Equitable Implementation of Distributed Energy Resources

Katherine Dillon | Jonathan Klan | Evan Magallanes | Sierra Rowe

TEXAS LBJ School
The University of Texas at Austin
Lyndon B. Johnson School of Public Affairs

AUSTIN ENERGY®

Abstract

This LBJ School of Public Affairs Policy Research Project outlines recommendations for embedding equity into distributed energy resources (DER) expansion plans within Austin Energy's service territory. The project identified six barriers to DER adoption among low- and moderate-income homeowners and renters: physical limitations, high costs, inadequate financial structures, split incentives, knowledge gaps, and lack of trust. To overcome these challenges, the project identified five best practices: community engagement, energy efficiency programs, community solar, specialized financing, and building and land code amendments. The research culminated in a set of five recommendations: (1) Replicate internal emphasis on safety to include equity, (2) Strengthen community engagement through collaboration with community- and faith-based organizations; (3) Focus community solar programs on low- and moderate-income and renter populations; (4) Amend the city's land code to create a solar fund; and (5) Explore partnerships to establish a green bank.

Executive Summary

Many cities have set ambitious decarbonization goals and recognized the importance of addressing historical energy and climate injustices; among them, Austin, Texas, through their Climate Equity Plan, has an explicit goal of achieving net zero carbon emissions by 2040[1].

An important component of the path to net-zero carbon emissions is the proliferation of distributed energy resources (DERs). DERs describe a range of technologies associated with renewable energy production and storage that can be purchased and used directly by consumers, such as electric vehicles, solar panels, and home batteries

This LBJ School of Public Affairs Policy Research offers a set of recommendations for how Austin Energy, the nation's third-largest municipal utility, can equitably increase DER adoption among populations that traditionally face barriers to the adoption of new, innovative, often expensive technologies, namely low- and moderate-income homeowners and renters.

The recommendations presented in the report are informed by: (1) a comprehensive literature review; (2) semi-structured interviews with Austin community leaders and experts in energy equity and DER technologies; a review of programs from utility companies across the nation; (4) a roundtable discussion with DER subject matter experts; and (5) a half-day policy development workshop with Austin Energy.

[1] (City of Austin 2020)

Barriers to DER adoption and the best practices to overcome those barriers

Our research identified six barriers to DER adoption for low- and moderate-income homeowner and renter populations: physical limitations, high costs, inadequate financial structures, split incentives, knowledge gaps, and trust. To overcome these challenges, five best practices emerged as the most effective strategies to overcome these most prominent barriers: community engagement efforts, energy efficiency programs, community solar programs, specialized financing schemes, and building and land code amendments.

Taken together, this suite of best practices carries the potential to overcome all of the most prominent barriers to DER adoption, but crucially, there is no single best practice that is able to address all of the most persistent adoption barriers at once.

Recommendations to Austin Energy for centering equity in DER expansion plans

The LBJ research developed the following five recommendations and related strategies to center equity in DER expansion plans for Austin, Texas.

- **Internally Replicate the Emphasis on Safety to Include Equity**
  Safety is a priority in all Austin Energy programs because safety is baked into the culture at Austin Energy. An internal culture focused on equity, in addition to safety, can be developed. Associated strategies call for Austin Energy to do the following: (1) Utilize internal equity moments (2) Create shared DER definitions and visions; (3) Require equity training for all staff (4) Reflect equity on the Austin Energy website (5) Create and track equity metrics for all relevant programs.

- **Strengthen Community Engagement Through Collaboration with Community- and Faith-Based Organizations**
  Recognizing the need for fostering trust with target communities through relationship building, Austin Energy (1) can bolster existing connections with community-based organizations and faith-based organizations. Austin Energy can also directly build relationships with community stakeholders by (2) establishing an Energy Ambassador Program

- **Focus Community Solar Programs on LMI and Renter Populations**
  Community Solar is effective at overcoming the physical and financial barriers to DER adoption that many low- and moderate-income homeowners and renters face. To capitalize on the equity benefits of this technology, Austin Energy can (1) prioritize LMI and renter enrollment. Equity benefits can be taken a step further by

(2) embedding workforce development programs in future community solar projects.

- **Amend the City's Land Code to Create a Solar Fund**
  Incentives can help increase participation in the use of DERs, but mandates can drive full participation. (1) Amending the land use code to create a solar fund can both increase solar participation and develop a source of funding for future community solar projects.

- **Explore Partnerships to Establish a Green Bank**
  Green banks provide gap financing for green energy projects and low or zero-percent interest rate financing options for customers facing financial barriers. New funding through the Inflation Reduction Act (IRA) provides Austin Energy with the opportunity to (1) expand its use of existing revolving loan funds. Beyond the IRA, Austin Energy can also explore the prospect of (2) establishing a Green Bank with an outside entity.

Table of Contents

Introduction

Burning fossil fuels for energy and the subsequent release of greenhouse gas emissions has been a primary driver of climate change over the past century.[2] Rising temperatures resulting from greenhouse gas emissions trapping heat in the atmosphere have caused various environmental impacts, such as sea level rise, heatwaves, droughts, and increased frequency of extreme weather events such as hurricanes and winter storms.[3] With the human and economic toll of climate change predicted to be astronomical – "roughly 0.7 percent of gross domestic product lost per 1°F increase on average"[4] according to Dr. Jima at the University of Chicago, governments across the globe have taken drastic action to slash harmful greenhouse gas emissions.

Cities, in particular, have been at the forefront of decarbonization efforts. Globally, cities are responsible for approximately 70 percent of global carbon dioxide emissions.[5] Cities stand to incur massive human and economic losses from the increased instance of extreme weather events, such as flooding, wildfires, and hurricanes, further augmenting their incentive to take immediate and substantial action. As a result, many cities have implemented changes needed to reduce emissions. The work being done by these cities has led to the development of the C40 Alliance. The C40 Alliance is a global network of approximately 100 city mayors committed to cutting their emissions in half and actively building "healthy, equitable, and resilient communities,"[6] of which Austin is a member.

Understanding its role as a leader in the energy transition, the City of Austin has been setting and refining ambitious net-zero goals since 2007.[7] In the last ten years, the city adopted a resolution and planned to be net-zero by 2050.[8] Later in the process, the city created a climate resilience plan that specifically addresses those who will be most impacted by climate change: underserved communities.[9] In 2020, the net-zero by 2050 plan and the climate resilience plan were merged into a newly revised plan that sought to achieve net-zero by 2040 with equity at the forefront of the plan.[10] The city plans to increase the percentage of carbon-free energy generation load by up to 93 percent from 2020 levels while simultaneously centering underserved communities.[11]

---

[2] (Understanding Global Change, UC Berkeley n.d.)
[3] (Bertrand 2021)
[4] (Jina n.d.)
[5] (Dasgupta, Lall, and Wheeler 2022)
[6] (C40 Cities n.d.)
[7] (City of Austin 2020)
[8] (City of Austin 2020)
[9] (City of Austin 2020)
[10] (City of Austin 2020)
[11] (City of Austin 2020)

An important component of the path to net-zero carbon emissions is the proliferation of distributed energy resources (DERs). Distributed energy resources describe a range of technologies associated with renewable energy production and storage that can be purchased directly by consumers, such as electric vehicles, solar panels, and home batteries.[12] The traditional grid is characterized by a one-way flow of energy (from the power plant to the end-user), while DERs are characterized by a two-way flow, where end-users can generate or manage their own electricity.[13] For the City of Austin's ambitious carbon reduction strategy, the widespread adoption of these technologies will be vital. However, the implementation of DERs across the City has been that of a typical energy transition: the wealthier are earlier adopters and therefore reap the benefits of these technologies while lower-income communities are left behind.[14] Typically, these communities are most affected by the effects of climate change, most likely to experience high energy burdens, least able to afford these technologies, and least able to implement them due to property ownership status.[15] Varying DER adoption rates across demographics both exacerbate energy equity problems and slow down decarbonization processes.

For the last 20 years, Austin Energy, the City of Austin's energy provider, has been a leading municipally-owned utility in the support and implementation of renewable energy technologies. Austin Energy is the 3rd largest municipally-owned utility, servicing over half of a million customers.[16] Currently, 50 percent of their total power generation comes from renewable sources.[17] Their work started with purchasing wind energy from West Texas wind farms and supporting homeowners as they installed solar technologies on their homes. Over the years, they expanded into investing in large solar arrays known as community solar, developing electric vehicle charging infrastructure throughout the city, and providing support for home batteries. Recognizing the importance of equalizing DER adoption rates for both decarbonization goals and fostering energy equity, Austin Energy then partnered with The LBJ School of Public Affairs at The University of Texas at Austin to research and provide strategic recommendations to address the City's goals and best achieve equitable implementation of distributed energy resources

The following report provides recommendations to Austin Energy on how to achieve equitable implementation of distributed energy resources, including recommendations to:

---

[12] (ACEEE n.d.)
[13] (Hoffman and Freburg 2022)
[14] (Forrester and Barbose 2022)
[15] (Moss 2022)
[16] (Hoffman and Freburg 2022)
[17] (Hoffman and Freburg 2022)

- Internally replicate their emphasis on safety to include equity
- Strengthen their community engagement through collaboration with community-based organizations
- Focus their community solar programs on low- and moderate-income and renter populations
- Amend the city's land use code to require solar or create a solar fund
- Explore partnerships to establish a Green Bank

These recommendations are the result of an extensive review of existing literature, interviews with energy justice and DER experts and community leaders, a review of utilities across the nation, and collaboration with teammates within Austin Energy. The recommendations provide a framework for how Austin can center equity in new and existing plans to expand the adoption of DERs throughout the city.

Acknowledgments

This report was made possible by the time, expertise, and dedication of Austin Energy, the LBJ School at the University of Texas at Austin, the professionals in the energy field, and the community leaders who participated in our interviews.

Austin Energy

Cameron Andrews
Keree Brannen
Aiden Cohen
Amy Everhart
Jill Faulkner
Cameron Freburg
Jessica Galloway
Tim Harvey
Michael Hoffman
Alicia Loving
Sara Norris
Valerie Paxton
Holly Prosser
Eric Stager
Joseph Teng
Yasmin Turk

Interviewees

Galen Barbose - Research Scientist in the Electricity Markets and Policy Department at Lawrence Berkeley National Laboratory
Gaby Benitez - 2021-2022 City of Austin Community Climate Ambassador
Dr. Anna Brockway - PhD from the Energy and Resources Group at UC Berkeley
Sydney Forrester - Scientific Engineering Associate working in the Electricity Markets and Policy Department at Lawrence Berkeley National Laboratory
Nakyshia Fralin - 2020-2021 City of Austin Community Climate Ambassador
Karla Loeb - Head of Government Affairs at Arcadia & Board of Directors at Solar Energy Industries Association
Hannah Mitchell - Texas Program Director at Solar United Neighbors
Dr. Jacquie Moss - Research Fellow at the Texas Energy Poverty Research Institute
Jason Pittman - President & Co-Founder of Big Sun Solar
Dr. Michael Webber - Josey Centennial Professor in Energy Resources, Author, and Professor of Mechanical Engineering at the University of Texas at Austin

The LBJ School of Public Affairs at The University of Texas at Austin

Steven Pedigo

Our Approach

The LBJ School research team (LBJ team) was guided by three research questions to create the recommendations for Austin Energy: (1) What are the various barriers to distributed energy resources (DER) adoption among different tenancy statuses and income levels? (2) What are the best practices for how to center equity in DER expansion efforts? And (3) How can matching DER technologies to different demographics overcome barriers to adoption? Several qualitative methods were used, including a literature review, semi-structured interviews, roundtable discussions, and workshop sessions, to collect the information needed to answer these questions. From these, the LBJ team developed the final recommendations for how to center equity in DER expansion plans.

Step 1: Literature Review

The first step to understanding the barriers to DER adoption that low- and moderate-income homeowners and renters may face (Research Question 1) and the best practices for overcoming those barriers (Research Question 2) was to conduct a literature review. With the use of DER technology being a relatively new phenomenon, the breadth of relevant published literature was limited in scope. Most current work either focuses on the challenges and benefits surrounding DER proliferation or on energy justice and energy equity, but only a small amount of research has explored the intersectionality between equity and DER adoption. Findings from the literature review can be found starting on page 12.

Step 2: Expert Interviews

Because of the current literature gap left by a lack of exploration of the intersectionality between equity and DER adoption, the primary information source to address Research Questions 1 and 2 was hour-long semi-structured interviews with twelve experts and major stakeholders in the equitable DER adoption space. Interviews fell mainly into three categories of conversation focus. First, the LBJ team had conversations with researchers and academics to understand what the landscape of barriers looked like for individuals of different tenancy statuses and income levels and what possible solutions may be most appropriate for overcoming barriers to DER adoption. Second, conversations with stakeholders working to expand DER access to more individuals offered details of best practice programs and how they could operate to reduce barriers to DER adoption. Third was conversations with individuals who work directly with low- and moderate-income homeowners and renters in greater Texas and in Austin to understand which barriers to DER adoption are the most prevalent in the Austin Energy service area.

In addition to the 12 semi-structured interviews, the LBJ research team also engaged in one interview that doubled as a tour of an Austin area community solar farm and one roundtable discussion with Austin Energy's DER technology subject matter experts. Both of these additional activities provided the LBJ team with a technical understanding of the various DER technologies (community solar, solar, energy efficiency, EVs, and battery storage). Findings from expert semi-structured interviews can be found starting on page 28.

Step 3: Review of Peer Utility Companies

To further inform the best practices research aimed at answering Research Question 2, the LBJ team reviewed six utilities from across the country: specifically, those that have an equity framework related to DER expansion as found through the literature review or as recommended from the semi-structured interviews. The purpose of reviewing the programs and actions of utility companies was to help start the analysis of what types of actions and programs would be most feasible and actionable within the Austin context.

Step 4: Workshop policy session with Austin Energy

After synthesizing the information collected in the above three steps, the LBJ team hosted a half-day workshop with approximately 12 relevant stakeholders within Austin Energy, with the goal of addressing Research Question 3. After understanding the barriers to DER adoption and learning of best practices that could potentially overcome those barriers, the LBJ team guided conversation and activities to understand which strategies for centering equity in DER expansion plans would be the most feasible within the Austin context. This workgroup, informed by the information collected in steps 1-3, contributed heavily to the recommendations found starting on page 49 of this report.

