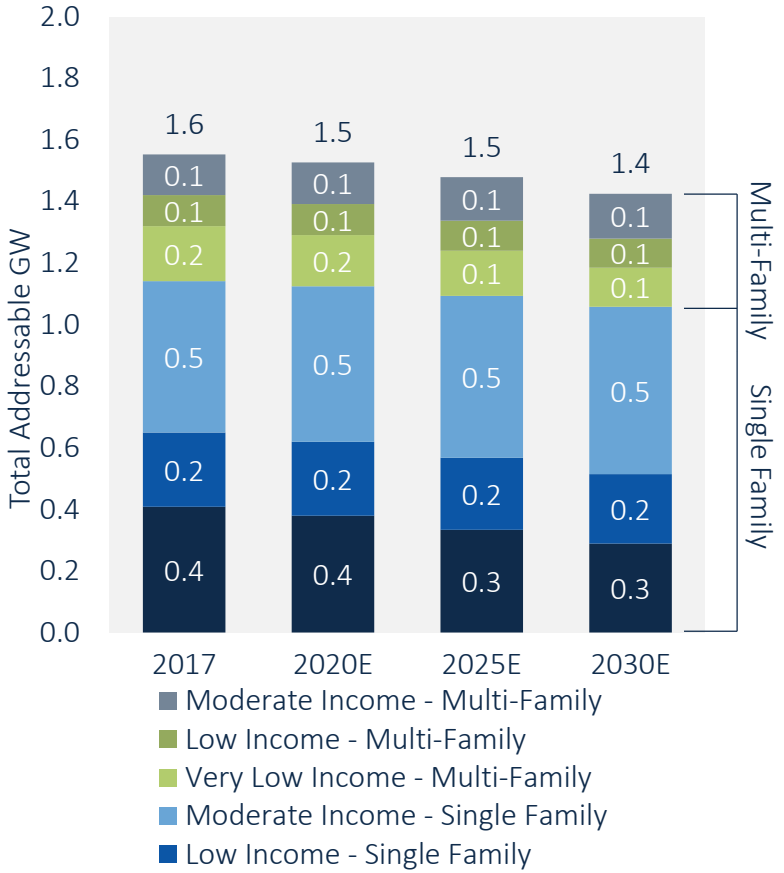
Low- and Moderate-Income Addressable Market – Michigan

Residential Addressable Market by Income (# of HHs)



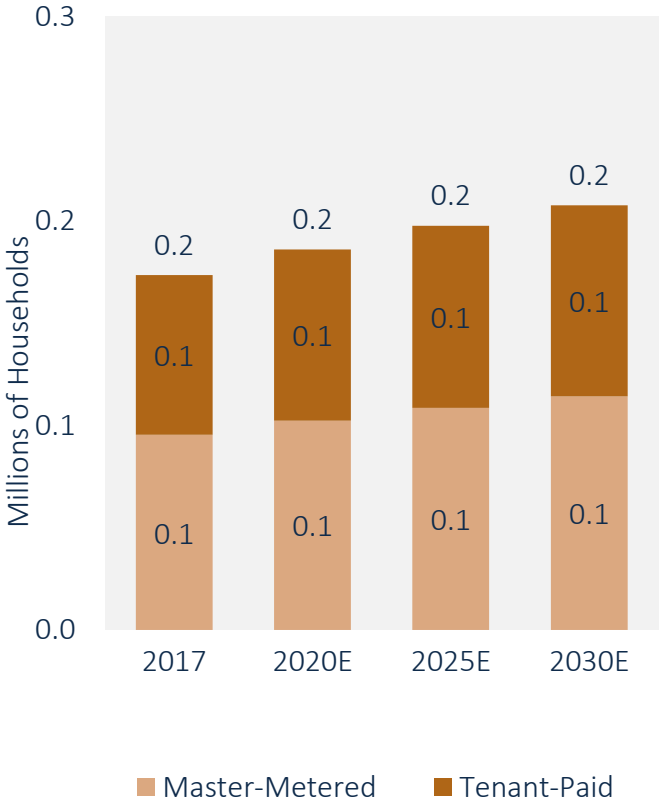
Source: GTM Research Wood Mackenzie, NREL, U.S. Census

LMI Households by Single- vs. Multi-Family Unit



Source: GTM Research Wood Mackenzie, NREL, U.S. Census

Affordable Housing Market by Type (# of HHs)



Source: GTM Research Wood Mackenzie, NREL, U.S. Census

Modeling Customer Benefits for Community Solar in Michigan

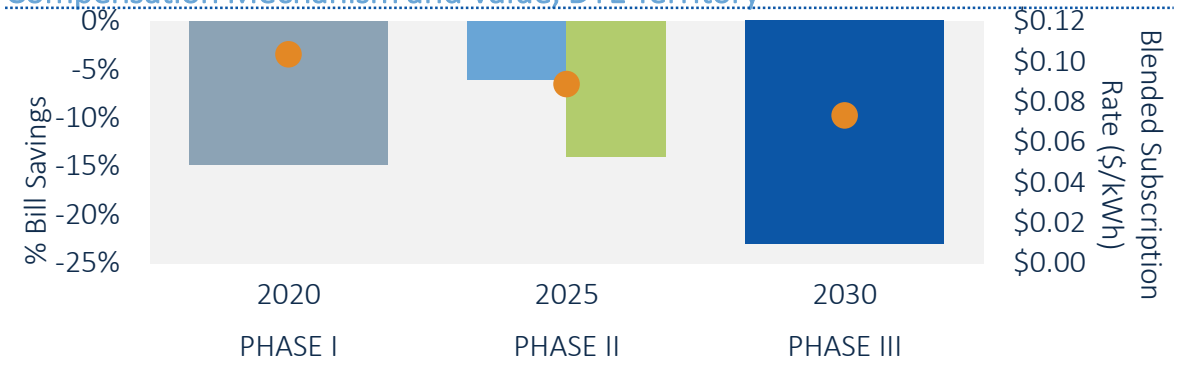
Customer benefits generally tight for community solar in Phase I and II in Michigan

Relatively low solar resources and relatively little industry scale in Michigan inflate the community solar subscription price relative to other markets studied.

In the Limited Scenario, most customer segments would see relatively weak savings from community solar — just 10%-15% net savings off the total bill. While these are compelling numbers for today's community solar market, they will lag offerings in Michigan's peer states.

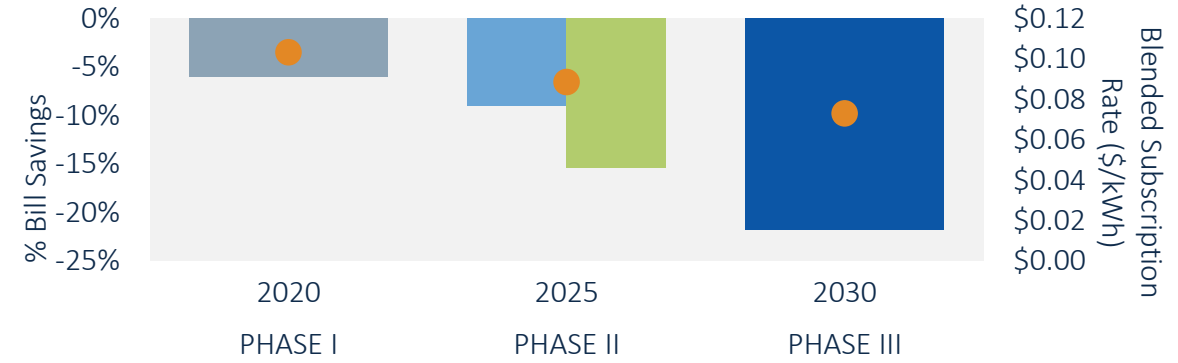
Michigan would likely need to pull together a compromise on net metering, a transitional credit, or accept a moderate value-of-solar tariff in order to jump-start community solar in the state.

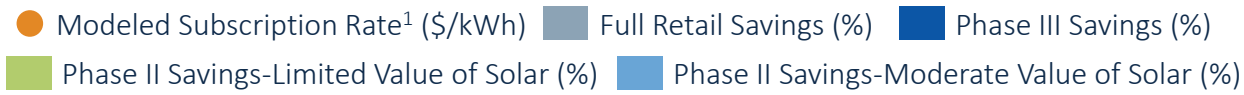
Potential Residential Community Solar Subscription Rate and Bill Savings by Compensation Mechanism and Value, DTE Territory



Source: GTM Research, Wood Mackenzie

Potential Large Commercial and Industrial Community Solar Subscription Rate and Bill Savings by Compensation Mechanism and Value, DTE Territory





[1]Modeled subscription rate utilizes assumptions in "Charting a Path for the Cost of Community Solar"

Michigan Community Solar Deployments Could Reach 1.4 GW to 2.3 GW by 2030

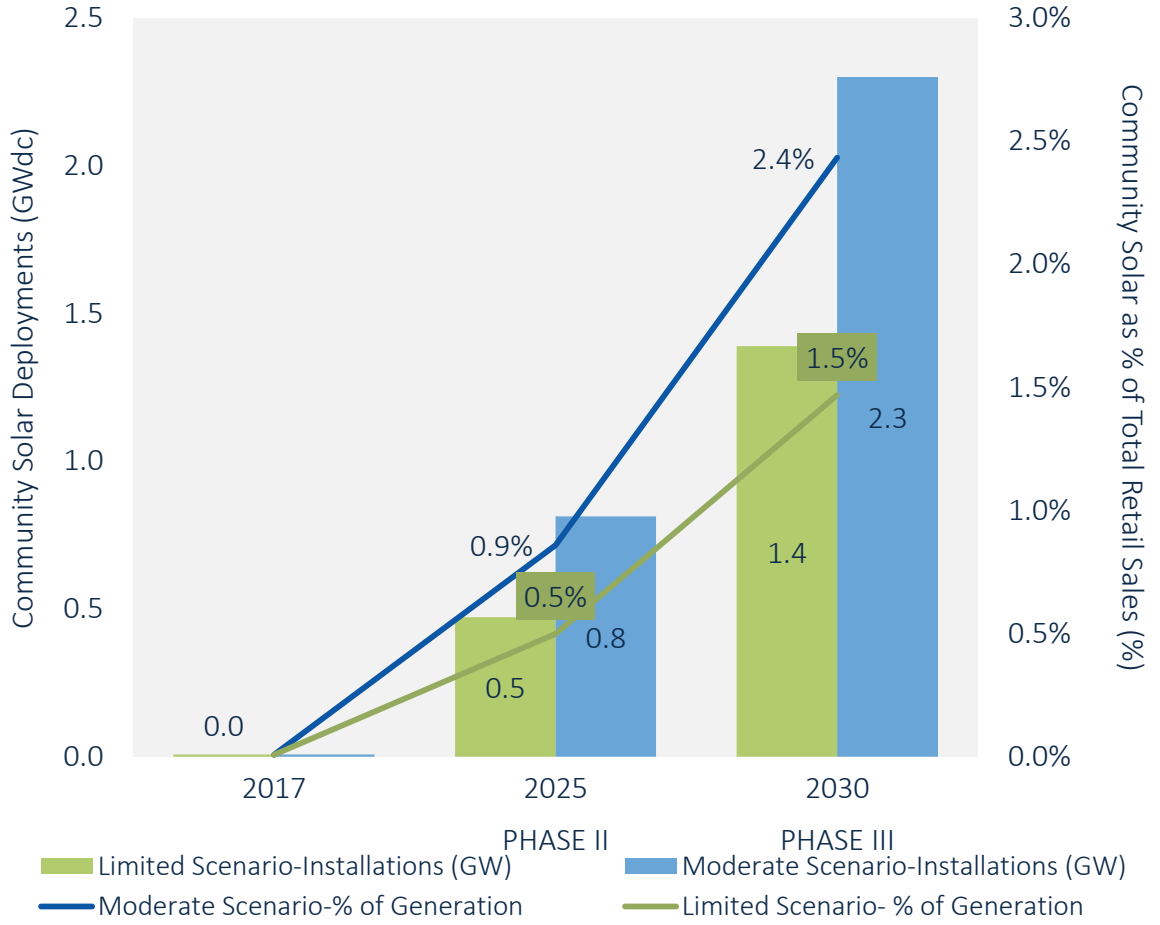
Community solar could be a main driver of Michigan's overall solar market if properly incentivized

Solar generation would likely require a broad value-of-solar tariff or another compelling bill credit mechanism. But if a compelling bill credit were introduced, community solar could quickly make up more than a quarter of the state's total annual solar build.

In fact, the 1.4 GW to 2.3 GW of community solar that could be deployed by 2030 would represent a 10x to 15x expansion of Michigan's present-day solar deployments.

Even so, getting to a robust market seems in contrast to the existing utility-sponsored community solar programs built at a premium to customer bills — and to various utility-proposed bill credits at well under average retail rates. Compared to other states covered in this study, Michigan could require significantly more innovation in order to see a flourishing market.

Cumulative Community Solar Market Potential: Michigan



Source: GTM Research Wood Mackenzie

Community Solar in Michigan: Market Potential

Community solar in Michigan could be a significant boost for distributed generation in the state. With just over 100 MW of solar installed to date and few supportive statewide policies for solar, Michigan lags nationally in the deployment of distributed generation. In the current regulatory debate around the compensation for the little distributed solar that does exist, policymakers could also look to community solar as a critical resource for ensuring all customer segments can access local clean electricity.

Community Solar Market Potential in Michigan, 2030 Vision Scenarios

Total Addressable Market: **3.9 million customers**

Total Community Solar Capacity Operating: **1.4 GW to 2.3 GW**

Annual Electricity Generated: **1.5 TWh to 2.5 TWh**

- Share of State Electricity Consumption: **1.5% to 2.4%**

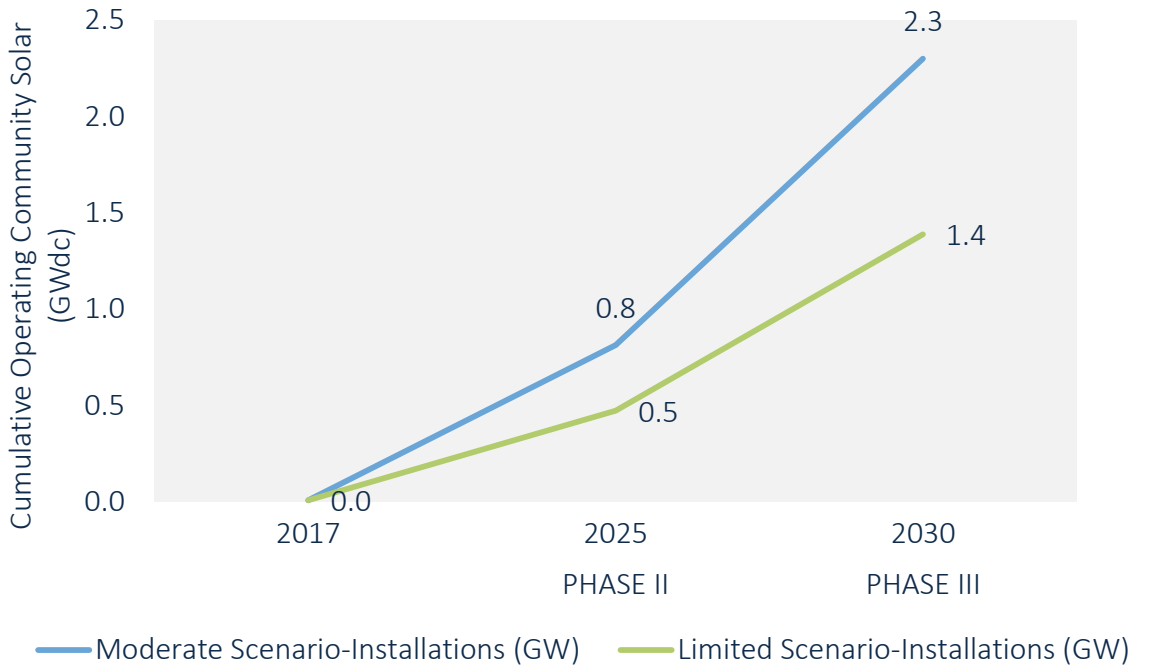
Subscribers Served: **177,000 to 288,000**

- Low- and Moderate-Income Households Supported: **92,000 to 176,000**

Cumulative Capital Invested*: **$2.0 billion to $3.0 billion**

Annual Spend on Operations, Leases and Taxes: **$21 million to $35 million**

Community Solar in Michigan: Market Potential



Source: GTM Research Wood Mackenzie

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Charting the Vision for Community Solar

New Jersey

New Jersey's Community Solar Market to Date

New Jersey Overview

New Jersey has long been one of the nation's leading solar states despite its relatively middling solar resource. Contrary to other states examined in this report, New Jersey's solar installations are primarily on-site distributed generation. At the end of 2017, non-residential systems made up over 50% of cumulative installed solar, with residential systems adding another 27%.

In early 2018, New Jersey passed an ambitious increase to the state's renewable portfolio standard that also includes provisions for offshore wind, energy storage, energy efficiency and community solar. The new law raises the RPS target to 35% in 2025 and 50% in 2030, while also sunsetting the solar renewable energy credits (SREC) incentive program by June 2021.

Given the SREC program's foundational role to New Jersey's historical solar growth, the law requires the Board of Public Utilities (BPU) to develop an "orderly and transparent mechanism" for transitioning from the SREC program — one that ensures sustainable costs and importantly pushes New Jersey toward its 50% renewables target. A fair, stable and transparent successor will be key for the state's continued solar leadership.

