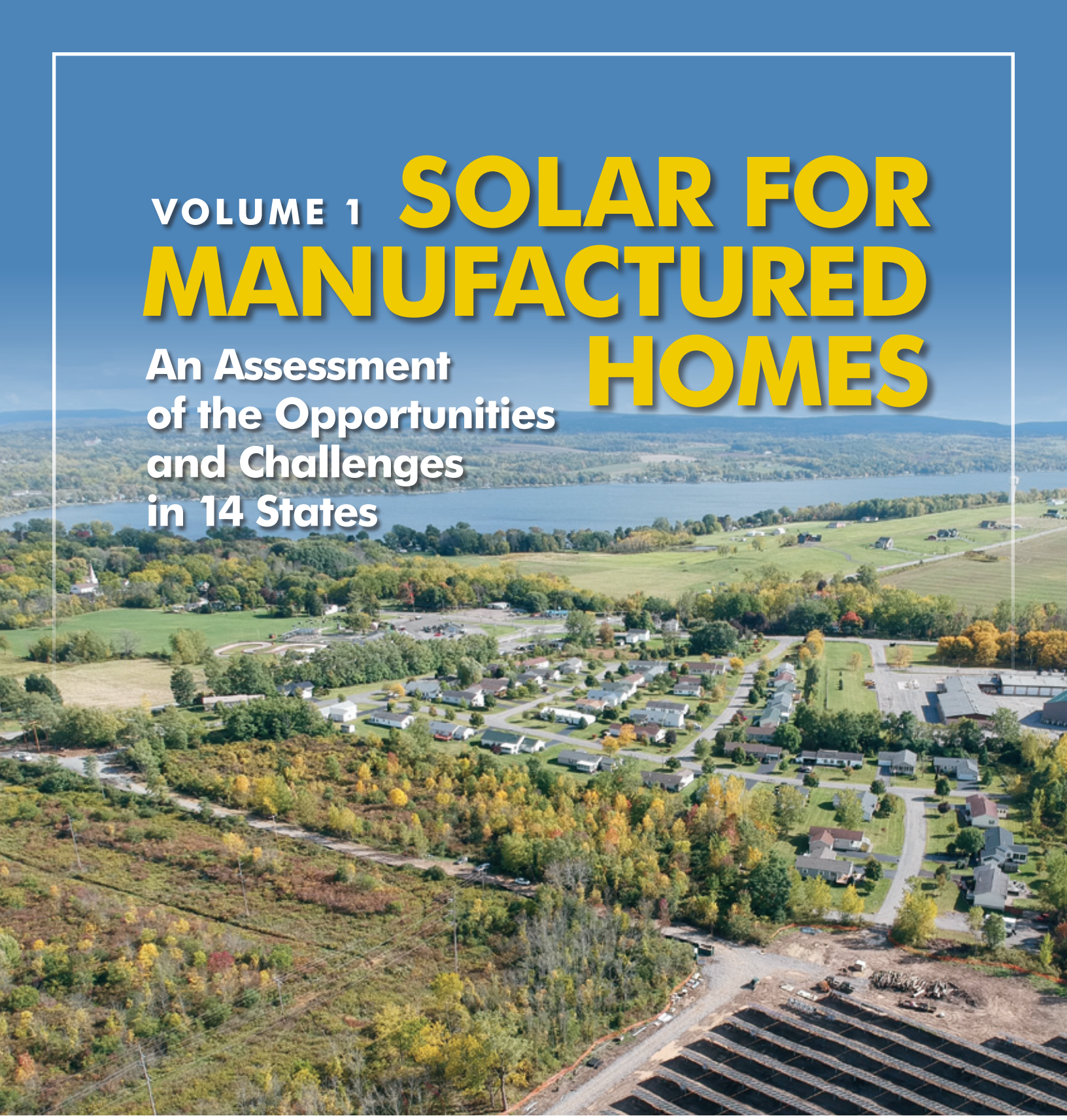
VOLUME 1

SOLAR FOR MANUFACTURED HOMES

An Assessment of the Opportunities and Challenges in 14 States



CleanEnergy States Alliance

WARREN LEON, KAT BURNHAM,
NATE HAUSMAN, AND LAURA SCHIEB

APRIL 2021

ABOUT THIS REPORT

The Clean Energy States Alliance (CESA) produced this two-volume report as part of its Scaling Up Solar for Under-Resourced Communities project. This three-year project is a wide-ranging initiative to accelerate solar development that will benefit low- and moderate-income (LMI) households and communities. It focuses on three distinct subsets of the LMI solar market: single-family homes, multifamily affordable housing, and manufactured homes. Several authors prepared this report during their ongoing and former time as CESA staff members: Warren Leon, CESA Executive Director; Kat Burnham, former Research Associate; Nate Hausman, Project Director; and Laura Schieb, former Program Associate.

The Scaling Up Solar for Under-Resourced Communities project is supported by the US Department of Energy Office of Energy Efficiency and Renewable Energy (EERE) under the Solar Energy Technologies Office Award Number DE-EE-0008758. The Solar Energy Technologies Office supports early-stage research and development to improve the affordability, reliability, and domestic benefit of solar technologies on the grid. Learn more at energy.gov/solar-office.

With the release of this report, CESA will begin outreach to and work with state energy agencies and utilities to explore launching pilot projects to develop solar installations that benefit manufactured home residents. To find out more about this effort or to join a working group of government agencies and utilities interested in solar for manufactured homes, contact CESA Project Manager Wafa May Elamin at WafaMay@cleanegroup.org.

DISCLAIMER

Cover photo: Aiken Electric Cooperative

ACKNOWLEDGEMENTS

The authors would like to thank the many individuals who provided input and suggestions to improve this report.

Ammar Qusaibaty, the US Department of Energy's Technology Manager for this project, suggested the idea for this report and provided valuable guidance throughout the research process. An advisory committee of experts on solar energy, manufactured housing, and energy equity helped shape the report's scope, contributed research information, and supplied useful feedback on the outline and draft of the report. The authors would like to thank the advisory committee members for their valuable contributions: Dave Anderson (Executive Director, National Manufactured Home Owners Association), Sara Birmingham (Senior Director for State Affairs, Solar Energy Industries Association), Bob Capenos (Executive Director, New York Housing Association), Elizabeth Doris (Laboratory Program Manager for State, Local, and Tribal Audiences at the National Renewable Energy Laboratory), Kevin Porter (Loan Officer, ROC USA Capital), Melanie Santiago-Mosier (Managing Director for Access and Equity, Vote Solar), Miguel Yanez (Project Associate, Environmental and Energy Study Institute).

Several CESA staff members, in addition to the report authors, contributed to the report. Wafa May Elamin and Georgena Terry wrote case studies; Charles Hua prepared the maps and helped with the data analysis; and Maria Blais Costello copyedited the report, and she managed production with David Gerratt of DG Communications, the report's designer.

Autumn Proudlove and Brian Lips of the North Caroline Clean Energy Technology Center analyzed the economics of indicative residential solar installations in the 14 target states. Their analysis appears in Appendix A. Darren Krolewski and John Mason of Datacomp shared data in their company's database of manufactured home communities and later reviewed a draft of the report for accuracy. Naim Darghouth of Lawrence Berkeley National Laboratory linked the communities in the Datacomp database to their census tracts and to their local electric utilities.

Although we cannot thank them all individually here, we very much appreciate the help we received from dozens of people who provided us with information during the research phase of this project.

Leading scholars of manufactured housing—Noah Durst of Michigan State University and Esther Sullivan of the University of Colorado Denver—read a draft of the report and provided useful comments. The following people supplied edits that improved the chapters on specific states: Chris Meyer (Executive Director, Local Energy Alliance Program), Catherine Reed (Deputy Director, South Carolina Energy Office), and Julie Staveland (State Energy Program Specialist, Michigan Department of Environment, Great Lakes, and Energy).

Any errors or omissions are the authors' alone. The document is not intended to provide legal or technical advice.

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VOLUME 2 (Separate Volume)

This report is comprised of two volumes. Volume 2 contains state-specific information for each of the 14 states analyzed for this report: Arizona, California, Florida, Georgia, Kentucky, Maine, Michigan, Missouri, New Mexico, North Carolina, Ohio, South Carolina, Texas, and Virginia. Each state chapter includes maps of the geography of manufactured homes in the state and tables showing the number and types of manufactured home communities. The report offers state-specific recommendations on the likely best opportunities for implementing solar for manufactured homes. Each state's chapter contains sections with the following information:

- **The State's Manufactured Housing Stock**
- **The State's Solar Landscape**
- **Recommendations**
- **The Geography of the State's Manufactured Homes**
- **Data about the State's Manufactured Home Communities**

Additionally, Volume 2 contains three Appendices:

- **Appendix A: Residential PV System Costs in Target States.** This appendix contains the full results analysis of typical PV systems in the 14 states. It also describes the methodology that was used to get those results.
- **Appendix B: Twelve Additional States.** This appendix presents brief findings about 12 states that were initially target-state possibilities but were not selected for detailed study.
- **Appendix C: Methodology for Analyzing Data on Manufactured Home Communities.** This appendix explains the methodology used for linking and analyzing the various quantitative data sources.

Both volumes can be found on CESA's web site at www.cesa.org/resource-library/resource/solar-for-manufactured-homes.

EXECUTIVE SUMMARY

Solar for Manufactured Homes

Manufactured homes[1] (formerly referred to as mobile homes) comprise a significant share of America's housing stock and represent an even larger share of the housing for low- and moderate-income (LMI) households. The 2019 US Census American Community Survey estimates that 6.1 percent of the nation's housing stock consists of more than 8,500,000 manufactured homes. In some states, the percentage of manufactured homes is much larger than that, reaching 17 percent in New Mexico (see Figure ES1, p.9).

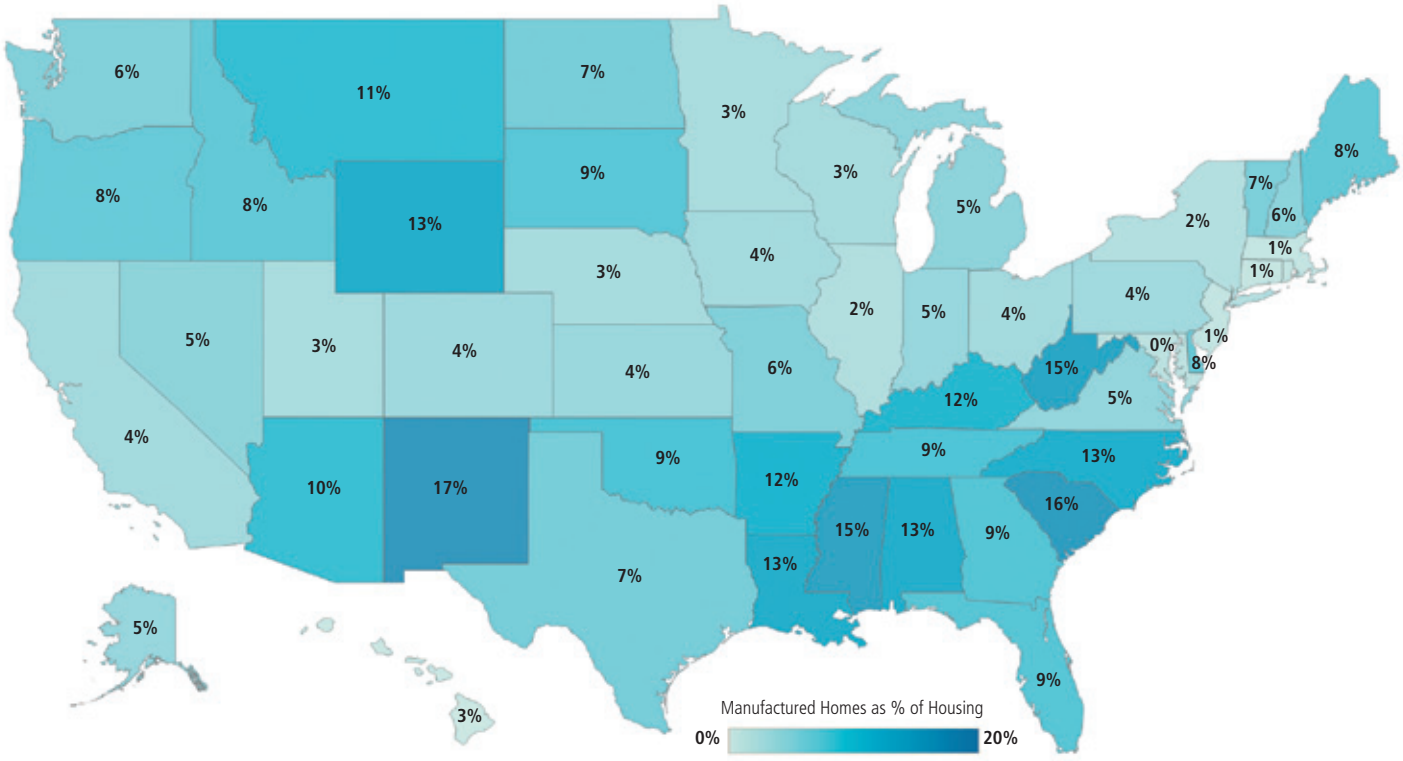
This two-volume report looks at both the opportunities and challenges for using solar photovoltaic (PV) technology with manufactured housing by providing an overview, case studies, and general findings and recommendations (Volume 1). It also provides a landscape assessment of 14 states in different parts of the country, each with different solar markets and policies (Volume 2). The states analyzed in the report are the following:

1. Arizona
2. California
3. Florida
4. Georgia
5. Kentucky
6. Maine
7. Michigan
8. Missouri
9. New Mexico
10. North Carolina
11. Ohio
12. South Carolina
13. Texas
14. Virginia

The overarching premise of the report is that the fastest and greatest progress to expand solar will occur when the LMI solar market is not seen as an undifferentiated sector, and when state policymakers, utilities, and the solar industry focus on specific sub-markets for solar within the broader LMI population. Manufactured homes represent one important sub-market.

1 The US Department of Housing and Urban Development defines "manufactured homes" as homes that "are built in the controlled environment of a manufacturing plant and are transported in one or more sections on a permanent chassis." See: US Department of Housing and Urban Development, "Manufactured Housing and Standards—Frequently Asked Questions," *https://www.hud.gov/program_offices/housing/rmra/mhs/faqs* (accessed August 25, 2020).

FIGURE ES1: **Manufactured Homes as Proportion of Housing Stock**[2]



UNDERSTANDING MANUFACTURED HOUSING

To develop solar for the manufactured housing sub-market requires an understanding of the nature of manufactured housing. Manufactured homes vary in size, generally based on whether they are delivered on a single flatbed truck in one piece ("single-wide") or in multiple pieces that are joined together on site ("double-wide" or more).

The 1974 *National Manufactured Housing Construction and Safety Standards Act* was an important milestone, because it authorized the US Department of Housing and Urban Development (HUD) to establish federal standards for manufactured homes to assure quality, durability, safety, and affordability."[3] Those standards, which went into effect in 1976, require all new manufactured homes to have a certification label saying that they meet the HUD standards. Unlike site-built homes and modular homes,[4] manufactured homes need to conform with the federal code rather than to the requirements of state and local building codes. Because HUD's energy standards for manufactured homes were significantly upgraded in 1994, the existing housing stock can generally be divided into three time periods—pre-1976, 1976–1994, and post-1994.

2 Map based on data from US Census Bureau, ACS 2019 Table B25024 "Units in Structure", *https://data.census.gov/cedsci/table?q=B25024&g=0100000US.04000.001&tid=ACSDT5Y2019.B25024&hidePreview=true*.

3 US HUD, "Office of Manufactured Housing Programs," accessed August 28, 2020, *https://www.hud.gov/program_offices/housing/rmra/mhs/mhshome*.

4 Like manufactured homes, modular homes are built in a factory, but they are required to meet state and local buildings codes.

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The efficiencies of factory production are a key reason why manufactured houses are generally less expensive than a comparably sized site-built house. Data from the US Census shows that new manufactured homes generally cost between 52–65 percent as much as a site-built home per square foot, not counting the cost of land, with single-wide homes being the least expensive on a square foot basis.[5]

Although the typical image of manufactured housing is the "mobile home park," which is a dedicated community with multiple sites for manufactured homes, about 60 percent of manufactured homes are not located in such communities, but rather they are sited on privately owned individual plots of land. Nevertheless, there are about 60,000 manufactured home communities (i.e., mobile home parks) in the US, ranging in size from fewer than 10 homesites to more than 2,000.[6] Generally, a community owner develops the land, provides utilities and sewers or septic systems, and offers lots for manufactured homeowners to rent.

Most often, the community owner leases homesites to homeowners who purchase and locate their manufactured home on the site. In a minority of cases, the community owner owns both the land and the manufactured home, which is rented to a resident. Some communities include a mix of homeowners and renters. A different, but relatively limited, variation is the resident-owned community (ROC), where the community is structured as a non-profit cooperative with the homeowners owning their individual homes, as well as holding a voting membership within the cooperative organization.

Most manufactured homes, especially in manufactured home communities, are classified as personal property. Site-built homes are legally classified as "real" property because they are permanently installed on purchased land. Site-built homes can be financed by a traditional real estate mortgage. In comparison, the financing of manufactured homes is commonly

5 See for example, US Census Bureau, "Cost & Size Comparisons: New Manufactured Homes and New Single-Family Site-Built Homes (2007 - 2014)," *https://www2.census.gov/programs-surveys/mhs/tables/time-series/sitebuiltvsmh.pdf.*

6 Consumer Financial Protection Bureau, *Manufactured-Housing Consumer Finance in the United States*, p. 42.

done through personal loans, which can have shorter loan terms, higher interest rates, and fewer lenders. There are also fewer consumer protections.

The people who live in manufactured housing vary greatly in age, ethnicity, household size, and income. Most notably for the purpose of this report, manufactured housing is disproportionately owned by households with low and moderate incomes, even though some residents have higher incomes. Manufactured housing represents a significant share of affordable housing for LMI households and an even larger share of the affordable housing that does not receive direct public subsidies. It is way to access home ownership for those without significant wealth. A higher proportion of the LMI residents of manufactured housing own their homes than do the residents of multifamily affordable housing.

WHY ADDRESS SOLAR FOR MANUFACTURED HOUSING?

The primary reason for seeking to promote solar for manufactured housing is simple—in many states a significant number or share of all households are living in manufactured homes, and they should have access to solar benefits as well as to public incentives to deploy solar. Because a large percentage of the residents of manufactured homes have low or moderate incomes, they have a great need for the electricity cost-savings that solar can provide. Like other households with below average incomes, those in manufactured homes have a high "energy burden," with a significant share of their income going to energy.

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The manufactured homes housing stock is relatively energy *inefficient*. Nearly half of these homes use electricity for heating/cooling systems and other energy needs. This means that they have a large electric load that could be served by solar generation. With the right policies and incentives, solar installations could provide meaningful financial relief for manufactured home residents.

A variety of solar technologies could work with manufactured housing, depending upon the situation. Those technologies include rooftop installations, ground-mounted systems, pole-mounted systems, community solar projects, and pre-installed solar systems on new manufactured homes.

THE CHALLENGES TO BRINGING SOLAR TO MANUFACTURED HOUSING

There is no getting around the fact that manufactured housing is—and will continue to be—a tough market for solar. The challenges fall into two categories—those inherent in all initiatives aimed at LMI households, and those specifically linked to the nature of manufactured housing as a housing type.

The most obvious barrier for low-income households to go solar is that they have low incomes, which can make it difficult to build financial wealth. Although solar can save households money on their utility bills, low-income customers are generally unable to overcome the hurdle of paying the initial cost of a PV system without assistance. Moreover, for a solar program to be beneficial for LMI households, it needs to do more than predict the likely savings; it needs to prevent financial risks for those households because a financial setback could be economically devastating. Other barriers include the inability of many low-income consumers to take advantage of federal tax credits for solar installations because they do not pay enough income tax, although that will become a less important distinction if the residential solar tax credit sunsets after 2023, as currently scheduled.

Solar marketers and solar installation companies have been reluctant to focus their efforts on low-income customers, as they are perceived to have insufficient cash on hand to buy a system outright and are more likely to have low credit scores and little equity in their home, making the transaction complicated. Because marketers do not target LMI customers, including those in manufactured housing, those households are often less aware of the benefits of solar power and have less trust of marketers pushing an unfamiliar and expensive technology.

A survey for this report of 170 residents of manufactured homes found that few of them have deep familiarity with solar, and it is rare for them to have discussed solar with a friend, relative, or acquaintance who already has a PV system. Many of them had potential interest in solar, but they have concerns that would need to be addressed before they would be comfortable moving forward with a project. Outreach and education would be necessary to make significant progress in bringing solar to manufactured home communities.

Distinct from the general obstacles faced by potential LMI solar customers, there are several that are specific to the nature of manufactured housing. The most important one is that rooftop solar installations will not work on many manufactured homes because the roofs would not be able to support the weight of the solar panels. Ground-mounted or pole-mounted systems are often suggested as alternatives to rooftop systems, but they pose their own

challenges. Residents may be reluctant to install solar if they do not own the land upon which their house sits; additionally, there could be community rules that prohibit ground-mounted or pole-mounted systems. Some homeowners may be hesitant to place a system on their roof in case they need to move the home to a different location in the future (although more than 90 percent of homes stay at one location).