Literature Review

The rapid global transition to increase the use of renewable energy sources started to take off at the beginning of the 21st century.[18] Prior to the 21st century, the world relied on coal to generate electricity. However, recent trends show that the world is shifting away from coal-generated electricity toward renewable sources of energy generation.[19] Estimates suggest that demand for coal-generated electricity peaked in 2003 among OECD countries and has been steadily declining since 2008, with demand dropping by more than 40 percent.[20] The declining demand for coal-generated electricity, although due in part to the increased supply of natural gas and gas-generated electricity, has also occurred due to an increase in electricity generated through renewable fuel sources. Despite this growth, today, energy generated through renewable fuel sources accounts for less than 20 percent of the United States' total energy output, far behind traditional sources of energy generation.[21]

Given the accelerated threat of climate change, the United States is in the midst of a transformative shift in how energy is produced, distributed, and consumed. As broad decarbonization efforts are underway, the proportion of energy produced from renewable energy sources is expected to continue growing through 2050, with renewable sources projected to surpass natural gas sources for electricity production in the U.S. as early as 2030.[22] This rapid shift to renewable energy is encouraging communities across the country to reimagine their energy grid systems. The City of Austin's energy provider, Austin Energy, seeks to be a leader in the clean energy transition process by focusing on the equitable deployment of distributed energy resources (DERs) citywide. Distributed energy resources describe a range of technologies associated with renewable energy production and storage that can be purchased directly by consumers, such as electric vehicles, solar panels, and home batteries. To help them address the equitable deployment of DERs, two research questions guided this literature review.

1. What are the barriers to DER adoption among different tenancy statuses and income levels?
2. What are the best practices for how to center equity in DER expansion efforts?

Given the novelty of this area, a broad body of research pertaining to DERs has yet to be developed, with the intersection of DERs and equity yet to be substantially explored. As the

[18] (U.S. Energy Information Administration 2021)
[19] (Energy Information Administration, 2022)
[20] (Bond, Butler-Sloss 2022)
[21] (Energy Information Administration 2022)
[22] (Dubin 2021)

global energy transition continues, the body of related research is expected to grow alongside it. This literature review captures the current, novel landscape of information pertaining to both DERs and equity by centering around six research areas.

- Defining Distributed Energy Resources (DER)
- Defining Energy Equity and Energy Justice
- DERs Can Achieve Energy Equity and Resiliency
- The Unequal Distribution of DERs
- The Current State of DER Implementation Across the U.S.
- DER and Energy Equity Efforts in Austin, Texas

Defining Distributed Energy Resources (DER)

The traditional energy grid, based on fossil fuels, is characterized by a one-way energy flow from a generation plant to the consumer. DERs are characterized by a two-way flow of energy. They are a system of technologies ranging from electric vehicles, solar panels, wind turbines, and smart thermostats that generate, store, and manage the distribution of energy to consumers.[23] Unlike the traditional grid system, energy generation using DERs can occur either at a power plant or at the consumers' property or place of residence. When energy generation happens at the consumer's property, excess energy is fed back onto the traditional grid. This characteristic is what makes these technologies "distributed." As the U.S. continues to shift away from fossil fuels, DER technologies will become ever-present in the lives of millions of Americans. In 1985, wind and solar respectively made up less than 0.01% of the energy production portfolio in the U.S.[24] As of 2022, solar energy made up 3.96%, and wind energy made up 9.11% of the energy portfolio.[25] These gains have come at the expense of both coal and petroleum.[26] DER capacity has grown alongside the proportion of energy generated by renewable resources, with installed DER capacity growing from 78 gigawatts between 2017 and 2021 to 175 gigawatts poised to be installed through 2026.[27]

The 21st century shift to a reduced carbon economy, however, raises important questions about how these emerging energy systems will deal with questions of equitable access and adoption of new technologies.

---

[23] (Austin Energy 2022)
[24] (Our World in Data 2022)
[25] (Our World in Data 2022)
[26] (Our World in Data 2022)
[27] (Kellison 2020)

Defining Energy Equity and Energy Justice

Although DER technology is becoming more mainstream, distributed energy generation remains prohibitively expensive for most low-income Austinites. Additionally, among renters, adoption of DERs remains significantly lower than among high-income homeowners.[28] The adoption gap between high and low-income customers poses a challenge to the broader efforts to decarbonize the U.S. economy and the City of Austin's climate goals. The lack of an equity framework for DERs, both in terms of persistently high barriers to entry and inequitable cost sharing between DER and non-DER customers, is a formidable obstacle to expanding the use of distributed generation technology to low- and moderate-income (LMI) renters and homeowners in Austin.[29] The concept of energy equity and, more broadly, energy justice are key components to this engagement and will ultimately guide the suite of strategies and recommendations borne from this research. Energy equity is derived from energy justice concepts, and these concepts have provided much of the foundation for the research used within this literature review. Defining it will provide a guiding framework for the rest of this literature review's research.

Energy Justice

Energy justice has several interpretations and definitions but is broadly characterized as "the goal of achieving equity in both the social and economic participation in the energy system, while also remediating social, economic, and health burdens on those historically harmed by the energy system."[30] A comprehensive overview of the existing energy justice literature reveals deep roots in the tradition of philosophy and political thought. In their work, Pellegrini-Masini et al. reveal energy justice's shared roots with political thought and, in the process, strengthen the concept of energy justice and improve "its suitability to application in policy design and policy evaluation."[31] By conceptualizing energy justice as rooted in the concept of equality, the authors argue that it "anchors energy justice to a stable philosophical principle such as equality, considered to be at the foundation of any theory of justice, and…makes it easier for policymakers to understand its relevance and its potential for policy implementation."[32]

The concepts presented in the energy justice literature lend themselves to policies that

[28] (Hall, Jewell, and Ryan n.d.)

[29] Low- and moderate-income are terms defined by the U.S. Department of Housing and Urban Development. Per their definitions, moderate-income is 80% of average median income (AMI) and low-income refers to 50% of AMI. In Austin, Texas, the AMI is $79,542 thus moderate-income households are at or below $63,634 per year and low-income households are at or below $39,771 per year.

[30] (Baker, DeVar, and Prakash 2019)

[31] (Pellegrini-Masini, Prini, and Maran 2020)

[32] (Pellegrini-Masini, Prini, and Maran 2020)

embed equity in their design and implementation. In their article, Elmallah, Reames, and Spurlock explore the impacts of centering energy justice on such policy design.[33] The authors suggest that, in reviewing the breadth of energy justice literature, they are able to identify "transformative policy proposals that critically engage with property ownership, knowledge production, and rights and recognition in energy interventions."[34] It is these four factors - ownership, knowledge, rights, and recognitions - that guide this engagement. The definition of energy justice encompasses a far broader set of goals and outcomes and, as such, extends beyond the scope of this engagement. However, it is worth noting the presence of existing energy justice literature and its influence on local, state, and federal climate goals, as well as its influence on the City of Austin's climate goals. Though not a central tenet of this project, the concept of energy justice will serve as the foundation for energy equity.

Energy Equity

A framework for conceptualizing energy equity was developed by the American Council for an Energy Efficient Economy (ACEEE), a nonprofit research center specializing in energy efficiency and the clean energy transition, and was further refined by Texas Energy Poverty Research Institute (TEPRI), a nonprofit dedicated to achieving an equitable energy transition. Serving as the foundation for TEPRI's energy equity framework, Drehobl's white paper for ACEEE illustrates the organization's holistic approach to crafting an energy equity framework along four primary dimensions: structural, procedural, distributional, and transgenerational equity.[35] The goal of distributional equity, which requires that the benefits and burdens of clean energy programs and policies be distributed fairly across all communities, is the most applicable equity lens for this project because of the emphasis on the equitable adoption of DER technologies among LMI populations.[36] Achieving the other three forms of equity requires various methods: structural equity requires a recognition of the "historical, cultural, and institutional dynamics that have led to clean energy inequities;"[37] procedural equity requires decision-makers to "create inclusive and accessible processes for developing and implementing clean energy programs;"[38] and transgenerational equity requires consideration of the "the impact on future generations of clean energy policies and programs."[39]

The breadth of this equity framework reinforces the multifaceted nature of energy

[33] (Elmallah, Reames, and Spurlock 2022)
[34] (Elmallah, Reames, and Spurlock 2022)
[35] (Drehobl 2021)
[36] (Drehobl 2021)
[37] (Drehobl 2021)
[38] (Drehobl 2021)
[39] (Drehobl 2021)

inequities and, for the purposes of this engagement, offers a comprehensive understanding of the challenges to achieving equity in the context of DER adoption for LMI communities in Austin. Drehobl and ACEEE acknowledge the structural barriers to achieving equitable energy systems but suggest that the forthcoming clean energy transition offers an opportunity to embed equity into these systems before discrimination and inequality can become entrenched.

TEPRI's "Energy Equity Primer" refines the energy equity framework established by ACEEE, offering a streamlined approach to energy equity in the context of DER accessibility in Austin. TEPRI's energy equity framework centers on four key outcomes necessary for achieving equity. Energy equity can be achieved when energy is *affordable*, *accessible*, *sustainable*, *and resilient*. In the context of this engagement, DER technology presents a way to achieve these preconditions for energy equity. TEPRI's energy equity primer, although not created specifically as an equity framework for DER adoption, is a good conceptual tool for how DERs can achieve energy equity.

Further research finds widespread benefits of using an energy equity framework such as the one presented by TEPRI. Priya Patel's research finds policies that embed energy equity into their design and implementation, especially among LMI households, can reduce the financial burden of energy substantially.[40] This body of work suggests that policies designed to alleviate energy burdens and make energy more affordable stand to benefit greatly by employing an energy equity framework, leading to greater cost savings for LMI customers. Further, in a report by Michael Carliner that focuses primarily on tenants, similar evidence for the efficacy of energy equity frameworks and reduced energy burdens is presented.[41] His research outlines the unique challenges faced by renters pertaining to energy affordability and consumption. The piece offers valuable context into the challenges, constraints, and incentives faced by renters and landlords when it comes to energy use. Given the scope of the current research, such insights into the unique energy affordability challenges faced by low-income homeowners and renters are essential for future policy recommendations. Energy burdens and energy affordability have proven to be persistent among LMI communities in Texas, but DERs offer a realistic pathway towards achieving energy savings among this population and, in the process, achieving a key tenet of energy equity, making energy more affordable.[42] The next section looks at how DERs can be leveraged to achieve the four tenets of energy equity.

[40] (Patel 2022)
[41] (Carliner 2013)
[42] (Drehobl 2021)

DERs Can Achieve Energy Equity and Resiliency

Equitable energy systems are defined by affordability, accessibility, sustainability, and reliability. An energy system is affordable if households do not have to pay more than six percent of household income on energy costs; accessible if a household can immediately receive its needed energy; sustainable if the energy system minimizes harm to people and the planet; and resilient if energy losses are minimized during times of disruption.[43] Existing literature illustrates that DER technologies present an optimistic path toward a more equitable energy future.

Affordability

Electricity is an inelastic good, meaning that demand stays relatively constant in the face of price fluctuations. If the price of electricity goes up, almost all homes will spend a higher percentage of income on energy rather than foregoing the additional cost. A household's energy burden is defined as the percentage of household income spent on energy expenses.[44] Household energy burdens can vary dramatically depending on household income and the cost of power in a specific geographic area. A household experiencing energy poverty will spend ten percent or more of household income on energy expenses, whereas a low-burdened household spends less than six percent of household income on energy.[45] An energy affordability gap is the difference between the percent of household income a family is actually paying for energy and the target of spending six percent or below of household income on energy.[46] An equitable energy system aims to close these energy affordability gaps and ensure that all households pay no more than six percent of household income on energy.

Harmon, James, Wolfe, and Moss detail two approaches for reducing energy expenditures, including shallow and deep retrofits in Harris County, Texas. Shallow retrofits typically include minor energy efficiency upgrades that result in energy cost savings. For example, if all of Harris County changed all lightbulbs to LEDs, LMI communities could collectively see $84.7 million in savings.[47] Deep retrofits are characterized by high-impact but expensive investments in energy technology. For instance, Harris County has made efforts to promote household weatherization, which includes improving the quality of windows and interior insulation, as a way to improve household energy efficiency and significantly reduce energy costs.[48] While the cost-saving potential of DERs is able to benefit all

---

[43] (Texas Energy Poverty Research Institute 2022)
[44] (Texas Energy Poverty Research Institute 2022)
[45] (Texas Energy Poverty Research Institute 2022)
[46] (Hall, Jewell, and Ryan, n.d.)
[47] (Harmon et al. 2021)
[48] (Harmon et al. 2021)

households regardless of energy burden, concentrating efforts to bring DERs into homes experiencing energy poverty could substantially improve the equitability of a power system.

The Environmental Defense Fund (EDF), one of the largest climate advocacy nonprofits, argues that strategically integrating DER technology into an existing energy system can reduce energy affordability gaps.[49] DERs can alleviate the energy cost burden in four ways. First, updates to energy grid systems can lead to system efficiency, thereby reducing costs for all consumers. Second, community solar models, which are large-scale solar gardens that give access to individuals often through subscription models rather than ownership models, offer a low-cost option for consumers that does not require homeownership or upfront capital because community solar can provide clean energy. Third, energy efficiency improvements in high-burdened homes can reduce costs. Last, widespread implementation of new technologies breeds job opportunities that can potentially increase an individual's household income, thereby reducing their energy burden.[50]

Accessibility

The more equitable a good is, the more it is accessible to a wide variety of populations. The diversity of DER technology drives its accessibility. DER technology can be as simple as an LED light bulb and as complex as retrofitting a roof to fit solar panels. In addition to cost saving impacts of DERs in Harris County described by Harmon, Jones, Wolfe, and Moss, the study also emphasizes how focusing on small energy efficiency improvements, such as changing light bulbs to LEDs or installing a low-flow showerhead, are largely accessible changes that can collectively have a substantial impact on energy costs incurred by LMI households. In their study, Harmon et al. determined that if households in Harris County realized the full technical potential of LED lightbulb adoption, total avoided annual costs for LMI households would be around $84.7 million per year, representing a 16% reduction in the total energy affordability gap within the county.[51] The barrier to entry for shallow retrofits is so low that many of these energy efficiency changes could be implemented by most households immediately. Starting with the “low-hanging fruit” can serve as an introduction for households to the potential benefits of implementing DER technologies.[52]

Despite larger barriers frequently blocking access to deep retrofit DER technologies, such as rooftop solar and electric vehicles (EV), research suggests that carefully developed equity programs may be used for accessibility of deep retrofit DER technologies. A white

[49] (Harmon et al. 2021)
[50] (Harmon et al. 2021)
[51] (Harmon et al. 2021)
[52] (Harmon et al. 2021)

paper by Hassan Shaban and Lacy Stockton introduces a data-driven strategy that can be applied to programs aimed at making DERs more accessible to populations that may face significant barriers to adoption. The preferred model Shaban and Stocktain detail relies heavily on establishing strong feedback loops that update program delivery and repeatedly evaluate whether goals are being reached.[53] Although their example focuses primarily on low-income bill assistance programs, a municipality could apply the same framework in the context of a community solar program designed for low-income households, with the goal of increasing access to the benefits of solar in low-income and renter communities. Although the efficacy of these strategies has been proven in the context of low-income bill assistance programs, further research is needed to understand how effective these strategies are at increasing the accessibility of high-impact DER technologies.