New Jersey by the Numbers

- Total Cumulative Solar: **2.4 GWdc**
- State Solar Rank*: **5**
- Solar % of Total Electricity: **3.9%**
- Community Solar: **0 MW**
- Community Solar Rank*: **50**

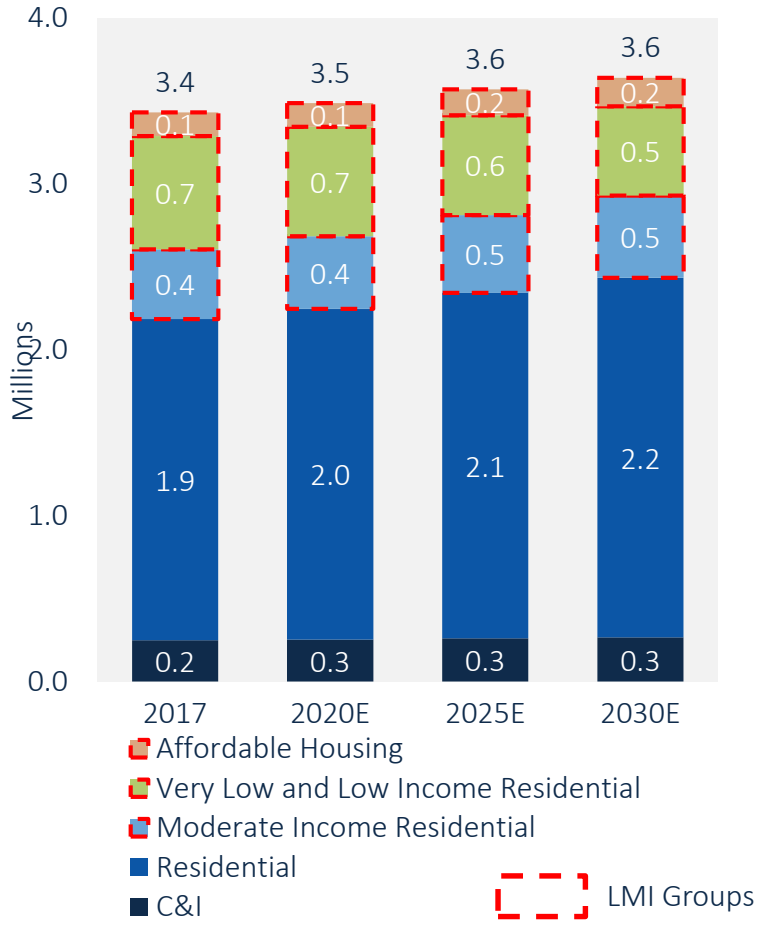
*By cumulative installed solar capacity

A Note on New Jersey's New Community Solar Policy

A key piece of New Jersey's new renewable energy plan is the development of a long-term community solar program. The law is vague beyond a general directive to the BPU to establish a pilot program that is converted to a permanent program within the next three years. The permanent program should aim to develop a minimum of 50 MW annually.

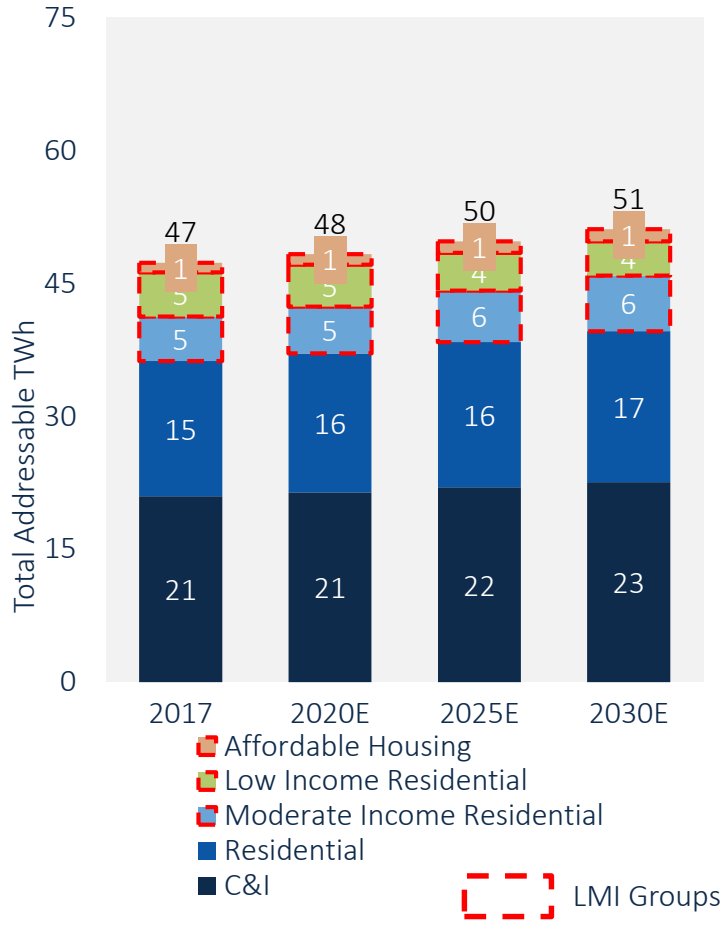
Total Addressable Market for Community Solar – New Jersey

Addressable Households and Organizations (#)



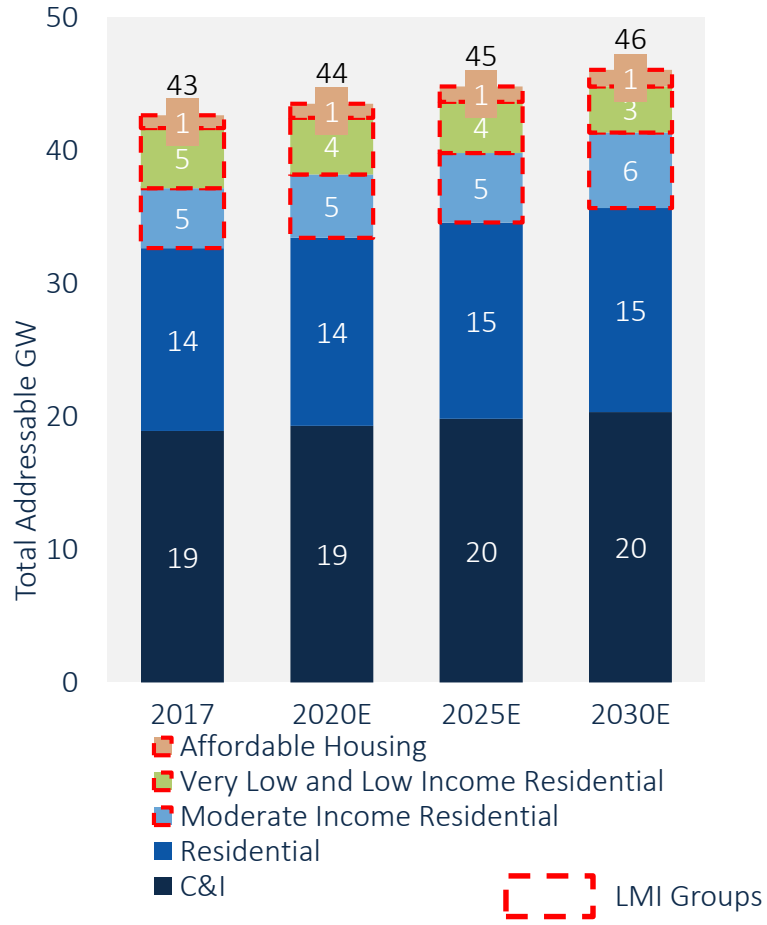
Source: GTM Research Wood Mackenzie, NREL, U.S. Census

Addressable Households and Organizations (TWh)



Source: GTM Research Wood Mackenzie, NREL, U.S. Census

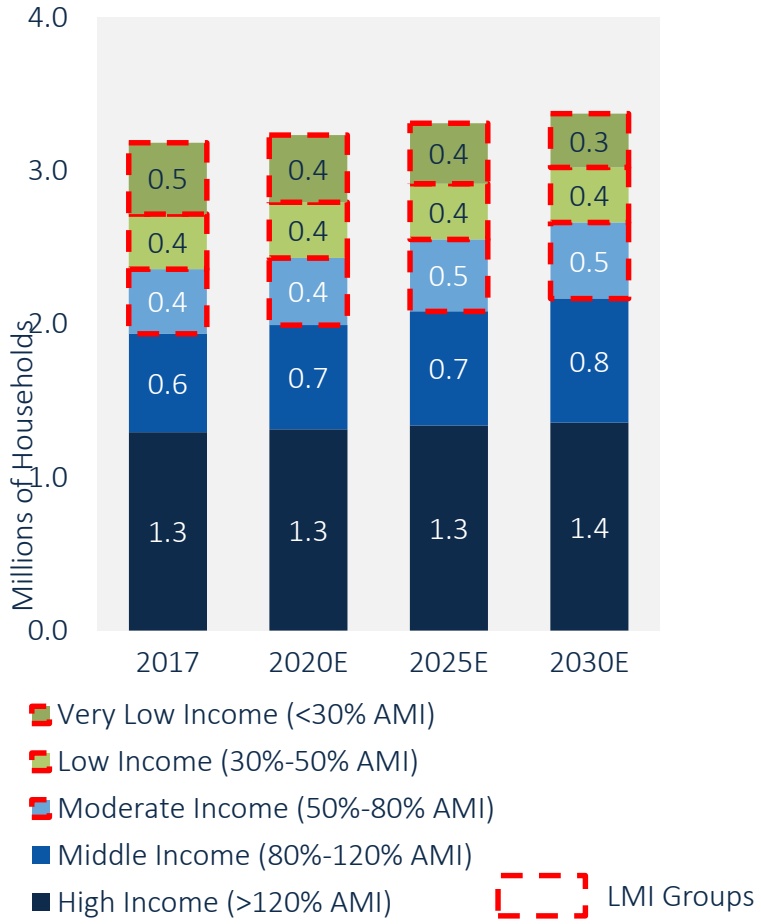
Addressable Households and Organizations (GW)



Source: GTM Research Wood Mackenzie, NREL, U.S. Census

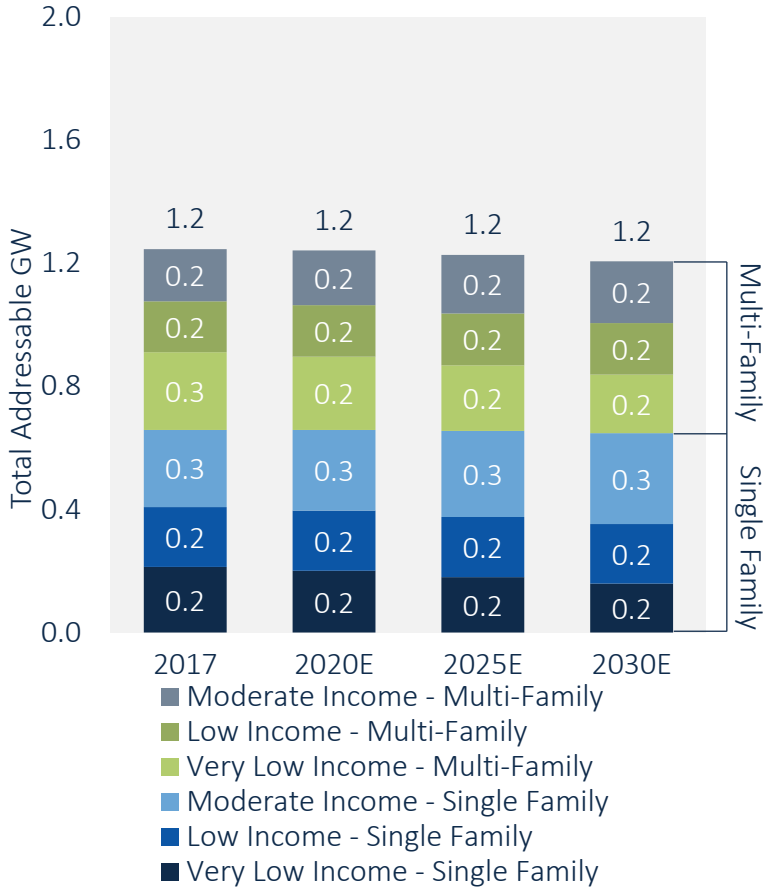
Low- and Moderate-Income Addressable Market – New Jersey

Residential Addressable Market by Income (# of HHs)



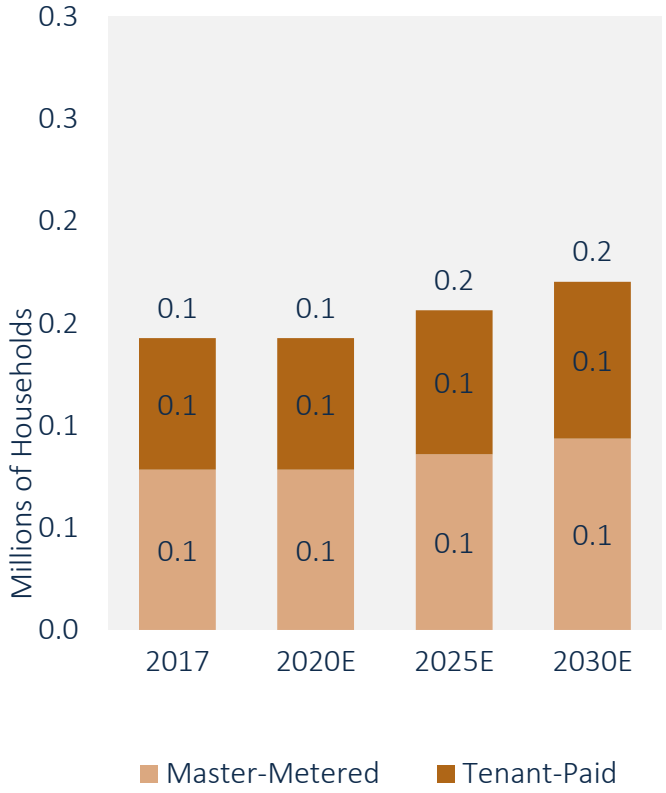
Source: GTM Research Wood Mackenzie, NREL, U.S. Census

LMI Households by Single- vs. Multi-Family Unit



Source: GTM Research Wood Mackenzie, NREL, U.S. Census

Affordable Housing Market by Type (# of HHs)



Source: GTM Research Wood Mackenzie, NREL, U.S. Census

Modeling Community Solar Customer Benefits in New Jersey

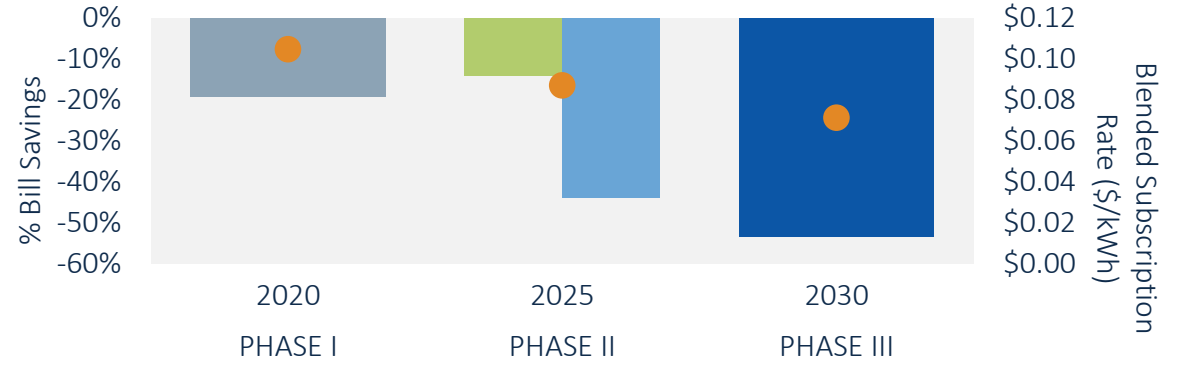
Community solar could provide modest savings to all customer segments in New Jersey for most scenarios

As we note in the walkthrough of state-level costs, our model does not convey a direct state-level incentive or SREC past 2021, but does open the possibility for an SREC successor.

In our Moderate Scenario, an SREC successor could easily fit the bill for a transitional credit — one that could help push New Jersey toward its 2030 target of 50% renewables while also significantly reducing the cost of community solar to renters and other residents that do not have access to rooftop solar or may not be the direct beneficiary of other solar and wind generation programs.

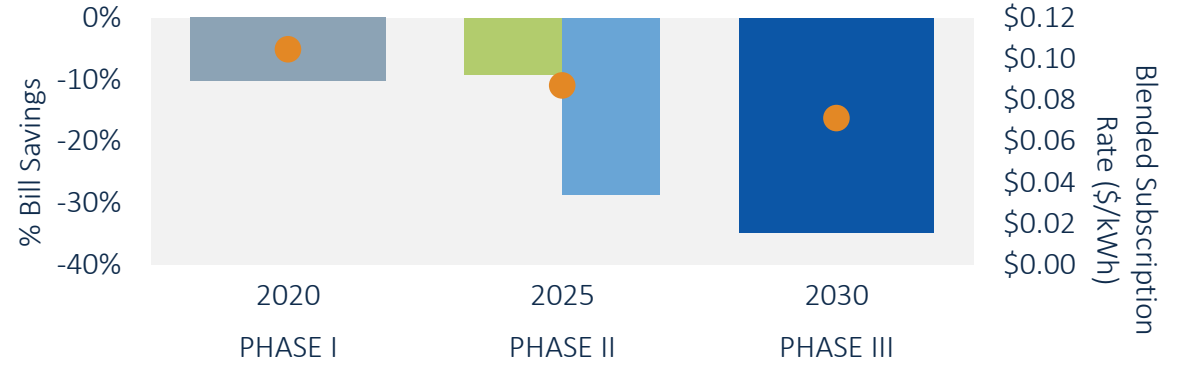
By 2030, community solar with a moderate value of solar compensation could convey 40%-50% savings off customer bills — whether compared to a blended bill or just simply off of what retail electricity would have been.