FINDINGS RELATED TO THE MANUFACTURED HOMES HOUSING STOCK

To determine potential opportunities for solar in each of the 14 target states, this project analyzed the manufactured homes housing stock in those states. In addition to information from the US Census Bureau and from published research, the analysis relied on data collected by Datacomp, "the nation's largest provider of manufactured and mobile home value reports, price information, appraisal reports and inspections."[7] That data included the location, size, rental prices, and other characteristics of 24,391 manufactured home communities in the 14 states. Project researchers linked each community to its local electric utility and to information on the median income of each community's census tract.

The following general findings emerge from all this data.

There is tremendous variation among the target states in the composition of their manufactured homes housing stock. Among the numerous variations:

- the share of manufactured homes in a state's housing stock ranges from less than 4 percent in California and Ohio to more than 16 percent in New Mexico and South Carolina.

7 Datacomp website, home page, accessed August 16, 2020, *https://www.datacompua.com/about-datacomp*.

Aiken Electric Cooperative

- in some states, most manufactured homes are in manufactured home communities, while in other states most are sited on individually owned plots of land.
- in some states, most communities are quite large, with more than half the communities in Arizona and Michigan having more than 100 homesites, whereas in some other states, such as Kentucky, most communities have fewer than 49 homesites.
- in Arizona, 35.5 percent of communities are age restricted to residents older than 55, and at least 17.7 percent are in California and Florida, but fewer than 3 percent are in Georgia, Kentucky, North Carolina, and Virginia.
- the size and importance of the market for new manufactured homes also varies widely, with manufactured homes representing more than 20 percent of all new single-family homes in 2019 in Kentucky, Michigan, and New Mexico, but fewer than 7 percent in Arizona, California, and Virginia.[8]

Manufactured homes are usually, but not always, in locations with incomes below the median.

Analysis performed for this report compared a county's median household income to the percentage of the local housing stock that is manufactured homes (both in communities and on individual plots of land). This frequently yielded an inverse relationship between a county's median income and the percentage of manufactured homes. In other words, there are more manufactured homes by percentage in counties where incomes are lower. This is unsurprising because manufactured homes are more prevalent in rural areas, which tend to have lower median incomes.

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To analyze each manufactured home community, researchers used median household income at the census-tract level to create a proxy for residents of the community. This census-tract household income was compared to both the area median income (AMI) and the state median household income. When compared to the state median, in most but not all cases, the census tracts of the manufactured home communities have below-average incomes (i.e., they are LMI). When comparison is made to the geographically smaller AMI, fewer of the manufactured home communities' census tracts tend to have below average incomes. This pattern of lower incomes than the state median, but not necessarily lower incomes than the AMI, indicates that manufactured home com-munities tend to be in parts of a state with relatively low incomes overall.

Arizona, California, Florida, and Georgia stand out in terms of the high share of manufactured home communities and homesites that are in census tracts that are LMI and low-income, while Michigan and Maine have significantly lower proportions of LMI and low-income communities and sites when compared to the AMI. There is no standard pattern in the LMI status of age-restricted communities.

8 Numbers based on US Census Bureau, "U.S. Manufactured Housing Shipments by State: 2019," *https://www2.census.gov/programs-surveys/mhs/visualizations/2019/2019usmapbystate.pdf*; and US Census Bureau, "Building Permits Survey Annual Data," *https://www.census.gov/construction/bps/stateannual.html*.

Most households in manufactured housing own their home.
This can create opportunities for the accumulation of home equity that LMI renters do not have. On the other hand, when the homeowner does not own the land on which the home is sited, the home is most often a depreciating asset. Solar initiatives targeted at the manufactured homes market could contribute to LMI wealth building, especially in situations where the homeowner also owns the land, or where the home is sited in a resident-owned community (ROC) or in a nonprofit community.

Most LMI households in manufactured homes live near other manufactured homes.
This is true whether the home is in a community or in an informal subdivision. This creates good opportunities for targeted solar outreach and marketing campaigns because the households are clustered together.

STRATEGIES FOR ADVANCING SOLAR FOR MANUFACTURED HOMES

Although it is important for states and utilities to try to bring the benefits of solar energy to residents of manufactured homes, it will not be easy. It is unrealistic to think any state, with the possible exception of California, could roll out an initiative that would impact tens of thousands of households in the near term. It will be most useful for states and utilities to experiment with different strategies to see which have the greatest potential to be replicated. If they are in locations with pre-existing, robust, solar-friendly policies and have experience promoting LMI solar for other types of housing, they should find it easier to add manufactured homes to their repertoire. But all states have potential to address solar for manufactured homes at some level.

This report identifies eight recommended LMI solar strategies for states and utilities to consider:

1. Assess the manufactured housing stock in the state or utility service territory
2. Start with modest targeted efforts
3. Recognize that special funding or incentives will be necessary
4. Find the best venues for pursuing a "Solarize" strategy involving group purchasing and a community marketing campaign
5. Target resident-owned and other nonprofit manufactured housing communities
6. Promote certain types of large community-scale solar arrays
7. Support efforts to incorporate solar into new manufactured homes
8. Consider third-party ownership, on-bill financing, and other special financing options

Because the manufactured homes housing stock and appropriate solar strategies vary so much from state to state, Volume 2 of this report consists of detailed information, extensive data, and specific recommendations for each of the 14 states. Further information is included in the Appendices in Volume 2.

CHAPTER ONE

Introduction

Manufactured homes[9] (formerly referred to as mobile homes) comprise a significant share of America's housing stock and represent an even larger share of the housing for low- and moderate-income (LMI) households. The 2019 US Census Bureau's American Community Survey (ACS) estimates that 6.1 percent of the nation's households live in more than 8,500,000 manufactured homes. In some states, the percentage of families living in manufactured homes is much larger than that, reaching 17 percent in New Mexico. Many manufactured home residents have low or moderate incomes; their median income "is roughly half the median income among families in other types of homes."[10]

Clayton

9 The US Department of Housing and Urban Development defines "manufactured homes" as homes that "are built in the controlled environment of a manufacturing plant and are transported in one or more sections on a permanent chassis." US Department of Housing and Urban Development, "Manufactured Housing and Standards—Frequently Asked Questions," accessed August 25, 2020, *https://www.hud.gov/program_offices/housing/rmra/mhs/faqs*.

10 Consumer Financial Protection Bureau, *Manufactured-Housing Consumer Finance in the United States* (Consumer Financial Protection Bureau, 2014), *https://files.consumerfinance.gov/f/201409_cfpb_report_manufactured-housing.pdf*.

Because of the prominence of this type of housing among LMI households, especially among homeowners rather than renters, it is important to consider the potential of solar photovoltaic (PV) systems for manufactured homes. LMI households face a disproportionate share of energy and economic burdens. Participation in the solar economy can ease those burdens and provide LMI residents with economic relief. Moreover, demonstrating that solar can benefit all Americans, including those living in manufactured housing, can ensure that the public continues to support solar development.

Nevertheless, there are considerable challenges to implementing solar in ways that benefit LMI households living in manufactured housing. Some of the challenges are the same as for other types of LMI housing, including the residents' difficulty paying for the upfront cost of a PV system without financial assistance, solar companies' historically limited interest in marketing in LMI communities, and the significant risks to an LMI household's financial wellbeing if a PV system does not perform as expected. There are also special obstacles linked specifically to manufactured housing, including the inability of many roofs of manufactured homes to support a rooftop solar installation, and many manufactured housing homeowners not owning the land on which their houses are sited, even though they own the house.

The overarching premise of the report is that the fastest and greatest progress to expand solar will occur when the LMI solar market is not seen as an undifferentiated sector, and when state policymakers, utilities, and the solar industry focus on specific sub-markets within the broader LMI population.

This report looks at both the opportunities and challenges for solar for manufactured housing, primarily through a landscape assessment of 14 states in different parts of the country, each with different solar markets and policies. The report offers specific recommendations for how solar might be most effectively developed in the different states. It also gathers extensive information on the manufactured homes in the states so that a wide range of stakeholders will have relevant data and information for making future decisions related to solar for manufactured homes.

The overarching premise of the report is that the fastest and greatest progress to expand solar will occur when the LMI solar market is not seen as an undifferentiated sector, and when state policymakers, utilities, and the solar industry focus on specific sub-markets within the broader LMI population. A solar development strategy that works well with multifamily affordable housing may not work well with manufactured housing or with LMI homeowners in conventionally built single-family homes.

THE RESEARCH METHOD

The research for this report proceeded on several tracks. Researchers examined the energy policies, electricity markets, and solar markets in the 14 target states. That examination took place, in part, through desktop research and interviews with state energy officials and solar industry representatives. Information on the types of solar installations that could be appropriate for manufactured homes and on various financing possibilities was collected. To understand the perspective of the "customer," responses from 170 individual owners of manufactured homes were obtained. To understand the perspective of solar installers, the authors and reserachers secured survey responses from and had conversations with more than 25 solar installation companies in the 14 states.

To provide a general sense of the economics of a solar PV system scaled to the needs of a typical manufactured home in the 14 states, staff of the North Carolina Clean Energy Technology Center (NCCETC) generated cost and electricity savings numbers for a typical 4-kilowatt PV system in each of the states. They also modeled the potential cost and savings impacts of two possible special incentives: (1) a loan with a below-market interest rate of 2 percent, and (2) an upfront cash rebate of $5,000 on a PV system. The results of their analyses are used throughout this report and are compiled in Appendix A in Volume 2.

Understanding Manufactured Housing

Much of the research was aimed at understanding the composition and distribution of the manufactured homes housing stock in the 14 target states because this information is not easily accessible. Most state energy offices have little detailed knowledge about the manufactured homes in their state. As two housing scholars pointed out in a 2019 research paper: "Manufactured housing (MH) is widely overlooked in both academic scholarship and housing policy. Moreover, the few studies that document the widespread use of MH as affordable housing treat it as a monolith…."[11]

The standard source of information on the manufactured homes housing stock is the US Census Bureau, especially the American Community Survey (ACS), which is updated annually, and the American Housing Survey (AHS), which is reported biennially. Most studies of manufactured homes, including this report, rely on the data from the US Census.[12] But even though the ACS and AHS census information provide the best *general* picture of manufactured housing by state and county, there are limitations for understanding the solar development potential in specific states, because the ACS and AHS rely on sampling and then extrapolate the results to all locations. The 2019 ACS was based on 2,059,945 interviews, while the 2018 survey tables relied on 2,143,000.[13]

To go beyond the census information on manufactured housing, we secured the use of proprietary data collected by Datacomp. Datacomp is "the nation's largest provider of manufactured and mobile home value reports, price information, appraisal reports and inspections."[14] Datacomp operates MH Village, which is an "online marketplace for buying and selling manufactured homes" and claims to be "the number one consumer website for the manufactured housing industry." Datacomp collects data on the location, size, rental prices, housing costs, and other characteristics of dedicated communities of manufactured homes.

For this report, we used Datacomp data on 24,391 residential communities in the 14 states. We then identified the electric utilities in whose service territories these communities are located and then determined the median income of the census tracts in which the manufactured home

11 Noah J. Durst and Esther Sullivan, "The Contribution of Manufactured Housing to Affordable Housing in the United States: Assessing Variation Among Manufactured Housing Tenures and Community Types," *Housing Policy Debate* (June 2019), p. 1, *https://www.researchgate.net/publication/333711399_The_Contribution_of_Manufactured_Housing_to_Affordable_Housing_in_the_United_States_Assessing_Variation_Among_Manufactured_Housing_Tenures_and_Community_Types*.

12 See, for example, Consumer Financial Protection Bureau, *Manufactured-Housing Consumer Finance in the United States, https://files.consumerfinance.gov/f/201409_cfpb_report_manufactured-housing.pdf.*

13 US Census Bureau, "American Community Survey Sample Size," *https://www.census.gov/acs/www/methodology/sample-size-and-data-quality/sample-size/index.php* and "American Housing Survey (AHS) Methodology," *https://www.census.gov/programs-surveys/ahs/about/methodology.html*.

14 Datacomp website, home page, accessed August 16, 2020, *https://www.datacompua.com/about-datacomp*.

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communities are located.[15] This allowed for detailed quantitative analysis of the manufactured home communities in the states. The results are featured prominently in this report.

The Datacomp data has certain limitations. For one thing, most manufactured homes are not located within dedicated manufactured home communities, but are dispersed on individually owned plots of private land. Moreover, Datacomp's information on communities is collected over time and some of it is not necessarily completely current, thereby causing a margin of error in the results reported in this report. In some cases, Datacomp knows the location of a manufactured home community but does not have a count of the number of homesites within the community. This is more likely to be the case for smaller manufactured home communities than larger ones.

Because of these data limitations, the results in this report are not accurate to a high degree of precision and should be regarded as estimates. However, we are confident that the outcomes are correct in their overall direction. For example, if the data shows that one state has five times as many homesites located in large manufactured home communities (i.e., those with more than 100 homesites) as another state, the margin of error could mean that the actual difference is 5.5 times or 4.5 times; but the data clearly indicates the state where large communities are more plentiful. To offer another example, though the available data for the

15 Using the median income of the census tract was the most practical way to estimate the median income level of the residents of the community, but it is an imprecise approximation, because most census tracts likely also include other, site-built homes.

utility service territories of manufactured home communities misses some communities and homesites, it does provide valuable information on the minimum number of known communities and homesites in a utility's service territory. Overall, the report's findings provide a much clearer and more comprehensive picture of manufactured housing in the 14 states than has been put forward in the past. Additional details about the research sources and methodology are available in Appendix C of Volume 2.

How the 14 Target States Were Selected

Researchers for this report started with a list of 26 states out of 50 to study. These were the states that ranked highest in either the total number of manufactured homes in the state (at least 166,000), as estimated by the US Census Bureau's 2017 ACS,[16] or that ranked highest in the percentage of their housing stock composed of manufactured housing (at least 9 percent). Because the remaining 24 states had fewer manufactured homes by these two measures, they were a lower priority for in-depth study. This report seeks to inform and encourage states and utilities to launch new programs to implement solar for LMI residents of manufactured homes and such programs are most likely to happen where manufactured housing is a significant feature of the state's housing stock, even though solar programs that are focused on manufactured housing may also make sense elsewhere.

This report seeks to inform and encourage states and utilities to launch new programs to implement solar for LMI residents of manufactured homes and such programs are most likely to happen where manufactured housing is a significant feature of the state's housing stock.

To narrow things down from the 26 initial states to a more manageable number, a range of factors was considered. We selected most of the states that seemed to be especially likely to develop initiatives for solar for manufactured homes. But we also wanted to choose a range of states in terms of size, region of the country, and maturity of their solar market. The fact that a state was not chosen as a target for our research does not necessarily mean that it is an unpromising market for solar for manufactured homes.

The 14 states selected for detailed analysis are:

1. Arizona
2. California
3. Florida
4. Georgia
5. Kentucky
6. Maine
7. Michigan
8. Missouri
9. New Mexico
10. North Carolina
11. Ohio
12. South Carolina
13. Texas
14. Virginia

16 Later in the research process, the US Census issued the 2018 and 2019 ACS. The numbers in the 2019 survey are what are reported throughout the rest of this report.

HOW THE REPORT IS ORGANIZED

The report is organized into two volumes.

Volume 1 presents a general picture of solar for manufactured housing, covered in five chapters. After the introduction provided in Chapter One, the report turns to Chapter Two for background information on manufactured housing and the manufactured housing stock in the 14 target states. This description of the housing stock highlights the much greater diversity in manufactured housing than is assumed in typical portrayals of it.

Chapter Three looks at the need and challenges for using solar with manufactured homes. It explains the general obstacles to LMI solar, as well as additional challenges related specifically to manufactured housing. To understand the perspective of residents, we summarize the findings from the project's survey of manufactured-home owners. The chapter ends with a discussion of types of solar technologies that can work with manufactured housing.

Chapter Four starts to identify some of the opportunities for developing solar for manufactured homes. The chapter includes nine case studies that show a range of ways in which solar can be deployed to benefit residents of manufactured housing.

Chapter Five offers general findings on the potential for solar development for manufactured homes that cut across states. It also discusses the types of initiatives and financing options that can work in a range of settings.

Volume 2 provides a landscape assessment for each of the 14 target states. Each state chapter includes maps of the geography of manufactured homes in the state and tables showing the number and types of manufactured home communities. The report offers state-specific recommendations on the likely best opportunities for implementing solar for manufactured homes.

Volume 2 also contains three Appendices:

1. **Appendix A** collects the full results of the NCCETC analysis of typical PV systems in the 14 states. It also describes the methodology that was used to get those results.
2. **Appendix B** presents brief findings about the 12 states that were initially target-state possibilities that were not selected for detailed study. Because we collected information about those states before the target states were selected, we did not want to lose that information, so we share it here.
3. **Appendix C** explains the methodology used for analyzing the Datacomp data and linking it to other data sources.

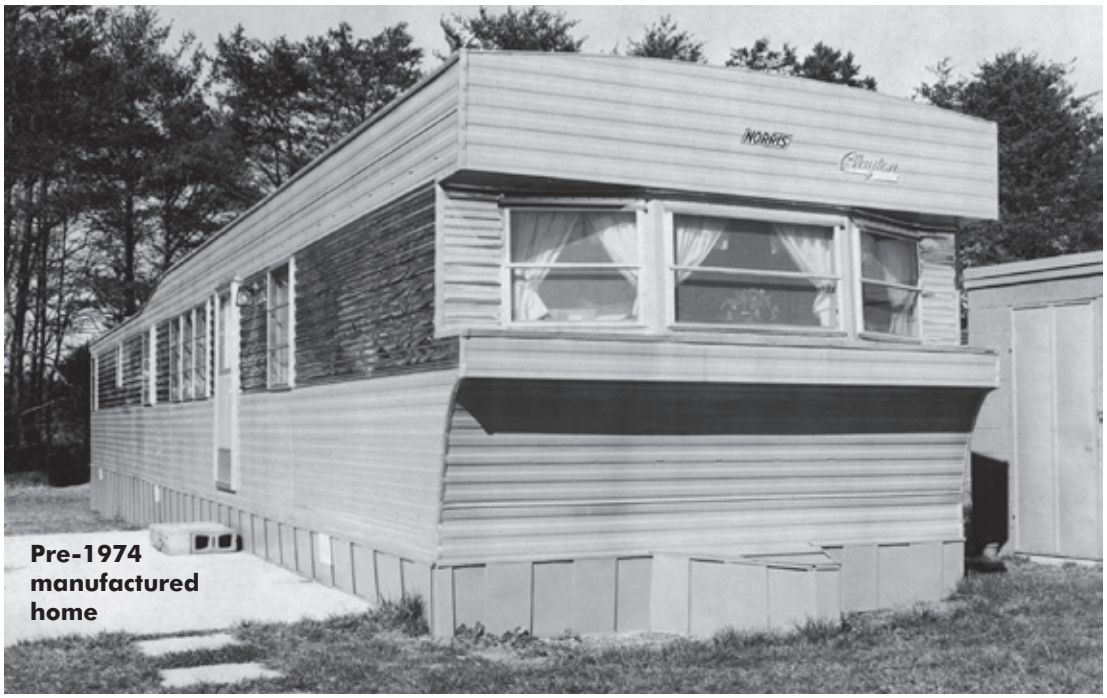
Volume 1 and Volume 2 of this report can be found on the Clean Energy States Alliance website at www.cesa.org/resource-library/resource/solar-for-manufactured-homes.

CHAPTER TWO

Manufactured Housing: An Overview

Factory-built housing has changed considerably over time. During the mid-20th century, a period with a high demand for inexpensive housing, many mobile homes were manufactured quickly and cheaply, with few standards and little regulation. Those homes, which were colloquially called "trailers" (owing to their branching off from the "travel trailer" industry), even when placed in a semi-permanent or permanent location, were often little different than campers that were designed to be moved regularly.

Because of concerns about quality in the early manufactured housing, in 1974 Congress passed the *National Manufactured Housing Construction and Safety Standards Act*. This law authorized the US Department of Housing and Urban Development (HUD) "to establish federal standards for the design and construction of manufactured homes to assure quality, durability, safety, and affordability."[17] Those standards went into effect in 1976. Mobile homes



Pre-1974 manufactured home

Clayton

17 US HUD, "Office of Manufactured Housing Programs," accessed August 28, 2020, *https://www.hud.gov/program_offices/housing/rmra/mhs/mhshome*.

were required to have a certification label saying that they meet the HUD standards. The federal *Housing Act and Community Development Act of 1980* required that "the term 'manufactured' be used in place of 'mobile' in all federal laws and literature that referenced homes built after 1976."[18]

HUD's energy standards for manufactured homes were significantly upgraded in 1994, mandating whole-house ventilation and raising minimum insulation requirements.[19] Because this resulted in significant improvements in the quality of manufactured homes, the existing housing stock can be roughly divided into three time periods—pre-1976, 1976–1994, and post-1994, although manufacturers have continued to make incremental improvements to new models since then. Some pre-1976 housing still exists in communities of manufactured homes and on private property, but at least 80 percent of the existing manufactured housing stock was built after that.