Sustainability

The impacts of a warming planet are not borne equally across society. Because of this, energy technologies that are sustainable and do not exacerbate the impacts of climate change can be seen as more equitable. The literature considers DERs to be a sustainable source of power generation because DERs generate energy from renewable resources and have the potential to reduce the overall demand for fossil fuels. Today, most power in the U.S. is generated by natural gas or coal, both of which are fossil fuels.[54] Carbon dioxide emissions from burning fossil fuels for energy have been linked to both health hazards such as respiratory illness and the warming of the Earth due to carbon dioxide's heat-trapping properties.[55,56] The United Nations Intergovernmental Panel on Climate Change (IPCC) warns that should temperatures increase by 2 degrees Celsius above what the average global temperature was pre-Industrial Revolution, the impacts on water, agriculture, health, and infrastructure could be catastrophic.[57] Currently, The Earth is 1.1 degrees Celsius warmer when compared to the time before the Industrial Revolution and on track to rise to at least 1.5 degrees Celsius. Replacing coal or natural gas-powered energy generation with renewable energy sources can reduce the amount of carbon in the atmosphere.[58] Energy-generating DERs have the capability to achieve sustainability since they rely on renewable, inexhaustible resources that do not release excess carbon into the atmosphere.[59] Moreover, fossil fuels are finite resources, making them far less sustainable than generating power using renewable resources. In addition to the global benefits of carbon-free energy generation, DERs also have the potential to reduce the overall demand

[53] (Shaban and Stockton 2020)
[54] (Energy Information Administration 2022)
[55] (Candanosa 2021)
[56] (NASA Global Climate Change: Vital Signs of the Planet, n.d.)
[57] (Pörtner et al. 2022)
[58] (Adrian et al, 2022)
[59] (Adrian et al, 2022)

for fossil fuels through energy-saving functions. Technologies, including weatherization and smart thermostats, can reduce the amount of energy needed to be produced either from fossil fuels or from renewable energy sources.[60]

The sustainability properties of DERs are recognized by Gundlach, Justin, and Burcin in their report, which considers how the value of DERs ought to be measured. They acknowledge the cost-saving benefits of DER technologies but argue that the value of DER technologies should factor in elements beyond cost-saving. The true value of DER technology can be measured using a stack of factors including wholesale energy, wholesale capacity, transmission costs, system capacity, greenhouse gas emissions, ambient air pollutants, and resilience.[61] The sustainable energy generation solutions that characterize DERs and their ability to reduce dependency on exhaustible and carbon-emitting fossil fuels have been recognized to add to the value equation of DER technology substantially.

Reliability

Reliability contributes to equity because consistent access to power is essential for meeting basic human needs in today's society. Reliability refers to the ability of the grid to avoid outages, particularly as it relates to aging infrastructure or small system faults.[62] On a broad scale, research shows that DER technology can increase the reliability of a power system, both by generating additional energy and by reducing the overall energy load. Depending on the type of DER technology, either of these two objectives can be met, resulting in improved resilience across an energy system.[63]

Technical studies, such as the one from Gautam, Piya, and Karki, reflect the breadth of research into the grid resilience benefits of DERs. Their study shows that DERs can minimize the impact of extreme weather events through two pathways: first, by decreasing the expected probability of system interruption by minimizing the propagation of further grid damage, and second, by lowering the expected outage duration of the system by restoring electricity generation to key areas and households.[64] Other technical studies, such as Poudel and Dubey's, reflect models on how to ensure that DERs are best able to respond in times of extreme weather events.[65] Resiliency benefits from DERs can be even greater with more widespread adoption, as they would be better able to meet electricity load requirements, especially during times of crisis or exceptionally high demand. While

[60] (Harmon et al. 2021)
[61] (Gundlach and Unel 2019)
[62] (Levite n.d.)
[63] (Tierney 2016)
[64] (Gautam, Piya, and Karki 2021)
[65] (Poudel and Dubey 2019)

the potential is immense, concentrated efforts are needed to ensure that the equity benefits from DER technology are realized.

Winter storm Uri in 2021 highlighted the need for improved grid resiliency and reliability, particularly regarding low-income and marginalized customers in Texas. Winter storm Uri set records for consecutive days of sub-zero temperatures and left much of the state of Texas covered in ice and snow.[66] During the storm, demand for electricity increased, and the lack of weatherization caused infrastructure to fail, resulting in power blackouts across the state.[67] In response, the Electric Reliability Council of Texas (ERCOT), an independent system operator responsible for managing Texas' electric load, induced rolling blackouts to prevent the entire grid from shutting down.[68] Ultimately, 210 Texans lost their lives due to Winter Storm Uri and the prolonged power outages.[69]

In a study of Harris County, researchers used phone signal densities as a proxy for power outages. In theory, areas with the largest drops in signal density would have been most affected by power outages. Researchers found that the greatest intensity of outages was correlated with low-income populations, Black populations, and Hispanic populations.[70] DER technology has the ability to prevent the electricity issues that low-income communities, in particular, are burdened with and to create a more reliable and resilient grid.

Power grid resilience is an important element of energy reliability. Resilience refers to the ability of the grid to respond quickly and appropriately to a power outage. Like Winter Storm Uri, this is most essential during high-impact, low-probability events to prevent injury or even death. These events are typically not accounted for in reliability estimates but can have widespread consequences to the grid because of the magnitude of the impact – events like these typically affect multiple areas of the grid instead of being isolated.

Despite potential benefits to energy equity, the distribution of DERs remains unequal

DERs have historically been prohibitively expensive as they tend to be relatively new technologies and have yet to achieve economies of scale. Because of the relatively low market penetration of some DERs, incentive policies to encourage the purchase of DERs are typically implemented in the hopes that manufacturers can begin producing these

[66] (Donald 2021)
[67] (Donald 2021)
[68] (ERCOT, 2023)
[69] (Donald 2021)
[70] (Lee, Maron, and Mostafavi 2022)

technologies more efficiently and bring prices down.[71] While these policies have been effective in bringing prices down, many LMI communities have been unable to participate in substantial DER technology adoption, such as adopting electric vehicles (EV) or rooftop solar systems.[72] This is due to a variety of factors.

First, Brockway, Conde, and Callaway reviewed California's existing grid limits as a constraint on further implementation of DERs.[73] They found that areas and communities that are already disproportionately unable to afford DERs also lack the grid quality needed to implement DERs if and when they become affordable enough to purchase. These grid constraints further drive up the cost for LMI households as either expensive grid upgrades or expensive complementary DERs, like solar panels and storage batteries, are needed.[74]

Second, in addition to this infrastructure limitation, houses can be another infrastructure barrier, particularly in adopting rooftop solar. Simply being able to own a home is often the first and most substantial barrier. Typically, access to DERs has been an issue for LMI communities as these populations tend to lack ownership of their homes and therefore lack the ability to implement many types of DER technologies, even if the desire exists. These communities are subject to landlords who fall into split-incentive issues whereby tenants and landlords benefit from different energy cost reductions, depending on which party is responsible for paying utility bills.[75] When LMI populations do own their homes, the structural requirements for installing rooftop solar panels can also be a barrier. Solar panels need to be placed on unobstructed south-facing roofs with a slope of 15-40 degrees, and it is best installed with a new shingle roof.[76] In addition, solar panels add weight to the roof, so the underlying structural integrity must be sound enough to take on this additional weight. In a blog post from the Department of Energy's Solar Technologies Office, they recommend adding rooftop solar panels at the time of roof replacement because the solar panels typically last as long as the shingles that are most commonly installed.[77] The same article also points out that installing a roof can, on average, cost $10,000, further contributing to the cost barrier many LMI households face.

Third, the adoption of large technologies such as solar panels requires large sums of money upfront. The need for a new roof to provide solar in addition to investing in solar panels presents one financial barrier among many for LMI households. Typically, the initial

[71] (Department of Energy 2021)
[72] (Crago and Chernyakhoskiy 2017)
[73] (Brockway, Conde, and Callaway 2021)
[74] (Brockway, Conde, and Callaway 2021)
[75] (Heeter et al. 2021)
[76] (Solar Energy Technologies Office 2016)
[77] (Jones-Albertus 2021)

policies help share the burden for early adopters of new energy technologies: as early adopters partake in these policies, the price of these technologies decreases. These policies then taper off over time as the prices come down. Yet these prices can still exclude much of the population that is unfairly burdened by energy poverty.[78] According to research from Lawrence Berkeley National Laboratory, the current trends across the country show that adopters of rooftop solar tended to have median incomes of around $110,000 per year, far above the national average of $63,000 per year.[79] This same trend is repeated in Texas as well. Even states like California, which have long provided incentives and benefits to increase adoption rates of solar, have found it difficult to implement solar in LMI populations.[80]

Finally, aside from solar, where much of the research regarding barriers to adoption currently focuses, electric vehicles provide some ability for LMI populations to participate in the adoption of DERs. However, until recently, electric vehicles have been marketed as luxury vehicles with high sticker prices and have struggled to compete with lower-cost alternatives on the market. While there are many incentives to bring these initial prices down, they still require upfront costs and refunds through rebates.[81] However, more manufacturers are entering the electric vehicle market, so more affordable vehicles will be added, bringing their prices down and allowing more used electric vehicles to circulate. Electric vehicles are able to be financed through traditional means and do not require major modifications to homes in order to be implemented. Currently, vehicles tend to be a large burden on low-income households because of the purchase price, maintenance, and fuel costs.[82] In the near future, these barriers will decline in their impact. However, as it stands today, the bulk of electric vehicle ownership is still among luxury vehicle owners and not in LMI populations.[83]

Much of the existing literature regarding the equitable distribution of DERs is related to deep retrofit solutions that have a high barrier to entry, such as rooftop solar and EVs. Little research has considered questions about equity as it relates to shallow retrofit DER technologies with lower barriers to entry. Whether or not significant barriers exist that prevent LMI communities and renters from adopting smaller-scale DER technologies and to what extent barriers to adopting deep and shallow retrofit DER technologies mirror each other, is an important area to be explored by future researchers.

---

[78] (Forrester et al. 2022)
[79] (Forrester et al. 2022)
[80] (Lukanov and Krieger 2019)
[81] (Borenstein and Davis 2016)
[82] (Bauer, Hsu, and Lutsey 2021)
[83] (Bauer, Hsu, and Lutsey 2021)

The Current State of DER Implementation Across the U.S.

As cities and states across the nation set aggressive carbon reduction goals, novel strategies and programs provide a foundation that this research draws on. States like California, Hawaii, and New York have begun addressing the issue of equity as they add DERs to their respective grids. While much of this literature review has built the case for why the widespread implementation of DER technologies across income levels and tenancy statuses is important, this section and the next will look at what has already been done both outside of and within Austin.

Throughout the literature, California emerges as a pioneer in terms of policies and incentives to increase DER adoption. California's government prioritizes policies that explicitly address climate change and has aggressively pursued DER implementation policy since 2016 through studies and directives to the California Public Utilities Commission (CPUC). The first action plan was initiated in 2016 and was designed as a framework for DER implementation across multiple agencies. While the CPUC leads this effort, there are many agencies involved in the Action Plan. The second phase, which they are currently in, was designed to build off the initial plan and account for the changing landscape of renewable energy use in the state.[84] This report details California's plans for the next four years to manage the expected increases in DER technology adoptions. They are focused on four aspects of DER adoption in California: load flexibility and rates, grid infrastructure, market integration, and DER customer programs.

In addition to the state-wide plan, there are also specific recommendations for the state from places like Lawrence Berkeley National Laboratory and researchers at the Scripps Institution of Oceanography at the University of California, San Diego. These recommendations include continuing to provide incentives for LMI populations despite the phase-outs in most solar adoption policies,[85] promoting the non-energy benefits of solar,[86] and improving the infrastructure needed to bring more solar online.[87] California has long led the way in adopting DERs but still, they have much work to do in terms of equity: LMI populations are still far behind the rest of the state in solar adoption.[88]

Across the ocean, Hawaiian Electric Company's Customer Energy Resources has a plan to achieve 100% renewable energy by 2045.[89] This report is similar to the City of Austin's, yet its key difference is that it is for all islands that comprise the state. In addition to this, the

---

[84] (California Public Utilities Commission 2022)
[85] (O'Shaughnessy 2022)
[86] (Light, McIntosh, and Stephenson 2022)
[87] (Light, McIntosh, and Stephenson 2022)
[88] (Lukanov and Krieger 2019)
[89] (Hawaiian Electric Company 2021)

report details how Hawai’i has centered its customers on the need for deploying DERs. Their report is not dissimilar to what this engagement hopes to achieve, despite the differences in grid structure and state-level support. Hawai’i has been a leader in the space of renewable energy. They were the first to set 100% renewable energy goals[90] and have closed their last coal energy plant.[91] When looking specifically at American cities, Honolulu ranked first in solar per person and fourth in solar capacity installed. [92]

While both Hawai’i and California are developing strategies centered around their residents and customers, New York developed an economic perspective for calculating the benefits of DERs.[93] The initial calculations that New York had previously used were the standard cost-effectiveness of DERs. Yet DERs provide benefits outside of cost savings and typically, this narrow view unintentionally excludes the people who could benefit most from these technologies. Instead, this report provides a technical framework for how to calculate the ancillary costs that DERs bring about. In essence, it provides a method to analyze those non-energy benefits that DERs provide[94] as noted in the Light, McIntosh, and Stephenson article.[95]

DER implementation is not new across the country or even in Austin. The states that have been detailed above provide frameworks to review that have been in place for several years. From here, the engagement is able to analyze Austin Energy’s approach and provide subsequent recommendations that align with current policy practices and that can be built on.