Potential Residential Community Solar Subscription Rate and Bill Savings by Compensation Mechanism and Value, JCP&L Territory



Source: GTM Research, Wood Mackenzie

Potential Large Commercial and Industrial Community Solar Subscription Rate and Bill Savings by Compensation Mechanism and Value, JCP&L Territory



[1]Modeled subscription rate utilizes assumptions in "Charting a Path for the Cost of Community Solar"

New Jersey Community Solar Deployments Could Reach 2.0 to 3.3 GW by 2030

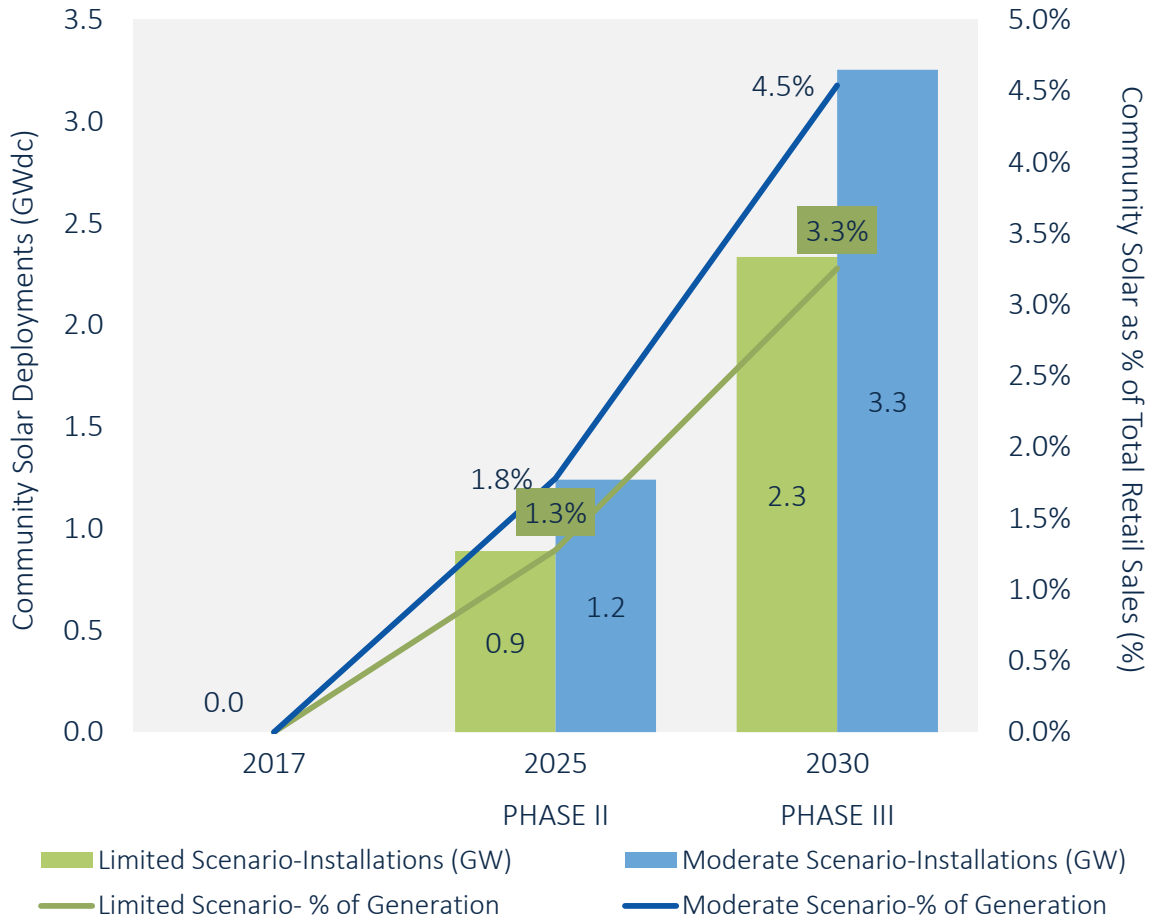
New Jersey could see over 4.5% of its total electricity come from community solar by 2030 – equivalent to all solar energy deployments in New Jersey today.

With continued community solar product improvement and a stable and strong framework in place, New Jersey could deploy 2.3 GW to 3.3 GW of community solar in the span of a little more than 10 years — 3x to 6x the amount that's minimally required by New Jersey's required community solar program.

In other words, New Jersey has the potential to replicate the success of its SREC program with community solar — only at lower costs and higher end value.

New Jersey's pilot community solar program will be vital in proving to subscribers and other stakeholders that community solar can provide the foundation to broad system and societal value.

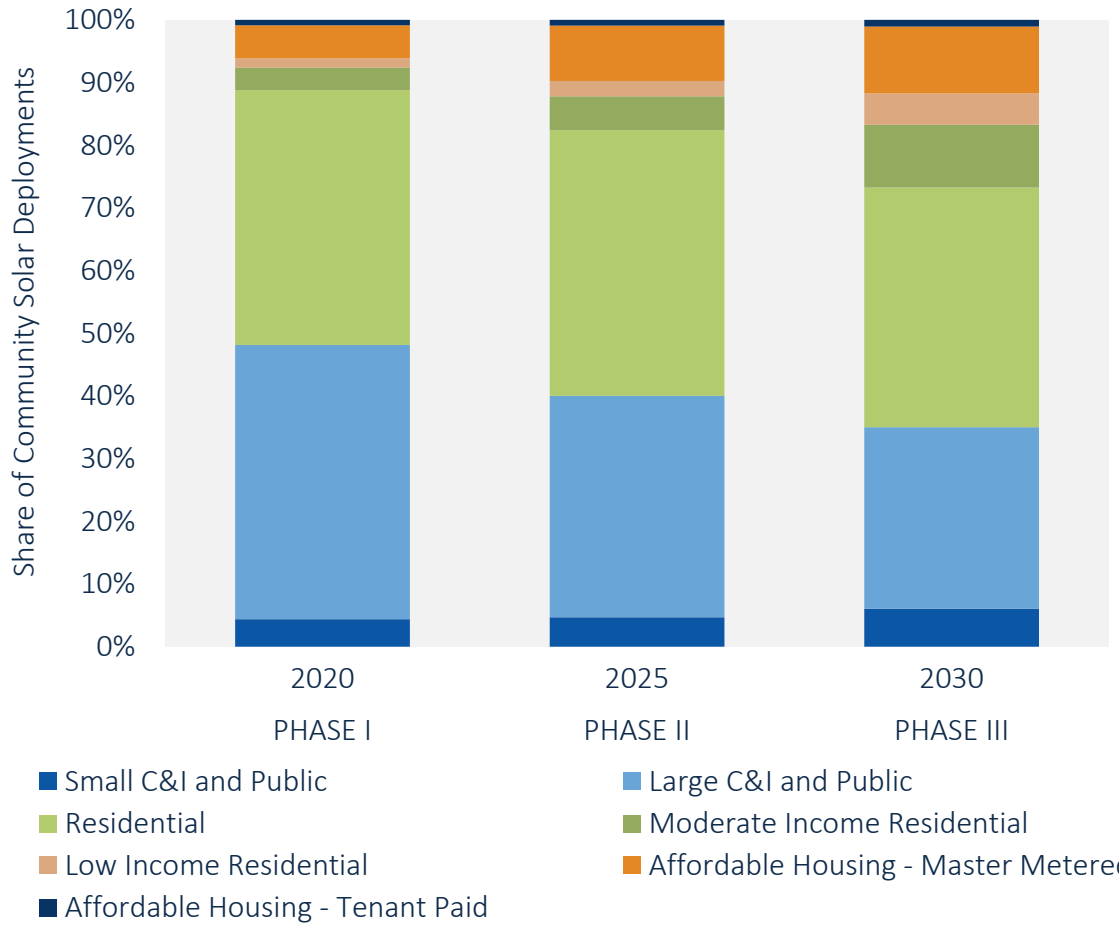
Cumulative Community Solar Market Potential: New Jersey



Source: GTM Research Wood Mackenzie

Master-Metered Affordable Housing Units Could Be Well Served by Community Solar

New Jersey Community Solar Segmented Subscriber Adoption



Source: GTM Research Wood Mackenzie

Community solar could serve between 25% and 35% of all master-metered affordable housing units in New Jersey by 2030.

Partially driven by a relatively low volume of master-metered affordable housing units (an expected 180,000 households by 2030), the penetration is nonetheless a strong opportunity to deliver strong value to the LMI community.

A key driver of this outlook is that the new community solar legislation requires the BPU to ensure that low-income and multifamily housing customers are able to participate in the community solar program. Second, there are multiple paths forward for the state to leverage public sources of capital to support LMI adoption of community solar — whether via a standalone green bank, or the development of a clean-energy-focused division of the governor's proposed Public Bank, or the pre-existing Infrastructure Bank.

State legislation has ensured that the final program design will include policies that encourage LMI adoption of community solar, which could build upon best practices from other states to include a combination of program carve-outs, incentive adders and public sources of financing.

In addition to its benefits for LMI customers, community solar conveys strong and compelling savings for residential and commercial market segments across the major utility territories

By 2030, residential subscribers, including LMI households, will make up the majority of community solar capacity, but non-residential systems won't be left out; in our Moderate Scenario, C&I subscriptions could exceed 1.2 GW by 2030.

Community Solar in New Jersey: Market Potential

New Jersey is in the beginning stages of incorporating community solar into its portfolio. A leader in distributed energy deployment, New Jersey recognizes the importance of setting strong solar policy. Robust design of pilots and sustained community solar programs would help residents and businesses thus far locked out of New Jersey's solar success. For example, by 2030, community solar could serve over 250,000 LMI households, including 25%-35% of all affordable housing tenants in the state.

Community Solar Market Potential in New Jersey, 2030 Vision Scenarios

Total Addressable Market: **3.6 million customers**

Total Community Solar Capacity Operating: **2.3 GW to 3.3 GW**

Annual Electricity Generated: **2.6 TWh to 3.6 TWh**

- Share of State Electricity Consumption: **3.3% to 4.5%**

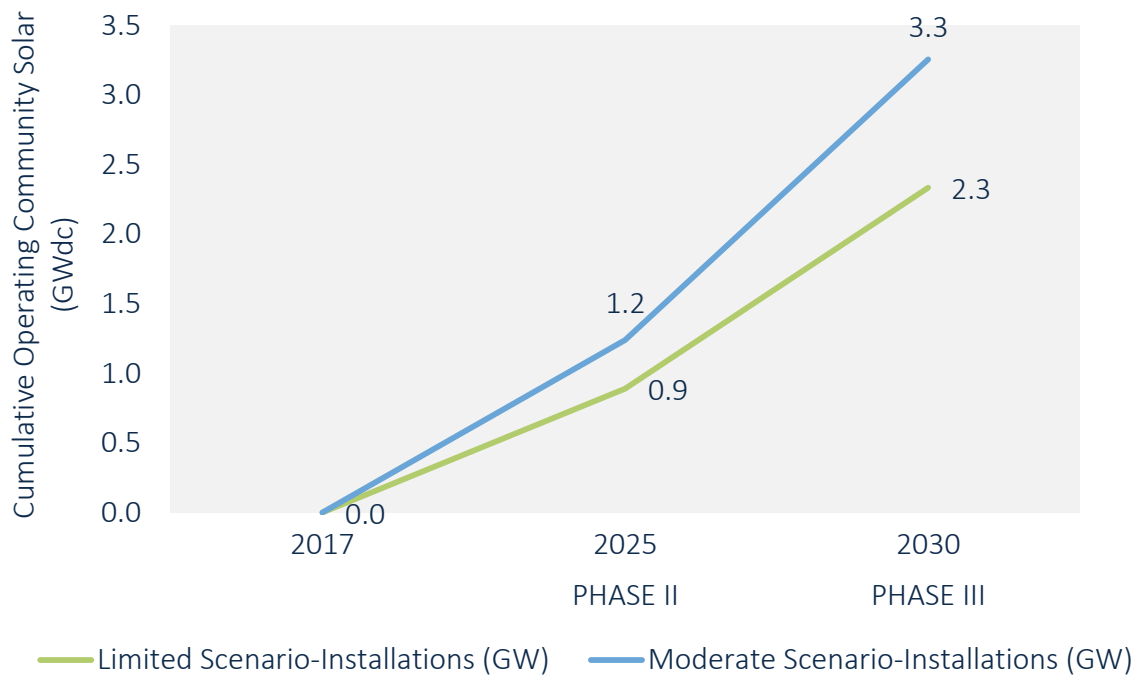
Subscribers Served: **219,000 to 410,000**

- Low- and Moderate-Income Households Supported: **119,000 to 255,000**

Cumulative Capital Invested*: **$2.8 billion to $4.9 billion**

Annual Spend on Operations, Leases and Taxes: **$47 million to $65 million**

Community Solar in New Jersey: Market Potential



Source: GTM Research Wood Mackenzie

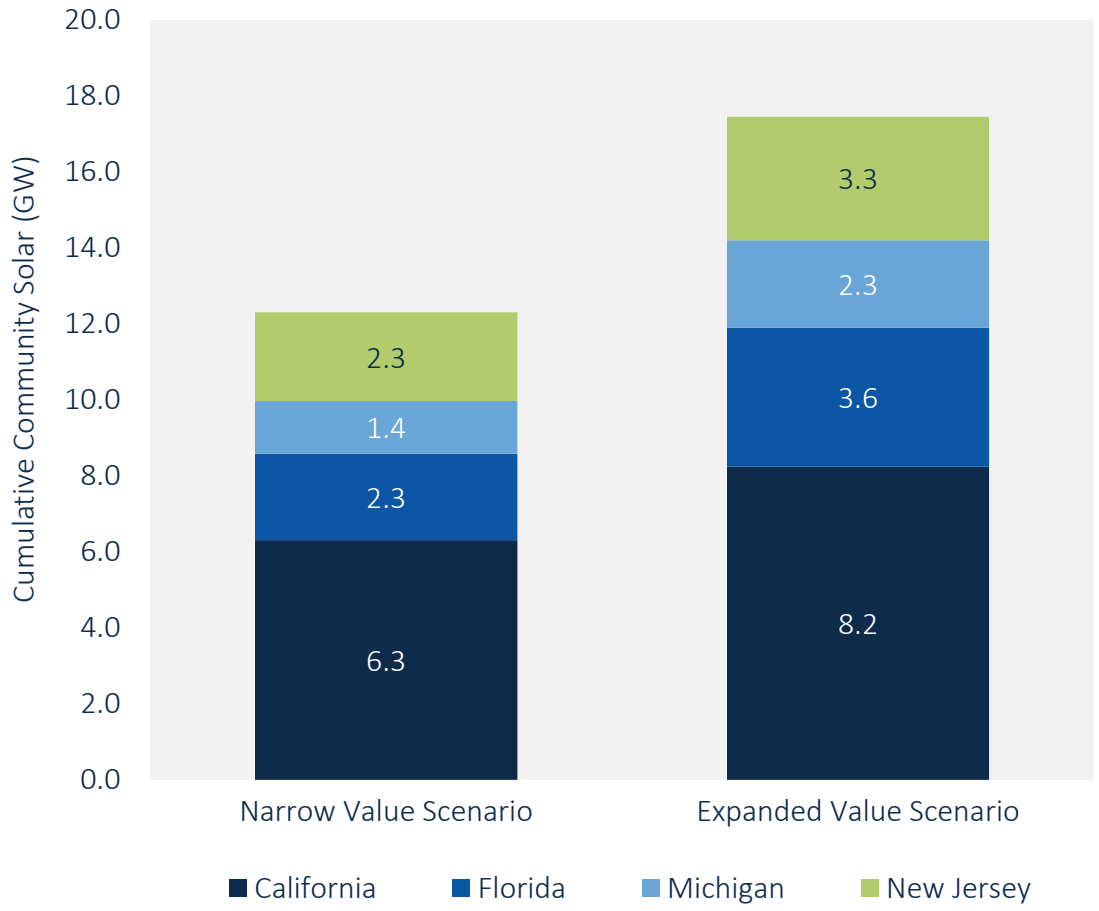
"Limited Scenario" and **"Moderate Scenario"** refer to the set of grid and environmental benefits included in the compensation for community solar. Neither reflect a full account of all costs and benefits, especially more difficult to calculate economic development and societal health benefits. Adoption forecast also includes assumptions of strong community solar and LMI adoption policy and continued subscription product innovations

*Cumulative capital invested represent total initial costs to build community solar plants, including all materials, installation materials and upfront supply chain, development and financing costs. Does not include ongoing operating costs

6. The Community Solar Vision: A National View

With the Four States Combined, Total Deployments Could Reach 12.3 GW to 17.5 GW

Cumulative Community Solar Deployments by State and Scenario, 2030



Source: GTM Research Wood Mackenzie

Based on customer-level economic benefits, while keeping in mind energy and market constraints, community solar could drive a significant portion of new solar generation in each of the four states we study.