The HUD standards define a manufactured home as a dwelling unit "of at least 320 square feet in size with a permanent chassis to assure the initial and continued transportability of the home."[20] The HUD standards not only ensure some basic quality minimums for manufactured homes, but they have also been essential to a well-functioning manufactured homes market. Unlike site-built homes, manufactured homes need to conform with the federal code rather than to the requirements of state and local building codes. The code specifies requirements based on three wind zones, three thermal zones, and three roof load zones. This makes it possible for manufacturers to create standard models without having to vary their products

Recent single-wide manufactured home

Clayton

18 Hannah D., "What's the Difference? - Mobile vs. Manufactured vs. Modular," *Clayton Homes Website* (August 2019), *https://www.claytonhomes.com/studio/defined-mobile-manufactured-and-modular-homes*.

19 HUD proposed some additional updates to the code in February 2020.

20 US HUD, "Homeowner's Fact Sheet," accessed August 28, 2020, *https://www.hud.gov/program_offices/housing/rmra/mhs/factsheet*.

Recent double-wide manufactured home

Clayton

to each locality. A home purchaser knows that the home can be moved to a different location, even if that location has a different local building code. This makes manufactured homes different from "modular homes," which are also constructed in factories but are required to meet state and local building codes.

Manufactured homes vary in size, generally based on whether they are delivered on a single flatbed truck in one piece ("single-wide") or in multiple pieces that are joined together on site ("double-wide" or more).[21] In recent years, a roughly equal percentage of single-wide and multiple-section homes have been manufactured.

The efficiencies of factory production are one reason why manufactured houses are generally less expensive than a comparably sized site-built house. Data from the US Census Bureau shows that new manufactured homes generally cost between 52–65 percent as much as a site-built home per square foot, not counting the cost of land. Single-wide homes are less expensive per square foot, while double-wide and larger homes are more expensive, although still less costly than a site-built house. Since 2007, average monthly and annual sales prices for single-wide houses have ranged from $37,300–$55,600 and from $75,700–$107,500 for multiple-section houses.[22] Older manufactured homes on the resale market generally sell for less than new ones.

21 Only about one percent of manufactured homes are triple-wides or larger.

22 See for example, US Census Bureau, "Cost & Size Comparisons: New Manufactured Homes and New Single-Family Site-Built Homes (2007 - 2014)," *https://www2.census.gov/programs-surveys/mhs/tables/time-series/sitebuiltvsmh.pdf*, and "Average Sales Price of New Manufactured Homes by Region and Size of Home by Region and Month of Shipment," *https://www.census.gov/data/tables/time-series/econ/mhs/latest-data.html*.

Manufactured vs. Modular Homes

This report focuses on solar for manufactured homes. But there is another type of housing—modular housing—that is also produced in factories. It is important to understand the difference between these two types of housing.

Manufactured homes are built to conform to the federal HUD code and are issued a HUD compliance certificate. They are constructed on a permanent chassis so that they can later be moved to a new site on a flatbed truck or trucks. When placed in a manufactured home community or on an individually owned plot of land, they do not need a permanent foundation, although they are sometimes placed on one.

Modular homes are typically factory-constructed in sections. The sections are transported to their destination, where a contractor joins them together and finishes the house. As described by manufacturer Clayton, "Modular homes are built to conform to all state, local and/or regional codes that apply based on the final location of the home, just like site-built homes."[23] They are designed to be installed on a permanent foundation and are usually financed with the same types of real estate mortgages as site-built homes. Although the subject of this report is manufactured homes, it includes two case studies of modular homes that have been designed to fit on homesites in manufactured home communities.

Some manufacturers specialize in manufactured homes, while others focus on modular homes. Some companies produce both.

THE MANUFACTURED HOMES HOUSING STOCK IN THE UNITED STATES

There are more than 8,500,000 manufactured homes in the United States.[24] These homes comprise 6.1 percent of the nation's housing stock and provide residences for about 22 million Americans.[25]

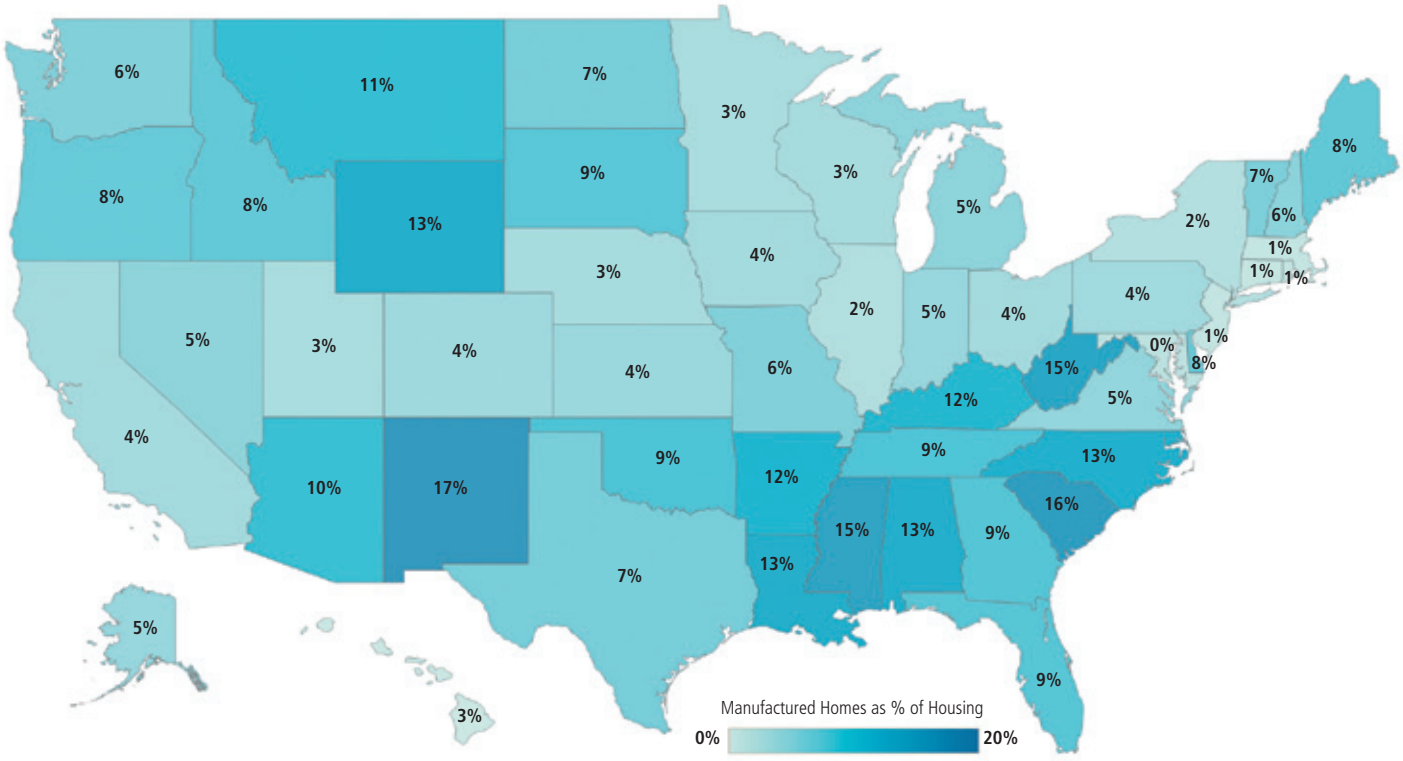
In three states—Mississippi, New Mexico, and South Carolina—more than 15 percent of the housing is manufactured homes. On the other hand, there are five states—Connecticut, Hawaii, Massachusetts, New Jersey, and Rhode Island—plus the District of Columbia, where less than 1 percent of housing consists of manufactured homes. In general, manufactured homes are more prevalent in the southern half of the country than in the northern half, although some states do not conform to this pattern. Figure 1 shows the percentage of each state's housing that is manufactured housing.

23 Hannah D., "What's the Difference?—Mobile vs. Manufactured vs. Modular," Clayton Homes, August 14, 2019, *https://www.claytonhomes.com/studio/defined-mobile-manufactured-and-modular-homes*.

24 Note that at any given time, at least one million of these homes are unoccupied, because they are either for rent, for sale, or used only seasonally.

25 Manufactured Housing Institute, "Manufactured Housing in the United States" (2020), *https://www.manufacturedhousing.org/wp-content/uploads/2020/03/Manufactured-Housing-in-the-US-2020.pdf*.

FIGURE 1: **Manufactured Homes as Proportion of Housing Stock**[26]



Manufactured housing is significantly less common in large cities. Outside of metropolitan areas, manufactured housing comprises 14 percent of housing. A study by the Consumer Protection Finance Bureau reports that "in 112 U.S. counties—predominately in Southern and Western states—over one-third of homes are manufactured housing."[27] However, these numbers do not mean that all manufactured homes are in rural settings. Some are in small cities outside of what the US Census Bureau categorizes as "metropolitan statistical areas." Although 46 percent of manufactured housing is in metropolitan areas, many are in the suburban or rural parts of those census areas.[28]

Given the large total populations of California, Florida, and Texas, it is unsurprising that those three states rank high in total number of manufactured homes, even though their percentages are not among the highest. Florida has the most with 840,074 manufactured homes, and Texas the second most with 775,632. North Carolina is next with 594,578, followed by California with 521,135. Figure 2 shows the number of manufactured homes for all states.

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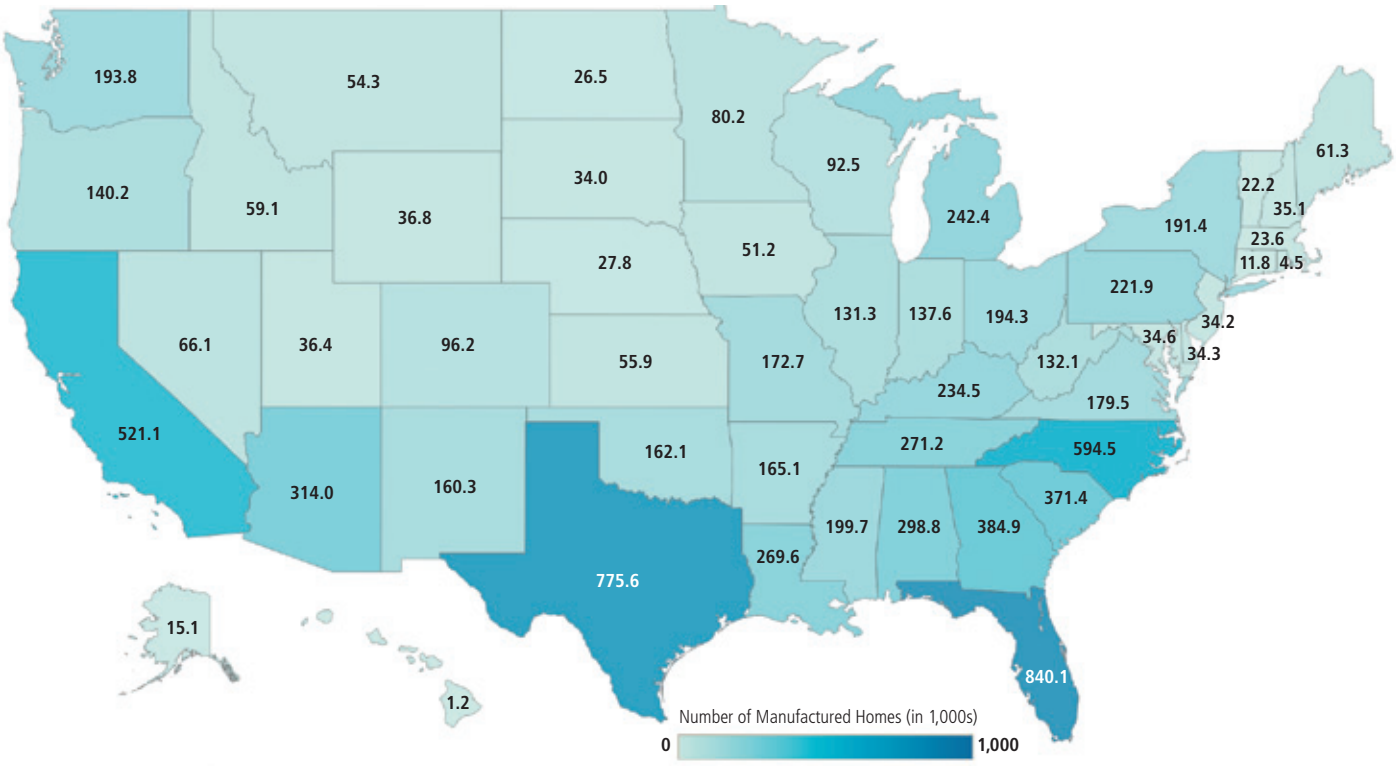
26 Map based on data from US Census Bureau, ACS 2019 Table 2502, *https://data.census.gov/cedsci/table?q=B25024&g=0100000US.04000.001&tid=ACSDT5Y2019.B25024&hidePreview=true4*.

27 Consumer Financial Protection Bureau, *Manufactured-Housing Consumer Finance in the United States*, 2014), p. 6, *https://files.consumerfinance.gov/f/201409_cfpb_report_manufactured-housing.pdf*.

28 Noah J. Durst and Esther Sullivan, "The Contribution of Manufactured Housing to Affordable Housing in the United States: Assessing Variation Among Manufactured Housing Tenures and Community Types," *Housing Policy Debate* (June 2019), p. 2,17, *https://www.researchgate.net/publication/333711399_The_Contribution_of_Manufactured_Housing_to_Affordable_Housing_in_the_United_States_Assessing_Variation_Among_Manufactured_Housing_Tenures_and_Community_Types*.

FIGURE 2: **Total Number of Manufactured Homes**[29]



Since 2017, more than 90,000 manufactured homes have been produced and shipped annually. That is considerably more than in previous recent years when home construction was suppressed by the subprime mortgage crisis and Great Recession. Currently, about 10 percent of all new home construction is manufactured housing, which is significantly less than before 2000.

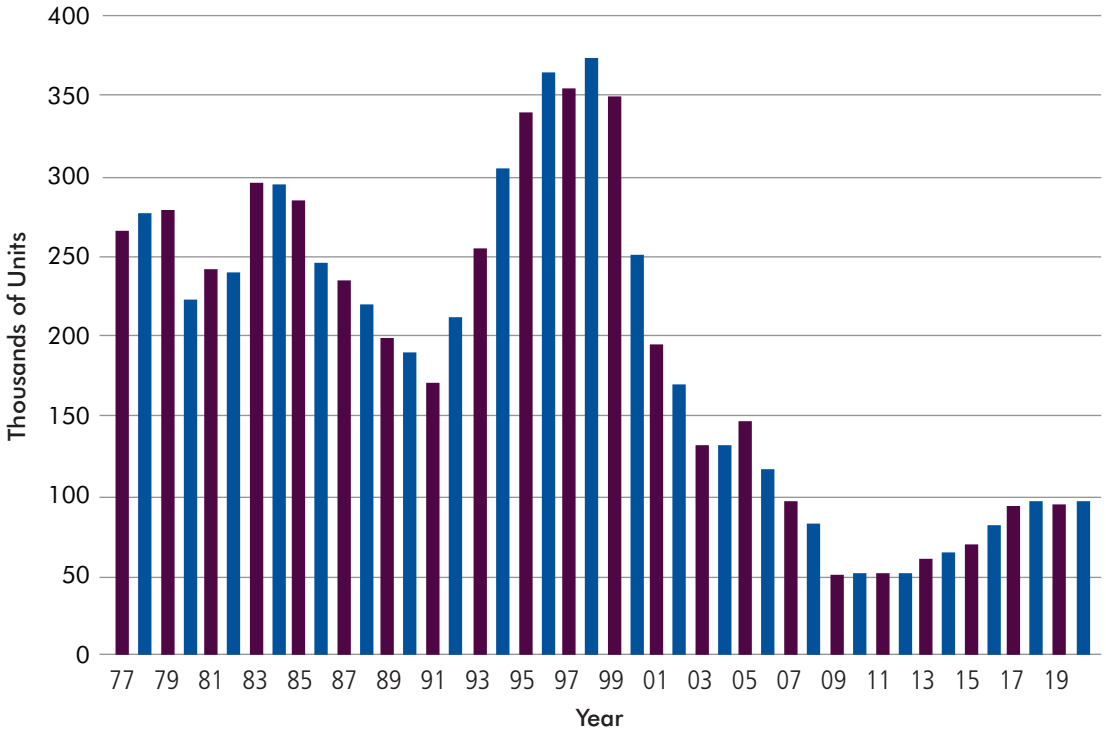
The manufactured housing industry's share of new home construction rose sharply in the 1990s. In the peak year of 1998, manufacturers produced and shipped 373,000 houses. According to a 2002 study, two-thirds of the affordable housing added to the nation's housing stock during the 1990s was manufactured homes.[30] Factory-built housing declined considerably after 2000, as the boom market was shown to have been plagued by lax credit standards and loan underwriting practices that led to a large number of defaults. As the Consumer Financial Protection Bureau reports, "in the year 2000 alone, more than 75,000 consumers had their manufactured homes repossessed, about 3.5 times the typical number during the 1990s. Between the beginning of 1999 and the end of 2002, repossessed inventory grew more than fourfold to $1.3 billion."[31] After 2000, the widespread availability of subprime mortgages made it easier for potential homeowners to qualify for loans for conventional

29 Map based on data from US Census Bureau, ACS 2019 Table 2502, *https://data.census.gov/cedsci/table?q=B25024&g=0100000US.04000.001&tid=ACSDT5Y2019.B25024&hidePreview=true4*.

30 William Apgar et al., *An Examination of Manufactured Housing as a Community and Asset Building Strategy*, (Neighborhood Reinvestment Corporation and Joint Center for Housing Studies of Harvard University, 2002), p. 1, *https://www.jchs.harvard.edu/sites/default/files/w02-11_apgar_et_al.pdf*.

31 Consumer Financial Protection Bureau, *Manufactured-Housing Consumer Finance in the United States*, p. 6.

FIGURE 3: **Number of New Manufactured Homes Shipped by Year**[32]



houses. Figure 3 shows the number of manufactured homes produced and shipped for every year since the first set of HUD standards went into effect in 1976.

The sharp drop-off in new production of manufactured homes in the 21st century means that most of the existing housing stock does not meet the highest energy efficiency standards, and most date prior to the updated standards set by HUD in 1994. Nearly 20 percent of the manufactured homes housing stock consists of highly energy-*inefficient* homes that date from before the initial establishment of HUD standards in 1976.[33]

MANUFACTURED HOME COMMUNITIES VERSUS INDIVIDUAL LAND PLOTS

The typical image of manufactured housing is the "mobile home park," a dedicated community with multiple sites for manufactured homes. In reality, about 60 percent of manufactured homes are placed on privately owned individual plots of land. As the state-by-state profiles in this report show, the balance between manufactured home communities and individual land plots varies considerably among states.

32 Figure derived from US Census Bureau, "Shipments of New Manufactured Homes" (2020), *https://www.census.gov/data/tables/time-series/econ/mhs/shipments.html*.

33 A 2012 study by the American Council for an Energy-Efficient Economy included an estimate that 22 percent of manufactured homes were older than 1976, but since then older homes have continued to be retired and new homes manufactured. See Jacob Talbot, *Mobilizing Energy Efficiency in the Manufactured Homes Sector* (American Council for an Energy-Efficient Economy, July 2012), p. 4, *https://www.aceee.org/sites/default/files/publications/researchreports/a124.pdf*.

Older manufactured home sited on an individually owned land plot

iStockphoto/Lisa-Blue

Many of the homes on individual land plots are clustered near each other even though they are not in formal manufactured home communities. A 2019 study by two housing scholars, Noah Durst and Esther Sullivan, found that about half the homes on individual land plots (about 30 percent of all manufactured homes) are located in what they call informal subdivisions. These are "residential subdivisions that are developed with austere levels of infrastructure and services (often lacking paved roads, sidewalks, streetlights, sewer service, and sometimes even piped water and electricity) and under minimal regulatory control…."[34] Not all—nor even most—of the homes in a specific informal subdivision are manufactured houses, but these informal subdivisions have higher than usual concentrations of manufactured homes because planning and zoning regulations prohibit such homes in many other more heavily regulated locations.