DER and Energy Equity Efforts in Austin, Texas

Energy trends in Texas and in Austin specifically, are creating an environment where widespread DER implementation can thrive. A report from The U.S. Energy Information Administration (EIA) states that one-fourth of Texas's energy generation comes from renewable energy and that Texas leads the nation in wind generation and is second in solar generation.[96] This fosters an environment that is amenable to the market penetration of DER technologies, notably rooftop solar in the context of Texas. The presentation “Residential Solar-Adopter Income and Demographic Trends: 2022,” details Texas’s performance as a solar adopter. Although market coverage remains just under 50 percent, Texas has the second lowest difference between state area median income (AMI) and the

---

[90] (U.S. Energy Information Administration, n.d.)
[91] (Osborne 2022)
[92] (Pforzheimer and Neumann 2022)
[93] (Woolf et al. 2014)
[94] (Woolf et al. 2014)
[95] (Light, McIntosh, and Stephenson 2022)
[96] (U.S. Energy Information Administration, n.d.)

median income of solar adopters. Texas also has one of the highest shares of adoption among LMI households compared to other states.[97]

These trends push Austin to the forefront of DER implementation. Austin Energy, one of the largest municipally-owned public utilities in the U.S., sees the potential for DER technology to enhance the electric grid's resilience, generate cost savings for customers, and accelerate the transition to a clean energy future. Austin has developed a Climate Equity Plan, which has the goal of reaching "net-zero community-wide greenhouse gas emissions by 2040."[98] For the electricity sector, this means building 375 MW of community solar, and 200 MW of rooftop solar as well as improving energy efficiency in buildings, notably from distributed generation. The city is already a leader in electric vehicle and solar adoption. Travis County leads the state with 18,000 electric vehicles,[99] and as of 2021, Austin is 13th in the nation in terms of total solar capacity with 92.3 MW.[100]

Given its stated goals and the larger statewide trends, Austin is positioned to remain a leader in DER implementation. With this in mind, it is essential for the City and Austin Energy to become leaders in ensuring that DER technology is distributed equitably. Currently, Austin Energy has several programs dedicated to DER implementation, specifically with solar energy and energy efficiency devices. Austin Energy has received federal funding from the SHINES program, which has allowed them to make improvements to the local grid through the implementation of batteries. Through this, the utility has been able to bolster its existing stock of community solar arrays such as La Loma, the Palmer Event Center, and the Austin Bergstrom International Airport, which cumulatively provides almost 5 MW of energy.[101] For customers seeking rooftop solar, Austin Energy has a rebate program that gives $2,500 for installation. Austin Energy also offers energy efficiency programs that make free weatherization improvements to people's homes for no cost if they are an LMI customer, and will pay customers to register their smart thermostat for demand response, a strategy that can reduce the overall amount of energy a household uses and therefore pays for.[102] Outside of the DER space, Austin Energy has shown a commitment to fostering energy equity. Austin Energy's Customer Assistance Program (CAP) helps to lower energy bills for households experiencing financial hardship or serious medical conditions.[103]

---

[97] (Forrester et al. 2022)
[98] (City of Austin, n.d.)
[99] (Sechler 2022)
[100] (Pforzheimer and Neumann 2022)
[101] (Austin Energy, n.d.)
[102] (Austin Energy, n.d.)
[103] (Austin Energy 2022)

The same considerations for equity need to be considered in incentive programs that seek to enable customers, especially LMI households, to access DER technology. Austin has a large LMI population and currently, 55 percent of the population consists of renters. Among renters, almost 65 percent are in the low to moderate income range, with a median income that is 80 percent of the Area Median Income.[104] Additionally, much of the housing stock - nearly 85 percent - was built before 2010, meaning that improvements to the roof or home may be necessary before DER technology can be implemented.[105] Because of this, Austin Energy sees the importance of combining its commitment to energy equity and its commitment to decarbonization

DERs and Energy Equity - Filling In the Research Gap

While the City of Austin and Austin Energy have started taking steps to move toward the widespread adoption of DER technologies, and have implemented programs to assist households carrying a significant energy burden, they have not established a formal plan or framework to center equity specifically in DER expansion efforts. While bits and pieces of an equity framework exist across the country, the absence of an equity framework specifically for DER expansion efforts is likely due to the fact that this type of plan is not commonplace throughout the U.S. Much of today's existing research focuses on either DERs and their impacts, or on energy equity and energy justice, leaving a largely unexplored information gap regarding the intersection of the impact of DERs and energy equity. This engagement seeks to begin filling in that knowledge gap by weaving together what is known about the impacts of DERs and what is known about energy equity. With this, we can provide Austin Energy with an equity framework for DER expansions that has the potential to substantially benefit traditionally marginalized communities, as well as the broader Austin community.

[104] (U.S. Census Bureau 2021)
[105] (Point2Homes, n.d.)

Discovery Findings

The discovery phase of the process addressed the first two research questions: (1) What are the various barriers to DER adoption among different tenancy statuses and income levels? And (2) What are the best practices for how to center equity in DER expansion efforts? The research found six barriers as the most pertinent to inhibiting DER adoption and five best practices that were the most effective at addressing them. The following sections discuss these specific findings from the research process.

Barriers to Equitable DER Adoption

This section explores the barriers to adopting DER technology faced by low- and moderate-income (LMI) populations and renters in Austin. Although DER technology has become more accessible within the last decade, impediments to widespread adoption remain and are mostly concentrated among these population groups. Throughout the discovery process, six barriers emerged as particularly difficult to overcome for these populations: physical limitations, high costs, inadequate financial structures, split incentives, knowledge gaps, and trust. Importantly, this list does not represent the entirety of possible barriers to DER adoption facing LMI and renter populations but does represent the most salient examples that emerged from the discovery process. These barriers fit within three categories: structural barriers (physical), financial barriers (high costs, inadequate financial, and split incentives), and social barriers (knowledge and language gaps and distrust). This section includes the populations and DER technologies most impacted by each barrier. The sections also summarize key takeaways from the 11 semi-structured interviews conducted with researchers, industry experts, and energy justice advocates. A full list of interview participants can be found in the acknowledgments section of this report on page 9.

Table 1. DER adoption barriers are listed with the populations most impacted and DERs most inhibited by these barriers.

Barrier	Populations Most Impacted	DER Most Impacted
Physical Barriers	• Low-Income Homeowners • Renters	• Solar • EVs
High Costs	• Low-Income Homeowners • Low-Income Renters	• Solar • EVs • Storage
Inadequate Financial Structures	• Low-Income Homeowners • Low-Income Renters	• Energy Efficiency • Solar
Split Incentives	• All Renters	• Energy Efficiency • Solar
Knowledge and Language Gaps	• Low-Income Homeowners • Low-Income Renters • Non-English Speakers	• All Technologies
Distrust	• Low-Income Homeowners • Low-Income Renters	• All Technologies

Barrier 1: Physical Barriers

- **Populations Most Impacted:** Low-income homeowners, Renters
- **DER Technologies Most Impacted:** Solar, Electric Vehicles

With any discussion surrounding a new technology, it is important to acknowledge the constraints of the technology itself. Many of the inherent constraints of DER technologies are physical. Austin is an excellent location for solar panels due to the abundance of sun and an abundance of single-family homes. However, many of the Austin area homes that are owned by low-income and disadvantaged individuals lack the adequate rooftop infrastructure required to host a solar array. Galen Barbose and Sydney Forrester, researchers from Lawrence Berkeley National Laboratory, indicated that structural barriers to DER adoption were primarily an issue of roof age. A structurally sound roof is needed to support a solar array, meaning that older roofs would need to be replaced before a solar panel could be installed. Yet even if this issue is addressed, technological efficiency and energy output are maximized when the panels face south, are set at the proper angle, and are unobstructed. For some, roof direction and tree cover make it impossible to adopt rooftop solar.

Physical barriers also impact the deployment of electric vehicles (EV) and EV charging stations. Offering EV charging stations can encourage EV uptake as these are a faster and more convenient way to charge the vehicle. Although all EVs can be charged through a standard 120-volt outlet found in most homes, doing so requires significantly more time –around eight hours – than EV charging stations.[106] This creates a compounding issue for low-income communities. Typically, EV charging stations are prioritized in high-income communities where there tends to be a higher concentration of EVs.[107] Low-income communities typically cannot afford the high upfront costs of EVs, so there tend to be fewer charging stations within the community. This starts a vicious cycle for low-income communities. If and when they can afford the high upfront costs (or these costs come down), they need the ability to charge their EVs. Yet their homes may lack the infrastructure for a charger, and charging stations may have not been installed within their neighborhood, preventing owning an EV from being a viable option.

For all DER technologies, physical barriers tend to be more prevalent in low-income communities. These households not only tend to live in older homes but also lack the monetary and political resources necessary to address these technical barriers.

Barrier 2: High Costs

- **Populations Most Impacted:** Low-income homeowners, Low-income renters
- **DER Technologies Most Impacted:** Solar, Electric Vehicles, Storage

High upfront costs are one of the most persistent DER adoption barriers. Although the cost of DERs, including EVs and solar installations, is expected to decrease rapidly in the next few years, their prices remain prohibitively expensive for low-income households. The ownership of DER technologies like solar is over-represented by wealthy homeowners. Barbose and Forrester emphasized this issue of over-representation among affluent homeowners and suggested that high upfront capital costs among DER technologies like solar, were a major impediment to widespread adoption across the country. Although these technologies offer month-to-month savings, the high upfront costs prevent low-income customers from experiencing these benefits. Moreover, lower electricity prices in Austin relative to the rest of Texas greatly increase the return on investment time, particularly for solar panels.[108] The average cost for installing a full array of solar panels on a roof ranges

[106](US Department of Transportation 2022)
[107](Fitzpatrick, Muller, and Davis 2023)
[108] (Austin Energy 2023)

from $19,000-$25,000, the average cost of a new EV was over $60,000, and household energy storage devices cost over $30,000.[109] [110] [111] Although the cost of solar panels has decreased over the last two decades, many LMI populations still lack adequate resources to absorb these high upfront costs.[112] For LMI individuals and families in Austin making less than $60,000 and $80,000 a year (80% area median income), respectively, these upfront costs make DER technology a prohibitively expensive investment.[113] The issue of high costs and physical barriers are not mutually exclusive. Oftentimes, they reinforce one another, exacerbating existing DER adoption barriers for LMI communities. For instance, installation costs can be even higher when a house's rooftop requires structural updates to host a solar array.

These high upfront costs reinforce the view that DER technologies are a luxury good, reserved for wealthy homeowners. Austin's Climate Ambassadors discussed the need to reverse this perception of DER technologies to achieve widespread adoption. Many of the DER technologies in the market can generate cost savings in the long run, bringing down overall energy burdens for LMI homeowners. However, for many LMI homeowners living paycheck to paycheck, weighing future savings with high costs in the short run, the value proposition of DERs is not compelling enough. Although the prevalence of DERs has led to the emergence of an entire industry devoted to helping LMI populations finance these technologies, these financial instruments fall short of addressing the unique needs and barriers faced by LMI populations and renters. The next section will explore the barrier of inadequate financial instruments and structures in greater detail.

Barrier 3: Inadequate Financial Structures

- **Populations Most Impacted:** Low-income homeowners, Low-income renters
- **DER Technologies Most Impacted**: Energy Efficiency, Solar

New distributed energy resources often have high upfront costs that come down over time as adoption increases and production comes to scale.[114] In their early development phases, new DER technologies are expensive to implement as their manufacturing costs are high and demand is quite low. As the demand increases over time, manufacturing costs decrease as firms become more efficient at producing these DER technologies. However, this can be a slow process as the high prices can deter widespread adoption, which is required to reduce the price.

[109] (Center for Sustainable Energy 2023)
[110] (Ewing 2023)
[111] (NREL 2021)
[112] (Forrester et al. 2022)
[113] (City of Austin 2022)
[114] (Feldman et al. 2021)

Utility companies and government entities have sought to increase the pace of this by providing subsidies to early adopters. These subsidy funds typically come from current utility customers or taxpayers and reduce the high costs of new DER technologies to a level that higher-income households can afford.[115]

Fundamentally, DER technologies offer long-term savings after a one-time investment, but this investment is a sacrifice that many low-income families cannot make as they are frequently focused primarily on month-to-month necessities.[116] Looking outside of the utility provider for assistance on DER technology upgrades is often an inequitable process as well. Traditional financial institutions typically do not offer loans for solar–instead, they provide unsecured personal loans which have higher interest rates and require good credit histories.[117] Because of the lack of solar-specific loans available, the solar industry has created its own financing options. While this has benefitted many homeowners, it has also created a parallel economy in which scams and predatory financing have taken advantage of these new, less-regulated financing options.[118] LMI populations are particularly sensitive to these scams and may be unwilling to attempt to use further DERs even if traditional financing is available.

These inadequate financial structures most impact homeowners. Renters, on the other hand, are impacted by the split incentive between landlord and tenants, as outlined in the next section.

Barrier 4: Split Incentives

- **Populations Most Impacted:** Renters
- **DER Technologies Most Impacted:** Energy Efficiency, Solar

Renters often face unique issues with adopting DER technologies regarding who can maximize their cost savings or possibly even profit. The motivation and incentive for using DERs differ between landlords and tenants. If a landlord installed solar panels, they would pay the upfront costs while the tenants would benefit from a reduced energy bill. Conversely, if a tenant paid for efficiency upgrades, ultimately the landlord benefits by being able to rent or sell the apartment for a higher price because of the premium upgrades. The two scenarios below detail what the split incentive barrier might look like.

115 (Clements and Parry 2018)
116 (Dinan 2009)
117 (Millerbernd 2023)
118 (Burns 2021)

Scenario 1 - Landlord pays the electricity bill:

In this scenario, the landlord pays the electricity bill for the entire complex and incorporates the extra costs into the tenant's rent. Assuming they had the necessary capital to meet the upfront costs, the landlord would be incentivized to install solar panels to reduce their overall cost of electricity. However, since rent is a more static cost than electricity bills, renters would not be incentivized to reduce their electricity usage. In turn, the landlord would be incentivized to raise rent further to cover the capital cost or to account for the increased demand of having a "luxury" good on the property.

Scenario 2 - Tenant pays the electricity bill:

In this scenario, tenants would be incentivized to reduce their energy usage; however, they would be less incentivized to invest in DER technology to do so. If tenants paid the upfront costs for smart thermostats or energy efficiency improvements, they would only experience the benefits for a short amount of time, likely not long enough to cover the upfront costs. Landlords would also lack the incentive to install DER technology. While the long-term benefits are more applicable, they would not be incentivized by the need for short-term cost savings as they are not paying the utility bill.

The split incentive barrier results in neither party taking action because neither is able to realize the full benefits of their investment in the technology. When renters are responsible for paying electricity bills, they are incentivized to conserve energy. When landlords are responsible for energy costs, technology upgrades, and energy efficiency improvements are incentivized. Neither scenario maximizes cost savings, however, because neither achieves both behavioral change and technology upgrades. In conjunction with each other, energy conservation and DER technology can maximize the cost savings associated with DER adoption.[119] Yet with the split incentive barrier, there is no motivation for either party to adopt the missing part for maximum cost savings. Further, this split incentive barrier is amplified for solar technology, a DER that requires a significantly higher upfront investment and energy efficiency investments. Barbose and Forrester's research revealed that only 3% of registered solar panels in the U.S. are on multi-family units. While the previously described barriers pertain largely to specific issues surrounding money and physical constraints, the upcoming two barriers are less tangible and technical, impacting access to all DER technologies.