Individually, these states represent different policy environments, market structures, levels of solar deployment and experience with community solar.

Yet with the right policy ingredients, these four states could see between 12.3 GW and 17.5 GW of new solar generation, representing between 8% and 40% of total distributed solar deployments in each state. Furthermore, much of community solar will serve populations that have thus far been left behind in the mass solar market.

In addition to the clean energy produced, these deployments will generate multiple decades of stable energy cost reduction for their subscribers, an avenue for policymakers to support low- and moderate-income populations and an asset for deeper customer engagement and grid reliability.

Upfront Community Solar Investment in the Four States Could Top $24.3 billion by 2030

Community solar could add $1.5 billion to $2.0 billion in upfront capital investment per year in the four studied states combined through 2030. This represents private sector investment in the electricity infrastructure of the future.

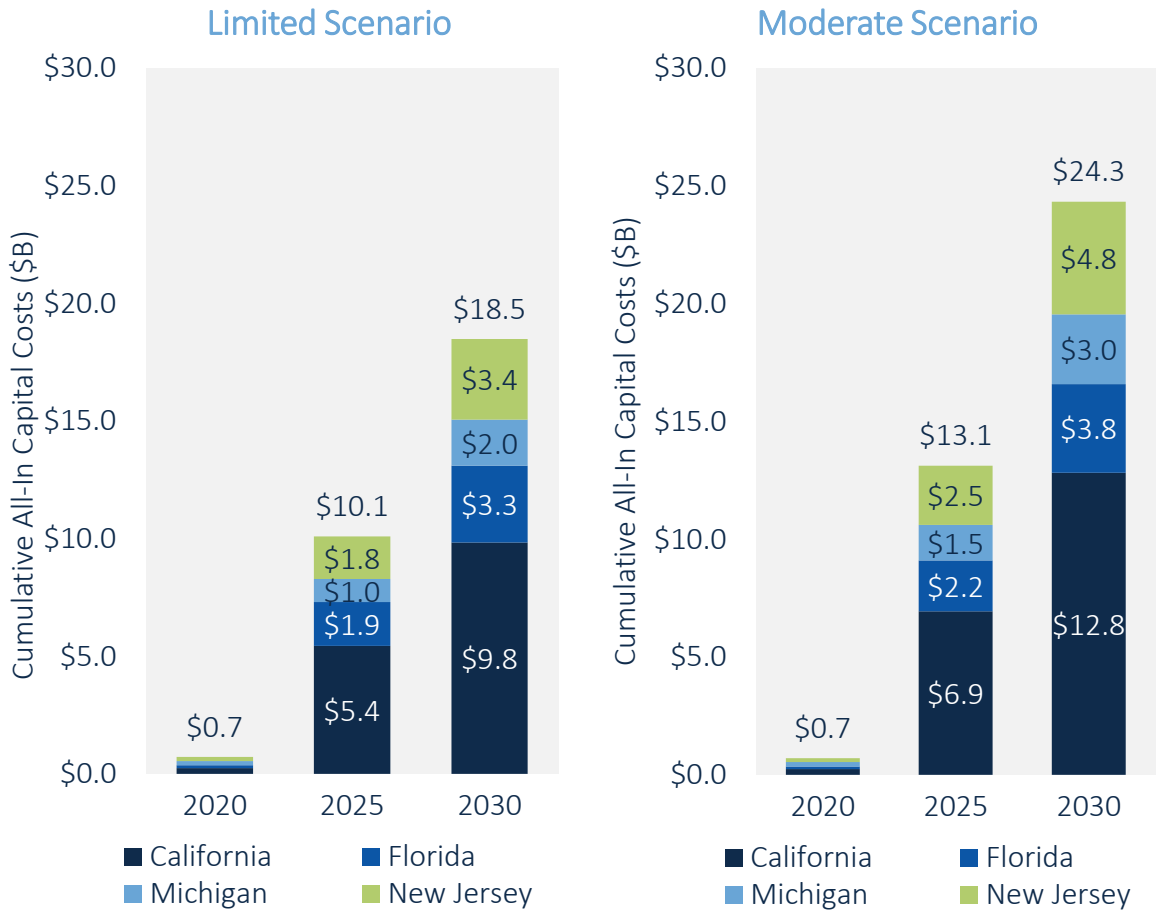
This estimate accounts for only capital expenditures for new solar installations and does not include payments from subscribers, nor ongoing costs such as land lease and property taxes.

Even in our low projection, over $18.5 billion ($1.5 billion per year) would be invested into community solar.

California leads the way, with $9.8 billion to $12.8 billion invested by 2030, triple the spend of Florida, the next highest ranked state.

Despite falling solar costs, Michigan's investment in community solar accelerates from $1.3 billion between 2020 and 2025 to $1.5 billion between 2025 and 2030.

Cumulative Community Solar Upfront Capital Expenditures



Source: GTM Research Wood Mackenzie

What If Every State Opened Its Doors to Community Solar?

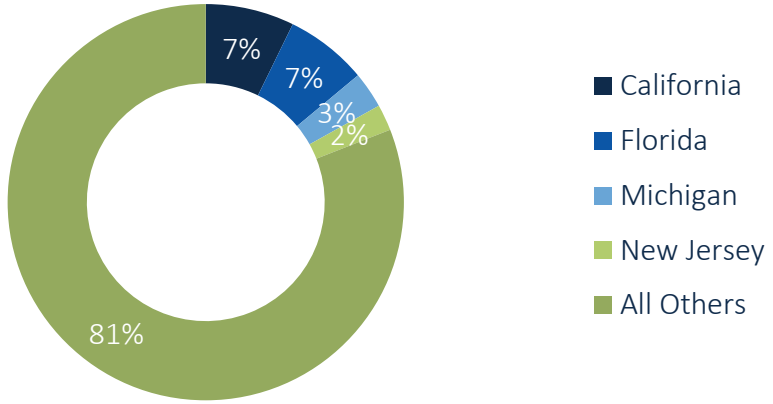
Contribution from community solar rises from a negligible share to as much as 3.1% of total energy consumption in the four states examined in the span of a decade.

The four states in focus represent one-fifth of all electricity sales nationally. Even the 19 states with current statewide community solar programs in place represent only 40% of total energy customers.

If over the next decade, every state were to adopt policies that similarly supported and valued community solar for an expanded array of customer, environmental, grid and social benefits, community solar could exceed 84 GW by the end of the next decade.

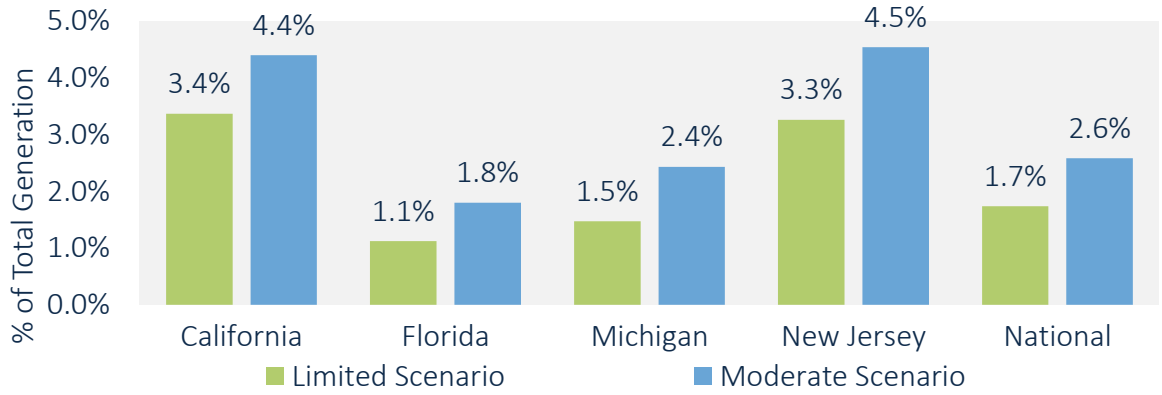
In other words, if all states were to see similar adoption rates as the four states examined (accounting for differences in state load and solar resource), community solar could supply 1.7%-2.6% of all electricity consumed in the U.S. by 2030.

State-Level Electricity Consumption as Share of National Total



Source: EIA

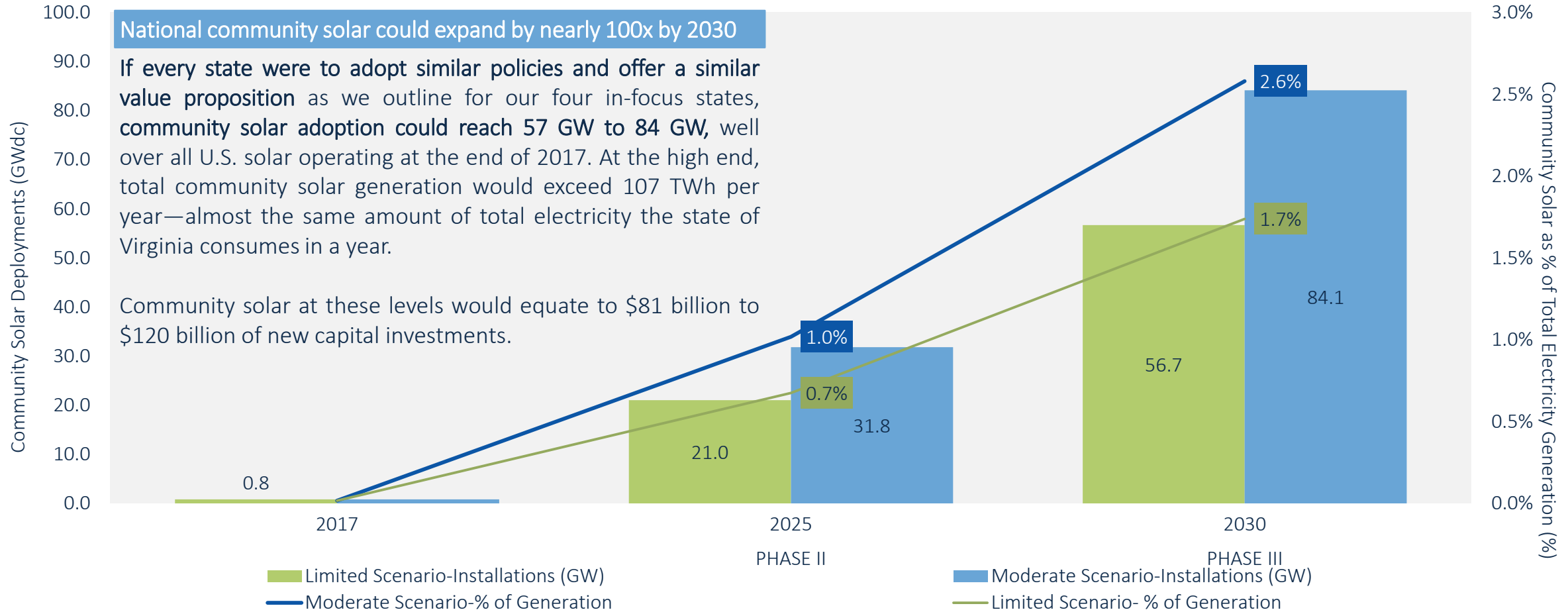
Forecasted Electricity Contribution From Community Solar by Scenario, 2030



Source: GTM Research Wood Mackenzie

Community Solar Could Generate Over 2.6% of U.S. Electricity by 2030 Equaling 57 GW to 84 GW

National Community Solar Installations by Scenario (Assuming All States Adopt Forward-Looking Community Solar Policies)



Source: GTM Research Wood Mackenzie

7. Appendix: Total Addressable Market Methodology

Total Addressable Market Approach and Data Source

Work Steps	Data Source
Step 1: Establish number of customers for the reference year (2017) • Summarize the number of customers by size and type • Summarize the number of households by income groups at county level • Summarize the number of affordable housing units by government programs at state level	• 2011-2015 American Community Survey, NREL Rooftop Energy Potential of Low Income Communities in America (REPLICA) • National Housing Preservation Database • Statistics of U.S. Businesses (SUSB)
Step 2: Forecast number of customers for total addressable market (2020, 2025, 2030) • Develop projection of C&I customers driven by GDP growth and elasticity rate • Develop projection of county-level households by income group driven by GDP growth, population growth and Gini index • Develop projection of affordable housing units driven by assumptions of the availability to low-income households	• Wood Mackenzie Macro Economic Research • GTM Research
Step 3: Evaluate the average customer capacity and annual consumption • Assume different levels of capacity and consumption by customer sub-segments • Split the affordable housing customers by master-metered and tenant-paid	• EIA • NREL REPLICA • Department of Housing and Urban Development
Step 4: Forecast of capacity and annual consumption for total addressable market (2020, 2025, 2030) • Develop projection of total capacity and annual consumption by subsegments less projected values for onsite solar • Summarize the forecast of capacity and annual consumption by five customer segments at state level	• Wood Mackenzie Power Service • GTM Research Solar Service

5 Customer Segments Are Identified to Represent the Addressable Market

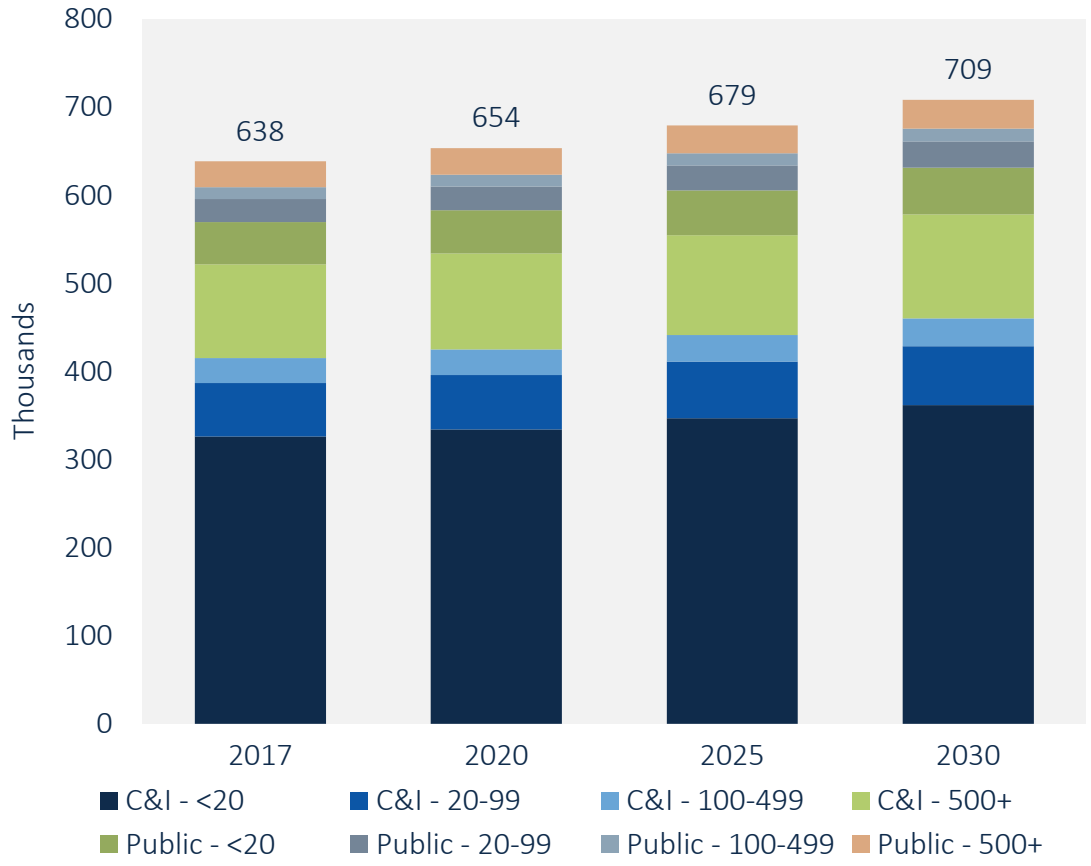
Community Solar Customer Segment Definitions

C&I (Inclusive of public institutions)	The business establishments with fewer than 20 employees are not considered as addressable market. C&I Private includes agriculture, mining, utilities, construction, manufacturing, trade, transportation and warehousing, information, finance and insurance, real estate, professional, management of companies, art and entertainment, accommodations and food. Public includes administrative and support, educational services, health care and social assistance, government/municipal, military.
Residential	Includes high income (greater than 120% AMI[1]) and middle income (between 80% and 120% AMI) households per Department of Housing and Urban Development definition
Moderate-Income Residential	Includes moderate-income (between 50% and 80% AMI) households per HUD definition
Low-Income Residential	Includes low-income (between 30% and 50% AMI) and very-low-income (less than 30% AMI) households per HUD definition
Affordable Housing Properties	Various programs targeting low-income households offered by Department of Housing and Urban Development and U.S. Department of Agriculture and Rural Development. Includes Low-Income Housing Tax Credit (LIHTC), Section 8, HOME, Public Housing, USDA programs and others.