When informal subdivisions are developed for manufactured home communities, it follows that a majority of manufactured home residents live in close proximity to other manufactured homes. Using data from the 2013 American Housing Survey, Durst and Sullivan estimate that of all the occupied manufactured homes "approximately 69% are located within one half block of another manufactured home." In comparison, only 4 percent of conventional homeowners and renters live so close to a manufactured home.[35]

Manufactured homes in informal subdivisions are much more heavily concentrated in the South. Durst and Sullivan found that "a remarkable 75% of mobile homes in [informal sub-divisions] are located there, compared with only 15% in the West, 6% in the Midwest, and 4% in the Northeast." The percentage of *all* manufactured homes in the South is much smaller—37 percent. The concentration of informal subdivisions there stems in part from development that occurred before some states enacted strict land-use regulations for unincorporated areas and from "the ongoing proliferation of [informal subdivisions] in Texas."[36]

34 Durst and Sullivan, "The Contribution of Manufactured Housing to Affordable Housing in the United States," pp. 4, 8.

35 Ibid., p. 8.

36 Ibid., p. 8.

The vast majority of informal subdivisions are in rural settings, with 58 percent of housing units located in the rural parts of nonmetropolitan areas, and 26 percent in the rural parts of metropolitan areas. One reason for the absence of informal subdivisions with manufactured homes in more urban locations is that zoning codes and other local laws often prohibit manufactured homes outside of manufactured home communities.[37]

In addition to the manufactured home communities and the informal subdivisions, there is still roughly another 30 percent of all manufactured housing that is dispersed on individual land plots but not in informal subdivisions.

How Manufactured Homes Parks Are Structured

There are about 60,000 manufactured home communities in the US.[38] These are land-lease communities (sometimes referred to as "parks"), with the property owner developing the land and providing utilities and sewers or septic systems for the community. Some of the communities have special amenities such as swimming pools and other recreational or community facilities. Communities range dramatically in size from fewer than 10 homesites to more than 2,000.

There are about 60,000 manufactured home communities in the US. These are land-lease communities (sometimes referred to as "parks"), with the property owner developing the land and providing utilities and sewers or septic systems for the community.

Most often, the community owner leases homesites to homeowners who purchase and locate their manufactured home on the site. This can sometimes create an unstable situation for the homeowner, as the community owner can unilaterally raise the monthly lease payment or even sell the property, causing the manufactured homeowner to move the house to a different location. This has become a more serious problem in recent years as some community owners have pursued more aggressive strategies for squeezing additional revenue out of their properties.[39] (A few states—Delaware, New York, Oregon, and Rhode Island—regulate lot rents, as do some localities in other states.)

In contrast to site-built homes that are financed by a real estate mortgage, most manufactured homes, especially in manufactured home communities, are classified as personal property and financed as "chattel," which is the legal term for personal property. This is different than "real" property, which includes land and the structures attached to the land. Chattel lending includes loans for automobiles and household appliances. In comparison to real estate mortgage financing, chattel financing of manufactured homes can have shorter loan terms, higher interest rates, fewer consumer protections, and fewer lenders. On the other hand, mortgages usually have higher loan origination costs and take longer to close than chattel lending.[40]

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37 Ibid., pp. 8, 10, 4.

38 Consumer Financial Protection Bureau, *Manufactured-Housing Consumer Finance in the United States*, p. 42, *https://files.consumerfinance.gov/f/201409_cfpb_report_manufactured-housing.pdf.*

39 For a discussion of some landlords' predatory practices, including steep rent hikes and evictions, see a fascinating ethnographic study by Eileen Sullivan, *Manufactured Insecurity: Mobile Home Parks and Americans' Tenuous Right to Place* (University of California Press, 2019). See also a 2019 episode of comedian John Oliver's HBO TV show, *https://www.youtube.com/watch?v=jCC8fPQOaxU* and Sheelah Kohlhatkar, "What Happens When Investment Firms Acquire Trailer Parks," New Yorker (March 8, 2021), *https://www.newyorker.com/magazine/2021/03/15/what-happens-when-investment-firms-acquire-trailer-parks*.

40 For more on financing for manufactured homes, see Consumer Financial Protection Bureau, *Manufactured-Housing Consumer Finance in the United States*, pp. 23-2-39.

In a minority of cases, the community owner owns both the land and the manufactured home, that is rented to a resident. Some communities include a mix of homeowners and renters.

A different variation in manufactured home community ownership is the resident-owned community (ROC), where the community is structured as a nonprofit cooperative. The cooperative owns the land and manages the community services. The homeowners own their individual house and have a voting membership in the cooperative organization. ROCs are most frequently established when a community owner goes to sell the community and the residents band together to purchase it.[41] There are about 1,200 ROCs in the United States, which is only a small percentage of all manufactured home communities.

WHO LIVES IN MANUFACTURED HOUSING?

The people who live in manufactured housing vary greatly in age, ethnicity, household size, and income, although some segments of the American population are represented either more or less than in other types of housing.

Most notably for the purpose of this report, which is focused on LMI solar, manufactured housing is disproportionately used by households with low and moderate incomes, even though some residents have higher incomes. Households in manufactured homes have roughly half the median incomes of all other households. They also have significantly lower net worth—the Consumer Finance Protection Bureau found it to be "just about one-quarter the net worth of families in site-built homes."[42]

The previously cited study by Durst and Sullivan found that households in manufactured home communities had average incomes of $35,688, and households in informal subdivisions had average incomes of $42,704. This is significantly lower than the average income for owners of conventional site-built homes ($91,342) and renters of conventional homes ($50,056).[43] A much higher percentage of households in manufactured homes were living in poverty.[44]

Manufactured housing represents a significant share of affordable housing for LMI households, and an even larger share of the affordable housing that does not receive direct public subsidies. Because of the low cost per square foot, manufactured housing is an affordable route to home ownership, leading to a higher proportion of the LMI residents of manufactured housing owning their homes than do the residents of multifamily affordable housing.

As for ethnicity of households living in manufactured housing, a large majority of residents self-define as "White" (81 percent compared to 74 percent for site-built housing). People who self-define as Hispanic or Latino are also slightly over-represented (18 percent compared to 16 percent for site-built housing). African Americans are under-represented (9 percent

41 For more on ROCs, see the website of ROC USA, a nonprofit organization dedicated to promoting and assisting ROCs, *https://rocusa.org*. ROC USA is located in New Hampshire where the ROC concept was pioneered and where there is a high market penetration of ROCs.

42 Consumer Financial Protection Bureau, *Manufactured-Housing Consumer Finance in the United States*, p. 17. This report includes a good section on "Residents of manufactured housing" that covers multiple characteristics of the households; see pp. 13–20.

43 Durst and Sullivan, "The Contribution of Manufactured Housing to Affordable Housing in the United States," p. 11. Some of these differences are accounted for by many manufactured homes' rural locations, where wages and living costs are lower than in cities.

44 Durst and Sullivan, "The Contribution of Manufactured Housing to Affordable Housing in the United States," p. 11.

compared to 12 percent for site-built housing, as are Asians (1 percent compared to 5 percent for site-built housing).[45] African Americans are a larger share of the homeowners in informal subdivisions (12 percent) than in manufactured home communities (6 percent); this compares to their 9 percent share as owners of conventional homes.[46]

The Consumer Protection Finance Board found that manufactured home residents have the following demographics:

- A much lower proportion has completed education beyond high school
- A higher proportion is headed by a retiree (32 percent versus 24 percent in site-built housing)
- Among owner-occupied homes, the head of household is slightly more likely to be older than 70 or younger than 30 than for site-built homes.[47]

THE 14 TARGET STATES

The following two tables (Table 1 and Table 2) summarize the quantity and nature of the manufactured housing stock in the 14 target states. Table 1 shows the total number of manufactured homes per state, according to the US Census.

TABLE 1: **Number of Manufactured Homes in Target States**[48]

State	Housing Unit Estimate July 1, 2019	# of Manufactured Homes	Manufactured Homes as a % of Total Housing Stock
Arizona	3,003,286	314,042	10.5%
California	14,175,976	521,135	3.7%
Florida	9,448,159	840,074	8.9%
Georgia	4,283,477	384,876	9.0%
Kentucky	1,983,949	234,488	11.8%
Maine	742,788	61,283	8.3%
Michigan	4,596,198	242,393	5.3%
Missouri	2,790,397	172,734	6.2%
New Mexico	937,920	160,303	17.1%
North Carolina	4,627,089	594,578	12.8%
Ohio	5,202,304	194,322	3.7%
South Carolina	2,286,826	371,360	16.2%
Texas	10,937,026	775,632	7.1%
Virginia	3,514,032	179,512	5.1%

45 Consumer Financial Protection Bureau, *Manufactured-Housing Consumer Finance in the United States*, p. 20.

46 Durst and Sullivan, "The Contribution of Manufactured Housing to Affordable Housing in the United States," p. 11.

47 Ibid., pp. 13-14.

48 US Census Bureau, ACS 2019 Table 2502, *https://data.census.gov/cedsci/table?q=B25024&g=0100000US.04000.001&tid=ACSDT5Y2019.B25024&hidePreview=true4*.

Table 2 shows the share of manufactured homesites in each of the 14 states that is located on homesites in the Datacomp database of manufactured home communities. The range is quite substantial, going from only 10 percent in North Carolina to 75 percent in Michigan. Because of the limitations of the data in the database, the exact number of homesites in manufactured home communities is not known, but the results are sufficiently striking to show where manufactured home communities are a larger and smaller share of the total manufactured homes housing stock.[49]

TABLE 2: **Share of Manufactured Homes in Manufactured Home Communities in Target States**[50]

State	# of Manufactured Homes as of July 1, 2019	# of Homesites in Manufactured Homes Communities, per Datacomp Database	% of Manufactured Homes in Manufactured Homes Communities
Arizona	314,042	147,379	47%
California	521,135	349,974	67%
Florida	840,074	390,121	46%
Georgia	384,876	39,537	10%
Kentucky	234,488	35,196	15%
Maine	61,283	13,186	22%
Michigan	242,393	182,868	75%
Missouri	172,734	40,712	24%
New Mexico	160,303	24,110	15%
North Carolina	594,578	62,009	10%
Ohio	194,322	133,750	69%
South Carolina	371,360	47,344	13%
Texas	775,632	185,642	24%
Virginia	179,512	41,276	23%

49 On the one hand, the Datacomp database is missing homesite numbers for some smaller communities. On the other hand, some homesites may no longer have a house on them and some communities may have closed since Datacomp collected its data.

50 Total number of manufactured homes comes from the 2019 American Community Survey; the number of homesites in manufactured home communities comes from Datacomp's proprietary data provided to this research project. See *https://www.datacompua.com*.

CHAPTER THREE

Solar for Manufactured Homes: The Proposition and Challenges

THE PROPOSITION: WHY STATES AND UTILITIES SHOULD ADDRESS SOLAR FOR MANUFACTURED HOUSING

The primary reason to address solar access for residents of manufactured housing is simple—in many states, a significant number or percentage of all households live in manufactured housing and they should have access to the benefits of solar as it is deployed throughout society. Solar should ideally be implemented in ways that allow all segments of the population to participate, and solar adoption should reduce rather than exacerbate inequality.

The residents of manufactured homes have a great need for the electricity cost savings that solar can provide. Because such a high percentage of those households that reside in manufactured homes have low or moderate incomes, any reduction in expenses is welcome. Like other households with below average incomes, those in manufactured homes have a high "energy burden," with a significant share of their income going to energy.

Nearly half of manufactured homes (47 percent) are all-electric, meaning that they use electricity for home heating, cooling, and cooking. This large electric load could be served by solar PV generation.

The manufactured homes housing stock is relatively energy inefficient. A 2012 study from the American Council for an Energy-Efficient Economy reported that the small size of manufactured homes meant that homeowners used about 35 percent less energy per capita than did the owners of site-built homes. But on average they spend significantly more per square foot ($1.38/sf per year vs. $0.74/sf for site-built homes). Residents of the highly inefficient pre-1974 manufactured homes often spent much more. "On average, residents of manufactured homes spend $1,500 annually on energy, or 5 percent of total household income. This is 30 percent more income spent on energy than spent by the average American household, and 66 percent more than the owners of site-built homes."[51]

Nearly half of manufactured homes (47 percent) are all-electric, meaning that they use electricity for home heating, cooling, and cooking. This large electric load could be served

51 Jacob Talbot, *Mobilizing Energy Efficiency in the Manufactured Housing Sector* (American Council for an Energy-Efficient Economy, July 2012), pp. 12, 7, *https://www.aceee.org/sites/default/files/publications/researchreports/a124.pdf*.

by solar PV generation. All-electric homes are especially common in the South. Most other manufactured homes (48 percent of the total) use natural gas, or propane, for space heating.[52]

In theory, access to solar installations—either at individual homesites or in shared community solar arrays—could provide meaningful financial relief for manufactured home residents.

THE CHALLENGES TO BRINGING SOLAR TO MANUFACTURED HOUSING

There is no getting around the fact that manufactured housing is—and will continue to be—a challenging market for solar. It will not be easy to develop thousands of solar projects that benefit residents of manufactured homes. The challenge falls into two categories—those inherent in all initiatives aimed at LMI households, and those specifically linked to the nature of manufactured housing as a housing type.

Obstacles to LMI Solar Adoption

The most obvious barrier for low-income households to go solar is that they have low incomes, which can make it difficult to build financial wealth. Although solar can save them money on their utility bills, and thus reduce their energy burden, they are generally unable to overcome the hurdle of paying the initial cost of a PV system without assistance. As the results detailed in Appendix A in Volume 2 of this report show, market-rate solar PV systems in many of the target states can save a homeowner money over the 25-year life of the system, but only in California is there a monthly savings in the first year of the installation. This means that special incentives targeted specifically at LMI customers are necessary elsewhere.[53]

The most obvious barrier for low-income households to go solar is that they have low incomes. Although solar can save them money on their utility bills, and thus reduce their energy burden, they are generally unable to overcome the hurdle of paying the initial cost of a PV system without assistance.

In addition, for a solar program to be beneficial for LMI households, it needs to do more than project likely savings from day one. It also needs to prevent financial risks for those households because LMI households are less able to withstand financial setbacks than wealthier households. A small unexpected financial reversal can be catastrophic; therefore, a solar project would be undesirable if it involves a long-term financial obligation with even a small chance of losing money, regardless of a much larger probability of saving participants money. Emphasis needs to be placed on arrangements that will either provide guaranteed savings to the customer or that allow customers to easily withdraw from the arrangement at any time, if changes in policy or the electricity market mean that the customer is no longer saving money. Of course, it is more expensive and less profitable for companies to offer products with such consumer-friendly features, emphasizing that special incentives from government or utilities are necessary.

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52 Ibid., p. 10.

53 For more extended discussions of the obstacles to LMI solar, see Bentham Paulos, *Bringing the Benefits of Solar Energy to Low-Income Communities: A Guide to States & Municipalities* (CESA, May 2017), Chapter 2, *https://www.cesa.org/resource-library/resource/bringing-the-benefits-of-solar-energy-to-low-income-consumers*; and Warren Leon et al., *Solar with Justice: Strategies for Powering Up Under-Resourced Communities and Growing an Inclusive Solar Market* (CESA, December 2019), Chapter 2, *https://www.cesa.org/resource-library/resource/solar-with-justice*.

Another challenge is the frequent reluctance on the part of solar marketers and solar installation companies to focus their efforts on low-income customers. Those customers are unlikely to have sufficient cash on hand to buy a system outright and are more likely to have low credit scores and little equity in their home, so the transaction is likely to be more complicated than with a wealthier customer and would require special financing strategies.

Because marketers are unlikely to focus their limited advertising budgets or tailor their marketing to reach low-income customers, including those in manufactured housing, low-income customers may be less aware of the benefits of solar power and may distrust solar marketers. This lack of customer awareness of solar in turn makes low-income customers less attractive to marketers and drives a negative feedback loop.

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Many low-income consumers do not pay enough income tax to take advantage of federal tax credits for solar installations. Because the residential solar tax credit is currently scheduled to sunset after 2023, this may become a less important issue in the future.

Some LMI households may qualify for discounted electricity rates available to low-income customers by their local utility. While this has the desirable benefit of reducing those households' cost of living, it has the inadvertent effect of making solar less attractive because it reduces the amount of money the customer can save from going solar.

Finally, many LMI households rent their homes. Because the housing owner may not benefit if the renter's energy costs are reduced, it can be difficult to interest the owner in a solar project. It can also be difficult to structure the project in a way that ensures that financial savings flow to the renters. This needs to be kept in mind when a project involves renters of manufactured homes.

On the other hand, this last challenge suggests a reason why states and utilities should consider focusing on manufactured housing. A high percentage of manufactured housing occupants consists of homeowners. According to the US Energy Information Administration's *Residential Energy Consumption Survey*, 73.5 percent of households in manufactured housing are homeowners and 26.5 percent are renters.[54] Not all those homeowners have low or moderate incomes, but most do.

Obstacles to Solar for Manufactured Housing

There are also several obstacles that are specific to manufactured housing. The most important one is that rooftop solar installations will not work on many manufactured homes. The reasons for this are discussed in detail later in this chapter in the section on rooftop solar. Ground-mounted or pole-mounted systems are often suggested as alternatives to rooftop systems, but they pose their own challenges, which are discussed below in sections on those technologies.

54 US Energy Information Administration, "Household Demographics of U.S. Homes by Housing Unit Type, 2015," *Residential Energy Consumption Survey, 2015* (US Energy Information Administration, 2018), *https://www.eia.gov/consumption/residential/data/2015/hc/php/hc9.1.php*.

There could be an impediment to manufactured housing residents wanting to go solar if they live in a community where electricity from the grid is master-metered, without the residents having their own sub-meters. In that case, residents have little incentive to reduce their electricity use. However, that situation is rare. Zachary Beck, National Sales Manager for Conservice, a firm that provides energy services to master-metered buildings, estimates that fewer than 10 percent of manufactured home communities are master-metered, and the vast majority of those have sub-meters.[55]

Even in communities that are not master-metered, residents who do not own the land under their house may be subject to community rules that prohibit ground-mounted or pole-mounted systems. They may be hesitant to place a system on their roof if they think there is a chance that they will have to move their home to a different location. Of course, these concerns apply less to manufactured homes that are on individually owned plots of land, as opposed to those sited in communities.

THE PERSPECTIVES OF RESIDENTS

Solar for manufactured homes will never be successful if the residents are uninterested in solar or believe there is no possibility that it would be feasible or beneficial.

To start to get a sense of residents' attitudes, researchers circulated a survey to some residents of manufactured homes. Because it was difficult to make direct contact with individual residents, we worked through intermediaries who had access to them. It turned out to be easiest to reach residents of resident-owned communities (ROCs) in New Hampshire and New York.

One hundred seventy responses were received from residents of ROCs—152 from New Hampshire and 18 from New York. The respondents reside in more than 70 different communities.[56] Most of the respondents (72 percent) have lived in their home for more than five years. Although it appears that the respondents do not differ dramatically in income or home tenure from many manufactured homes residents of other states, it is possible that they would be more likely to consider solar because of the greater security they have living in a ROC and the ease of taking collective action in such a community.

Most respondents (63 percent) said that they have a little familiarity with PV technology and residential solar projects. In contrast, 32 percent said they have no familiarity, and 5 percent said they have extensive familiarity.

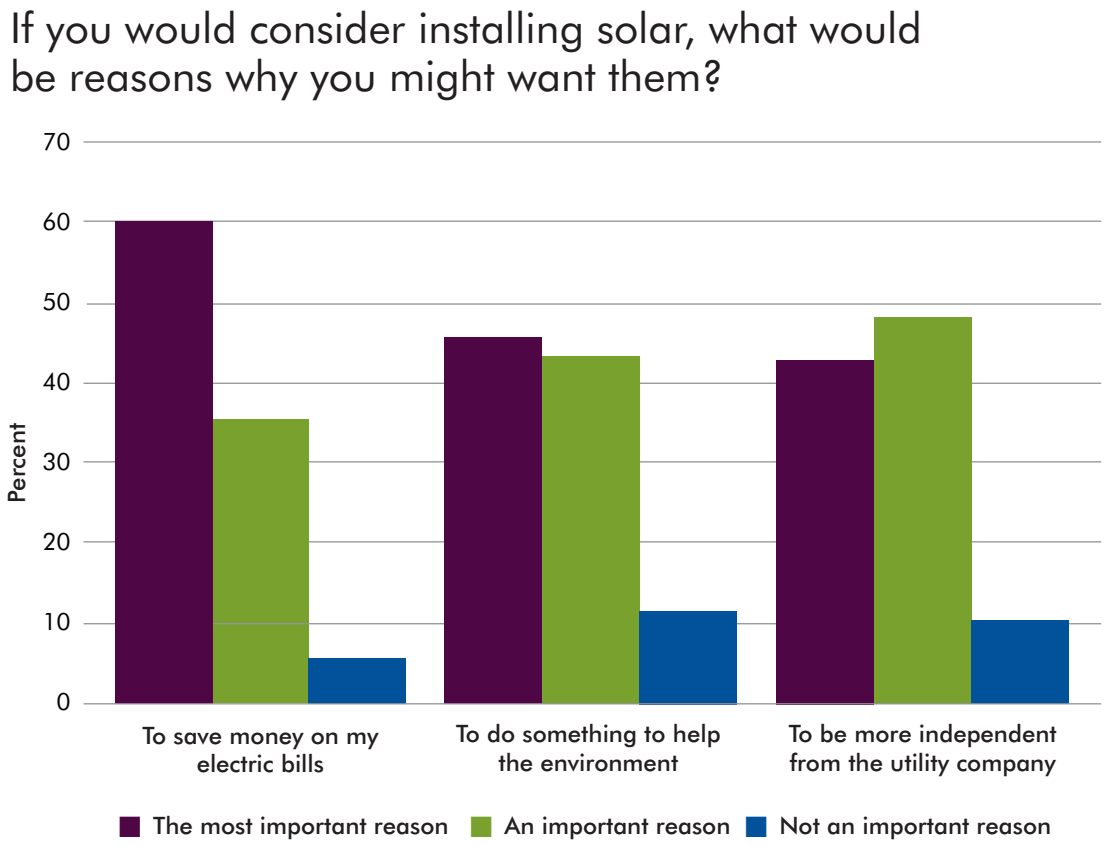
Those who have a little familiarity with the technology generally did not know people who have PV systems. The majority (56 percent) reporrted that they do not know anyone who has solar installed on or at their house. For those who did know someone with an installation, it is most often a friend, with smaller numbers knowing a relative, work colleague, or someone else. But even among those people who knew someone with a system, most (59 percent) had never discussed it with that person. Among the rest, 33 percent had discussed the system briefly and 8 percent had discussed it in depth.