[119] (ACEEE n.d.)

Barrier 5: Knowledge and Language Gaps

- **Populations Most Impacted**: Low-income homeowners, Low-income renters, Non-English speakers
- **DER Technologies Most Impacted**: All

The widespread availability of DER technology is a relatively new phenomenon, and with novelty comes a learning curve for new participants. DER technologies can carry different price points, physical requirements, and levels of commitment, making it challenging and time-consuming for consumers to figure out the most appropriate technology for their needs. This challenge is exacerbated by the fact that no centralized, trusted resource exists detailing all information about the suite of DER technologies households may have access to. Further, with a variety of sources looking to profit off of the sale of DER technologies, finding information that is accurate and trustworthy can be difficult. Hanna Mitchell of Solar United Neighbors explains that this is especially true in the residential rooftop solar industry, where scams are prevalent, and there is a lack of expert consensus on the benefits of investing in residential rooftop solar for low-income households. The information market in its current form is difficult to navigate, especially for someone who is not already familiar with the energy industry and the current energy transition.

A large contributor to the knowledge gap is the fact that the majority of available information about DER adoption is only available in English. This issue also stems from the general novelty of the technologies, as much of the information has yet to be translated and dispersed in other languages. Mitchell, along with Galen Barbose and Sydney Forrester of Lawrence Berkeley National Laboratory, explained that the lack of language diversity in educational materials frequently precludes non-English speakers from the DER market, which has resulted in lower levels of DER adoption among households where English is not the prominent language spoken at home overall.[120] Further complicating DER adoption ability is the fact that inadequate or complicated sources of information frequently breed distrust, a prominent barrier that is further explored below.

Barrier 6: Distrust

- **Populations Most Impacted:** Low-income homeowners, Low-income renters
- **DER Technologies Most Impacted:** Energy Efficiency, Solar, Electric Vehicles

Even if all of the above barriers are overcome, it will be difficult to design equitable programs for DER technologies without addressing the distrust that low- and moderate-income (LMI) customers may hold toward DER technologies and their utility

[120] (Batalova and Fix 2010)

provider more broadly. Jacquie Moss from the Texas Energy Poverty Research Institute explained that DER programs will come up short if there is no community engagement strategy that authentically builds trust in the community. Three major prongs fuel the barrier of distrust against DERs in Austin. First, the knowledge gap directly underlies the lack of trust. Hanna Mitchell of Solar United Neighbors articulated that most emerging technologies are rife with scams, and in the case of DERs, this is especially true with residential rooftop solar panels. Austin Energy receives several complaints per year of instances of predatory loan practices. Having to sift through new information about an unfamiliar technology, and also decipher what source is credible and safe and what source is not, can cause potential consumers to lose trust in the industry as a whole. Second, the perception that DER technologies are a “premium good” fuels distrust within these communities. Particularly with EV charging stations, low-income and disadvantaged communities view this as a luxury technology, built for the wealthy, instead of a public good. Conversations with the City of Austin Community Climate Ambassadors revealed that many DER technologies are associated with incoming gentrification and fuel fears of imminent displacement.

Finally, generally, energy consumers tend to have negative perceptions of their utility provider. Both experts and Climate Community Ambassadors explain that the inherent distrust in utility providers often originates from the fact that typically, individuals only interact with their provider to pay a bill or report a power outage, neither of which stoke positive feelings. In Austin specifically, a history of inequitable governance[121], a growing prevalence of gentrification[122], and recent widespread power outages have led to distrust in local public institutions, including the utility.[123] This distrust of utilities can make it challenging for traditionally disadvantaged customers to change their behavior simply because their utility provider encourages them to do so. Understanding the root of the distrust that hinders the proliferation of DER technologies among LMI households and renters is important to building community relationships that will result in behavior change.

Despite evidence that adopting DER technologies would advance energy equity and benefit all participating, the barriers to adopting DERs for LMI households and renters in the Austin area are numerous and complex. In the next section, we will examine five potential solutions that are best suited for overcoming the unique challenges traditionally disadvantaged populations face to DER adoption.

---

[121] (Burnette and Cruz 2017)
[122] (Way et al. 2018)
[123] (Aguilar 2023)

Best Practices for Addressing Barriers to DER Adoption

Throughout the discovery process, a series of highly effective strategies emerged as instructive for overcoming these six barriers to widespread DER adoption. Over the course of 11 semi-structured interviews with industry experts and researchers, a roundtable with subject-matter experts from Austin Energy, and a comprehensive literature review process, a set of best practices emerged about how utility companies could overcome persistent DER adoption barriers among LMI and renter populations. Ultimately, a set of five emerged throughout the discovery process. Although there was not one single best practice that addressed all six identified DER adoption barriers, the findings from subject matter experts suggested a combination of policies and strategies to overcome all six barriers.

The sections also highlight several case studies, demonstrating the potential for these best practices to address the previously identified barriers to DER adoption while also achieving meaningful benefits for LMI communities, including cost savings and energy burden reductions. The following five sections address community outreach, energy efficiency, community solar, specialized financing, and changes to the building/land code. Each section will acknowledge the barriers to DER adoption that are addressed, as well as the components of energy equity that are fulfilled.

Table 2. Best practices to address the barriers to DER adoption are listed along with the specific barriers directly addressed. Areas of the energy equity framework that are addressed are included as well.

Best Practice	Barriers Addressed	Equity Area Addressed
Community Engagement	• Knowledge and Language Gaps • Distrust	• Accessibility • Sustainability
Energy Efficiency	• High Costs • Split Incentives • Knowledge and Language Gaps	• Affordability • Accessibility
Community Solar	• Physical Barriers • High Costs • Inadequate Financial Structures • Split Incentives	• Affordability • Accessibility • Sustainability • Resiliency
Specialized Financing	• High Costs • Inadequate Financial Structures	• Affordability • Accessibility
Building Code Mandates	• Physical Barriers • High Costs • Split Incentives	• Affordability • Accessibility • Sustainability • Resiliency

Best Practice 1: Community Engagement

- **Barriers Addressed:** Knowledge/Language Gaps, Distrust
- **Equity Areas Addressed:** Accessibility, Sustainability

Expanding the use of DERs requires individuals to either take action (often financial action) or change their habits, and inspiring someone to break from the status quo requires a foundation of trust. Trust between a provider and a consumer can be built through consistent and intentional community engagement.

Creating relationships takes effort from both the utility and the consumer, but it is important for the utility to meet the consumer where they are to start the conversation. For example, Nina Fralin, a Community Climate Ambassador for the Office of Sustainability, pointed out that creating spaces to inform the community and waiting for community members to participate isn't enough. Information and education sessions should take care of transportation, food, and other expenses to show the valuation of the customer's time and input. To make this type of community engagement effort successful partnerships are key. Because people frequently carry neutral or negative perceptions of their utility provider, working with community-based organizations can make community engagement easier by using a trusted source as the facilitator or the messenger. Moreover, an "anchor" community group will already be familiar with the needs and biases of a target community, making it easier for a utility to meet these needs more efficiently. Jacquie Moss from the Texas Energy Poverty Research Institute pointed out that this is fundamentally about building trust, and that trust cannot be built with a singular interaction. Rather, sustained and consistent community engagement efforts are the way to foster trust within a target community thus resulting in a desired behavior change, such as increasing DER adoption rates among low-adopting communities such as LMI households and renters. Dominion Energy's Neighborhood Sweep Program in North Carolina demonstrates how a utility provider can utilize consistent community engagement efforts to generate positive outcomes for the community, itself, and its customers.

No DER program can successfully address equity without a community engagement element. Community engagement is the only practice that is shown to address knowledge, language, and distrust barriers effectively. Effective community engagement involves understanding and meeting the community's needs, building relationships with community-based organizations, and building trust through consistent and intentional outreach. When providing an essential service to individuals, commitment to customer care is important, but services are less effective without an altruistic commitment to understanding the diverse needs and challenges of the community being served. When offering programs, the focus should be not only on signing up households but also on creating a meaningful relationship with the customer to foster trust.

Case Study: Neighborhood Sweep Program, North Carolina

Community engagement can be effectively paired with energy programs as demonstrated by the Neighborhood Sweep Program conducted by Duke and Dominion Energy in North Carolina.[124] In this program, the utilities partnered with trusted community-based organizations, community action agencies, and community health centers, and walked through LMI neighborhoods to conduct free energy efficiency retrofits such as weatherstripping, LED light installation, and filter replacements. The program also conducted energy assessments and participant education. Dominion's Neighborhood

[124] (EPA n.d.)

Sweep Program was a resounding success, serving 2,000 customers in North Carolina and reducing electricity usage by 925,000 kWh.[125] This success would not have been possible without partnerships with community-based organizations, as these were essential for alleviating trust issues and increasing program participation. The next section will discuss in greater detail the potential of energy efficiency, how it can address DER adoption barriers, and help achieve equitable energy outcomes.

Best Practice 2: Energy Efficiency

- **Barriers Addressed:** High Costs, Split Incentives, Knowledge/Language Gaps
- **Equity Areas Addressed:** Affordability, Accessibility, Resiliency

Energy efficiency improvements emerged as a top solution due to ease of adoption and low costs. Energy efficiency improvements include any technology or home improvement that reduces a household's energy usage.[126] This can range from something as simple as installing LED light bulbs or smart thermostats to a full window replacement or weather-stripping of a home. Several of the technologies can be applied regardless of the age or status of the home. It is often the ideal solution for older homes as these technologies provide the necessary upgrades to reduce energy waste and energy costs. In an interview with Karla Loeb from Arcadia, Loeb highlighted the advantage of energy efficiency: when these improvements are made first, it makes all other technologies more advantageous in terms of efficiency and cost. Additionally, energy efficiency subsidies are common among municipal electric utilities, making them even more affordable for LMI communities.

Energy efficiency improvements address two of our six barriers: high costs and split incentives. LMI households already pay a greater proportion of their household income to energy expenses than higher-income households. Many families are energy burdened, with more than 6% of their income going to their utility bills.[127] Energy efficiency improvements are one of the best ways to address this issue, allowing customers to save money and live more comfortably in their homes. Through this, the high-cost barrier is addressed, as families now have access to a lower-cost DER technology, and now have savings that may be used to invest in more DER technologies. To further reduce costs for LMI households, subsidizing energy efficiency is a feasible and popular option. Since the cost of this technology is typically already low, utilities are more willing to take on installation costs. Through this, the split incentive barrier can be addressed as well, as renters would no

[125] (EPA n.d.)
[126] (Hoffman and Freburg 2022)
[127] (TEPRI 2022)

longer be disincentivized by the costs, and landlords could be eager to accept technology improvements on their property

Energy efficiency improvements are important on the utility side as well. With widespread smart energy efficiency technologies, utilities can enable demand response, allowing the utility to curb energy use during peak demand hours.[128] This would not only reduce costs for customers but also improve reliability for the utility.

Energy efficiency is frequently seen as a “low-hanging fruit” for further DER improvements. Often, the simplicity and benefits of the technologies and the programs surrounding them encourage households to understand and explore further benefits associated with other DER technologies, such as solar panels. CPS Energy’s Save for Tomorrow Energy Plan in San Antonio, Texas, demonstrates the potential benefits energy efficiency improvements can achieve for both utility providers and, more importantly, for its customers.

Case Study: Save for Tomorrow Energy Plan, San Antonio

The Save for Tomorrow Energy Plan in San Antonio is an exemplary example of what an energy efficiency program dedicated to reducing costs and building relationships within the community can accomplish. Within this plan, 34 different programs were designed to subsidize energy efficiency upgrades for low-income customers. Programs included passing out LED light bulbs at community events, covering the cost of residential HVAC installations and upgrades, and allocating $5,000 for each low-income household for energy efficiency improvements. In preparation for this program, CPS Energy studied subsidies being offered by other utility companies for each of these technologies and tried to be as aggressive as possible with matching or exceeding those subsidies. For example, CPS Energy offered an $85 incentive for Smart Thermostats and a $576/kW rebate for lighting, both the highest among peers. However, cost savings was not the sole focus of the program, CPS Energy made a concerted effort to get these technologies into the homes of their customers. Because of this, over the 10-year span of the program, CPS Energy saved 1.4 TWh, had 1.4 million customer interactions, generated half a billion dollars in savings, and created nearly 2,000 jobs. Energy efficiency improvements clearly provide a low-cost approach to addressing DER adoption barriers and achieving energy equity. One best practice, however, emerged as the most comprehensive for addressing DER adoption barriers. Community solar and its potential benefits are discussed in the following section.

[128] (Hoffman and Freburg 2022)

Best Practice 3: Community Solar

- **Barriers Addressed:** Physical Barriers, High Costs, Inadequate Financing, Split Incentives
- **Equity Areas Addressed:** Affordability, Accessibility, Sustainability, Resiliency

Conversations throughout the discovery process, especially those with Sydney Forrester, Galen Barbose, Jacquie Moss, and Jason Pittman, revealed community solar as one of the most effective ways to reduce the equity gaps associated with traditional forms of rooftop solar, including high upfront costs, physical barriers, inadequate financial structures, and split incentive issues. Community solar arrays take the benefits of individual solar panels – including clean energy production, tax and bill credits, and reduced energy usage – and aggregate them on a larger scale. Customers, instead of paying for and installing solar panels on their roofs, can subscribe to a utility-ran or privately-ran community solar program, to participate in a clean energy program and experience cost savings on their energy bills. These savings from participation can be derived through bill credits, reimbursements, or renewable energy credits provided by the sponsoring utility provider. These larger-scale solar arrays are more cost-effective for utility companies than individual rooftop solar generation systems because of their ability to achieve economies of scale. For low-income households, community solar can achieve equitable outcomes by lowering upfront costs, generating energy savings, and expanding access to the solar market. The off-site nature of the technology means that groups typically excluded from the rooftop solar market, such as renters and low-income populations, can receive the benefits of solar energy generation through bill credits or monthly reimbursements. The persistence of high costs, physical barriers, inadequate financial structures, and split incentives associated with the rooftop solar market make community solar vital for ensuring an equitable DER expansion plan and for guaranteeing LMI and renter participation in utility-scale DER programs.

Community Solar addresses four barriers, including physical barriers, high upfront costs, inadequate financial structures, and split incentives. First, because the solar panels for community solar are not placed on individual homes, the age of the roof, the direction of the home, and other physical barriers are not a prerequisite for program participation. In practice, this allows households with inadequate roof characteristics to engage in the solar energy market. Second, effective program design can overcome high costs and inadequate financing barriers. Since the customer is not paying the entirety of upfront costs – particularly costs associated with installation and rooftop retrofits – but instead pays any monthly costs either as a subscription or loan payment, community solar presents a cost-effective alternative to rooftop solar. Because it is also possible for the customer to receive solar bill credits, monthly payments for low-income customers may see a decrease.