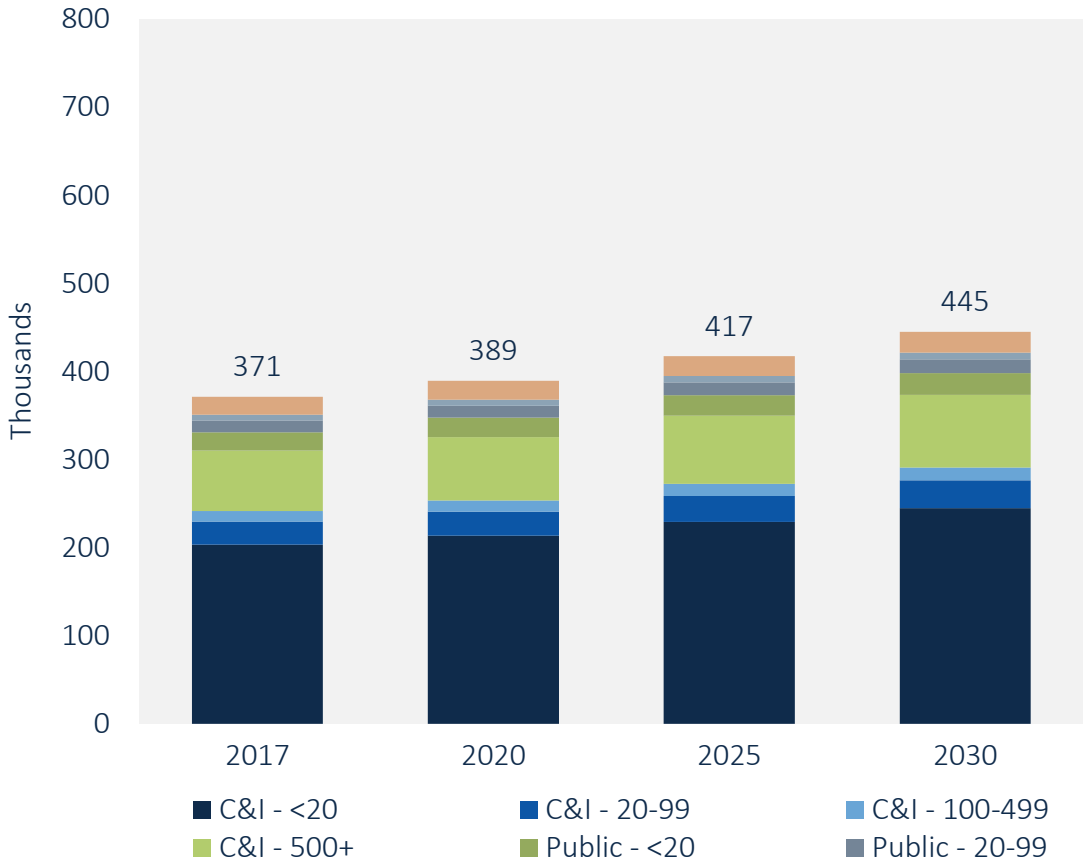
Source: Wood Mackenzie GTM Research. Note 1: AMI refers to area median income

Number of Potential C&I Customers Increases by 10% to 20% by 2030 in California and Florida

Number of C&I Establishments by Type and Size, California



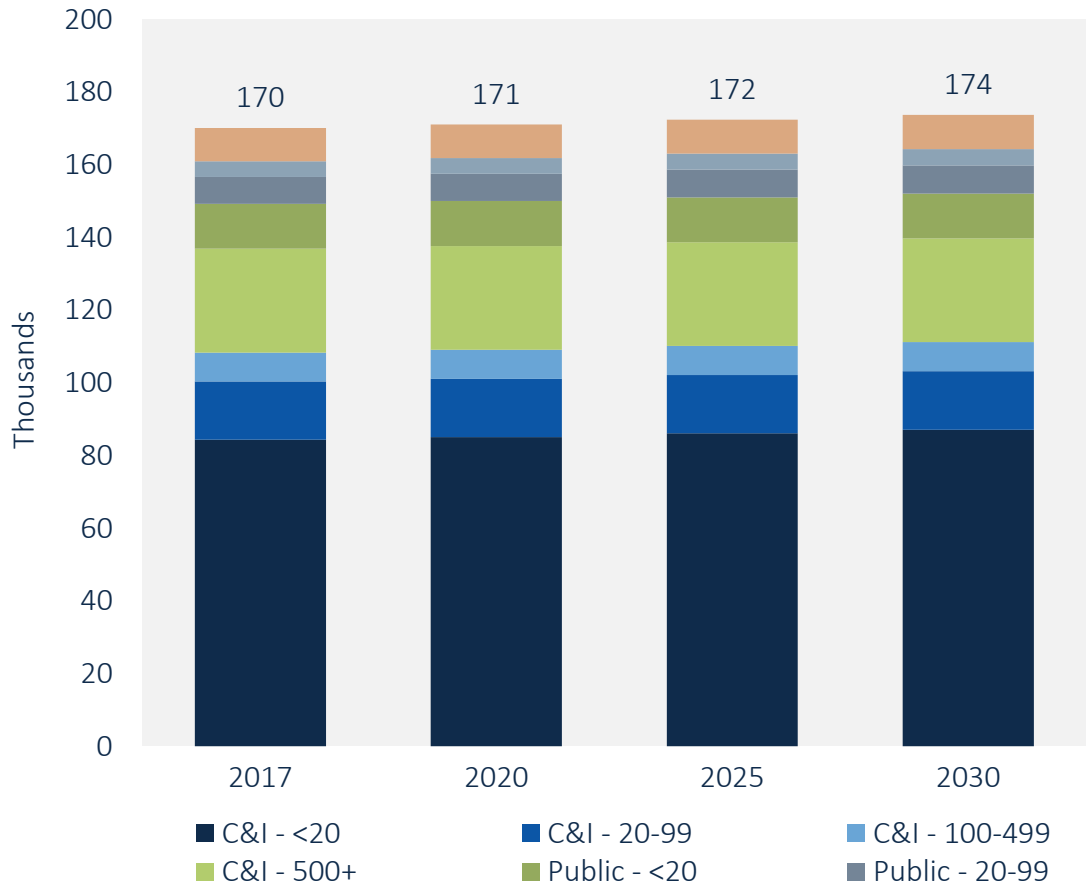
Number of C&I Establishments by Type and Size, Florida



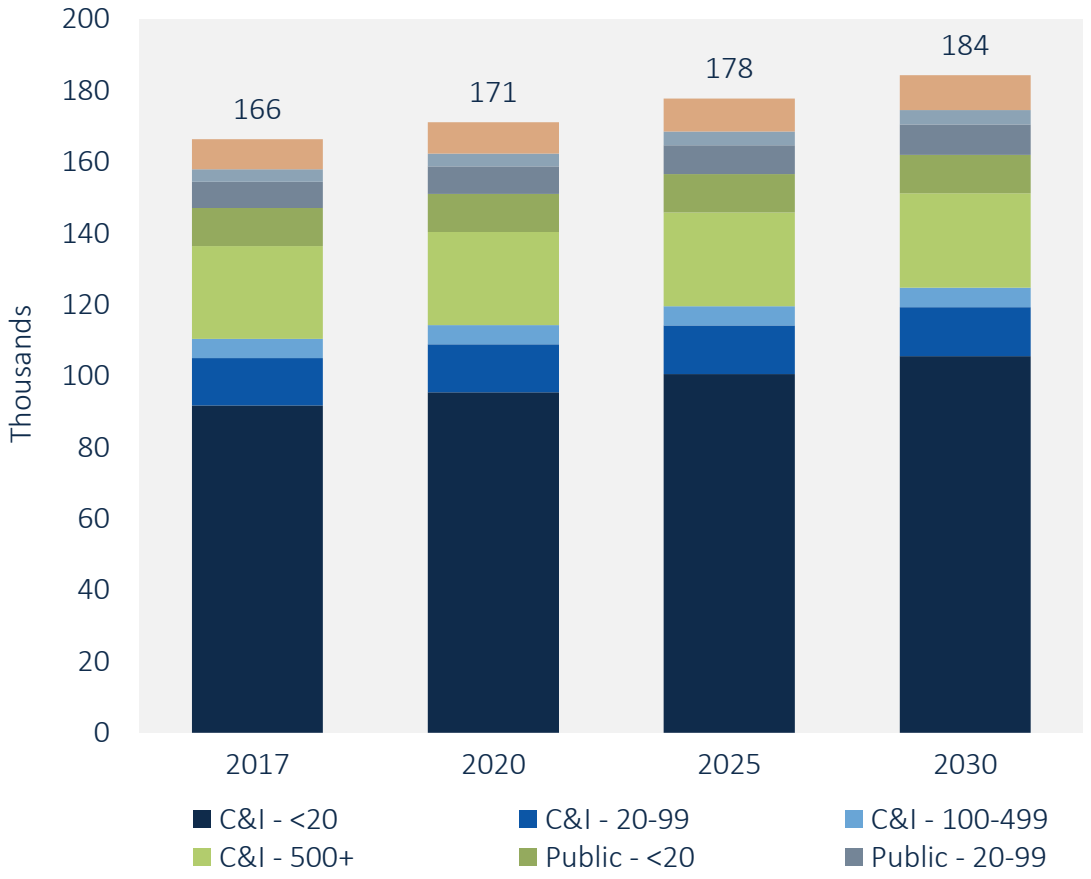
Source: Wood Mackenzie GTM Research, Statistics of U.S. Businesses (SUSB)
Note: <20, 20-99, 100-499 and 500+ refer to the number of employees in each establishment

C&I Addressable Market Stays Flat in Michigan, but Sees Modest Increase in New Jersey

Number of C&I Establishments by Type and Size, Michigan



Number of C&I Establishments by Type and Size, New Jersey

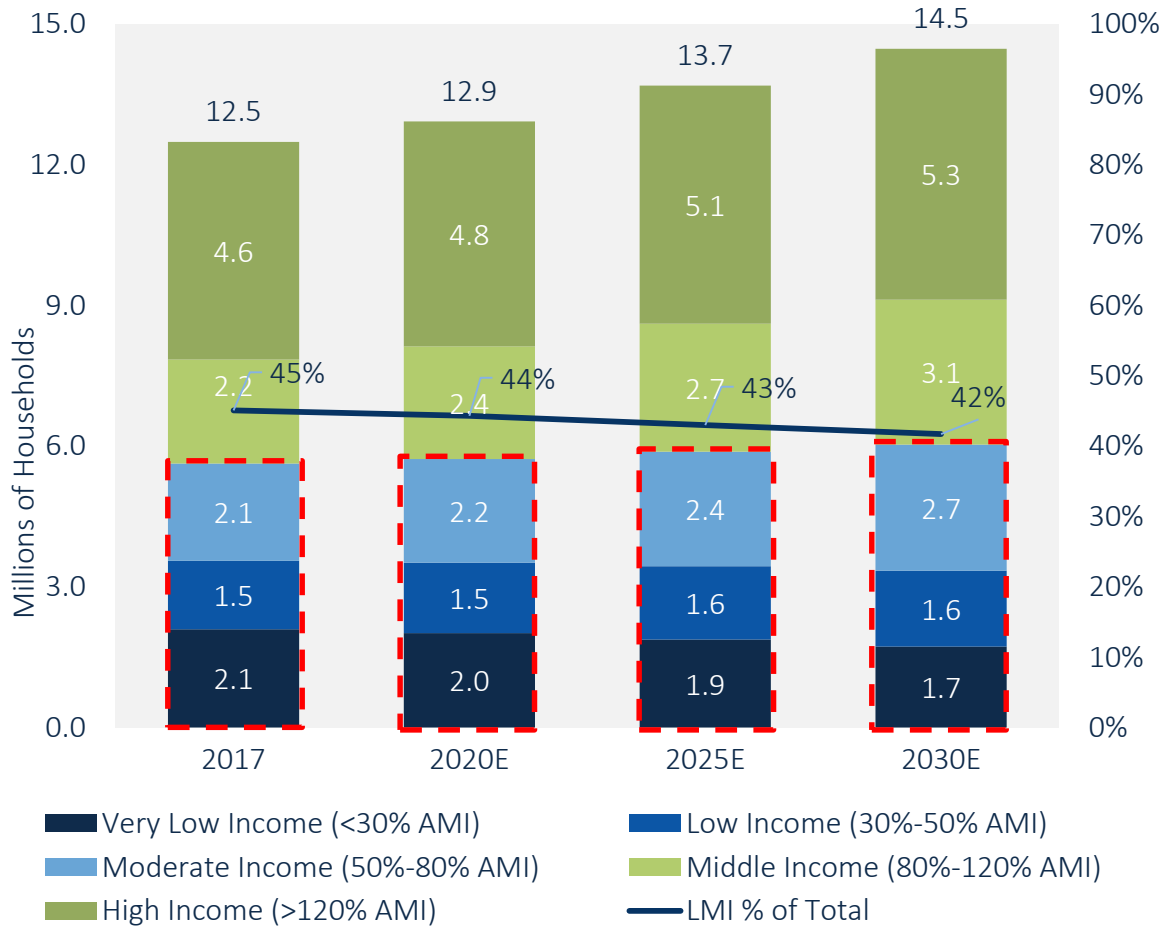


Source: Wood Mackenzie GTM Research, Statistics of U.S. Businesses (SUSB)

Note: <20, 20-99, 100-499 and 500+ refer to the number of employees in each establishment

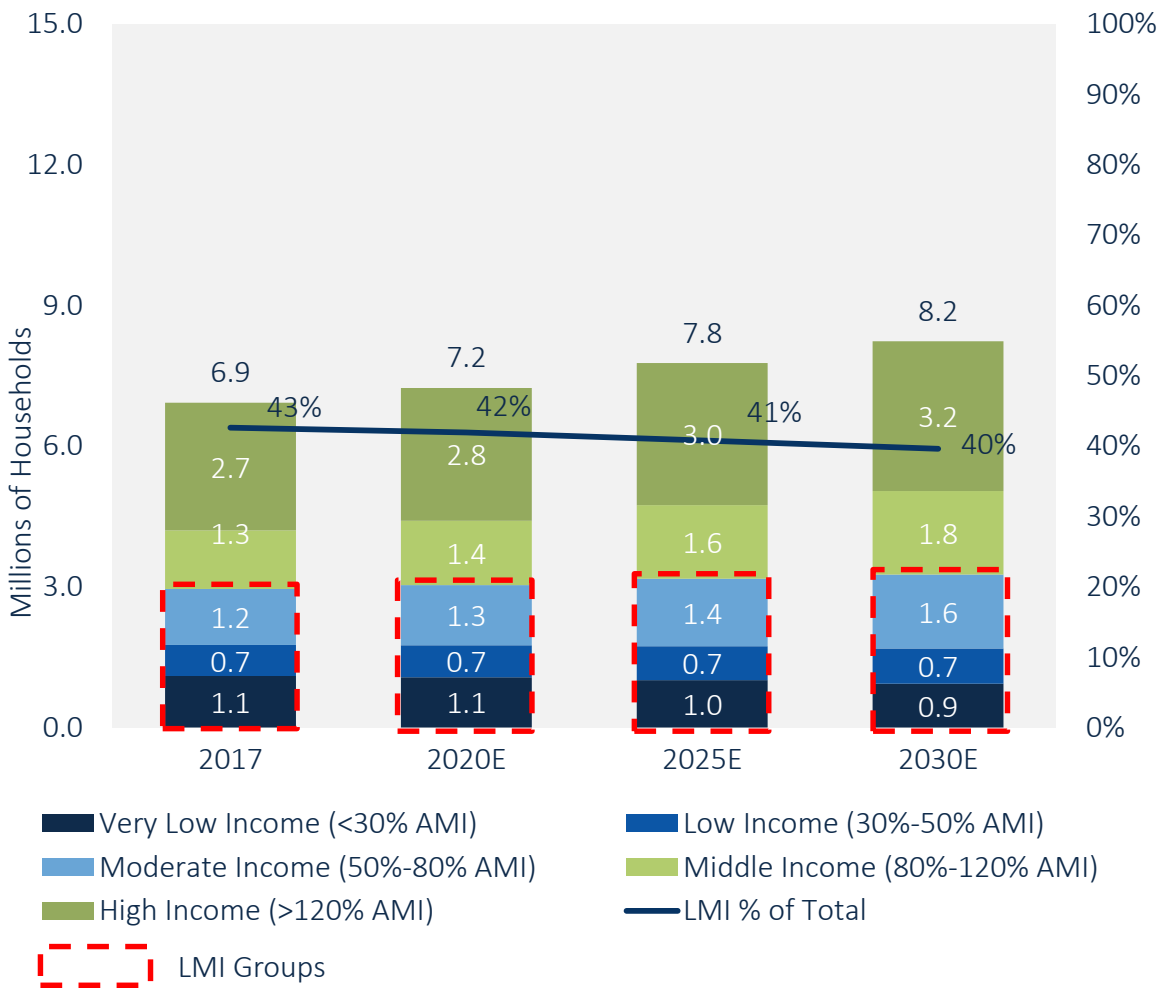
We Expect Strong Population and GDP Growth in California and Florida, Increasing the Total

Number of Households Forecast by Income Group, California



Source: Wood Mackenzie GTM Research, NREL, American Community Survey 2011-2015

Number of Households Forecast by Income Group, Florida



Relative Flat Economic Outlook in Michigan and New Jersey, Further Shrinking the Number of Households Falling Into LMI Group With More Even Income Distribution