55 Interview with Zachary Beck, September 16, 2020.

56 The number of communities is not exact, because it was difficult to tell which community a few respondents were referring to.

Most respondents (74 percent) said that they would consider installing a PV system in the future. When those people were asked why they would be interested in solar, most (60 percent) said a primary motivation would be to save money on their electric bills (see Figure 5), although there was also a strong interest in helping the environment and to be more independent from the utility company.[57]

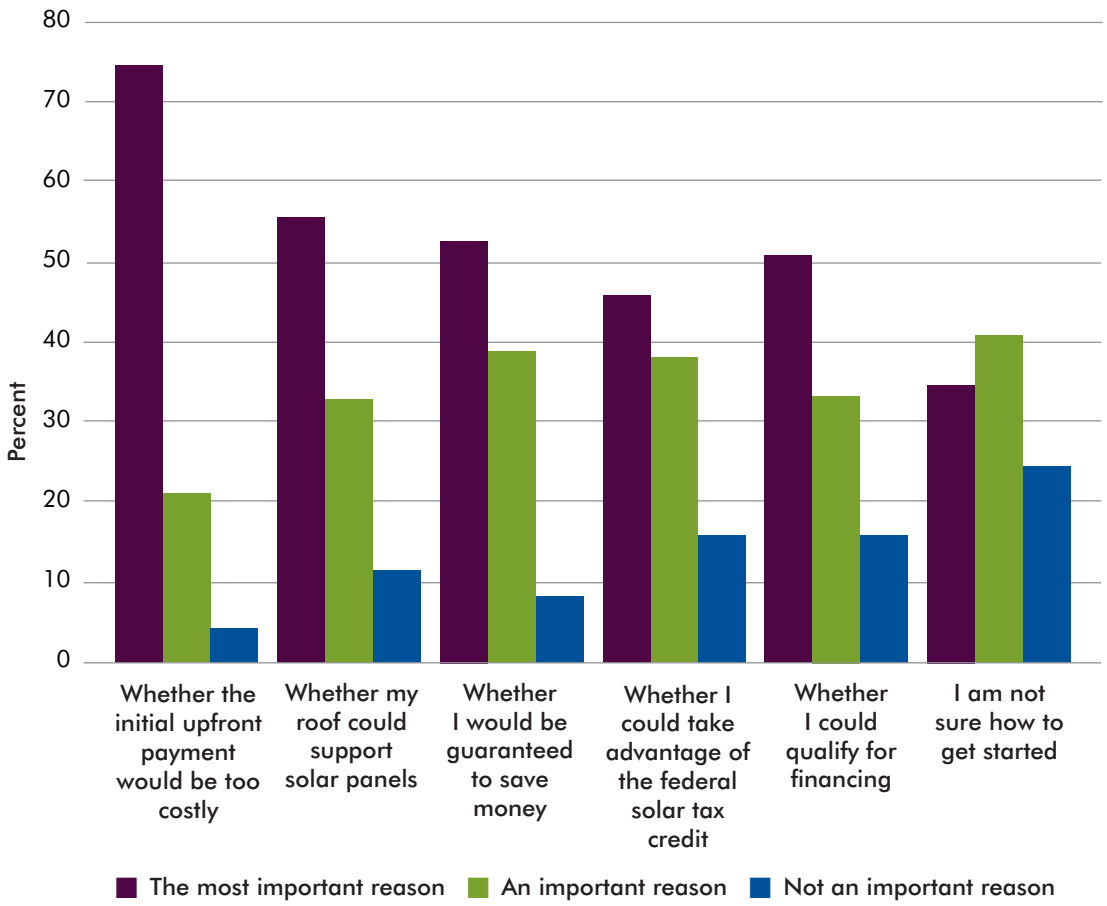
FIGURE 5: **Respondents' Reasons for Installing Solar**



The respondents who would consider solar were asked what concerns they might have that would have to be addressed before they proceeded to go solar. They noted many concerns. The most common one (75 percent ranked this as "the most important concern") is whether the initial upfront payment would be too costly, although there were also other significant concerns. More than half the respondents rated the following as "the most important concern:" whether the roof would support the solar panels (56 percent), whether the household would be guaranteed to save money (53 percent), and whether they could qualify for financing (51 percent). Obviously, these numbers add up to well more than 100 percent, so many respondents indicated multiple "most important concerns." For the full results, see Figure 6.

57 The results shown in Figure 5 show that the numbers for "the most important reason" add up to more than 100 percent because some respondents chose more than one "most important reason" in the survey.

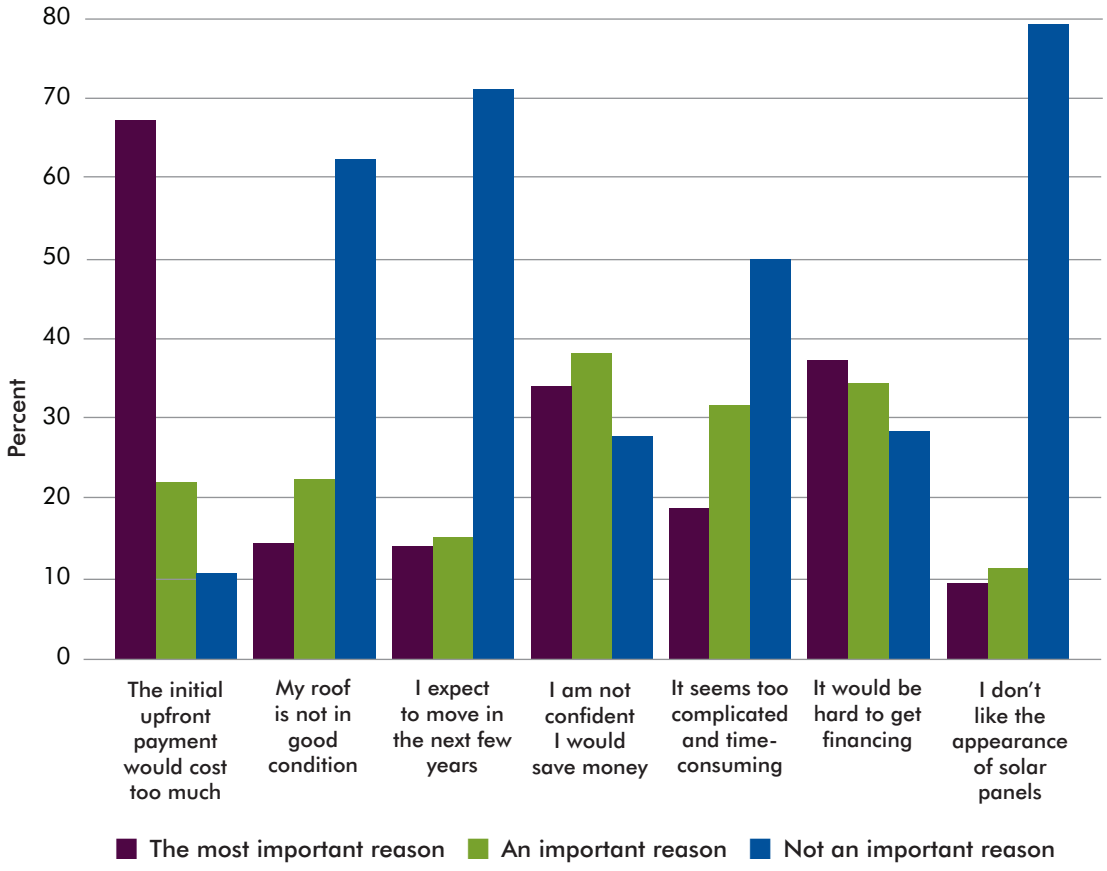
FIGURE 6: **Respondents' Concerns about Installing Solar Panels**



Among the 26 percent of respondents who were not interested in solar, two-thirds (67 percent) indicated that the most important reason was that the initial upfront payment would cost too much.[58] Significant numbers also expressed a lack of confidence that they would save money, and that they would have difficulty obtaining financing (see Figure 7). Beyond the options presented in the survey, some respondents offered additional reasons for their lack of interest, including that there are too many trees in the manufactured home community, manufactured homes roofs would not support solar panels, and an installation could complicate a future roof replacement.

58 The results shown in Figure 6 show that the numbers for "the most important reason" add up to more than 100 percent because some respondents chose more than one "most important reason" in the survey.

FIGURE 7: **Respondents' Reasons Not to Install Solar Panels**



Interestingly, only 29 percent of respondents were familiar with the concept of "community solar" or "shared solar." Among that minority of respondents, 45 percent thought their community should consider developing a community solar project, while 14 percent said they should not consider this, and 41 percent had no opinion. One respondent noted, "In a community-based project, my biggest concern would be how the energy savings would be distributed to the residents." Another respondent pointed out that his/her community of 81 homes had eight undeveloped acres that could be used for a community solar project. Yet another respondent commented that their community had considered doing community solar but turned out not to have enough available land to devote to an installation.

The following conclusions can be drawn from the survey responses:

- Few manufactured home residents have deep familiarity with solar, and it is rare for them to have discussed solar with a friend, relative, or acquaintance who already has a PV system.

- There is potential interest in solar among the population of manufactured home residents, but they have concerns that would need to be addressed before they would be comfortable moving forward with a project.
- Outreach and education will be necessary to make significant progress in bringing solar to manufactured home communities.

TECHNOLOGY OPTIONS

Developers, advocates, and planners creating initiatives to support residential solar can choose from a variety of technologies and strategies to extend solar benefits to residents of manufactured homes. What constitutes an effective solar project will vary depending on several factors, including the type of home, its location, and whether it is a new or existing structure. A project's design will be influenced by the home's energy consumption and property size. Local siting and building codes, available financing support, and intended payoff period are all important considerations.

Rooftop Installations

There are many reasons why a rooftop installation will not work on a particular manufactured home. As with any home, it is possible that the house is overly shaded or sited in a suboptimal direction. In some cases, the rafters are smaller than 2x4, making them unable to support the extra weight of the solar panels. If the roof has more than one layer of shingles on it, there can be weight limitation issues. Piercing the roof to install the solar panels can void a manufacturer's warranty. Some older units have a second roof that the owners built over the top of the house, supported by posts that may not be suitable for an installation. In some locations, a manufactured home that is not on a permanent foundation may not be approved by local building department officials for a solar permit.

Solar Solution AZ

Solar installed on existing manufactured home

Even if a rooftop installation is possible, there can be extra hurdles that drive up costs. California, for example, requires a special permit for an installation on a manufactured home. New Mexico requires the installer to have a special license. The home's manufacturer may insist on approving the plans for a PV system before it is installed. The solar installer may want to bring in a structural engineer to make sure that the installation will not cause problems for the house.

Nevertheless, there have been and will continue to be installations on manufactured homes. They tend to be more feasible on newer homes and on double-wide homes rather than single-wide models. In some cases, the extra costs associated with getting the plans approved are counterbalanced by low installation costs on a one-story building with an easily accessible roof.

But even if a solar installation is theoretically possible, it probably should not be attempted on an older manufactured house. Houses that pre-date the 1976 HUD code are especially poor candidates for solar, because they are energy-inefficient and are depreciating in value over time. They may not continue to be occupied for the life of the solar panels.

Ground-mounted solar

NREL/Paul Torcellini

Ground-Mounted Solar

For homes where a rooftop installation is not appropriate, it may be advantageous to locate solar panels elsewhere on the property using a ground-mounted system. Conventional ground-mounted systems hold PV panels securely in place using a metal frame driven into the ground. This design can provide several long-term benefits to the owner, but extra upfront costs can impact the overall economics of the project, making it more expensive than a rooftop installation.

Ground-mounted solar requires additional equipment, labor, and permitting. However, unlike rooftop projects, ground mounts are not limited by the physical constraints and orientation of the home's roof. Some roofs can face the wrong direction for useful solar generation, but with a ground mount, installers can place the panels where the conditions are best and orient them at an angle to maximize the power produced.

Pole-mounted solar

Barb Odell/Cornerstones

Most manufactured home communities offer uniform lot parcels and place the homes in relatively close proximity to other neighbors. The available space may restrict the solar project size and as a result, a ground-mount system may not work for some community members. Space constraints are often fewer for manufactured homes on individually owned plots of land. Even so, a homeowner or installer may determine that the lot size, proximity to the road, or external issues pose too many costs or inefficiencies to make a ground-mounted system feasible.

Pole-Mounted Solar Panels

Pole-mounted solar systems have a smaller footprint than conventional ground mounts and can overcome some space constraints. As the name suggests, a pole-mounted solar project raises PV panels high on a single pole and eliminates the other additional legs of a traditional ground-mounted system. Pole-mounted systems are effective options to take advantage of solar, even in areas that were historically difficult to install solar due to limited area or uneven terrain. When paired with a tracking system that can adjust the panels to best capture the sun's rays, pole-mounted PV systems can be especially productive. A case study in Chapter Four on New Mexico's PV on a Pole™ initiative further discusses benefits of pole-mounted solar.

Community Solar

A more widely applicable approach in many states for solar access by manufactured home residents is a large shared solar project, which is commonly called "community solar" by the solar industry and the federal government.[59] The US Department of Energy's (DOE) National

59 The term "community solar" can be confusing, because some environmental justice advocates and community organizations do not use the term for all shared solar projects, but instead use it to refer to a project that is shaped by the community and provides tangible benefits to the community, whether it involves multiple participants as subscribers or owners. For convenience, in this report, we use the term "community solar" in its most common usage, which is for a shared solar project, involving subscriptions for or ownership by multiple electricity ratepayers.

Community solar project

Maria Costello/CESA

Community Solar Partnership collects many useful resources on community solar and offers technical assistance to a wide range of stakeholders. It "broadly defines community solar to include any solar project or purchasing program, within a geographic area, in which the benefits flow to multiple participants (individuals, businesses, nonprofits, etc.)."[60] Generally, multiple utility ratepayers purchase subscriptions for a share of a solar project's electricity, or they own a portion of a solar array that is located away from their homes or businesses. However, community solar can only work in jurisdictions where electricity regulations allow it.

Where community solar is permitted, project developers have the flexibility to select a model that distributes the project's ownership, costs, and compensation among local participating stakeholders. This flexibility can be used to enable solar access by LMI customers and can relieve them from the burdens of upfront investment, long-term commitment, and ongoing maintenance responsibilities of individual rooftop and ground-mounted systems. Participants are typically compensated for the solar array's energy output through either direct payments, proportional electric bill reductions, or credits.[61]

Community solar projects are sited away from subscribers' homes in locations that can optimize electricity production. This approach is appealing to solar developers because they can serve many new customers and take advantage of economies of scale. Developers build the project to commercial size and orient it to optimize the solar panels' output, which lowers the project costs per watt and improves revenues. Community solar is an efficient use of resources and

60 US DOE, National Community Solar Partnership webpage, *https://www.energy.gov/eere/solar/national-community-solar-partnership* (accessed September 11, 2020).

61 Coalition for Community Solar Access, "Community Solar Policy Decision Matrix," *http://www.communitysolaraccess.org/wp-content/uploads/2019/04/2019CommunitySolarPolicyMatrix-2.pdf* (accessed September 21, 2020).

also an opportunity to derive value from land that may not be suitable for residential or business purposes. For example, some municipalities are looking to capped landfills and superfund sites as useful locations to site solar.[62]

Community solar may not always completely offset a subscriber's monthly electric bill, but it can reduce LMI customers' energy burden.

A New Generation of Manufactured Homes

Although many existing manufactured homes are not suitable for rooftop solar, some contemporary designs not only incorporate green building attributes and better materials to make the structures more efficient, but they can more easily accommodate solar. These new homes provide much greater comfort than earlier manufactured homes and require lower monthly energy costs, especially when compared to the outmoded pre-1976 homes. Initiatives to improve the quality and efficiency of newly constructed manufactured housing are spreading.

For example, the Northwest Energy-Efficient Manufactured Housing Program (NEEM), a collaborative effort among home builders, retailers, and utilities, awards homes the Energy Star certification for meeting high construction standards and implementing energy-saving weatherization measures. These efficiency updates reduce the household's overall energy consumption. With a stronger roof in place, new manufactured homes can successfully host residential rooftop solar. The combination of energy performance improvements and a growing variety of design options, while remaining less expensive than site-built homes, can enable these

Recent manufactured home designed to be solar ready

Clayton Home Building Group

62 EPA, "Alternative Energy at Superfund Sites," *https://www.epa.gov/superfund-redevelopment-initiative/alternative-energy-superfund-sites* (accessed September 22, 2020).

manufactured houses appeal to a broader residential market. Consumers, including LMI buyers, can customize the manufactured homes to meet different family needs.[63]

Most new manufactured homes still do not come solar-ready, but some do. J. Gavin Mabe, Director of Engineering and Technology for Clayton, states that Clayton has been producing models for ten years that are structurally able to support solar. However, those models are not available in all locations, and the company produces more of them in California than elsewhere. Mabe indicated that a solar-compatible home, with a disconnect for the inverter and either a truss with additional capacity or added blocking for a standard truss to support the weight of solar panels, adds approximately $500–$1,000 to the cost of a new home.[64] Clayton produces about 40 percent of all new manufactured homes.

Going beyond solar-ready homes, some people are seeking to incorporate solar into the manufactured home at the time of purchase and have it included in the home's initial financing. Ethan Good, co-founder of Phase3 Photovoltaics notes: "By integrating solar in the factory, the cost of materials is lower, larger solar panels can be lifted onto the manufactured home, and labor costs are less. In addition, there can be smarter roof penetrations so the roofs last longer and the company can apply a "copy and paste" design, to save costs due to economies of scale."[65] Phase3 Photovoltaics is featured in a case study in Chapter Four.

Zero-Energy Modular Homes

Some architects and manufacturers are taking home performance design a step further with Zero-Energy Modular (ZEM) homes. Conventional manufactured homes are required to meet the national HUD standards, but modular homes are instead designed to meet state and local building codes. A ZEM home is still factory-built but includes features such as airtight sealing, a continuous thermal envelope, high efficiency appliances, and a high-efficiency air source heat pump for heating and cooling. ZEMs meet the standard of "net-zero," meaning that any household electricity consumed is completely offset by onsite renewable energy, such as rooftop or ground-mounted solar.

Needing only a fraction of the electricity that previous generations of manufactured homes consumed, ZEMs are able to match their usage with a smaller solar project and further reduce costs. ZEMs essentially eliminate the household electricity bill. They are assets that are expected to appreciate in value. VEIC, a nonprofit in Vermont, has been a primary proponent of ZEMs.[66]

ZEMs are designed to match the footprint of a typical manufactured home so that they can be deployed to replace an older house and use the same foundation or site. The production and adoption of ZEMs are in nascent stages. The advanced energy technologies that provide the long-term energy benefits impose a relatively steep upfront cost per square foot. Residential rebates and incentives are needed to mitigate some of these costs. On the production side, few factories have yet produced ZEMs at a scale that provides adequate affordability per unit.

63 Northwest Energy-Efficient Manufactured Housing Program website, *https://www.neemhomes.com*.

64 J. Gavin Mabe, email correspondence, December 30, 2019.

65 Ethan Good, Phase3 Photovoltaics, videoconference interview, May 29, 2020.

66 VEIC, "Market Analysis for Zero Energy Modular in New York State," *https://www.veic.org/Media/default/documents/resources/reports/nys-zem-market-analysis.pdf* (accessed September 13, 2020).

ZeMod Delaware modular home

VEIC

Current factories produce highly customized ZEM homes in response to external special orders. With demand relatively low, the process to mass produce ZEMs is not yet streamlined.[67]

Planners, advocates, and experts are actively coordinating with modular home factories and affordable housing communities to create partner initiatives that overcome current barriers. Expanding ZEMs will require a concerted effort among allies. This includes better coordination with factories, relevant stakeholder information and education, homeowner financing support, and in some municipalities, adjustments to local codes and building definitions. Chapter Four of this report includes a case study on NYSERDA's experience navigating some of the regulatory and supply chain challenges to advancing ZEMs in New York State. There is also a case study of the McKnight Lane Redevelopment project in Vermont, which placed ZEM homes equipped with solar and battery storage systems on the site of an abandoned manufactured home community.

67 VEIC, "Zero Energy Modular Factory Initiative", *https://www.veic.org/Media/default/documents/resources/reports/zem-factory-initiative-april-2019.pdf* (accessed September 23, 2020).