Finally, because customers do not own these panels, and because panels are not hosted at a customer's residence, split incentive issues between tenants and landlords are avoided. Community solar circumvents the need for landlord approval, places the utility company as the entity responsible for the upkeep, helps the renter save money, and allows them to participate in the market for solar and clean energy use.

Beyond the barriers addressed, community solar programs can potentially leverage and deliver additional benefit streams to customers and utility providers. Community solar arrays benefit grid reliability, as they can be placed in more strategic locations that better match the grid's demands and load requirements. Community solar, when paired with energy storage, can also be used to improve resiliency. They provide an ideal model for resilience hubs, which in the event of a power outage, can remain online and provide power for the surrounding community.[129] Although community solar itself offers a way to address DER adoption barriers, program design, and implementation can drastically impact outcomes for LMI populations and renters.

Community solar programs are not all created equal. Some can utilize a subscription model where customers pay a premium to enroll in the program and receive clean energy generation. Other community solar programs rely on an ownership approach where program participants can enroll to own a portion of a larger offsite solar array. In this second version of community solar, the aggregation benefits of community solar are blended with the ownership benefits of traditional rooftop solar. In adopting this approach, these types of community solar programs can avoid the concerns of rooftop solar – primarily through avoiding high upfront costs, upkeep costs, and predatory lending practices – and the concerns of subscription-based community solar models – primarily by ensuring the full benefits associated with rooftop solar ownership, ensuring federal tax incentives, and by challenging the perception that community solar is a "luxury good" that is out of reach for many low-income communities. The importance of community solar program design is highlighted by *Big Sun Solar* and its innovative approach to achieving equitable community solar adoption in San Antonio.

Case Study: Big Sun Solar, San Antonio, Texas

Challenging the preexisting notions of community solar and the perceptions of DER technology more broadly was one of the foundational principles that drove Jason Pittman to found Big Sun Solar, a registered 501c(3) renewable energy nonprofit located in San Antonio, Texas.[130] In conversations with Pittman, he emphasized the potential of rooftop

---

[129] (Forrester and Barbose 2022)
[130] (Big Sun Solar n.d.)

solar ownership to generate wealth, which could prove to be a "game-changer for low-income families" looking to enter the solar market. His observations of the solar industry at the time, however, determined that the traditional form of rooftop solar was fundamentally at odds with broader equity goals. It was, in short, out of the question for many low-income families and renters. At the time of Big Sun's founding, the idea of community solar as a means to lower cost and physical barriers for LMI populations was already generally accepted. Although community solar could bring more underrepresented communities into the solar market, Big Sun determined that community solar programs that presented themselves as subscription-based models were at risk of dissuading the very populations that stood to benefit most from these programs.

Ensuring price parity between community solar-generated energy rates and standard utility energy rates was a central focus of Big Sun's value proposition and business plan. To achieve this parity, Big Sun shifted away from the subscription model, instead opting for an ownership approach. Customers would not pay monthly subscription fees but instead would pay a flat rate to own a portion of an offsite solar array. Ownership of the solar array would generate cost savings through monthly reimbursements sent directly to customers. Big Sun's original community solar model was based on a series of several stakeholder connections which include themselves, as well as an independent credit union to provide financing for low-income customers, and CPS Energy, the local municipal utility in the region. This credit union provided short-term, low-interest loans to qualifying low-income customers. As of today, Big Sun's ownership model has evolved, with Big Sun taking on more program delivery responsibility. In addition to the upkeep and maintenance of their community solar arrays and negotiating power purchase agreements (PPAs) between their program participants and CPS Energy, Big Sun now provides short-term loans to assist low-income program participants. Big Sun's solar arrays are constructed over parking lots, and parking fees generate the necessary revenue to assist with low-income financing. The company's novel approach to community solar garnered the attention of many in the industry, but garnering the attention of LMI residents in San Antonio required a concerted community engagement strategy. Although community solar represents a technical approach to overcoming DER adoption barriers, overcoming financial-based barriers requires solutions that address the inadequacy of existing financial mechanisms. The following section will highlight some of these approaches.

Best Practice 4: Specialized Financing

- **Barriers Addressed:** High Costs, Inadequate Financial Structures
- **Equity Areas Addressed:** Affordability, Accessibility

Although traditional financing options exist, they are not accessible for the customers who need them the most, as typical financing methods, designed to reduce the burden of upfront costs, often end up putting low-income customers further into debt. Specialized financing aims to alleviate this concern by focusing on creating new ways to reduce the upfront costs to DER technologies in a way that is accessible for all customers.

Galen Barbose and Sydney Forrester pointed out two main specialized financing options that are used by municipalities. The first one is on-bill financing. In this method, minimal upfront costs are paid by the customer. Instead, monthly payments are included on the utility bill along with normal electricity charges and solar bill credits. This way, the increased monthly payment can be matched with the cost savings from the bill credits. The second option is a green bank. Green banks are typically established by government entities and used to provide funds at lower interest rates than what a private company could provide. Funds from green banks can be used in two ways. One is to provide gap financing for private developers, reducing the cost and attracting more developers to the area. The other method is to offer low- or zero-interest loans to low-income customers to expand the installation of DER technologies.

Hanna Mitchell pointed out the downside of financing methods: delaying ownership and hindering the wealth-building ability of DER technologies, particularly solar. However, in Austin, this strategy is more feasible given the low costs of electricity that increase the timeframe for return on investment, and is necessary for expanding access. Washington, D.C.'s *Solar for All* program demonstrates both how novel financial methods can lead to improved equity outcomes for LMI and renter populations, and how leveraging alternative funding streams can help utility providers create more equitable DER programs.

Case Study: Solar for All, Washington D.C.

The Solar for All program in Washington D.C. showcases an exemplary use of green bank financing.[131] Although this example does not match up perfectly with Austin Energy's capabilities, it provides an analysis of the strength of specialized financing methods. Two different policy environments make this program possible. First, D.C. has multiple non-municipally owned utilities, unlike Austin Energy which is municipally owned and the only electricity provider in the Austin area. Second, D.C. competitive energy suppliers must pay part of their profits into the Renewable Energy Development Fund (REDF), and a certain amount of their energy must come from solar, demarcated by Solar Renewable Energy Credits.

[131] (Washington, D.C. Department of Energy and Environment n.d.)

The Solar for All program is run through the DC Sustainable Electric Utility (DCSEU) and was funded through two main streams. The first one was a bond issuance from the city, the second was a $7 million transfer from the REDF. Customers can sign up for the program if their income is 80 percent of the Area Median Income or below. Once signed up, the customers receive the net metering[132] benefits, and their bill is reduced. After 15 years, they will own the solar panels. The DCSEU receives benefits from the Solar Renewable Energy Credits that are produced and sold to competitive energy suppliers that need to meet their quota. From 2019 to 2021, the DCSEU built enough solar panels to provide energy needs for 6,000 households, many of which received utility bill savings of up to 50 percent. Although these types of specialized financing programs allow for improved DER accessibility at the individual level, broader reforms are needed to embed equity at the city and state levels. The next section discusses what these reforms could look like and how they would contribute to equitable DER expansion efforts.

Best Practice 5: Building/Land Code Mandates

- **Barriers Addressed**: Physical Barriers, High Costs, Split Incentives
- **Equity Areas Addressed:** Affordability, Accessibility, Sustainability, Resiliency

The first four recommendations are incentives to bolster interest in and implementation of distributed energy resources among individual consumers. The fifth recommendation is a mandate to increase the implementation of solar within the city. This recommendation was borne from an interview with Dr. Michael Webber in which he discussed how there is no incentive for landlords to place solar panels on their tenants' roofs. To overcome this barrier, he recommended mandates.

The Austin Land Code mandates that all new builds in Austin be "solar ready." Solar ready means that the homes must have the physical barriers like roof pitch and direction that typically prevent homeowners from adding solar panels addressed within the building design. Yet solar ready places the burden of purchasing solar panels onto the individual homeowners and places the high cost and split incentive barriers on LMI households. When a home is just "solar ready," families that have the ability to purchase a new home are then left to add solar panels at their convenience. This leaves the burden of high upfront costs on the homeowners and also requires that the homeowners pursue financial structures that may ultimately be inadequate.

Instead, with the mandate, the costs associated with solar panels and being "solar ready" are already included in the price of the home when it is purchased. With the price of the

132 According to NREL "is a metering and billing arrangement designed to compensate distributed energy generation system owners for any generation that is exported to the utility grid" (NREL, n.d.)

solar panels being included in the home purchase price, homeowners can pursue traditional financing options like a mortgage. While higher-income communities may still benefit by being able to afford the higher cost of the home, LMI populations reap benefits as well. By including a mandate on all new builds, buildings that are developed as affordable housing will already have solar included and provide affordable energy to LMI homeowners and tenants too.

In addition to the high cost, a solar mandate overcomes the barrier of split incentives. By requiring solar on all new buildings, including apartment complexes, renters can participate in the use of DERs. Like the LMI populations that benefit from solar panels being included in affordable housing, renters also benefit as any new home or apartment complex already includes solar. Tenants are then able to benefit from the cost savings that solar provides through net metering. Cities are already including these kinds of mandates in their building code, demonstrating how the City of Austin could amend its building code to increase the accessibility of DER technology.

Case Study: Building Code, Los Angeles, California

The City of Los Angeles's mandate boosted the number of participants in solar and serves as an example of what the City of Austin could do. Like Austin, Los Angeles had put in place a solar-ready mandate. However, in 2017, they expanded their building code through an ordinance. This ordinance required that all new single-family homes and low-rise residential structures – buildings that are three stories or less - incorporate solar panels into their design. It was then taken up not only by the Los Angeles Department of Water and Power but the Planning Department too. The mandate had two exceptions: if the solar panels would be obstructed by something in the built environment or if some other sort of renewable energy generation took place on site.

Increasing the use of solar was already a priority for the City and the Department of Water and Power. While the initial mandate required homes to be solar-ready, the Department of Water and Power had also streamlined the process for issuing solar permits and rebates so that solar could be installed more efficiently.

Key Takeaways from Discovery Process

The previous sections of this report identified six barriers standing in the way of widespread DER adoption among LMI and renters populations and presented a set of best practices for overcoming them. The overall results of the discovery process revealed critical insights that can inform DER implementation strategies at Austin Energy while achieving equitable outcomes for their LMI and renter customers.

Table 3: A matrix summarizing the findings from the Barriers and Best Practices sections. A cell highlighted in green indicates that the best practice addresses the particular barrier.

	Barriers					
Best Practices	Physical	High Costs	Inadequate Financing	Split Incentive	Knowledge Gaps	Distrust
Community Engagement						
Energy Efficiency						
Community Solar						
Specialized Financing						
Code Reform						

One of the most notable conclusions is the need to pair policies into a larger DER implementation strategy. No single best practice addressed all six DER adoption barriers. It is clear that there is no silver bullet technological solution for addressing these persistent adoption barriers. Another key takeaway from the discovery process is that DER technology alone cannot achieve equitable outcomes for LMI and renter populations. Even the most advanced DER innovations cannot overcome barriers such as trust and knowledge gaps, and in the case of rooftop solar, might leave several adoption barriers entirely unaddressed. Program design can help further equity goals, but without adequate engagement with community members to break down existing barriers and establish trust and community buy-in, there is a chance that programs fail to reach the populations that stand to benefit the most. Intentional program design that embeds equity can improve LMI and renter population outcomes, achieve cost reductions, and overcome physical barriers, but program design alone cannot break down persistent mistrust between communities and utility providers. Any DER technology and utility program must include a clear, consistent, and intentional community engagement component if it hopes to achieve broader program participation among LMI and renter populations. Jacquie Moss, who served as community outreach coordinator for Big Sun Solar, stated very clearly that even the most well-intentioned, well-thought-out community solar program would fall short of achieving broader equity goals if the company lacked a clearly defined community engagement strategy. Trust barriers and knowledge gaps could derail even the most sophisticated DER technology.

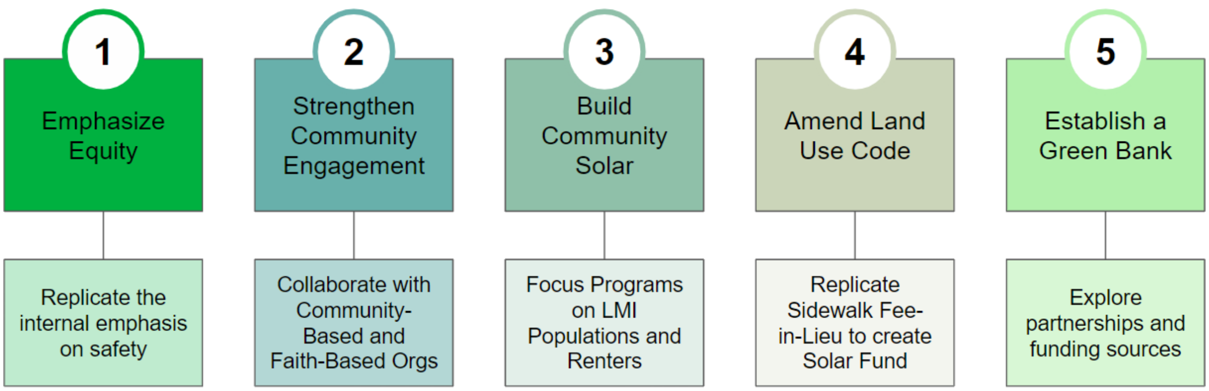
Given the disaggregated nature of DER technologies, it is fitting that achieving widespread, equitable adoption requires a disaggregated approach as well. Technological innovations have allowed for the growth of DERs in Austin and across the country over the last two decades, but to achieve an equitable clean energy transition, technology will need to be paired with equitable program design and intentional, long-term community engagement strategies. Chapter 5 aims to outline strategies for how Austin Energy can achieve equitable DER program outcomes through a series of evidence-based strategy recommendations informed by the engagement's discovery process.

Strategy Recommendations for Centering Equity in DER Expansion Efforts

The final phase of this engagement involved combining the insights from the discovery phase to answer Research Question 3: *How can matching DER technologies to different demographics overcome barriers to adoption?*, and apply the findings to the unique needs, limitations, and context of Austin Energy's organization. A key step in translating the discovery findings into actionable strategy recommendations involved a workshop session with teammates throughout Austin Energy.

The following sections highlight these recommendations in greater detail, as well as a series of strategies to help Austin Energy implement the recommendations into their operation. Case studies are also presented alongside each strategy, with some case studies representing multiple strategies within a particular recommendation. They were included as a way to illustrate both how Austin Energy could adopt these recommendations and what the results of adopting these recommendations could look like for the organization.

Figure 1. Summary of the recommendations to Austin Energy.