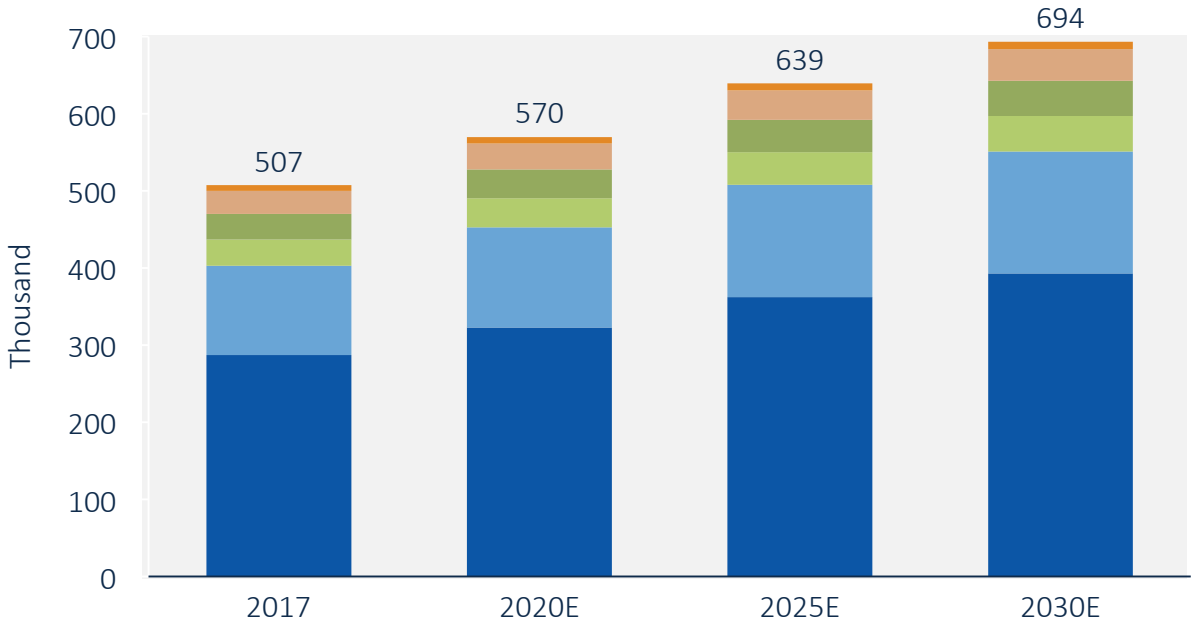
Number of Households Forecast by Income Group, Michigan

Source: Wood Mackenzie GTM Research, NREL, American Community Survey 2011-2015

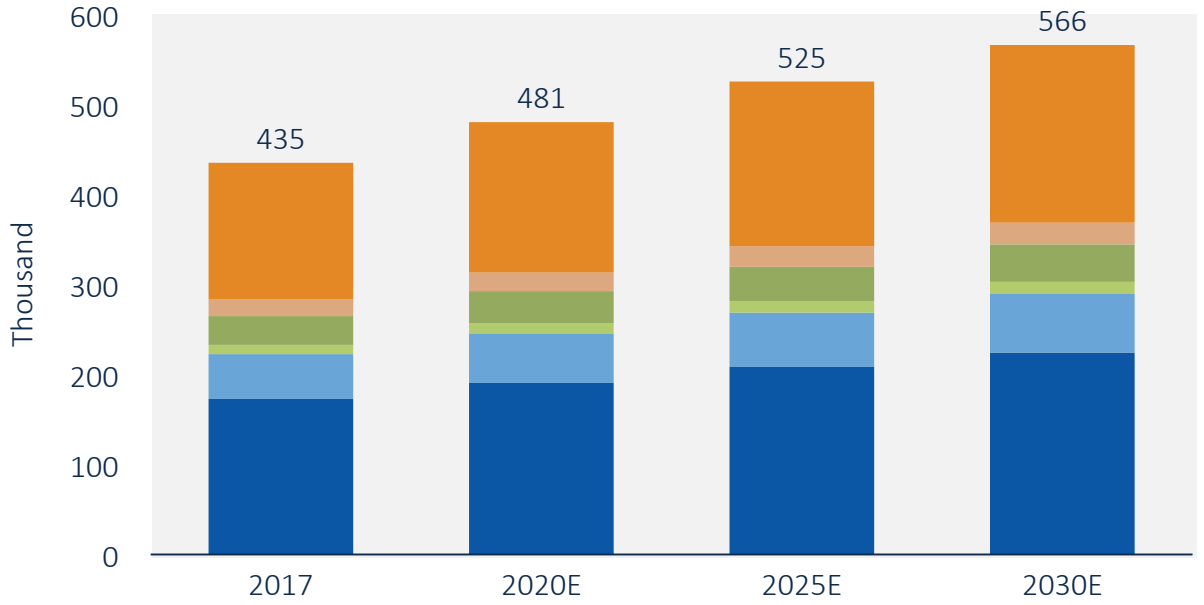
Number of Households Forecast by Income Group, New Jersey

Higher Percentage of LMI Group Is Expected to Receive Affordable Housing Support, Enlarging the Affordable Housing Customer Segment

Number of Affordable Housing Homes, California



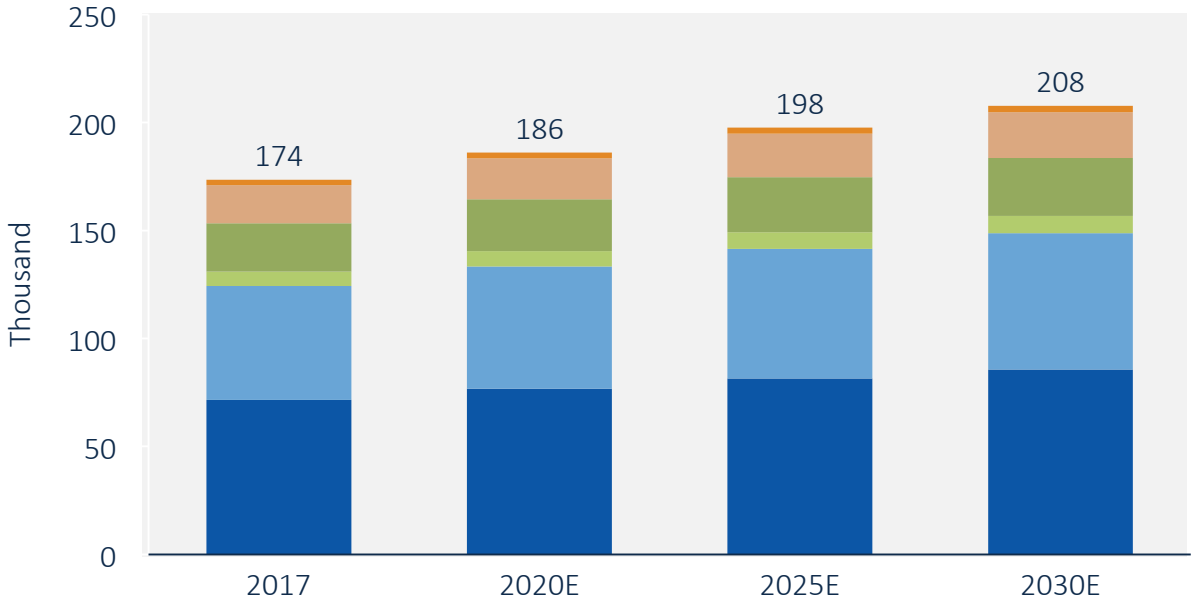
Number of Affordable Housing Homes, Florida



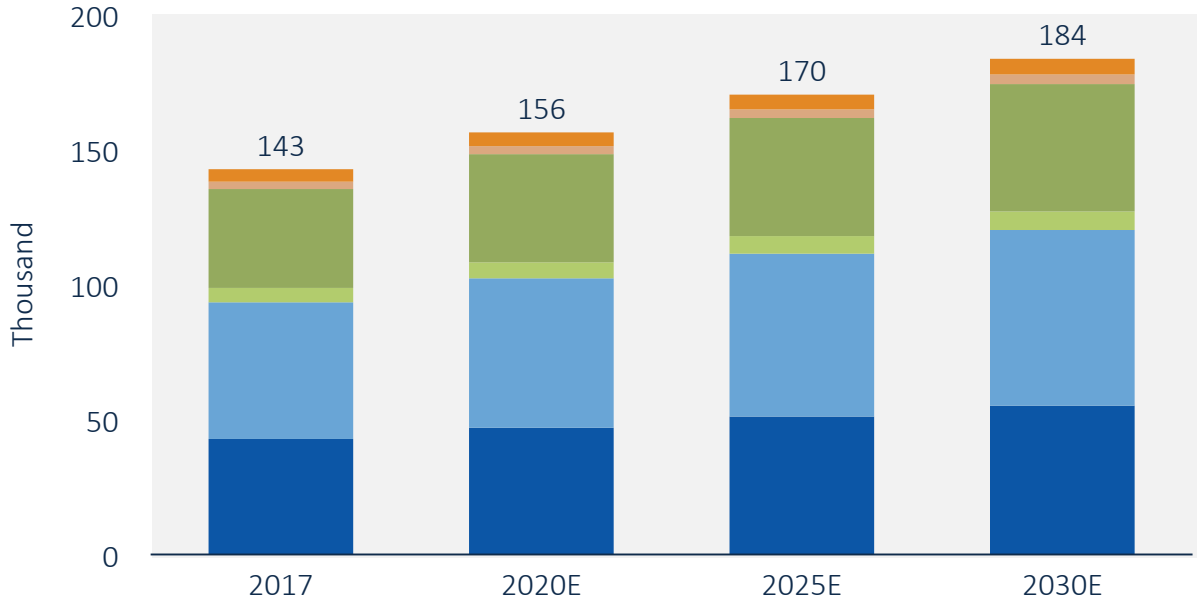
Source: Wood Mackenzie GTM Research, National Housing Preservation Database (NHPD), NREL, HUD, USDA

Michigan and New Jersey Have More Modest Growth Due to the Flat Outlook for Households in These States

Number of Affordable Housing Homes, Michigan



Number of Affordable Housing Homes, New Jersey



LIHTC | Section 8 | HOME | Public Housing | USDA Programs | Others

Source: Wood Mackenzie GTM Research, National Housing Preservation Database (NHPD), NREL, HUD, USDA

A Bottom-Up Approach to Estimate Total Addressable Market

	Addressable Market (# of Customers)		Capacity and Consumption		Addressable Market (GW, TWh)
C&I (Inclusive of public institutions)	# of C&I Businesses by Year *State-level businesses by type, GDP growth forecasts*	✖	Average Electricity Capacity and Consumption *State-level average business (private/public)*	=	C&I Capacity and Consumption
Residential	# of Households by Year *County-level household income, GDP growth, population growth and income distribution forecasts*	✖	Average Electricity Capacity and Consumption *County-level by home ownership and building type*	=	Residential (Mid/High Income) Capacity and Consumption
Moderate-Income Residential	# of Households by Year *County-level household income, GDP growth, population growth and income distribution forecasts*	✖	Average Electricity Capacity and Consumption *County-level by home ownership and building type*	=	Moderate-Income Capacity and Consumption
Low-Income Residential	# of Households by Year *County-level household income, GDP growth, population growth and income distribution forecasts*	✖	Average Electricity Capacity and Consumption *County-level by home ownership and building type*	=	Low-Income Capacity and Consumption
Affordable Housing Properties	# of Affordable Housing Properties by Year *State-level publicly supported housing, % of low-income under affordable housing*	✖	Average Electricity Capacity and Consumption *State-level multi-family rental homes*	=	Affordable Housing Capacity and Consumption

Affordable Housing Program Definitions

LIHTC	Tax credits for the acquisition, rehabilitation, or new construction of rental housing targeted to lower-income households.
Section 8	The Housing Choice Voucher Program (formerly Section 8) provides tenant-based assistance, in the form of a voucher, to low-income families, seniors and persons with disabilities for rental units chosen by the tenant in the private market.
HOME	Formula grants to fund a wide range of activities including building, buying, and/or rehabilitating affordable housing for rent or homeownership or providing direct rental assistance to low-income people.
Public Housing	Public housing was established to provide decent and safe rental housing for eligible low-income families, the elderly, and persons with disabilities.
USDA Programs	A variety of programs (in the form of loans or loan guarantees) to build or improve housing and essential community facilities in rural areas (low- and moderate-income rural Americans).
Others	Includes Section 236 HUD Insured Mortgages, Section 202 Direct Loans and State Section 236.

8. Appendix: Value of Solar Methodology

Value of Solar Methodology

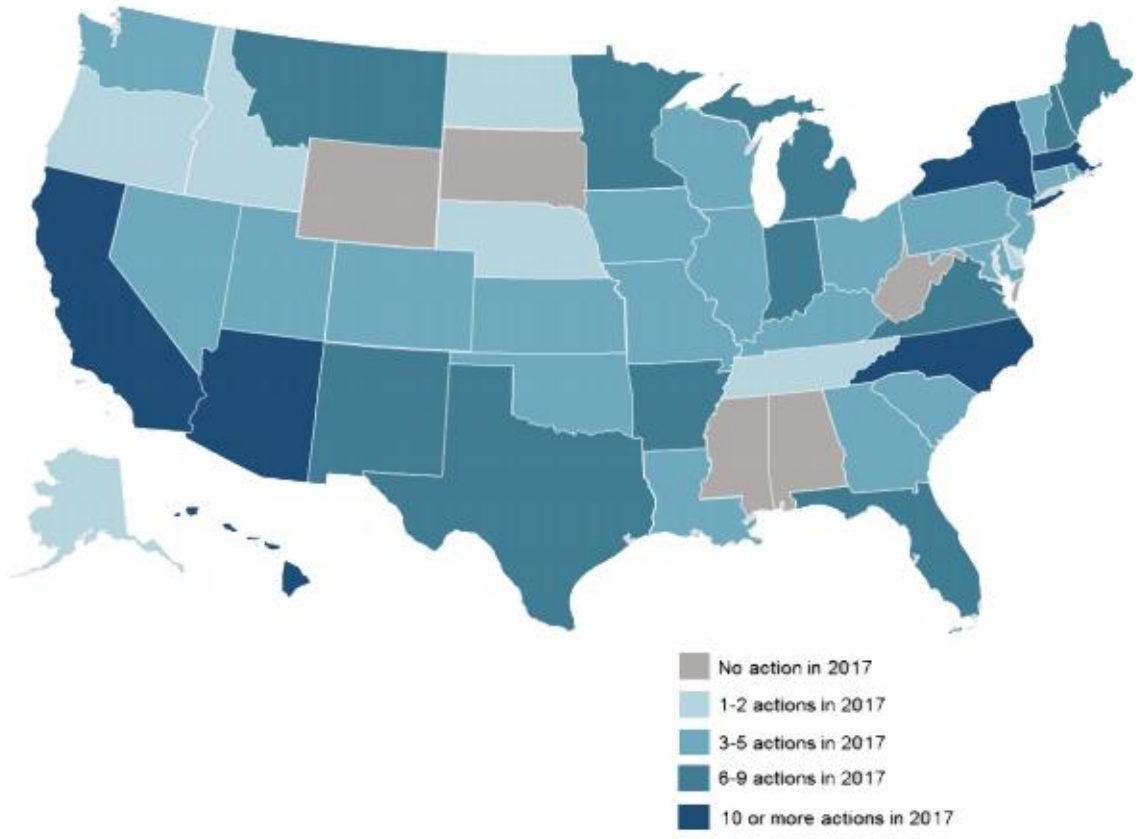
Work Steps	Data Sources
Step 1: Aggregate and categorize value-of-solar component estimates into common buckets • Define and collect individual data points for different value-of-solar components, relying on general categories primarily as defined by Rocky Mountain Institute in *A Review of Solar PV Benefit & Cost Studies* and the Interstate Renewable Energy Council in *A Regulator's Guidebook: Calculating Benefits and Costs of Distributed Solar Generation*	• Full List of Literature Consulted in References • Rocky Mountain Institute • IREC • PACE Energy and Climate Center
Step 2: Compare limited and moderate value-of-solar results with local retail rate at time of study • Use all-sector average rate by utility where study focuses on singular utility and state where study looks at a statewide estimate • Where studies derive multiple values for a specific utility or state territory, use base/average figures or the broadest view (typically multi-year, levelized values) for every utility studied	• EIA
Step 3: Group and weight studies' resulting discount/premium by their proximity and relevance to each studied market • Assign weights to each study that weights closest proximity, recency and similarity of markets most heavily	
Step 4: Apply resulting weighted average premium/discount to current utility-specific all-in rates • Apply resulting premiums/discounts to average retail rates by region to specific utilities' all-in rates • Project value of solar for future years using same escalator as for real retail rates to ensure discount/premium remains static	• EIA • Wood Mackenzie *North American Power Service*

What Is the Value of Distributed Solar Energy?

As more distributed energy, in particular distributed solar PV, is added to the grid, more states and utility territories are wrestling with the future of net metering policy and the proper compensation for distributed solar energy generation.

- According to DSIRE, 31 states and Washington, D.C. undertook some DG compensation policy action in 2017, with 21 states and Washington, D.C. enacting policy to examine the value of solar or net metering.
- These studies seek to find a value or tariff that accurately represents the full costs and benefits that distributed solar brings to customers, ratepayers, system operators and society as a whole.
- The sponsor of a study generally determines how the estimated value of solar weighs against prevailing retail rates. Although not universal, utility-sponsored studies generally show a low value of distributed solar while industry-sponsored studies show a value near or above retail rates. Regulatory filings and sponsored studies generally vary as much as the overall population of studies.