CHAPTER FOUR

Sample Projects and Initiatives to Bring Solar to Manufactured Housing

SOLAR FOR MANUFACTURED HOMES ON SOUTHERN CALIFORNIA TRIBAL RESERVATIONS

Project Name: **San Diego Tribal Energy Collaborative Solar Project**
Location: San Diego County, California
Date Started and Completed: 2011–2019
PV System Size: typically 4.2 kilowatts per house
Number of Households Benefitting: 151, about half manufactured homes

The San Diego Tribal Energy Collaborative was formed in July 2010 following a meeting of the Southern California Tribal Chairman's Association (SCTCA). The Collaborative encompasses three Indian reservations comprising 676 homes on 14,000 acres. When SCTCA conducted a series of sessions on energy-related issues in 2010, three of the attending tribes, the San Pasquale Band of Mission Indians, the La Jolla Band of Luiseño Indians, and the Mesa Grande Band of Mission Indians, were considering ways to achieve their environmental conservation and stewardship goals. The tribes wanted to increase tribal sovereignty by reducing their dependence on energy created off the reservations in order to decrease the cost of energy, so tribal families could apply the resulting savings to other household costs and to reduce greenhouse gas emissions.

@GRIDAlternatives

One of the speakers at the SCTCA meeting sessions was GRID Alternatives (GRID), a non-profit organization that provides renewable energy technology and job training to underserved communities. GRID has a Tribal Program initiative that helps tribes develop solar energy projects on their reservations, while actively participating in the project through education and hands-on training. GRID not only provides technical expertise, but also assists with fund-raising and financing. GRID leverages its relationships with equipment partners to acquire both donated and discounted equipment, such as inverters.

The Collaborative was enthusiastic about GRID's proposal for bringing solar PV to the reservations. In April 2011, the first residential PV installation was completed on a home on the La Jolla reservation. This soon led to requests for PV systems by other homeowners on all three reservations. Between 2011 and 2017, the three tribal partners and GRID installed solar on 106 residences, about half of which were manufactured homes. Because of structural issues, rooftop solar was not appropriate for some homes. In those cases, GRID installed ground-mounted solar arrays.

Members of the tribe actively participated in jobs such as grading, trenching, installation, and creation of site maps and land assignment boundaries. Participating organizations included the Tribal Employment Rights Office, the California Indian Manpower Consortium, and the San Pasquale Band of Mission Indians Public Works Department. Through GRID's Solar Spring Break program, a "classroom in the field," student volunteers from colleges around the country participated in the project, learning about solar energy technology and its positive effect on LMI communities.

Tribal leaders attribute the successful collaboration between GRID and the tribes to several factors. Clear communication was assured through regular on-reservation meetings, which delineated the construction timeline. GRID staff was available on site at scheduled times to assist tribal members with the details of construction. Tribal staff worked with GRID to help homeowners prepare the paperwork required for solar.

When the Tribal Energy Collaborative installed its first solar project in April 2011, it was primarily financed through California's Single-family Affordable Solar Homes Program (SASH), which is funded through system benefits charges on utility bills and is administered by GRID. The program promotes solar technology to qualified low-income homeowners whose total household income is 80 percent or less of the Area Median Income and who are installing solar on their primary residence. Tribal participants were eligible for a $3/watt rebate for systems whose size is between 1–5 kilowatts. The Tribal residential PV systems were typically 4.2 kilowatts. As well as providing rebates, the SASH program educated homeowners about energy efficiency and encouraged community volunteers to participate in the project.

In 2015, the US Department of Energy's Office of Indian Energy Policy and Programs issued a Funding Opportunity Announcement for Deployment of Clean Energy and Energy Efficiency on Indian Lands.[68] Projects were selected with the goal of accelerating clean energy development, reducing or stabilizing energy costs, and increasing energy resiliency on tribal lands. Non-federal cost sharing was required to cover at least 50 percent of total project costs. The

68 For information about this funding opportunity, see "DOE Deployment of Clean Energy and Energy Efficiency on Indian Lands FOA, "Energy.gov, 10 Dec. 2015, accessed September, 16 2020, *www.energy.gov/indianenergy/events/doe-deployment-clean-energy-and-energy-efficiency-indian-lands-foa*.

Collaborative applied for this grant and received $500,000 to support PV installations on 45 residences, approximately half of which were manufactured homes.

By 2019, 22 percent of the residences (a total of 151 homes) on the three reservations had solar power. Electrical usage by homeowners has been reduced by 35–75 percent, saving an average homeowner approximately $750 annually in electricity costs.[69]

COMMUNITY SOLAR IN NEW HAMPSHIRE: MASCOMA MEADOWS

Project Name: **Mascoma Meadows Cooperative Community Solar Array**
Location: Lebanon, New Hampshire
Date Started and Completed: January–December 2018
PV System Size: 100 kilowatts
Number of Households Benefitting: 45

Mascoma Meadows is a 50-home, resident-owned community (ROC) of manufactured homes in Lebanon, New Hampshire. It is the first ROC in the state to be powered by a community solar array. ROCs are based on a cooperative ownership framework in which each household is a member of the cooperative that owns the land on which the homes are sited. Members continue to own their own homes individually. The Mascoma Meadows community solar array is built on a half-acre of land donated by the neighboring Abundant Life Church of God. The 100-kilowatt array consists of 384 solar panels.

ReVision Energy

69 For more information about this project, see a technical report about it that was submitted to DOE: Desiree Morales-Whitman et al., *San Diego Tribal Energy Collaborative* (San Pasqual Band of Mission Indians, June 2020), *https://www.osti.gov/servlets/purl/1582071*.

The Mascoma Meadows solar project was designed to provide direct financial benefits to LMI and non-LMI residents of the ROC. The solar array is anticipated to save each of the participating LMI cooperative members approximately $20-$25 in housing-lot rent reduction per month. Forty-five of the 50 households in the Mascoma Meadows community are participants in the community solar array.

The project began in January 2018 at a meeting with the Mascoma Meadows Board of Directors. The Board held meetings with community members who participated in the planning and approval of the project. The community initially decided to invest $25,000 to purchase land from the neighboring church, but the church unexpectedly donated the land. A competitive project bidding process then took place and solar developer ReVision Energy was selected. Legal services were provided pro bono by the Vermont Law School Energy Clinic, which designed the Mascoma Meadows solar project model, and by an attorney from the law firm of Primmer, Piper, Eggleston & Cramer. Additional guidance was received from ROC-NH, a program of the New Hampshire Community Loan Fund that assists manufactured home communities convert to member-owned cooperatives, owned and governed by residents. The solar panels were installed in November 2018 and interconnection was completed in December of that year.

The cost of the community solar project was covered in part by a $168,000 grant from New Hampshire's Low-Moderate Income Community Solar Grant Program, which is part of the Renewable Energy Fund managed by the New Hampshire Public Utilities Commission (NH PUC). Financing was provided by a private impact investor through a power purchase agreement (PPA). Through the PPA, the developer and investor ReVision Solar Impact Investors own the community solar array for at least five years, which will allow the investor to leverage federal tax credits to reduce the total cost of the project. After five years, Mascoma Meadows will have the option to purchase the community solar array at fair market value using low-interest financing from the New Hampshire Community Loan Fund.

The Mascoma Meadows solar project model is distinctive in several ways. It leverages an investor's ability to take advantage of the Federal Investment Tax Credit that would otherwise be inaccessible to LMI residents. The grant received from the Low-Moderate Income Community Solar Grant Program is directed towards covering costs of the project and paying down the principal. There is no financial risk for the LMI participants.

Participating Mascoma Meadows residents receive direct financial benefits from the solar array with reductions in lot rent. Non-monetary benefits include educational opportunities to enhance residents' understanding of energy use and lowering electricity costs, and the project gives them the chance to lower carbon emissions and overcome the perception that solar energy is only for affluent communities.

Anne Radesi

COMMUNITY SOLAR IN NEW YORK: LAKEVILLE VILLAGE

Project Name: **Lakeville Village Community Solar Project**
Location: Geneseo, New York
Date Started and Completed: 2017–2021
PV System Size: 4 megawatts
Number of Households Benefitting: 50

Lakeville Village Inc., a manufactured home community in Geneseo, New York, purchased the land for its 50-site community in 2016 to become a ROC. As such, Lakeview Village is now organized as a cooperative with a democratically elected Board of Directors.

During its transition to become a ROC, the Lakeville Village community convened a Solar Committee to investigate the feasibility of installing a solar array on undeveloped land on the premises. In addition to the land where the manufactured homes sit, the Lakeville Village cooperative owns 20 acres of scrubland on a hill behind the home sites and near an electrical substation. With keen interest from the cooperative and suitable conditions for solar development, the Lakeville Village Solar Committee ultimately decided to pursue a community solar installation.

In 2017, Lakeview Village, in collaboration with Larsen Engineering and PathStone, a community development organization, applied for a New York State Energy Research and Development Authority (NYSERDA) grant, which would have included the funds to develop a solar array on Lakeville's land and to support energy efficiency upgrades on some of the cooperative's manufactured homes.

Although the grant application to NYSERDA was not approved, the process sparked a deeper relationship between Larsen Engineering and Lakeville Village. Larsen met with the Board of Directors at Lakeville Village and prepared a Request for Proposal for solar development of some of the acreage behind Lakeview's homesites. Through this competitive solicitation process, RER Energy Group was selected to lease land from the Lakeview Village cooperative for a solar array. RER Energy Group agreed to utilize 10 of the available acres for a 4-megawatt array.

Lakeville Village signed a land lease agreement with RER Energy Group for $850/acre/year, with an annual increase of 1.5 percent. RER Energy Group's array is structured as a community solar project with customers subscribing to it from surrounding communities. The revenue that Lakeview Village receives from the land lease deal with RER Energy Group helps reduce residents' monthly costs. The solar project broke ground on July 6, 2020 and went online in 2021.

COMMUNITY SOLAR IN COLORADO: PONDEROSA MOBILE HOME PARK AND LOW-INCOME RENTAL HOUSING

Project Name: **Ponderosa Community Solar Garden Pilot**
Location: Boulder, Colorado
Date Started and Completed: 2020–2021
PV System Size: 100 kilowatts plus 48 kilowatts in additional subscriptions purchased from a second project
Number of Households Benefitting: Up to 48

The City of Boulder, Colorado is surrounded by open space that is protected from development. As the city's population has increased, demand for housing has driven up home prices. The average home price is $700,000, which is an increase of about $400,000 over the last decade. Concerned about the need to preserve affordability of homes for all residents, the Boulder County Regional Housing Partnership set a goal of making 12 percent of Boulder's housing inventory affordable for LMI households by 2035.

GRID Alternatives

Although manufactured home communities comprise only 2.8 percent of Boulder's housing stock, the City of Boulder has recognized that they can play a valuable role. They provide a path to home ownership, support viable neighborhoods, and are reasonably priced for purchase by LMI households. Accordingly, in 2018 the City developed a Manufactured Housing Strategy to identify and implement options to benefit manufactured home communities.

This strategy dovetailed with the City of Boulder's 2017 $4.2 million purchase of the Ponderosa Mobile Home Park with funds provided by HUD's Community Development Block Grant–Disaster Recovery Fund and Boulder's Affordable Housing Fund. The park is one of the oldest in Boulder and was in dire need of infrastructure repair and replacement. Prior to its 2018 annexation by the City, it was in an unincorporated enclave. Annexation gave the City of Boulder flexibility in its administration of city codes during the ongoing process of upgrading Ponderosa.

Providing clean energy to LMI residents and supporting Boulder's goal of 100 percent renewable electricity by 2030 are components of the Ponderosa revitalization plan. However, it was a challenge to find ways to make PV systems available to residents. The roofs on Ponderosa's manufactured homes are not able to withstand the installation of solar panels. Community solar, which is frequently referred to in Colorado as a "solar garden," turned out to be more appropriate since it does not require roof structures and LMI customers do not incur the upfront costs of installing solar.

The City of Boulder therefore launched a solar garden pilot project for the Ponderosa Mobile Home Park, which could be expanded to other manufactured home communities, if successful. A 100-kW solar garden was constructed by the city on municipal land near Boulder Reservoir. The project provides solar garden subscriptions to the LMI residents. The city purchased additional subscriptions from Jack's Solar Garden, a local privately owned project in Longmont, to ensure there were sufficient subscriptions for all Ponderosa residents.

Funding for the project was provided through the City of Boulder's Energy Impact Offset Fund. Facilities growing marijuana compensate for their intense energy use by purchasing offsets in the Fund. The Fund uses this revenue to capitalize projects that reduce greenhouse gas emissions.

Another project that is seeking to increase access to solar gardens for LMI residents is a 3.8-acre solar garden recently constructed on land owned by Boulder Housing Partners, the city's local housing authority. Built and operated by Grid Alternatives Colorado, this solar garden will benefit residents of affordable housing. The $1.2 million project was funded through a low-interest loan from the BQUEST Foundation, private equity, and grants from the US Department of Energy and the City of Boulder. Boulder Housing Partners will serve as the subscriber on behalf of their residents and will provide the benefit back to residents through reduced electricity bills.

Since solar garden profit margins are thin, developers typically prefer a minimum number of subscribers with high credit scores. A low-income carveout requirement in Colorado's Community Solar Act is often satisfied by subscriptions from housing authorities. But that effectively reduces opportunities for individual subscribers, especially those who are low-income. The City of Boulder's Ponderosa solar garden pilot project and its partnership with Boulder Housing Partners experiment with other models will play an important role in informing the City's future solar strategies.

New Mexico EMNRD

PV ON A POLE™ PUTS SOLAR IN REACH FOR LMI MANUFACTURED HOUSING RESIDENTS IN NEW MEXICO

Initiative Name: **PV on a Pole™**
Location: *New Mexico*

New Mexico has both a high poverty rate and the highest percentage of manufactured housing than any other state. In 2016, the New Mexico Energy, Minerals and Natural Resources Division (EMNRD) began exploring a solar option that could cater to the needs of LMI manufactured housing residents.

Any successful solar offering would need to address two main barriers. One concern was that manufactured homes often lack the structural integrity needed to support roof-mounted solar panels. The second was cost: roof-mounted PV panels can require a labor-intensive installation process that prices the system out of the range of most LMI customers.

To overcome these obstacles, EMNRD piloted PV on a Pole™, is a PV system that uses four solar panels mounted atop a vertical pole. The system has a minimal footprint, only needing land for the foundation and pole, which support the solar panel rack. The streamlined set-up means that PV on a Pole™ can be installed in as little as four hours with a truck-mounted auger drill, and the system can be removed, transported, and reinstalled at any time. Because of the minimal labor required, when produced at scale, the system would cost less than $3/watt when fully installed and could work under a variety of financing models.

In the initial prototypes, PV on a Pole™ systems had a minimum capacity of 1.32 kilowatts, but as solar module technology advances, the system could have nearly twice the capacity. Although household usage and electricity rates vary, this can offset up to one-half of a household's electric bill, a major expense for most LMI households.

EMNRD has partnered with utilities as well as local and tribal governments to pilot several PV on a Pole™ installations. After sharing the concept with several tribal communities, prototype

arrays were installed at the manufactured home of Nambé Pueblo resident Victor Perez. Jemez Mountains Electric Cooperative, the local utility, installed two digital meters on the prototype arrays. Data collected from the meters shows the arrays perform favorably compared to roof-mounted panels.

The production and installation of the PV on a Pole™ systems could also bring meaningful employment opportunities. EMNRD is in talks with tribal communities to potentially train young adults in fabricating, installing, and selling the arrays. Thanks to the system's straightforward installation, it makes an excellent training tool for trades programs. In February 2020, EMNRD was able to source additional PV on a Pole™ kits for use by solar trades classes at Northern New Mexico College, which caters to LMI students. The college installed one of the kits on campus, where it is powering a greenhouse. Additional kits will be used in the college's first electrical training program beginning in 2021.

EMNRD is currently looking to partner with cities, states, and tribal governments, as well as nonprofits, electric utilities, and solar companies to scale up PV on a Pole™ deployment. The department recently worked with officials in Humboldt County, California to share program resources and documentation to replicate the concept. Humboldt County was able to raise $75,000 in funding to produce PV on a Pole™ kits for local installation.

Although this innovative system has yet to reach scale, its initial success indicates PV on a Pole™ could be a viable alternative for LMI manufactured housing residents.

McKNIGHT LANE REPLACES DEFUNCT MOBILE HOME PARK WITH SOLAR MODULAR HOMES WITH BATTERY STORAGE

Project Name: **McKnight Lane Affordable Housing Redevelopment**
Location: Waltham, VT
Date Started and Completed: October 2016
PV System Size: 14 6-kilowatt rooftop systems, including 6-8 kilowatt-hours of battery storage
Number of Households Benefitting: 14

Samantha Donalds/CESA

The McKnight Lane Redevelopment project in Waltham, VT was the first net-zero, low-income rental housing development in the US. Completed in October 2016, this project brought together a broad collaboration of stakeholders from nonprofit organizations, community development agencies, the local utility, industry, state and federal government, and philanthropy to transform a defunct manufactured home community into an innovative low-income community with new clean energy technology that includes solar power and battery storage for each rental manufactured home in the development.

McKnight Lane offers 14 affordable modular homes for rent to income qualified tenants: 12 two-bedroom homes and 2 three-bedroom homes. Each of the net-zero single-family homes has a 6-kilowatt (kW) rooftop solar array. These homes were constructed by VERMOD, a Vermont company that builds custom-designed modular homes that combine ultra-high energy efficiency measures and integrated rooftop solar PV.

With assistance from Green Mountain Power, the US Department of Energy, philanthropies, and two national clean energy nonprofits, the McKnight Lane Redevelopment project was able to add batteries to each of the housing units: 13 homes have a 6-kWh sonnen energy storage system and one of the homes has an 8-kWh battery. With resilient power systems installed in each home, during grid outages due to storms or other emergencies, the solar and battery storage system automatically disconnects from the grid and provides 3-5 hours of electricity to power essential functions of the home such as lights, furnace, and a refrigerator. If necessary, the solar panels can produce energy to replenish the batteries to provide ongoing back-up power. Additionally, during other times when the batteries are not needed for back-up power, the local utility, Green Mountain Power, can use the electricity stored in the batteries during times of high energy use on the grid to manage peak energy demand, which reduces electricity costs for all GMP customers.

The McKnight Lane homes also offer additional energy efficiency and health-promoting features include extra insulation surrounding each home to reduce energy loss, healthy materials that keep pollutants out of the air, filtered air to reduce symptoms from allergies and asthma, triple-pane windows, ENERGY STAR certified lighting and appliances, and cold-climate air source heat pumps that use electricity efficiently to heat and cool the home. The grid electricity needed to power the homes at McKnight Lane is expected to be reduced by nearly 100 percent so that averaged over the year, the energy generated by the PV system and stored by the battery should exceed the level of electricity used, resulting in zero electricity costs for each of the units.

The McKnight Lane Housing Development is unique in demonstrating that relatively new technology such as solar energy paired with battery storage can be made accessible to low-income communities. And in an area with a low vacancy rate for affordable housing, these 14 affordable homes contribute to filling the affordable housing gap. Rents are below market and serve households below 60 percent Area Median Income. Each home includes energy-efficient appliances including washers and dryers and a parking spot. Rent includes heat, air conditioning, hot water, laundry and electricity. The 14 homes are available to rent to qualified low- and middle-income households through the Addison Community Trust. McKnight Lane is owned by a tax credit limited partnership with Addison County Community Trust as the General Partner, which also manages the property.

The McKnight Lane Redevelopment housing developers, the Addison County Community Trust and Cathedral Square, a nonprofit organization providing affordable housing, were able to secure the $3.6 million financing to support the cost of the project, which included the site clean-up, improved infrastructure for the community, and the 14 VERMOD homes. The battery storage systems cost $132,000, after a 25 percent discount from the supplier, sonnen.[70]

PHASE3 PHOTOVOLTAICS INTEGRATES SOLAR INTO NEW MANUFACTURED HOUSING

Initiative Name: **Phase3 Photovoltaics, Inc.**
Location: Portland, Oregon
Date Started and Completed: In development

Phase3 Photovoltaics is a solar energy company based in Portland, Oregon that aims to increase access to solar energy for residents of manufactured homes by incorporating solar systems into the factory's manufacturing assembly process. The company believes that integrating solar systems into models created in the factory would make it more affordable for customers to purchase manufactured homes with rooftop solar.

In 2019, Phase3 won the first round of the American Made Solar Prize, given by the US DOE, for the company's integrated solar panel concept. The award included a $500,000 cash prize and $75,000 in vouchers for work with DOE's National Laboratories. With more than 20 million Americans living in manufactured homes, DOE officials stated that Phase3's innovative concept could expand solar access to a significant portion of the housing sector.

Phase3 Photovoltaics

70 More information about this project can be found on the McKnight Lane page on the Addison County Community Trust website, *https://www.addisontrust.org/mcknight-lane.html*, and on a case study webpage on Clean Energy Group's website, *https://www.cleanegroup.org/ceg-projects/resilient-power-project/featured-installations/mcknight-lane*.