Recommendation 1: Internally Replicate the Emphasis on Safety to Include Equity

Internal culture impacts everything from how programs are designed to how services are administered and how progress is measured. Safety is an integral part of Austin Energy's culture and is a primary concern for the organization's programs and actions. Safety considerations are second nature for everyone in the organization which widely benefits both the consumer and Austin Energy's line workers. Austin Energy's ability to cultivate a strong culture of safety can be replicated to cultivate a strong culture of equity. Just as safety considerations are built into programs and actions seamlessly, this recommendation is intended to, through internal culture development, prioritize equity concerns in the same way. Five strategies will help Austin Energy infuse equity into their culture.

- **Strategy 1: Equity Moments**
- **Strategy 2: Create shared definitions and visions**
- **Strategy 3: Equity training for all staff**
- **Strategy 4: Website updates**
- **Strategy 5: Create equity metrics for relevant programs**

Strategy 1: Equity Moments

Before every meeting at Austin Energy, Austin Energy does a "safety moment." For example, if a presentation is being given, one of the first slides might be dedicated to providing the audience a safety tip, such as "do not touch a tree that is touching a downed power line" or "do not plug a power strip into another power strip." Occasionally, Austin Energy has diversity, equity, and inclusion or "DEI moments," but this information is less consistently shared than safety moments. Austin Energy should, in addition to safety moments, incorporate equity moments into their day-to-day meetings with all teams across the organization. Much like safety moments, equity moments would highlight brief equity-related facts, such as defining what energy poverty is, or highlighting that there is less DER uptake in areas where English is not the primary language spoken. "Equity moments can be a simple tool to embed equity concerns within the organization and ensure that Austin Energy fosters an internal culture dedicated to both safety and equity.

Strategy 2: Create shared definitions and visions

Currently, multiple teams work on objectives related to DERs and DER adoption within Austin Energy, but there is inconsistent collaboration between them. Further, there are no definitions for ideas like equity or established goals and visions for equitable DER adoption that are established organization-wide. The lack of consistent collaboration between teams working on various aspects of DERs limits teams' abilities to share insight and resources that could be mutually beneficial, especially if multiple teams are working toward a common goal, like expanded DER adoption. The workshop with Austin Energy revealed that internal knowledge about what is happening across teams is relatively limited. Austin Energy should convene all of their teams that work on either DER or equity-related matters. At the first meeting, this team should establish shared definitions and shared visions for equitable DER expansion in Austin. Following the first meeting, this group should convene monthly to share progress on goals and what is currently being worked on. These update-meetings will create opportunities for resource sharing and collaboration where relevant, reducing opportunities for inefficient or duplicative work.

Given the complexity and variety of both DER technologies and the barriers that stand in the way of DER adoption, collaboration among Austin Energy's teams is essential to achieve equitable DER expansion in Austin.

Strategy 3: Equity training for all staff

While some within Austin Energy receive equity training, it is not mandated for all within the organization. To instill a strong internal culture of equity, all team members at Austin Energy should participate in equity training. Existing research finds that the most effective equity training is: in-person with a trained instructor as opposed to online; occurs over several sessions rather than a one-time event; and measures the impact of training.[133] This type of training will also provide important foundational knowledge to contextualize the increasingly widespread use of equity moments within the organization.

Strategy 4: Website updates

Most consumers' impression of and interaction with Austin Energy is through Austin Energy’s website, making the website a good resource to display important goals and values. Austin Energy has several opportunities to demonstrate its commitment to equity through its website. Their website clearly emphasizes the organization’s commitment to clean energy generation and to safety. The homepage immediately provides a link to Green Power and the first piece of highlighted information is Austin Energy’s commitment to safety. However, language or content regarding Austin Energy’s commitment to equity issues within the energy industry and programs related to equity could be highlighted on its “About” page next to its commitment to safety, or equity programs could be highlighted on the home page.

There is also an opportunity to encourage community engagement from the website. Information on which community-based organizations Austin Energy partners with and how to attend public meetings or participate in feedback opportunities could also be prominently featured on the homepage. Additionally, to increase website accessibility and help close language gaps, the website should ensure information is available in more than one language, especially Spanish.

Finally, many consumers manage their utilities online. Currently, various programs aimed at LMI populations utilize separate application processes. To increase accessibility, Austin Energy should create a singular online portal for individuals to easily see what programs

[133] (Carter, 2020)

they might have access to. For example, if someone seeks to sign up for the Customer Assistance Program they would also be given the option to sign up for a community solar subscription that they also qualify for, without having to submit a separate application. This also helps to alleviate the community outreach burden on Austin Energy teams tasked with promoting various programs to the public because qualifying individuals will be immediately given information to the suit of information they qualify for through the singular application process.

Strategy 5: Create equity metrics for relevant programs

The final internal strategy for Austin Energy is to create equity metrics for all relevant programs both DER or non-DER related. At present, both the California Public Utilities Commission and Portland General Electric are working on creating internal equity metrics to judge their services and programs, but their processes are either currently in progress or not publicly available.[134] [135] Some external organizations, like the American Council for an Energy Efficient Economy (ACEEE), have created metrics for evaluating how a utility as a whole is doing on equity matters, but this has limited utility for evaluating internal services and programs.[136] Yet, it could be a starting point. Austin Energy has a unique opportunity to be a leader in this space by creating its own internal equity metrics and then sharing those metrics and practices with other utility organizations. Further research could provide a better understanding of how to measure equity in utility companies' operations. These internal recommendations can help Austin Energy embed equity within their organization, but achieving equitable DER expansion requires an external engagement strategy to overcome persistent mistrust and bridge existing knowledge and language gaps between communities and Austin Energy. The following section highlights these recommendations.

Recommendation 2: Strengthen Community Engagement Through Collaboration with Community and Faith-Based Organizations

Internal commitments to equity are strengthened when the community sees an external commitment to equity through community engagement. Community engagement is a bedrock for any successful utility program, and is particularly important for programs aimed at helping underrepresented communities such as LMI populations. The need for a robust engagement strategy to build trust and break down knowledge barriers was cited heavily throughout the discovery process and was further emphasized throughout the workshop. Participants acknowledged the need for Austin Energy to revisit its approach to

[134] (Portland General Electric, 2021)
[135] (California Energy Commission, 2018)
[136] (ACEEE, 2023)

community engagement but were interested in improving the organization's community engagement efforts. Given the importance of community engagement efforts for achieving equitable DER program outcomes, bolstering Austin Energy's community outreach efforts is essential for creating a broader equity framework for their DER expansion efforts. Beyond the singular importance of substantive and intentional community engagement, the importance of Community-Based Organizations (CBOs) and Faith-Based Organizations (FBOs) in this process emerged as a key takeaway from the meeting.

The benefits of utilizing existing relationships with CBOs and FBOs in utility community engagement efforts arise from the prominent position these organizations have within their respective communities. Underrepresented communities often distrust their utility providers; a community's only interactions with a utility provider often have negative connotations, such as paying an energy bill or reporting a power outage. This is not a problem unique to Austin Energy, but nevertheless needs a trusted third party to overcome this friction. The notion of utility providers relying on the expertise of CBOs engaged in communities of interest is predicated on the fact that CBOs have a deeper understanding of a community's needs and concerns. In ideal scenarios, they can relay these sentiments to the utility.

Case studies and research revealed that this relationship must be mutually beneficial for both the utility and for the organization in question. In order to maximize the potential of community engagement efforts through CBOs, utilities must first foster their relationship with these organizations. A two-way relationship, whereby a utility can gain access to underrepresented and hard-to-reach communities, and where CBOs can receive an ear to voice community concerns and have these concerns acted upon, is foundational to fostering long-term relationships with the ultimate goal of improving community engagement efforts. The following strategies are meant to help Austin Energy improve its community engagement efforts through strengthening its existing CBO/FBO stakeholder networks.

- **Strategy 1: Bolster existing connections with CBOs and FBOs**
- **Strategy 2: Establish an Energy Ambassador Program**

Strategy 1: Bolster existing connections with CBOs and FBOs

Fostering a culture of trust within communities can be difficult for utility providers to achieve on their own. Overcoming persistent distrust requires a deep understanding of the communities in which utility providers operate. This type of knowledge can be difficult to attain, but is made significantly easier by relying on organizations embedded in these communities. Utility providers have a fundamentally different relationship than the relationship CBOs and FBOs have within their communities as CBOs and FBOs can serve as a convener of the community, as well as an advocate for community interests. In general, these types of organizations have a fundamental understanding of the challenges and concerns facing their constituents. Leveraging these organizations and their position within communities can lead to more effective community engagement efforts.

Strengthening existing connections with CBOs and FBOs cannot be done right away. Instead, there are a set of intermediate steps that must be taken to maximize these relationships and, in the process, maximize successful community engagement efforts. First, there must be an evaluation of organizations operating within communities of interest to determine those with shared values that align with Austin Energy. Second, once organizations with shared goals have been identified, another evaluation should be conducted to determine their capacity to carry out Austin Energy's equity goals. Once these organizations have been identified, the third step involves creating a centralized directory of relevant CBO/FBO stakeholders for internal use within Austin Energy across all external-facing parts of the organization. The creation of this directory helps avoid replicating the work done in steps one and two, and allows for a more streamlined and efficient CBO-based community engagement strategy. Each of these steps can help Austin Energy identify which CBO/FBO partner connections to foster over time, but these strategies represent only the first step toward fostering these connections. The following case study illustrates the power of strong connections with community organizations and the very real impact these types of connections can achieve.

Dominion Energy's Neighborhood Sweep Program was frequently cited by energy equity experts as one of the foremost utility-led community engagement efforts in the country.[137] The program began in 2013 and was designed from the very start as a neighborhood-level energy efficiency program specifically for low-income residents in North Carolina. Dominion's program went into underrepresented communities within their service territory and offered energy assessments, energy efficiency improvements, and program participant education at no additional cost.

The unique aspect of Dominion's Neighborhood Sweep program was not its approach to providing free services to their customers, but was instead the utility's reliance on CBOs operating within these neighborhoods. Dominion partnered with organizations within these underrepresented communities as a way to establish credibility and trust with residents. Dominion understood its position as an outsider to the neighborhood and its perception as a utility company. Overcoming this trust barrier required tapping into a local knowledge base from organizations that were operating on the ground and that

[137] (EPA n.d.)

understood the unique needs and concerns of their constituents. Over the program's ten-year span, the benefits have been clear. Overall energy usage was reduced by 925,000 kWh, benefitting residents who reduced their utility bills, as well as Dominion Energy, by reducing the overall energy load on the company's grid system.

Clearly, strengthened connections between CBOs with a shared vision and capacity to carry out Austin Energy's equity goals can lead to good outcomes for low-income customers and for the organization itself. Once these connections are bolstered, however, community engagement efforts can be improved even further. The next strategy illustrates how bolstered CBO connections can lead to innovative community engagement strategies that allow for substantive community feedback.

Strategy 2: Establish an Energy Ambassador Program

Improving community engagement efforts requires clear and open channels of communication between utility providers and the communities they serve but persistent trust barriers can make this task difficult. Relying on the expertise of trusted community leaders and organizations is the necessary first step. Going beyond this process to focus more specifically on community feedback from individual community members, rather than only from organizations, conveys community concerns more effectively. The City of Austin's Climate Ambassadors Program, established by the City's Office of Sustainability, offers a helpful blueprint for how Austin Energy can establish a similar program, and how the organization and its community engagement efforts can be assisted from a similar program.

The Climate Ambassador program was established by the Office of Sustainability as a way to solicit and incorporate candid community feedback into the City's Climate Equity Plan. The program was borne out of a desire to include the concerns and feedback from underrepresented communities in Austin to inform the City's equity efforts within their broader climate and environmental goals.[138] The City also acknowledged that the program could correct the inequities inherent in a changing climate, especially the fact that underrepresented communities are predicted to bear the greatest burden of the impacts of climate change.[139] The program's initial cohort included 12 members, representing underserved communities throughout Austin. Over the course of six months, these community members engaged their own personal and professional networks on climate-related issues. Climate Ambassadors hosted 35 engagement events to solicit feedback on climate and equity issues. The goal of the program was for the Climate

[138] (City of Austin n.d.)
[139] (Avtar et al. 2021)

Ambassadors to share their findings and provide the City a deeper understanding of how the forthcoming Climate Equity Plan would be received by underserved communities.

The Climate Ambassador Program offers a useful blueprint for Austin Energy to create an "Energy Ambassador Program" that solicits candid community concerns. Notably, Austin Water recently created a pilot program modeled on the Climate Ambassador Program. Their "Community Ambassador" initiative, as part of their "Water Forward 2024" plan, seeks to engage community members "who have been systematically left out of, misrepresented in, or ignored during previous planning initiatives."[140] The creation of a similar program, modeled on these examples, would allow Austin Energy to improve its community engagement efforts by opening up a channel of communication with highly trusted individuals who have buy-in within underserved communities. Further, the creation of a program like this would allow for a two-way channel of communication where community members would be able to more openly discuss concerns with Austin Energy and where Austin Energy would be able to seek meaningful feedback on the design of new low-income energy programs. It allows for a mutually beneficial partnership between communities and Austin Energy, all while strengthening the trust that undergirds any successful community engagement strategy. The next sections will explore more technical strategy recommendations that can be best implemented with improved community buy-in and trust achieved through improved community engagement strategies.

Recommendation 3: Focus Community Solar Programs on LMI and Renter Populations

Throughout the discovery process, nearly every subject-matter expert cited community solar as one of the most effective ways to alleviate energy burdens among LMI households and expand access to DER technologies among both LMI and renter populations, making it a critical pathway for embedding equity within DER technologies. Experts highlighted the potential for solar energy generation to achieve equitable outcomes through its ability to reduce energy bills and generate additional benefit streams through ownership. Solar power generated onsite can lower monthly energy costs for households through bill credits or monthly reimbursements from utility providers. Solar ownership also ensures further benefits to customers in the form of federal tax credits.[141] These benefits require customers to own their solar panels, which can exclude LMI and renter populations who cannot purchase this technology because of high costs and physical barriers. Experts, such as Forrester, Barbose, and Moss, also noted the inherent inequity of traditional rooftop solar models. Overcoming the barriers faced by rooftop solar requires a program that removes

[140] (Guerrero 2021)
[141] (Solar Energy Technologies Office 2023)

physical barriers as well as high costs and inadequate financial structures. Community solar achieves these barrier reductions, opening up the solar market to LMI and renter populations. There is not one single community solar program, however. Different models and program designs can have an impact on LMI enrollment.