Summary of 2017 Solar Policy and Rate Design Actions



Source: DSIRE *50 States of Solar Q4 2017 Quarterly Report and 2017 Annual Review*

Caveats for Our Value of Solar Methodology

Value-of-solar estimates vary due to the inherent locational and temporal details and a lack of commonly accepted core assumptions and methodologies

While various handbooks, white papers and initiatives seek to establish a common language and a set of methods to calculate the value of solar, an inherently balkanized utility and regulatory landscape results in very different sets of methods and values.

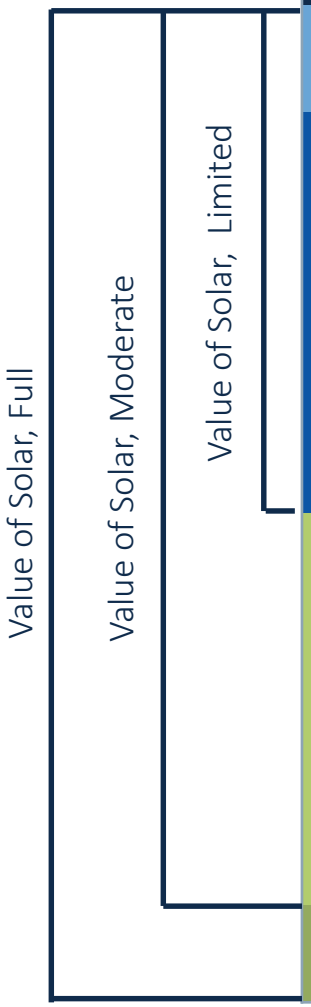
A bottom-up analysis of value of solar in each territory would be extensive, complex and no less controversial nor more valid than our top-down analysis, due to limited data for critical pieces of the analysis. Our intent is to convey the promise of community solar — not set a value-of-solar rate that warrants adoption.

Our purpose is not to prescribe a "value of community solar," but rather to use existing frameworks and literature to create proxy values we can couple with strong community solar policies, product innovation and LMI inclusivity to paint potential community solar adoption. In short, these are illustrative values only and should not be viewed as a proper valuation study nor used as robust, geography-specific estimates.

We accept that there are a number of shortcomings in our calculated value of community solar estimates, including but not limited to the small population of studies and variations to study methodologies on calculated components. We believe that a number of studies fall short in building in the true value of solar because of scope, data and calculation limitations. Similarly, a handful of broad studies incorporate values that may not be realistically employed.

In short, our values represent a simplistic proxy where further standardization, study and clarity is much needed.

Value of Solar Cost Categories and Components



Component	Description
Administrative Costs	Additional cost caused by managing permits and interconnections
Solar Integration Costs	Additional cost to grid operator for balancing solar intermittency
Avoided Energy	Credit for eliminating cost of displaced energy generation
Avoided Capacity	Credit for eliminating cost of displaced investment in new generating capacity
Avoided T&D Capacity	Credit for eliminating cost of displaced investment in new transmission and distribution capacity
Avoided Line Losses	Credit for energy consumed near the source and not lost over transmission and distribution lines
Environmental Compliance	Credit for renewable or environmental compliance requirements at the avoided cost of compliance
Price Reduction Effects	Reduction of total system-wide generation and capacity pricing as the result of reduced demand
Hedge Value	Credit for reduced uncertainty in future energy and generation capacity costs
Ancillary Services	Reduced need for grid support or ancillary services, either due to reduced demand or ability for distributed solar to provide services (e.g., reactive voltage support)
Carbon/GHG	Credit for reduced greenhouse gas emissions, often through the expectation of a future carbon market
Additional Economic, Environmental and Societal Benefits	Benefits to jobs, local economy, public health, and other environmental and societal benefits not otherwise accounted for

Reviewed Literature of State- and Utility-Specific Estimates of the Value of Solar

California
LBNL (2012)
Crossborder Energy (2013)
E3 (2010, 2011, 2012, 2018 Tool)

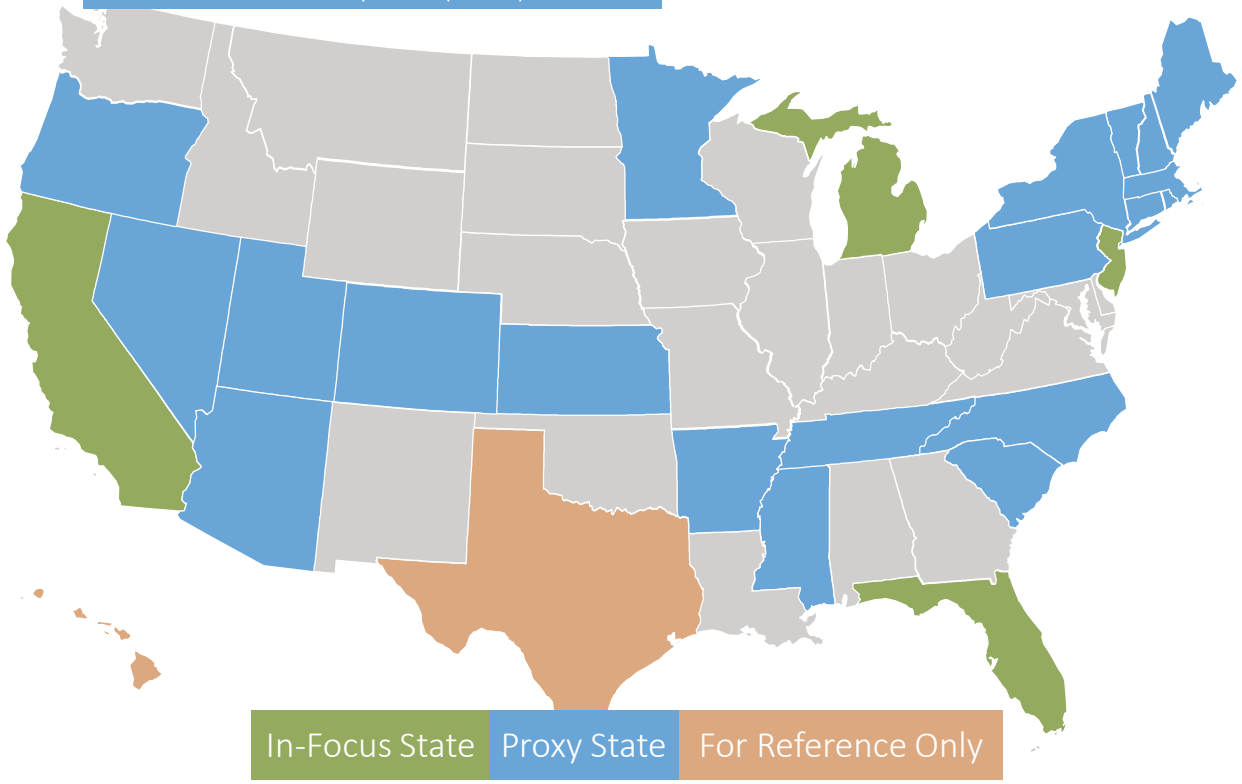
West
AZ: SAIC (2013)
Crossborder Energy (2013, 2016)
CO: Xcel Energy (2013)
Crossborder Energy (2013)
IREC + Clean Power Research (2015)
NV: E3 (2014, 2016)
Navigant consulting (2010)
SolarCity + NRDC (2016)
OR: Crossborder Energy (2018)
PGE (2018)
Idaho Power (2018)
PacifiCorp (2018)

Hawaii: E3 (2014)
Texas: Clean Power Research (2012)
Brattle Group (2012)
Clean Power Research (2013)
Austin Energy (Annual VOST Filings)

Source: GTM Research

Midwest
MN: Minnesota Power (VOS Filings)
Xcel Energy (VOS Filings)
Clean Power Research (2014)
NE: Lincoln Electric System (2014)

Michigan
Utility Financial Solutions (2015)
Utility Financial Solutions (2016)
DTE Energy (2014)



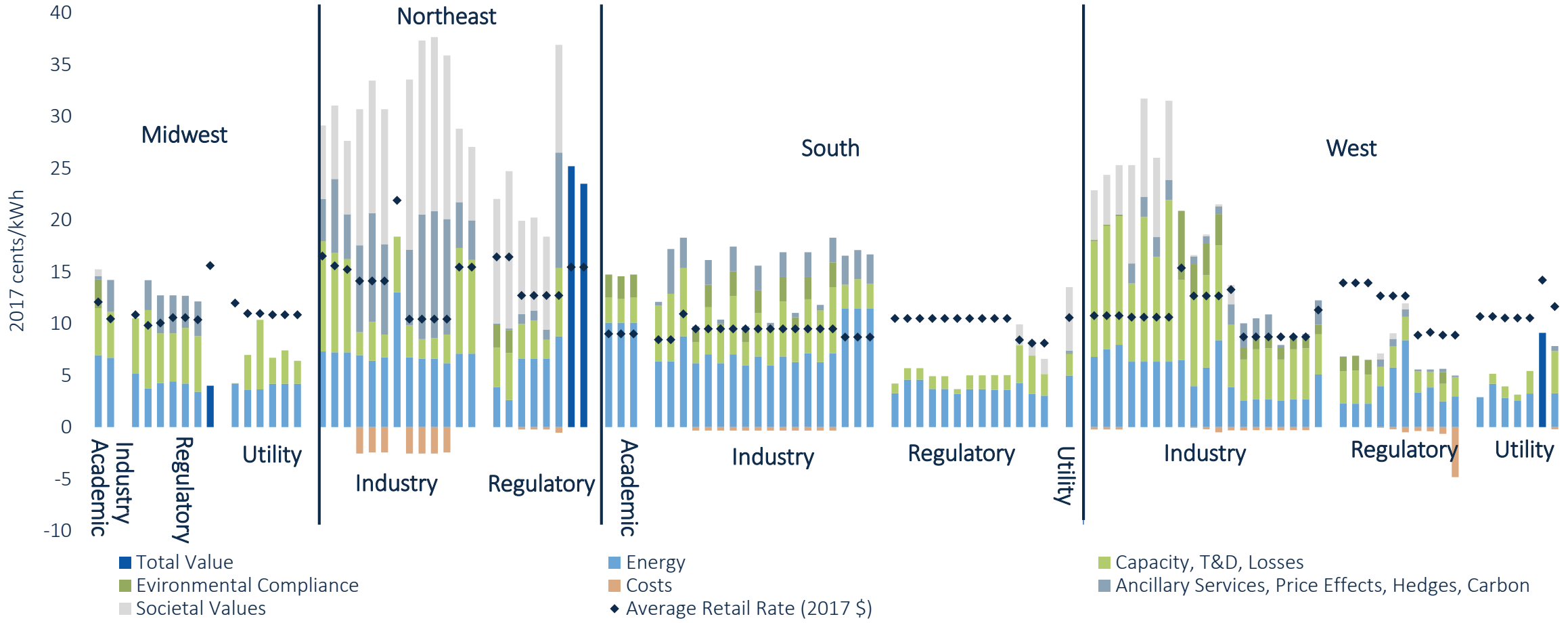
New Jersey
Clean Power Research (2012)

Northeast
CT: Acadia Center (2015)
MA: Acadia Center (2015)
Peregrine+ SEA+ Meister + La Capra (2015)
ME: Maine PUC (2015)
NH: Acadia Center (2015)
NY: VDER Proceedings
PA: Clean Power Research (2013)
RI: Acadia Center (2015)
VT: VT PSD (2014)

SOUTH
AR: Crossborder Energy (2017)
MS: Synapse Energy Economics (2014)
NC: Crossborder Energy (2013)
SC: SCE&G (2016, 2017)
Duke Energy (2016, 2017)
TN: TVA (2015)

Review of Value of Solar Literature: Value of Solar Components vs. Average Retail Rates

Review of Value of Solar by Component From 40 Value of Solar/Value of Distributed Energy Studies vs. Average EIA Retail Rates



Source: GTM Research, EIA (average retail rates in study year) Various Regulatory Filings and Studies (See References for Full List of Studies)

Quantifying a Limited and Moderate Value of Solar for Our In-Focus States

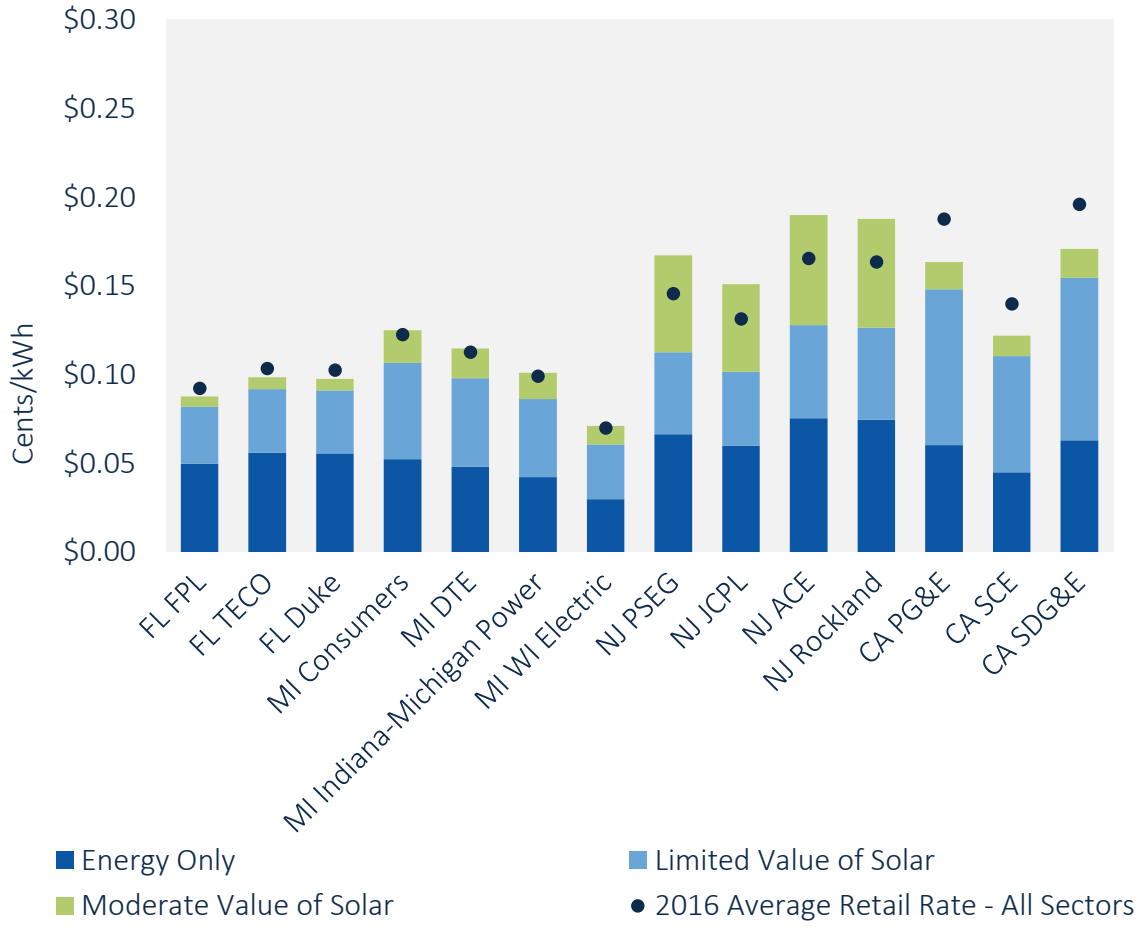
We build two value-of-solar estimates for each studied state

Despite differences in methodology, nearly all value-of-solar studies accept that distributed solar has value beyond the generated electrons (i.e., an energy-only value). However, adopted methodologies generally differ in which components are included and how these are calculated. Using our guide to different components, we come to two general categories of value of solar:

- **Limited value of solar:** Using only components that are more commonly calculated for value of solar in studies, including direct avoided costs and environmental credits that are directly monetizable (e.g., RECs)
- **Moderate value of solar:** Using a broader, but incomplete, set of components that pertain to grid value, excluding non-monetizable and more difficult-to-calculate societal benefits (e.g., social cost of emissions, jobs, low-income support).