The founders of Phase3, Ethan Good, Nathan Stoddard, and Steve Sefchick, developed their solar panel concept as a way to help LMI households that were underserved by energy-efficient solutions and had little access to solar energy. They believed that costs could be reduced by adding solar technology while manufactured homes were being constructed in the factory rather than during post-construction when costs tend to increase substantially. The concept, referred to as a "solar kit" by co-founder Ethan Good, incorporates an "end-to-end solution" that includes designs, materials procurement, training of factory personnel, permitting, and delivery.[71] Phase3 also seeks to work with financial lenders to incorporate anticipated electricity cost savings in the chattel or real estate mortgage application process, potentially enabling owners of manufactured homes to qualify for a lower rate and a higher loan amount.

To address concerns about potential risks to solar panels attached to a manufactured home during transportation, Phase3 modified the construction and mounting of solar panels that ensured the panels could withstand a speed of 70 miles per hour.

The owners of Phase3 describe additional benefits of producing manufactured homes with rooftop solar in the factory setting, including faster installation than on standard, site-built residential homes. Phase3 can quickly and easily test a range of products and make changes as needed in the factory. Phase3's founders believe that the company's innovative solar technology will attract new customers and could create a significant demand for the availability of manufactured homes with solar panels. The company is focusing on increasing demand for its solar kits by working with manufactured home community developers and by showcasing manufactured homes with pre-installed solar panels at the dealerships. This will help create more demand for manufactured homes with solar panels and increase the market for Phase3's solar kits.[72]

Co-founder Ethan Good believes that it would be most financially beneficial to fold the costs of the solar system into the mortgage because the solar system is not an added risk, but rather it is a revenue generator for the customer, thereby resulting in less risk to the lender. Good said there needs to be more of a shift towards focusing on sales and marketing at the dealer level to inform potential customers that with a small investment of money upfront, the financial return over the lifetime of a solar system is significant. For more information about Phase3, see *www.phase3pv.com*.

71 Carrie Kolehouse. "Company Awarded for Bringing Manufactured Home Solar Energy to Factory Floors." (November 2019.), *https://www.mhvillage.com/pro/manufactured-home-solar-energy.*

72 Ethan Good and Steve Sefchick, Phase3 Photovoltaics, videoconference interview, May 29, 2020.

VEIC

NEW YORK STATE AGENCIES ADVANCE ZEMS

Initiative Name: **Park of the Future**
Location: New York

As discussed earlier in Chapter Four, Zero Energy Modular Homes (ZEMs) are highly efficient and use onsite renewable energy to offset household energy consumption. These modular homes are designed to comply with local building codes.

The New York State Energy Research and Development Authority (NYSERDA) is charged with identifying and promoting clean energy strategies and technologies that reduce pollution and support sustainability. As the agency responsible for advancing energy efficiency and renewable energy, NYSERDA recognized that ZEMs could simultaneously benefit LMI residents and contribute to state decarbonization goals. NYSERDA has been working with fellow state agency Homes and Community Renewal (HCR) to explore ZEM opportunities.

NYSERDA commissioned a preliminary market analysis by researchers at VEIC to assess New York's manufactured home inventory, the potential for long-term affordability, existing policies and incentives, and the costs and benefits of ZEMs. This 2018 study confirmed that ZEMs could provide meaningful energy savings and environmental benefits in addition to improving the well-being of residents.[73]

Following the market assessment, HCR issued a request for proposals (RFP) in 2019 to offer funding support to New York manufactured home communities specifically to advance ZEMs. The "Park of the Future" Demonstration Program would complement existing HCR programs that fund maintenance, provide resources for upgrades, offer administrative support, and more.[74]

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73 Vermont Energy Investment Corporation, *Volume 1: Market Analysis for Zero Energy Modular in New York State* (VEIC, October 2018), *https://www.veic.org/Media/default/documents/resources/reports/nys-zem-market-analysis.pdf*.

74 The program referred to manufactured home communities using the term "park." See HCR, "Park of the Future Demonstration Program," *https://hcr.ny.gov/system/files/documents/2019/07/20190717_Park%20of%20the%20Future_RFP.pdf*.

In addition to the demonstration ZEM sites, HCR initiated a campaign to connect with stakeholders. In 2019, it began grassroots outreach by hosting AmeriCorps VISTAs in seven locations across the state. These representatives interviewed manufactured home residents, affordable housing advocates, local officials, and park owners. They also tracked park conditions and sales to better understand local challenges and areas to address.

This work revealed that there are some universal barriers to ZEM adoption, with solutions often requiring an understanding of local communities and government oversight. For HCR and NYSERDA to facilitate integrating ZEMs into existing mobile and manufactured home parks, they needed buy-in from park owners. The park owners typically have tight margins for their operational budgets and struggle to afford additional debt. The agencies needed to identify potential lenders to help finance park operation improvements and ZEM upgrades.

Another hurdle NYSERDA and HCR are tackling relates to the supply, production, and distribution of ZEMs. Few factories create net-zero modular homes and they have limited capacity. To lower industry costs and grow consumer interest, HCR and NYSERDA are finding partners in regions where demand is high. By strengthening the ZEM network, the agencies are endeavoring to streamline development and build on the learnings from the initial Park of the Future homes.

The ZEM effort in New York is a work in progress and continues. A report will be written to reflect on the Park of the Future processes and ZEM pilot sites. What is clear so far is the need for additional outreach and targeted education about ZEMs at each point of the supply chain. The process to identify viable pilot sites and construct ZEMs is already helping NYSERDA and HCR to think more comprehensively about ways to transform manufactured home communities. For example, the Park of the Future program is helping residents to purchase, own, and invest in their parks by establishing ROCs.

Park of the Future shows that it is possible to overcome the various industry and bureaucratic challenges to ZEM adoption. This fits into broader state priorities for energy and housing for LMI households.

SOUTH CAROLINA REDUCES HIGH ENERGY BURDENS THROUGH ENERGY EFFICIENCY AND ON-BILL FINANCING

Initiative Name: **Help My House Program**
Location: South Carolina
Date Started and Completed: 2011–Present
Number of Manufactured Homes in Pilot: 72
Number of Households Benefitting: 125 from the pilot; 800+ in total

"Help My House" is an on-bill financing, energy efficiency program that was piloted in South Carolina by rural electric cooperatives in 2011. It allowed residents and homeowners to make their homes more energy efficient by providing a "whole house" retrofit method. It has not focused on solar installations, but the combination of proactive involvement by electricity coops and on-bill financing could be adapted to promote solar development in the future.

During its pilot phase, Help My House benefitted 125 homes with more than half of them being manufactured homes. The pilot was the first energy efficiency program in the nation to access lending capital from the US Department of Agriculture's Rural Utility Service through the re-tooled Rural Economic Development Loan and Grant (REDLG) program. The model

Aiken Electric Cooperative

serves as a solution for the disproportionately high energy burden that many rural homeowners experience.

A high percentage of South Carolina's housing stock consists of manufactured homes, with most of them in rural low-income communities on individual, privately owned plots of land. Many of these homes are highly energy inefficient homes because they were constructed before the creation of the US Department of Housing and Urban Development's energy efficiency standards. During peak months, some low-income residents find themselves spending much of their income on energy, and the Help My House program can alleviate a significant amount of the energy burden.

The Help My House pilot provided homeowners with needed energy efficiency improvements, including heating, ventilation, and air conditioning; bathroom and kitchen vent repair, cleaning, and/or installation; attic insulation; envelope sealing; and duct cleaning. Some homeowners were also able to take advantage of routine maintenance checks and fixes. The pilot reduced average home use of electricity by 34 percent. These improvements were financed through loans to be paid back over time on residents' utility bills. The average payback was 6.5 years, far less than the 10-year loan period.

Eight out of South Carolina's 20 electric cooperatives participated in the initial pilot of Help My House. Those coops—Aiken Electric, Black River Electric, Broad River Electric, Horry Electric, Palmetto Electric, Santee Electric, and Tri County Electric—worked with wholesale power provider Central Electric Cooperative to form a nonprofit called KW Savings that administered 10-year, 2.5 percent interest loans funds, which were processed through 1st Cooperative Federal Credit Union. The Environmental and Energy Study Institute helped design the program and participated in outreach to key stakeholders, including Congress. Ecova, a firm focused on implementing energy efficiency programs for utilities, supported with the program planning, management, and analysis, and Integral Analytics provided the cost-effectiveness overview. Carton Donofrio Partners conducted surveys and supported marketing and training efforts.

The program continued after the initial pilot program model for five of the state's electric coops. This has benefited more than 800 homes in South Carolina. Although the Help My House approach may not work for every coop, it offers a method of on-bill financing. The program can be used by coops to identify homes to receive energy audits and then to select the best candidates to participate.

CHAPTER FIVE

General Findings and Recommendations

FINDINGS RELATED TO THE MANUFACTURED HOMES HOUSING STOCK

The analysis of data from the US Census Bureau and Datacomp, as well as information from other sources, leads to some general findings.

1. There Is Tremendous Variation among the Target States in their Manufactured Homes Housing Stock

The researchers for this project started with an assumption that there would be differences between the manufactured housing stock in different states, but they were surprised by the extent of those differences. Some differences—such as the large concentration of age-restricted communities in the traditional retirement settings of Arizona and Florida—were easy to predict, but the types and range of differences were strikingly large. In particular,

- The share of manufactured homes in a state's housing stock ranges from less than 4 percent in the case of California and Ohio to more than 16 percent in the case of New Mexico and South Carolina.
- In some states, homes are mostly located in manufactured home communities, while other states' homes are mostly located on individually owned plots of land. The Datacomp database of homesites in communities captures 67 percent or more of all manufactured homes in California, Michigan, and Ohio, but fewer than 15 percent in Georgia, North Carolina, and South Carolina.
- Some states are much more dominated by large, manufactured home communities than others (see Table 3 below). In Arizona, 64 percent of the communities with homesite data have more than 100 homesites, while 56 percent of the communities in Michigan have more than 100 homesites. In contrast, in Kentucky only 16 percent of the communities have more than 100 homesites. In terms of very large communities with more than 500 homesites, Florida has 169, and Arizona and Michigan both have more than 50; but Kentucky, Maine, Missouri, and North Carolina all have fewer than five.

TABLE 3: **Communities by Size (for communities with homesite data)**

	Large 100+ Homesites	% Large	Medium 50–99 Homesites	% Medium	Small 1–49 Homesites	% Small
Arizona	423	64.3%	131	19.9%	104	15.8%
California	1,309	38.5%	686	20.2%	1,405	41.3%
Florida	1,085	46.0%	278	11.8%	994	42.2%
Georgia	140	36.8%	95	25.0%	145	38.2%
Kentucky	101	16.5%	106	17.3%	406	66.2%
Maine	43	31.2%	31	22.5%	64	46.4%
Michigan	574	55.7%	252	24.4%	205	19.9%
Missouri	129	22.0%	124	21.2%	333	56.8%
New Mexico	68	29.7%	67	29.3%	94	41.0%
N. Carolina	185	21.5%	203	23.6%	473	54.9%
Ohio	427	22.8%	400	21.4%	1,043	55.8%
S. Carolina	110	28.8%	83	21.7%	192	50.3%
Texas	523	23.7%	419	19.0%	1,267	57.4%
Virginia	116	29.8%	109	28.0%	164	42.2%
Average	374	33.4%	213	21.8%	492	44.9%
Median	163	29.8%	128	21.6%	269	44.3%

- Most manufactured homes are located in large communities (i.e., those with more than 100 homesites). This holds true even for states where a large majority of the communities are small. Within the general pattern that most homes are in large communities, there are variations. In Arizona, Florida, and Michigan, at least 86 percent of the homesites in the database are in large communities with more than 100 homesites.
- In Arizona, 35.5 percent of communities are age restricted to residents at least 55 years of age; and at least 17.7 percent of communities are age-restricted in California and Florida, but fewer than 3 percent are restricted in Georgia, Kentucky, North Carolina, and Virginia.
- The size and significance of the market for new manufactured homes varies widely. In 2019, only 635 homes were shipped to market in Maine, but there were 15,866 shipped to market in Texas. As for the share of all new single-family homes in 2019, manufactured homes represent more than 20 percent of the total in Kentucky, Michigan, and New Mexico, but fewer than 7 percent in Arizona, California, and Virginia.[75]

75 Numbers based on US Census Bureau, "U.S. Manufactured Housing Shipments by State: 2019," *https://www2.census.gov/programs-surveys/mhs/visualizations/2019/2019usmapbystate.pdf*; and US Census Bureau, "Building Permits Survey Annual Data," *https://www.census.gov/construction/bps/stateannual.html*.

- It is also important to call out the considerable variation in the completeness of the Datacomp database for different states. The database does not include a count for the number of homesites in many communities. This data varies in its lack of coverage from less than 15 percent of communities in the case of Missouri, Michigan, Ohio, and Texas to more than 50 percent for Florida, Maine, North Carolina, and South Carolina. There is clearly a greater margin of error in the results for states with more missing homesite counts. Datacomp believes that most communities without site counts are small and some may even be defunct, but it suggests the need to recognize that there is a margin of error.

2. Manufactured Homes are Usually, but Not Always, in Locations with Incomes below the Median.

Individual household income is protected for privacy, so the researchers for this report had to explore the relationship between income and manufactured homes in other ways.

First, US Census Bueau data was used to examine the relationship between a county's median household income and the percentage of the local housing stock that is comprised of manufactured homes. Researchers included both manufactured homes in communities and those sited on individual plots of land, according to estimates from the Bureau's 2019 American Community Survey (ACS).[76] As shown in the state maps by county in Volume 2 of this report, there tends to be an inverse relationship between a county's median income and the percentage of manufactured homes. In other words, there are more manufactured homes by percentage in counties where incomes are lower. This is unsurprising, because manufactured homes tend to be more prevalent in rural areas, and those areas tend to have lower median incomes.

Second, to analyze each manufactured housing community listed in the Datacomp database, analysts used the ACS median household income at the census-tract level to create an appropriate proxy for residents in those geographic areas. This is, of course, an inexact measure of the income of residents in manufactured homes, since they usually do not comprise all the homes in the census tract. According to the Census Bureau, "Census tracts generally have a population size between 1,200 and 8,000 people, with an optimum size of 4,000 people."[77] This gives a sense of the income level of the immediate area in which a manufactured home community resides. In the case of the largest communities, the community can comprise most of the total census tract.

Once the median income of the census tract for each manufactured home community was determined, it was compared to the median income of the encompassing Core Based Statistical Area (CBSA). The CBSA is a larger geographic area and the unit of measure typically used to determine area median income (AMI). The Census Bureau defines CBSA as "the county or counties or equivalent entities associated with at least one core (urbanized area or urban cluster) of at least 10,000 population, plus adjacent counties having a high degree of social and economic integration with the core as measured through commuting ties with the counties associated with the core."[78] In cases where the CBSA information was not available, county-

76 US Census Bureau, "American Community Survey," *https://www.census.gov/programs-surveys/acs.*

77 US Census Bureau, "Glossary" webpage, *https://www.census.gov/programs-surveys/geography/about/glossary.html#par_textimage_13.*

78 bid.

level income data was used instead. The median income of the census tract was then compared to that of the state as a whole.

Finally, after comparing the median incomes at each geographic level, manufactured home communities were placed into income categories. For "low-income," the most common definition was used, which is having a household income of less than 80 percent of AMI. The common definition of "moderate income" was used, which is between 80–100 percent of AMI. Additional explanation about the data sources, assumptions, and methodology used is available in Volume 2, Appendix C.

Tables 4 and 5 show the results of this tabulation. They compare the median incomes of the census tracts of manufactured home communities and homesites to the AMI according to the relevant CBSA and to the state median income.

TABLE 4: **Census Tracts of Manufactured Home Communities Compared to AMI (CBSA)**

	% of Communities that are LMI	% of Homesites that are LMI	% of Communities that are Low Income	% of Homesites that are Low Income
Arizona	93.4%	90.7%	79.9%	70.6%
California	65.0%	66.2%	41.1%	39.6%
Florida	71.1%	74.2%	43.4%	47.0%
Georgia	63.6%	60.2%	36.3%	36.2%
Kentucky	41.1%	53.1%	19.2%	27.4%
Maine	29.5%	38.1%	11.5%	11.9%
Michigan	42.2%	44.0%	18.5%	15.7%
Missouri	47.0%	47.1%	20.0%	18.8%
New Mexico	55.3%	55.1%	25.7%	27.0%
N. Carolina	53.8%	45.5%	20.1%	20.7%
Ohio	47.7%	44.1%	22.0%	24.3%
S. Carolina	62.5%	68.4%	31.8%	17.9%
Texas	56.1%	53.2%	32.5%	30.5%
Virginia	47.7%	56.1%	21.5%	34.7%
Average	55.4%	56.9%	30.3%	30.2%
Median	54.5%	54.1%	23.9%	27.2%

TABLE 5: **Census Tracts of Manufactured Home Communities Compared to State Household Median Income**

	% of Homesites that are LMI	% of Homesites that are LMI	% of Communities that are Low Income	% of Homesites that are Low Income
Arizona	89.7%	86.3%	67.2%	58.1%
California	82.4%	74.4%	62.5%	51.7%
Florida	82.7%	82.4%	59.7%	57.5%
Georgia	75.4%	61.3%	54.8%	43.9%
Kentucky	69.0%	61.9%	38.5%	28.2%
Maine	52.1%	30.2%	27.2%	9.4%
Michigan	62.4%	51.2%	33.0%	21.9%
Missouri	65.0%	48.0%	32.2%	20.9%
New Mexico	59.2%	55.5%	38.5%	31.7%
N. Carolina	68.3%	56.1%	36.9%	31.8%
Ohio	65.2%	57.2%	34.3%	29.4%
S. Carolina	68.8%	70.0%	43.4%	28.5%
Texas	70.7%	66.6%	46.6%	44.7%
Virginia	81.7%	69.2%	60.4%	37.8%
Average	70.9%	62.2%	42.6%	35.4%
Median	68.9%	61.6%	40.9%	31.8%

Findings from these results include:

- Arizona, California, Florida, Georgia, and Virginia stand out in terms of share of LMI and low-income communities and sites across all key metrics. In contrast, Michigan and Maine have significantly lower proportions than average of LMI and low-income communities and sites when compared to AMI/CBSA.
- When using the state metrics, proportions of LMI and low-income communities and sites are usually higher than when the comparison is made to AMI/CBSA. The differences are large in a few states: Kentucky, Michigan, Ohio, and especially Virginia. These differences reinforce the notion that manufactured home communities tend to be in parts of a state with relatively low incomes overall.
- In general, the states that have high proportions of LMI and/or low-income communities and/or sites for the AMI/CBSA metric tend to also have high proportions for the state metric. The same trend of consistency applies to states with low proportions of LMI communities and sites. There are, however, two notable exceptions. South Carolina has relatively high proportions of LMI communities and sites based on the AMI/CBSA benchmark, but relatively low proportions of LMI communities and sites based on the state benchmark. Conversely, while Virginia has relatively low proportions of LMI communities and sites based on the AMI/CBSA benchmark, it has relatively high proportions of LMI communities and sites based on the state benchmark.

- There is no standard pattern in the LMI status of age-restricted communities. In general, age restrictions appear to be almost twice as prevalent in LMI communities (when comparing to the state median income numbers). But in the three states with the most age-restricted communities (Arizona, California, and Florida), those communities were at least slightly less likely to be LMI.
- A few states depart from typical patterns:
  - Kentucky has comparatively low proportions of LMI communities and sites, as well as low-income communities, yet has an above-average percent of low-income sites.
  - South Carolina has comparatively high proportions of LMI communities and sites and low-income communities, yet a significantly below-average percent of low-income sites.
  - Virginia has comparatively low proportions of LMI communities and sites and low-income communities, but a significantly above-average percent of low-income sites.
- It is, of course, possible that the households in a manufactured home community could be LMI even if their census tract is not. On the other hand, it is possible that there are LMI census tracts where the manufactured home community residents are not LMI. Given what is known about the general national pattern of relatively low incomes of manufactured home residents, the former situation is much more likely to be the case.

3. There Are Two Key Characteristics of Manufactured Home Residents

First, most households in manufactured housing own their home. This creates opportunities for the accumulation of home equity that LMI renters do not have. Solar initiatives targeted at the manufactured homes market can contribute to this wealth building.

Second, most LMI households in manufactured homes live near to other manufactured homes, whether they are in a community or in an informal subdivision. This creates good opportunities for targeted solar outreach and marketing campaigns because the households are clustered together.

STRATEGIES FOR ADVANCING SOLAR FOR MANUFACTURED HOMES

Although it is important for states and utilities to try to bring the benefits of solar energy to residents of manufactured homes, it will not be easy because of the obstacles discussed in Chapter Three. It is unrealistic to think any state, with the possible exception of California, could roll out an initiative that would impact tens of thousands of households in the near term.

The solar market for manufactured homes is in its early stages. It would be most useful to experiment with different strategies to see which have the greatest potential to be replicated. States and utilities in locations with pre-existing strong solar-friendly policies and with experience promoting LMI solar for other types of housing should have an easier time adding manufactured homes to their repertoire. But all states have potential to address solar for manufactured homes at some level.