Ultimately, our moderate value-of-solar averages range from a 13% discount to a 15% premium of average state-wide retail rates, with an average close to average retail rates. ***We also note that, due to the limitations of the literature reviewed, our moderate value of solar does not include a full benefit and cost accounting, including additional economic and societal benefits.***

Weighted Value of Solar vs. Average Retail Rate Based on Literature Review



Source: GTM Research

Identifying the Uncertainty and Potential Biases in Our Study

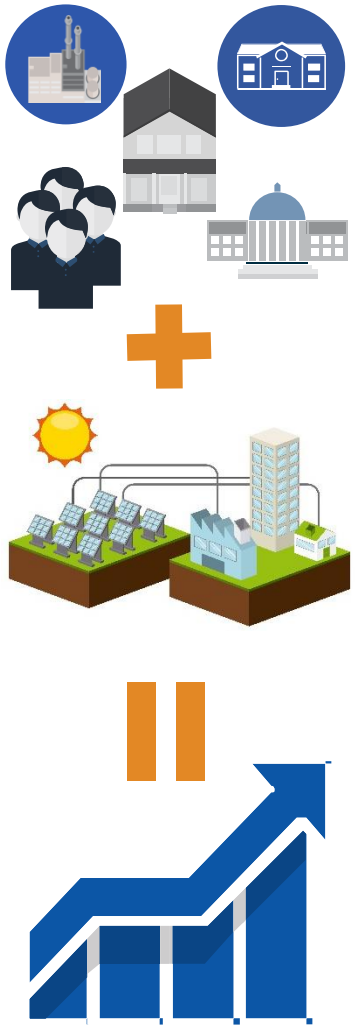
In addition to pragmatic differences in the reviewed studies' methodologies, we acknowledge the risk inherent to using a broad set of literature for values rather than a bottom-up calculation. The main risks to our utilized values include:

- **Bullish views on forward wholesale electricity prices:** Given the limitation of available data on the studied geographies and our intent for these estimates to be representatives rather than definitive, we employ a rough top-down average of existing studies rather than using best-in-class bottom-up calculations in each studied geography. Older studies may have more bullish views on natural-gas-driven wholesale energy prices, which would increase the long-term value of solar. We attempt to mitigate the impact of these factors by filtering out studies before 2010, as well as more heavily weighting recent studies with up-to-date views on energy and infrastructure costs.
- **Increasing solar deployment erodes the value of pure solar**: Our discount to average retail rate method could **overestimate the value of solar in high-penetration scenarios**, as concurrent solar generation does not mitigate all capacity costs and may increase certain integration costs. We assert that broad deployment of energy storage and flexible devices installed could mitigate the value erosion. These components will come at an additional cost but can also be utilized for services beyond mitigation of the effects of high solar penetration, adding value or potentially offsetting the costs of these additions.
- **Many value-of-solar studies take a limited view on broad values**: Our methodology averages in value-of-solar studies that ignore or cast aside best practice values, e.g., assuming capacity offset of solar is zero or assuming no ability to offset distribution equipment even at low solar penetration. In other circumstances, we look at estimates from regulatory filings in which the value-of-solar definition may be intentionally narrow, i.e., broader components are not even considered. Because these limited studies are also included in our averaged results, **our estimates may undersell the full value of solar**.

Overall, there is an inherent risk in mischaracterizing the value of distributed solar because current literature is incomplete or may otherwise inaccurately portray different component values. Significantly more work on a standard, agreed-upon framework and methodology should be implemented in markets that move towards a value of solar bill credit for community solar facilities.

9. Appendix: Forecast and Customer Benefit Calculation Methodology

Translating Customer Benefits to Deployments



Total Addressable Market

Our deployment forecasts starts with identifying the entire universe of all potential customers that could adopt community solar

- Derive total customers and segmentation from U.S. Census and other publicly available datasets
- Assess the factors driving addressable market shift for each segment identified

Community Solar Benefits

Next, we model adoption based on whether customer segments see enough tangible benefits to subscribe to community solar based on:

- Project economics and customer benefits analysis for each customer segment
- For Phase II and Phase III adoption, we build a top-down value-of-solar metric with which to compare community solar

Deployment Forecast

We assess a rate of adoption of community solar in each state and segment based on the tangible economic benefits, policy applications that ease subscribers' non-economic concerns, and continued maturity in community solar providers' business models to subscriber acquisition, retention and financing that improve attractiveness beyond bill savings with constraints from onsite distributed solar adoption and state-specific power market factors. We note that this is could be a conservative value as it does not fully account for all intangible, non-economic benefits that cause customers to participate.

Five Customer Segments Are Identified to Represent the Total Addressable Market

Community Solar Customer Segment Definitions

C&I (Inclusive of public institutions)	C&I Private includes agriculture, mining, utilities, construction, manufacturing, trade, transportation and warehousing, information, finance and insurance, real estate, professional, management of companies, art and entertainment, accommodation and food. Public includes administrative and support, educational services, health care and social assistance, government/municipal, military.
Residential	Includes high-income (greater than 120% AMI[1]) and middle-income (between 80% and 120% AMI) households per Department of Housing and Urban Development definition
Moderate-Income Residential	Includes moderate-income (between 50% and 80% AMI) households per HUD definition
Low-Income Residential	Includes low-income (between 30% and 50% AMI) and very-low-income (less than 30% AMI) households per HUD definition
Affordable Housing Properties	Various programs targeting low-income households offered by Department of Housing and Urban Development and U.S. Department of Agriculture and Rural Development. Includes LIHTC, Section 8, HOME, Public Housing, USDA Programs and others.

Source: Wood Mackenzie GTM Research. Note 1: AMI refers to area median income

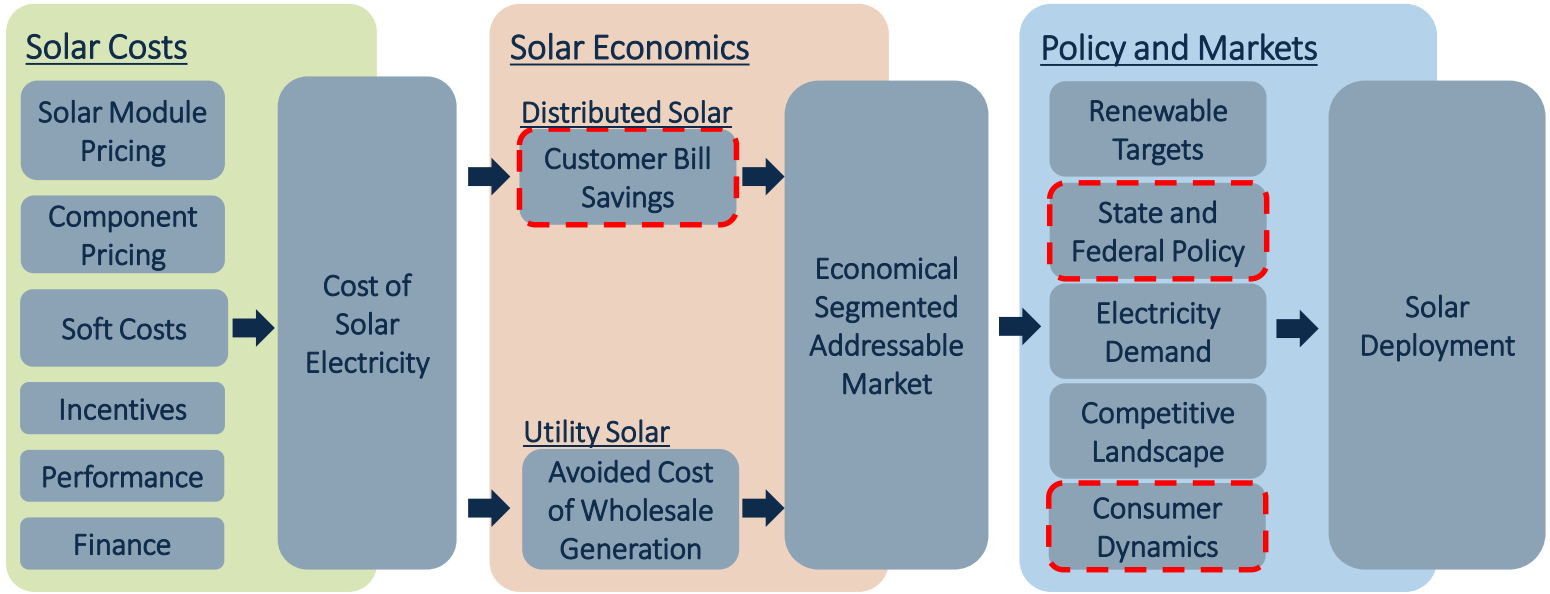
Translating Addressable Markets to a Deployment Forecast

We adapt GTM Research's proprietary deployment forecast model with a specific focus on community solar

- Customer savings are assumed to come in the form of bill credits according to community solar value in each phase
- State policy factors are adapted to allow for community solar without program caps
- New consumer dynamics formula built in to reflect a community solar product that is considerably more attractive than current community solar products
- Community solar forecast also includes consumer and competitive consideration of on-site/rooftop solar
- Policy intervention and market focus on subscriptions attract for increased LMI adoption, i.e., raising customer attraction/adoption scores for LMI segments

GTM Research's adoption forecast model underpins its state- and segment-level forecasts of the overall U.S. solar market

- Forecasts start with the economic foundation for addressable market and customer adoption
- Consumer dynamics built in via customer adoption curves based on historical experience and industry literature



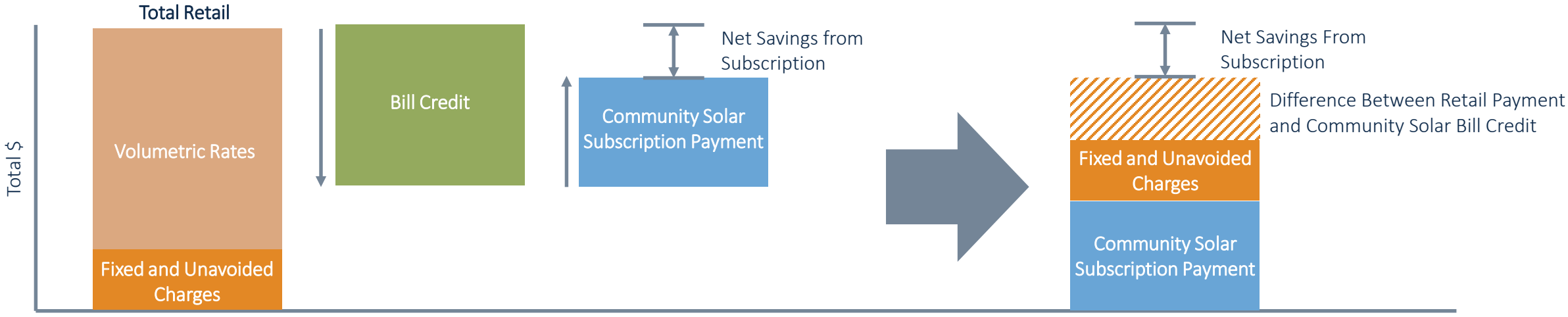
Modeling and Showing Community Solar Subscription Savings

We consider what solar can and can't offset for customers when looking at customer savings

Many residential and non-residential customers have portions of the bill that cannot be offset by on-site or bill credited solar generation, such as fixed charges, non-bypassable charges, demand charges and minimum bills. In addition, solar may not completely offset customer consumption, rendering a small part of the bill that is still subject to prevailing retail rates. Furthermore, when community solar is credited at a different rate than consumption, we must account for this difference in the costs to the subscriber

Thus, we use actual residential and commercial rate structures to calculate net avoided costs and bill savings resulting from a community solar subscription.

The example below shows how we arrive at net savings from a community solar subscription while accounting for these additional charges.



Stepping Through the Community Solar Proposition for DTE Territory in Michigan

Florida (in FPL Territory): Retail Rate vs. Net Community Solar Subscription Rate in Each Phase

PHASE I

Full retail-rate, business-as-usual scenario. Community solar is credited at full retail rate net metering.

PHASE II

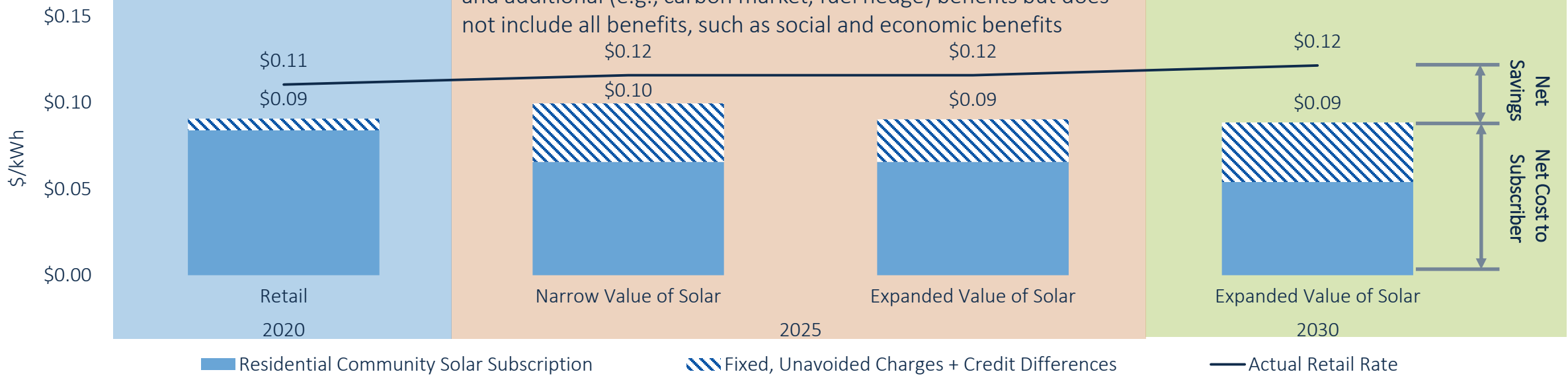
Market transitions into one of three scenarios, where community solar is compensated based on value of solar (see Appendix):

Limited Value of Solar: Only basic components of value of solar, including energy, capacity, T&D and monetizable environmental credits.

Moderate Value of Solar: Includes limited value of solar components and additional (e.g., carbon market, fuel hedge) benefits but does not include all benefits, such as social and economic benefits

PHASE III

Community solar is compared to an value of solar that is generally expected to provide all stakeholders, including subscribers, society and the grid, with value.



Source: GTM Research, Wood Mackenzie

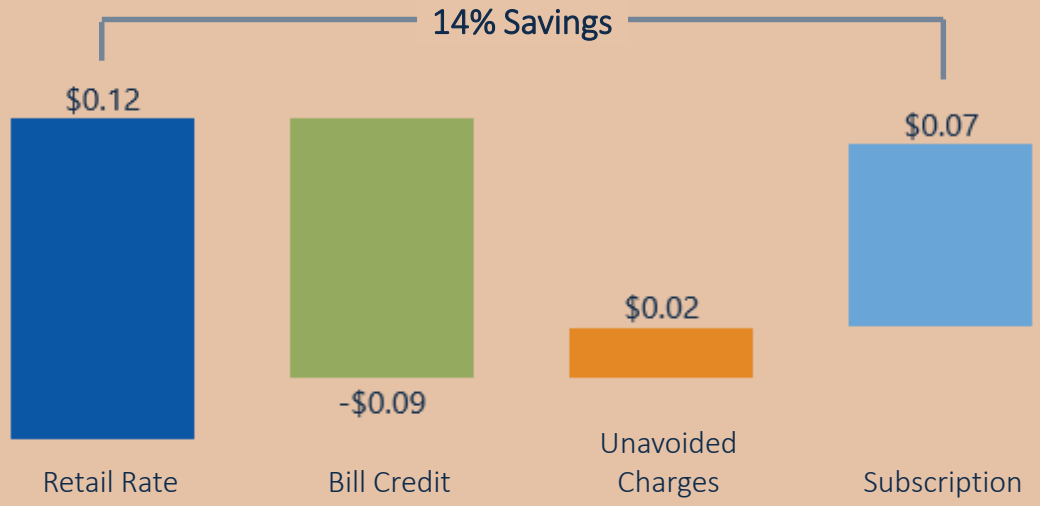
A Deeper Look at Phase II Customer Benefits in FPL Territory

Residential Community Solar Bill Payments and Savings Based on Three Bill Credit Scenarios in Florida FPL Territory

PHASE II: Limited Value of Solar

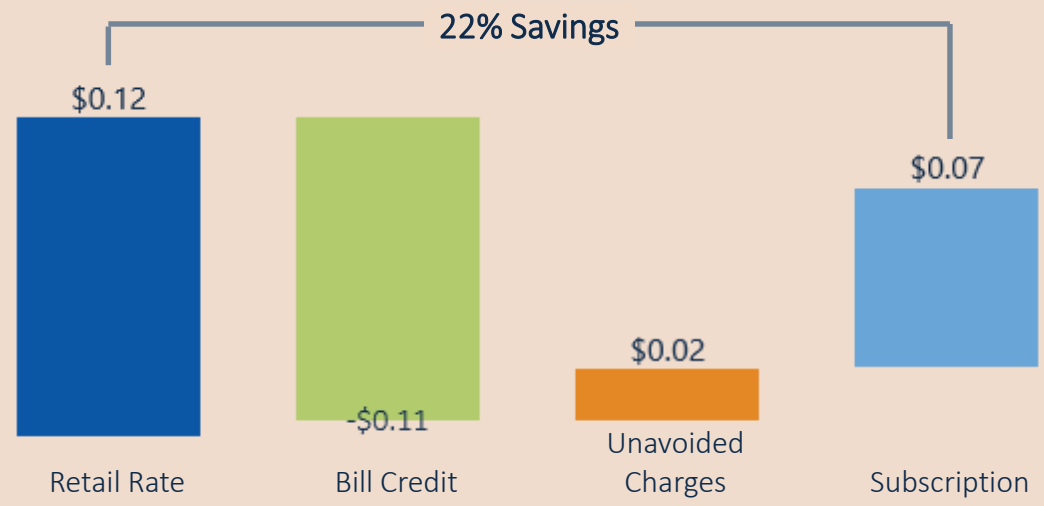
Under a Limited Value of Solar bill credit, subscription rates are well under retail and bill credit rates, but fixed charges and unavoided volumetric charges pull back net savings for the retail customer.

Nevertheless, costs are within an attractive savings range for initial residential community solar adopters.



PHASE II: Moderate Value of Solar

Under an moderate value of solar scenario, similar subscription levels offer greater savings due to a higher bill crediting rate, leading to stronger adoption rates. With a higher bill credit, operators have more space to tailor subscriptions to different customer classes to maximize financial gain while minimizing risk through a diverse customer set.



Source: GTM Research Wood Mackenzie

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