Through the rest of this chapter, we discuss eight strategies that states and utilities can consider when trying to include residents of manufactured homes in their LMI solar strategies:

1. Assess the housing stock in the state or utility service territory
2. Start with modest targeted efforts
3. Recognize that special funding or incentives will be necessary
4. Find the best venues for pursuing a "solarize" strategy
5. Target resident-owned and other nonprofit communities
6. Promote certain types of large community-scale arrays
7. Support efforts to incorporate solar into new homes
8. Consider third-party ownership, on-bill financing, and other special financing options

1. Assess the Housing Stock in the State or Utility Service Territory

As this report's findings show, there are many differences in the housing stock of manufactured homes among different states. This means that the easiest places to pilot a new solar program or project will vary, as will the possibilities for replication if the first projects are successful. In some cases, large manufactured home communities will be an appropriate initial focus, while in others informal subdivisions will make more sense. In some places, retirement communities may be especially plentiful, or there may be rural electric coops or municipal utilities that have demonstrated a commitment to helping low-income ratepayers and also have a significant number of manufactured homes in their territory.

Selecting a market segment to target is not a quantitative calculation, however. For example, even though a state's retirement communities might initially appear to be a good focus based on their abundance, closer inspection might reveal that some are in a heavily wooded part of the state or have little available land or have few residents who qualify as LMI.

2. Start with Modest Targeted Efforts

Rather than launch a large, general, manufactured homes initiative, it would be best to start with a modest effort aimed at a segment or segments of the manufactured housing in a state or utility service territory. To produce a track record of success, it makes sense to identify the low-hanging fruit—the locations, types of communities, and types of installations that will be easiest to achieve success with. It will be especially important to identify strategies and technologies that can be replicated in ways that will create economies of scale and bring down installation costs over time.

If a state does not want to be perceived as picking winners, it could issue an RFP, offering to fund a certain number of projects that meet specific criteria and asking bidders to indicate how their proposed projects will meet the criteria and the extent to which households in manufactured homes will benefit. Depending upon how the RFP is structured, the bidders could either be solar developers, municipalities, utilities, or manufactured home communities.

It is also worth considering how solar for manufactured homes can help advance other state priorities; perhaps there is a region of the state that has already been targeted for poverty alleviation or where a successful project would have an especially large impact.

3. Recognize that Special Funding or Incentives Will Be Necessary

For a program to truly benefit LMI households, it will need to provide meaningful financial savings while minimizing the risk; it must prevent the household from becoming tied to a contract that turns into a money loser. A market-rate program without special incentives will not achieve those things.

A state or utility needs to be prepared to provide extra funding beyond what might be available for a market-rate program for upper-income residents. Depending upon how the program is structured, that funding might be in the form of rebates or other cash incentives, interest-rate buydowns, loan-loss reserves for lenders, and/or funding for solar companies to enter the market and offer advantageous financial products.

Any special funding needs to be structured with safeguards that ensure that financial benefits are flowing to the manufactured home households and not just to project developers or community owners.

4. Find the Best Venues for Pursuing a "Solarize" Strategy

"Solarize" has proven to be an effective model for community-based marketing campaigns and it could be well matched to solar projects for manufactured homes. Solarize as a concept began in Portland, Oregon and spread to many other locations across the country. It is based on the insight that community social networks can be "a powerful force for driving social adoption." The classic Solarize campaign involves community-supported outreach, solar installers selected ahead of time through a bidding process, discount pricing, and a limited time period for consumers to participate. There have been many variants on this approach, but there is always a concerted marketing campaign focused on a particular location and with reasons for near-term participation.[79]

A research team led by Kenneth Gillingham of Yale University has shown that the Solarize approach leads to more solar installations and lower costs. They argue that solar is, in effect, contagious. "One of the central factors determining whether a given house installed solar was the actions and influence of peers. Over a six-month period, the presence of one solar rooftop project increased the average number of installations within a half-mile radius by nearly 50 percent."[80]

Solarize is especially well matched to manufactured housing for three reasons:

1. Most manufactured homes are located in close proximity to other manufactured homes, so a location-specific marketing campaign can reach a large number of potential customers.

2. The population has limited familiarity with solar and few nearby residential installations to see and learn from, so outreach and education need to be important components of any initiative.

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79 Kenneth Gillingham et al., *Solarize Your Community: An Evidence-Based Guide for Acceleration the Adoption of Residential Solar* (Yale Center for Business and the Environment, n.d.), pp. 8, 10, and passim, *https://cbey.yale.edu/sites/default/files/2019-09/Solarize%20Your%20Community%20Rev1%20Dig.pdf.* See also Nate Hausman and Nellie Condee, *Planning and Implementing a Solarize Initiative: A Guide for State Program Managers* (CESA, September 2014), *https://www.cesa.org/wp-content/uploads/CESA-Solarize-Guide-September-2014-lowres.pdf.*

80 Gillingham, *Solarize Your Community,* p. 8.

3. Specialized technologies (i.e., ground-mounted systems or pole-mounted systems) will often be needed. Costs will be much lower if a solar installer experienced with that type of system is recruited ahead of time and can make a bulk purchase of the needed equipment. Similarly, for community solar installations, costs will be lower if there is a marketing mechanism that can recruit a large number of subscribers.

In some states, manufactured housing communities will be the best targets for Solarize campaigns, while in other states it will be informal subdivisions. If informal subdivisions are chosen, the Solarize campaign does not need to be restricted to the manufactured homes in those communities, because the same technologies can work for other homes and households. Those other households are also very likely to have low or moderate incomes.

5. Target Resident-Owned and Other Nonprofit Communities

Resident-owned manufactured home communities (ROCs) are especially good settings for solar. In those communities, the residents not only own their own land, but have a voting membership in the cooperative organization. Each ROC is a nonprofit cooperative entity, with homeowners having equity in the coop. A board elected by the residents makes most day-to-day decisions, although a large decision, such as purchasing a solar array or participating in a solar project, is made by all the residents.

A ROC is empowered to make decisions that benefit its residents and there is no community owner with a different set of financial interests and incentives. Several different types of solar projects can work for a ROC, including a central array that provides power for and reduces operating costs for shared community facilities; a community solar project that enrolls some or all community members as subscribers; dispersed rooftop or ground-mounted arrays that provide power for individual homes in the community; and leasing community land for a community solar project. In the Mascoma Meadows case study in Chapter Four, 45 of the community's 50 households are participating in a community solar project. In the Lakeville Village project in the same chapter, the community leased out some of its land to a community solar developer.

In addition to ROCs, there are other types of manufactured home communities that are not owned by private sector owners seeking profit. These nonprofit owners can include community land trusts, housing agencies, nonprofit organizations, condominium associations, and municipalities, such as Boulder's Ponderosa Mobile Home Park, described in a case study in Chapter 4.

TABLE 6: **Resident-Owned (ROCs) and Other Nonprofit Communities**

	ROCs and Other Nonprofit Communities in the Datacomp Database
Arizona	13
California	202
Florida	183
Georgia	4
Kentucky	1
Maine	10
Michigan	4
Missouri	3
New Mexico	1
N. Carolina	5
Ohio	3
S. Carolina	0
Texas	13
Virginia	6
Total	448

As shown in Table 6, the Datacomp database shows 448 ROCs and other nonprofit communities in the 14 target states, the vast majority of which are ROCs. The number of these communities is large enough to suggest that there is significant potential to target this type of community, and there are some additional nonprofit communities that are not in the database. However, 86 percent of all the nonprofit communities in the Datacomp database are in just two states, California and Florida. There are therefore many opportunities in two of the 14 target states, but relatively few in the other 12 states. Even those states that have few ROCs can look into whether there are solar possibilities for those communities.

6. Promote Certain Types of Large Community-Scale Arrays

To get around the problem that most manufactured homes will have difficulty accommodating rooftop installations, states and utilities can focus on larger community-scale arrays. These can take several forms.

A large solar array for a manufactured home community can power community facilities, including recreational facilities, the community office, and streetlights. The two limitations of this approach are that there may not be a sufficient common electric load to create meaningful financial savings from a solar installation and, except in the case of nonprofit communities, it can be difficult to guarantee that the savings from the array benefit the residents rather than the community owner.

A more widely applicable approach is a large shared-solar project, which is commonly called "community solar" by the solar industry and the federal government (see Chapter Three for background on community solar). For two of the community solar projects profiled in Chapter 4, an auspicious congruence of circumstances created special opportunities. In the case of Lakeville Village, the community was fortunate to own a large tract of land that was attractive to developers because of its proximity to an existing utility substation. With Mascoma Meadows, a nearby church was willing to donate land and several private-sector organizations were willing to help with getting the project launched.

Other similar situations will likely emerge, but community solar for manufactured homes will not spread widely if it depends upon serendipity. More proactive efforts by states and utilities will be necessary. In some places, there are existing community solar initiatives that require LMI households to participate in projects. A state or utility can help project developers identify and recruit manufactured home residents who qualify under the provisions of the community solar policy or program.

States and utilities can also proactively seek to replicate either the Lakeville Village or Mascoma Meadows approach. Those projects not only provided financial benefits to community residents but also increased community pride and community cohesion, because a major clean energy project is specifically identified with the community. To find appropriate sites for similar projects, a state or utility could conduct or commission a study of manufactured home communities with appropriate land for a community solar project or could offer special incentives to solar developers for developing projects that target manufactured home residents.

Without such special initiatives, participation in solar programs by manufactured home residents is likely to remain low, in part because of their lack of awareness of solar and in part because project developers often have little interest in recruiting LMI subscribers, who

they perceive to be more difficult to recruit and less likely to maintain steady payments. Low credit scores can be a real or perceived barrier to marketing solar to LMI households.

It is also important to ensure that the manufactured home households are protected from financial reversals that could trigger a household crisis. Unless strong consumer protection measures are in place, LMI households can be locked into long-term community solar contracts that can be hard to exit if market or policy changes make the solar electricity more expensive than conventional electricity from the local utility. Solar projects should be structured so that they provide significant guaranteed bill savings for the LMI subscribers and are low or no risk (i.e., the LMI subscribers can withdraw without penalty at any time).[81]

One promising strategy is to involve an anchor tenant (i.e., a financially robust entity that contracts for a significant share of the electricity from the shared-solar project). The anchor tenant enables participation by LMI subscribers by accepting slightly lower cost savings on its share of the project and/or by agreeing to vary the amount of electricity it gets from the project as LMI customers join or withdraw. The project developer thereby receives a stable revenue stream and a sufficient rate of return to want to market to LMI customers, while the LMI subscribers achieve bill savings and can withdraw from participation as needed. Anchor customers have included private companies, churches, housing authorities, and government agencies. States and utilities can facilitate the participation of such anchor tenants in community solar projects aimed at manufactured home households.

7. Support Efforts to Incorporate Solar into New Homes

As discussed in Chapter Three, the cost of making new manufactured homes solar ready is not large. And adding solar to a home in the factory is usually easier and cheaper than a later onsite installation. If the price of the PV installation is included in a mortgage, the transaction is easy for the customer and can even lead to cost savings from day one. States and utilities should consider outreach to home dealers and manufacturers, as well as offer modest subsidies for LMI customers to incentivize these types of installations. The purchasers of new homes are more likely to have moderate incomes than low ones, but it is still a demographic well worth reaching. If just one percent of the new manufactured homes produced each year were built with installed solar, it would be nearly 1,000 installations. Of course, a higher percentage of the new homes could be targeted.

8. Consider Third-Party Ownership, On-Bill Payments, and Other Special Financing Options

A solar program for manufactured homes needs to include a way to address the upfront costs of a PV system so that the transaction is cash-flow positive for households from day one. It will otherwise be difficult to get households to participate, no matter how financially favorable a solar project would be in the long run. Different ownership and financing models could help solve that challenge.

81 On consumer protection problems and solutions, see Diana Chace and Nate Hausman, *Consumer Protection for Community Solar: A Guide for States* (CESA, June 2017), *https://www.cesa.org/assets/2017-Files/Consumer-Protection-for- Community-Solar.pdf.*

Third-Party Ownership. The easiest and most widely available financing approach is third-party ownership of the PV system through a lease or power purchase agreement (PPA). The modeling of sample systems by the North Carolina Clean Energy Technology Center in Volume 2, Appendix A shows the types of savings households might achieve using a lease in different states. Extra incentives from the state could make solar more attractive than these numbers indicate. Besides addressing the initial upfront payment issue, leases and PPAs monetize the federal tax credit for residents who do not pay sufficient income tax to benefit, because the third-party owner can qualify for the commercial solar tax credit to lower the initial cost of the system. On the other hand, there would need to be some consumer protections to ensure that annual increases in lease payments through an escalator clause do not turn the PV system into a negative investment over time.[82] Unfortunately, leases and PPAs are obviously not options in states that do not allow for third-party ownership.

On-Bill Payments. Various on-bill payment strategies are also worth considering. With the most common form of on-bill financing, consumers pay for the cost of energy improvements through monthly repayment on their electric utility bill.[83] In effect, the consumer receives a loan that is paid back over time. In some cases, the utility pays for the initial investment in the PV system, while in other cases private companies are able to offer a system through a lease or PPA and receive repayment through the customer's bill. More than 110 utilities offer on-bill financing. It is especially common in the Southeast, where there is high market penetration of manufactured homes.

The Environmental and Energy Study Institute manages a project to help utilities establish on-bill financing and has many useful resources on its website, including an interactive version of the map in Figure 8 and case studies of three utilities that have used on-bill financing for community solar.[84] Some on-bill financing programs have provisions that make them difficult to use for PV installations and make it difficult for LMI households with low credit scores to qualify, but other programs would be well matched to solar for manufactured homes. Utilities without existing on-bill financing can consider establishing such a program to facilitate energy efficiency and solar for LMI households.

An on-bill tariff is another approach to on-bill payment. In this case, neither the cost of the energy improvement nor the payment is tied to the household. Instead, the utility makes an expenditure that is tied to a specific utility meter. Much like other electric system improvements that a utility undertakes, regulators approve the utility's proposed improvements to a building

82 For consumer protection issues related to leases and PPAs, see Nate Hausman, *A Homeowner's Guide to Solar Financing: Leases, Loans, and PPAs* (CESA, revised edition, November 2018), *https://www.cesa.org/resource-library/resource/a-homeowners-guide-to-solar-financing-leases-loans-and-ppas*.

83 For an overview of on-bill financing, see Miguel Yanez-Barnuevo, *On-Bill Financing: Expanding Access to Energy Efficiency, Clean Energy Adoption, and Electrification for Everyone* (Environmental and Energy Study Institute, 2020), *https://www.eesi.org/files/Report-On-Bill-Financing-For-Solar-Energy-Miguel-Yanez.pdf*.

84 Environmental and Energy Study Institute, "EESI's On-Bill Financing (OBF) Project" webpage, *https://www.eesi.org/obf/main*.

FIGURE 8: **Utilities with On-Bill Financing**

Source: Environmental and Energy Study Institute

and authorizes it to recover those costs over time through a charge on the electric bill for the building. This approach often goes by the acronym of PAYS® for "Pay as You Save."[85]

Because an on-bill tariff is not structured as a loan for which the household needs to qualify, it is well-matched to project for LMI households and can work with renters. The household's responsibilities end if they move, and the utility can continue to receive payment from the next residents until the obligation is paid off.

A team of organizations, led by Groundswell, is in the midst of a US DOE-funded research project, LIFT Solar Everywhere, to study how on-bill tariffs can be used for LMI solar. Their initial research papers find the concept to have significant potential, but there are specific issues that need to be addressed, including how to monetize the federal solar tax credit and how to adjust the number of years over which repayment occurs to ensure that the consumer saves money from day one.[86]

85 For more on on-bill tariffs, see Clean Energy for Low Income Communities Accelerator, "Issue Brief: Low-income Energy Efficiency Financing through On-Bill Tariff Programs" (US DOE Better Buildings, n.d.), *https://betterbuildingssolutioncenter.energy.gov/sites/default/files/IB%20L-I%20EE%20Financing%20through%20On-Bill%20Tariffs_Final_0.pdf* and Clean Energy Works, "PAYS® for Energy Efficiency" webpage, *https://www.cleanenergyworks.org/about-pays-for-ee.*

Special Funding Opportunities. Manufactured housing in some locations may qualify for special funding under federal programs or private sector initiatives. The San Diego Tribal Energy Collaborative, described in Chapter 4, received funding through US DOE's Office of Indian Energy Policy and Programs. If and when there are other funding cycles through that office, there could be opportunities for solar for manufactured housing at other tribal reservations.[87]

The US Department of Agriculture administers the Rural Energy Savings Program, which was established by the 2014 Farm Bill and reauthorized in the 2018 Farm Bill. It aims to help rural families and small businesses reduce their energy costs. Given that a high percentage of manufactured homes are in rural areas, there can be opportunities to use this funding for solar installations. The current funding is fully subscribed, but there could be more in future years. The money is distributed in the form of zero-interest loans to rural utilities and other companies for energy efficiency programs. Rural electric coops, municipal utilities, and other utilities could in turn distribute the funds to manufactured housing homeowners through on-bill financing programs and other mechanisms.[88]

CONCLUSION

The eight general recommendations above can guide efforts by state governments, utilities, the solar industry, manufactured home associations/resident, and other stakeholders to bring solar to manufactured homes. Speedy progress will not be easy, given the significant obstacles to developing solar in ways that provide meaningful, risk-free, financial benefits to LMI manufactured home residents. But that is not a reason for inaction, because it is so important to ensure that all segments of the population, including those who live in manufactured homes, can benefit from solar energy.

A good starting point for making progress is to understand the opportunities and challenges for solar for manufactured homes in different specific locations. For that reason, Volume 2 of this report includes individual state chapters with detailed information about the situation in 14 states—Arizona, California, Florida, Georgia, Kentucky, Maine, Michigan, Missouri, New Mexico, North Carolina, Ohio, South Carolina, Texas, and Virginia. In addition to extensive quantitative information that is displayed through maps and tables, there is discussion of each state's relevant energy policies, solar market, and PV system costs. Each chapter features recommendations on the likely best opportunities for implementing solar for manufactured homes.

86 For information about the LIFT Solar Everywhere project, including a three-part research report, see Groundswell, "Lift Solar" webpage, *https://groundswell.org/liftsolar.*

87 For information about the Office of Indian Energy Policy and Programs, see its webpage, *https://www.energy.gov/indianenergy/office-indian-energy-policy-and-programs*.

88 For information about the Rural Electric Savings Program, see its webpage, *https://www.rd.usda.gov/programs-services/rural-energy-savings-program*.

SCALING UP SOLAR FOR UNDER-RESOURCED COMMUNITIES PROJECT

CESA's *Solar for Manufactured Homes* report was produced as part of the *Scaling Up Solar for Under-Resourced Communities Project,* a three-year effort to accelerate solar development that will benefit low-to-moderate income (LMI) households and communities. The project focuses on three distinct subsets of the LMI solar market: single-family homes, multifamily affordable housing, and manufactured homes. You can learn more about the project on its webpage at www.cesa.org/projects/scaling-up-solar-for-under-resourced-communities/single-family-homes.

As a follow-up to this two-volume report, the manufactured homes component of the project will continue to share information about solar for manufactured homes in 2021–2022. CESA is sponsoring a learning network for state policymakers, utilities, solar industry representatives, manufactured homes associations, and other interested stakeholders who want to be invited to virtual events to learn more about the topic. To receive invitations to learning network events, write to CESA Project Manager Wafa May Elamin at wafamay@cleanegroup.org and include "Learning Network" in the subject line.

CESA will also launch a working group of state agencies and utilities that want to explore developing pilot solar projects that benefit manufactured homes residents. To find out more about this working group or to join it, email wafamay@cleanegroup.org and include "Work Group" in the subject line.

The *Scaling Up Solar for Under-Resourced Communities Project* is funded in part by the US Department of Energy Solar Energy Technologies Office, which supports early-stage research and development to improve the affordability, reliability, and domestic benefit of solar technologies on the grid. You can learn more at energy.gov/solar-office.

OTHER CESA RESOURCES ON LMI CLEAN ENERGY

Since 2013, CESA has carried out initiatives to help state governments and other stakeholders implement solar and other clean energy technologies in ways that bring tangible benefits to LMI households and communities. Those initiatives have produced a wide range of guides, case studies, and other resources that are all available on the CESA website, www.cesa.org. Here are two notable examples:

- Directory of State Low- and Moderate-Income Clean Energy Programs
- Solar with Justice: Strategies for Powering Up Under-Resourced Communities and Growing an Inclusive Solar Market

CESA also produces the Solar Equity Digest, a free, monthly e-newsletter with news and resources from around the country on bringing the benefits of solar electricity to LMI communities. You can sign up at www.cesa.org/newsletters.

The Clean Energy States Alliance (CESA) is a national, nonprofit coalition of public agencies and organizations working together to advance clean energy. CESA members—mostly state agencies—include many of the most innovative, successful, and influential public funders of clean energy initiatives in the country.

Ørsted US Offshore Wind/Block Island Wind Farm

Clean Energy States Alliance

50 State Street, Suite 1, Montpelier, VT 05602
802.223.2554 | cesa@cleanegroup.org | www.cesa.org






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