A community solar program's design can vary between a subscription model or an ownership model. In the subscription model, customers pay a monthly fee and receive clean energy generated from a utility's offsite solar array. Austin Energy currently utilizes this subscription-based approach. To address the issues of LMI program enrollment, Austin Energy dedicates a certain number of program spots to their Customer Assistance Programs (CAP) customers. These customers can enroll in the community solar program without paying additional costs. Essentially, the program presents renewable energy as a viable alternative to traditional forms of energy generation instead of only as a premium good. Presenting renewable energy as a viable alternative to traditional energy generation is important for overcoming inherent distrust of clean energy and DER technology. As of now, Austin Energy reserves around 250 spots for CAP customers for their community solar program. Given the demographics of Austin, however, this figure underrepresents the true proportion of low-income residents in the city. Low-income customers are currently less likely to be enrolled in Austin Energy's community solar program compared to more affluent customers. Overcoming this program participation gap requires prioritizing enrollment of LMI and renter populations in Austin. The next sections will explore how Austin Energy can prioritize LMI enrollment for their community solar programs, and how the organization can further embed equity in their community solar programs through the development of a workforce development program.

- **Strategy 1: Prioritize LMI and renter enrollment**
- **Strategy 2: Embed workforce development programs in future community solar projects**

Strategy 1: Prioritize LMI and renter enrollment

Moving from a community solar program that seeks to include some LMI participation to a community solar program designed to prioritize LMI and renter enrollment seems, on its face, like a distinction without a difference. In reality, the subtle difference has implications for community solar program design, and can help embed equity within the program itself. Prioritizing LMI and renter enrollment for Austin Energy's community solar programs would entail changes to the organization's current approach to community solar, but would not require completely restructuring the program. This recommendation does not suggest that Austin Energy move away from its subscription model entirely. Instead, the recommendation proposes that Austin Energy designate one current or future community solar array as entirely devoted to low-income customers. For this particular solar array, program participation would be made up entirely of CAP customers, instead of having certain program slots designated for LMI customers.

Marketing this solar program to LMI communities and conducting substantive community engagement are a necessary second step to ensure the success of an LMI-centered community solar program. Building upon the report's previous recommendations for bolstering existing CBO connections, Austin Energy could lean on these stakeholders and their networks to help generate interest among LMI communities, ensuring program enrollment and uptake once a community solar array has been designated as "low-income serving." Prioritizing LMI enrollment in Austin Energy's existing community solar programs is a good way to embed equitable outcomes for a greater proportion of Austin's LMI population. Austin Energy can model their approach to LMI-centered community solar on a handful of community solar programs across the country dedicated entirely to servicing LMI communities. One of the most notable and successful of these LMI community solar models is Washington D.C.'s *Solar for All* program.

The *Solar for All* mission is to offer viable clean energy alternatives to low-income residents of the District, particularly affordable rooftop and community solar programs. As of today, Solar for All's community solar program services over 6,000 residents, of which 100 percent qualify as low-income.[142] Although the program includes a rooftop solar component, a majority of program participants are enrolled in community solar. *Solar for All* and Austin Energy are not entirely analogous, however. Solar for All is separate from PEPCO, D.C.'s utility company, and is funded in part through private means. Their funding includes the use of a $7 million Renewable Energy Development Fund to provide gap financing for clean energy projects including the program's large-scale community solar arrays. D.C.'s *Solar for All* program nevertheless offers a helpful blueprint for how Austin Energy could center LMI enrollment as the organization looks to expand its community solar portfolio. *Solar for All* also provides a framework for leveraging external funding streams to help cover the costs of subsidizing LMI community solar projects. Funding strategies will be discussed in the report's subsequent recommendations. The following section explores how equity can be embedded further within Austin Energy's community solar program.

Strategy 2: Embed workforce development programs in future community solar projects

The creation of a workforce development program dedicated to future community solar projects offers a way for Austin Energy to embed equity in multiple elements of its

[142] (Washington, D.C. Department of Energy and Environment n.d.)

programs. It also ensures that the organization's plans to expand its community solar portfolio can be achieved, all while augmenting Austin's solar industry. Embedded within Washington D.C.'s *Solar for All* program, is the *Solar Works D.C.* initiative, which offers a usable blueprint for Austin Energy to model their programs. The Solar Works initiative hosts a series of year-round cohorts in which participants carry out live solar installs on LMI homes (their most recent cohort performed 45 of these). A new cohort is started in the spring, summer, and fall respectively, and includes 150 D.C. residents over the age of 18. Residents who complete the program receive completion certificates, as well as OSHA 10 and CPR first aid certifications.[143] Most importantly, completion of the program allows for members of the cohort to sit for the National Association of Board Certified Energy Professionals, ensuring a pathway into the solar industry.

Solar for All D.C. offers Austin Energy a framework through which it can embed equity in its community solar program at multiple levels. In the short term, prioritizing LMI enrollment for the organization's existing community solar programs can achieve equitable goals by expanding access to affordable clean energy. In the long term, embedding a workforce development program within their future community solar planning allows Austin Energy to create a local talent pipeline for the city's growing solar industry. In doing so, Austin Energy can ensure that they are fostering the industry while at the same time generating cleaner, more affordable energy that is accessible to the City's LMI and renter populations. The following recommendations will explore how Austin Energy can leverage alternative funding streams to develop these equity-centered programs.

Recommendation 4: Amend the City's Land Code to Create a Solar Fund

The use of solar can be encouraged through incentives and mandates. Incentives encourage adoption through tax breaks or lowered purchase costs. Incentives help *increase* participation in the use of DERs but mandates drive *full* participation. Mandates ensure full participation by capturing those who may not have taken up the incentives. Over the years, the federal government and the City of Austin have encouraged the adoption of DERs through the use of incentives but by encouraging mandates, it will further increase the implementation of DERs. In the workshop with Austin Energy, the "fee in lieu" model emerged as the best way to implement a mandate while also ensuring equity.

"Fee in lieu" is the model that the City of Austin uses for sidewalk development. In the City of Austin Land Use Code, developers are required to include sidewalks in their proposed development or they pay a fee that is equivalent to the price of sidewalk installation to opt-out. The Land Use Code can further remove barriers to solar adoption for individuals participating in the solar market by duplicating the sidewalk "fee in lieu" program for solar.

[143] (Washington, D.C. Department of Energy and Environment n.d.)

This "fee in lieu" program for solar would require a developer to comply with one of two requirements. The first being that the developer establishes solar on all new developments. The second requirement is that developers pay a fee to the solar fund. A solar fund is an account in which the fees received from the developer are collected. After a certain amount of fees are collected, the money can be used to pay for solar elsewhere. Austin Energy can maximize the benefits of this solar fund by using it to provide a community solar farm for LMI communities. They could also use this to add solar panels to local community hubs like faith-based organizations or community centers. The following section details how the Land Use Code can be amended to duplicate the "fee-in-lieu" model for solar.

- **Strategy 1: Amend the Land Use Code to create a Solar Fund**

Strategy 1: Amend the Land Use Code to create a Solar Fund

The Land Use Code in Austin already contains language for "solar ready" and for the sidewalk "fee in lieu." Austin Energy, in partnership with the Land Use and Real Estate Division, can work together to create a mandate that all new buildings have solar on them and allow developers to pay a fee, under certain circumstances, to instead not install solar.

While not all parts of the sidewalk fee-in-lieu program are directly applicable, Austin Energy should work to duplicate key points of the sidewalk program in the following manner:

- The fee paid is equivalent to the cost of installing solar panels
- Developers can opt-out if their particular development is in an area that is not ideal for solar adoption, like a small complex that may be below the tree line.
- The fees from that solar are then used in the same neighborhood to install solar at a later date.
- If the funds are not used within 10 years, they are returned to the developer.

By designing the Land Code amendment with those key elements in mind, Austin Energy does three things: creates a fund in which the price of solar panels is already covered, provides benefits from development to low- and moderate-income communities, and ensures accountability in the funds. When Austin Energy receives these funds, they can then work with the CBOs and FBOs within neighborhoods to find where LMI communities would most benefit from solar panels and create buy-in from the communities. This would also fund the solar panels for these LMI communities and eliminate the barriers of high cost and inadequate financial structures.

By allowing for the opt-out with fees, Austin Energy can create an innovative approach to ensuring equitable implementation of DERs and leverage the Land Use Code to benefit LMI communities.

Recommendation 5: Explore Partnerships to Establish a Green Bank

Although several different methods of specialized financing are possible to reduce upfront costs for LMI customers, green banks can be established to improve the effectiveness and flexibility of fund distribution. Green banks are most often used for providing gap financing for green energy projects, incentivizing developers to build DERs in the area, and reducing the overall cost. They can also be used to provide access to DER technology for customers who cannot afford the cost. In these instances, funds are often provided at a low or zero-percent interest rate. In the U.S., green banks are typically run either by the state government or a quasi-governmental local entity. Green banks are a viable policy given the Inflation Reduction Act's $20 billion dedicated for initial green bank funding. With this in mind, Austin Energy has an opportunity to create a new fund that replicates its current revolving loan fund and expands it to include more DER technologies.

- **Strategy 1: Expand the use of existing revolving loan funds available through IRA**
- **Strategy 2: Establish a Green Bank with outside entity**

Strategy 1: Expand the use of existing revolving loan funds available through the IRA

In 2010 during the Obama administration, Austin Energy was given a $10 million grant by the Department of Energy to provide loans to low-income customers for weatherization improvements.[144] As part of the grant requirements, Austin Energy had to deposit the funds with a third-party provider, ensuring that funds would be secure and used only for the specified purpose. In 2011, Velocity Credit Union was named as the financing institution. An initial $5 million deposit was made as collateral for any defaults.[145] Another $5 million was deposited to be used as a revolving loan fund.[146]

The revolving loan fund could make $5 million worth of loans and then loan that money out again when the initial loans had been paid. The $5 million in collateral lowered the risk to Velocity Credit Union in making those loans. By lowering the risk, the institution could provide low-interest-rate loans to low-income customers. These loan offerings included a low-interest loan of up to $20,000 for Austin Energy Home Performance with ENERGY

[144] (Cohen and Jones 2023)
[145] (Cohen and Jones 2023)
[146] (Cohen and Jones 2023)

STAR improvements, and zero-interest loans up to $10,000 for HVAC improvements for Weatherization Assistance Program customers.[147] The program was generally successful with low default rates and significant funds remain available. With new funding being made available through the IRA, Austin Energy has the opportunity to replicate what they have done through this weatherization program and expand it to include more DER technologies.

Through its current revolving loan fund program, Austin Energy has proven that they have the administrative capability to run an effective green banking program with minimal losses. Austin Energy should begin exploring partnerships with credit unions to create a new funding source. Part of this process will involve being prepared to provide technical expertise and guidance on reaching LMI communities. Additionally, Austin Energy should closely follow the requirements and restrictions of the green bank portion of the IRA, which they shared should be updated sometime in the summer of 2023.[148]

Strategy 2: Establish a Green Bank with outside entity

Another mechanism for establishing a green bank is exemplified by the New York City Energy Efficiency Corporation (NYCEEC). The NYCEEC was the first local green bank established in the US and was initially funded through a $37.5 million federal grant.[149] What makes this green bank exemplary is that it is not a city department or government-owned entity, but was instead established by New York City as a non-profit organization. This way, the bank can be established without legislation, has more flexibility in carrying out its operations, and has access to funding through a wider variety of sources, such as private or philanthropic funds. New York City maintains the public accountability of NYCEEC through the two City officials sitting on the board.[150]

This green bank typically works with multifamily developers or other industrial-scale partners on projects that range from $250,000 to $2 million. However, similar to what Austin Energy would hope to achieve with a green bank, NYCEEC focuses explicitly on energy efficiency improvements and solar installations. Through this, NYCEEC has been responsible for eliminating 1.01 million metric tons of emissions, saving 25.9 million BTUs of energy, completing 85% of projects in LMI communities, and mobilizing $439 million worth of capital.[151]

---

[147] (Velocity Credit Union n.d.)
[148] (US EPA Office of the Administrator 2023)
[149] (C40 Cities 2020)
[150] (C40 Cities 2020)
[151] (NYCEEC n.d.)

Conclusion

Austin faces several challenges to equitable DER adoption. From conversations with leading experts in the energy equity and renewable energy space, six barriers emerged as the most important for addressing equitable DER access. Physical barriers, financial barriers, high costs, inadequate financial structures, split incentive issues, knowledge and language gaps, and distrust, were cited as major impediments to achieving widespread DER adoption among LMI and renter populations. These same conversations also revealed a set of five best practices that could be implemented by Austin Energy to help overcome the most prominent barriers to DER adoption and achieve equitable DER access. Community engagement, energy efficiency improvements, community solar, specialized financing, and building code reforms all demonstrated the capability of addressing DER physical and financial adoption barriers. Notably, community solar emerged as the most comprehensive best practice, with the potential to address physical and financial barriers. The discovery process also revealed the importance of community engagement as a way to address trust and knowledge gap barriers. Importantly, no single best practice could address all six barriers. The absence of a silver bullet solution suggests the need to develop and implement a set of strategic recommendations to overcome persistent barriers to widespread DER adoption.

The LBJ research team presented these six barriers and five best practices to Austin Energy and facilitated a half-day policy workshop session. The workshop provided the foundation for the LBJ team to develop a set of five strategy recommendations designed to help guide Austin Energy's equitable DER expansion plan development. The five recommendations included internally replicating the emphasis on safety to include an emphasis on safety, strengthening community engagement efforts through collaboration with CBOs and FBOs, prioritizing LMI and renter populations in community solar programs, amending the City's Land Use Code to create a solar fund, and exploring partnerships to establish a green bank. A series of strategies accompany each recommendation, demonstrating intermediate actions Austin Energy could take to begin the process of embedding equity within their organization and plans to expand the use of DERs in Austin.

The five strategy recommendations provide Austin Energy a path toward achieving energy equity and helping the City of Austin achieve its net zero goals. Equitable access to DERs is a necessary step towards net zero emissions in Austin. This report represents the necessary steps required to create a city where residents have equitable access to these technologies and their benefits. Austin's challenges to equitable DER adoption can be overcome with these strategies. Austin Energy's efforts to embed equity at the forefront of its expansion efforts can reduce energy inequities and accelerate decarbonization efforts.

It can be a leader in the equitable DER expansion efforts among electric utility providers and, in the process, ensure that the net-zero goals of the Climate Equity Plan are met.

Works Cited

ACEEE. "Distributed Energy Resources." Accessed April 23, 2023. https://www.aceee.org/topic/distributed-energy-resources.

ACEEE. (2023, March). ACEEE *Utility Scorecard Equity Metrics Implementation Strategy*. ACEEE Fact Sheet. Retrieved April 25, 2023, from https://www.aceee.org/sites/default/files/pdfs/utility_scorecard_equity_road map_with_metrics_update_3-1-23.pdf

Adrian, Tobias, Patrick Bolton, Alissa M. Kleinnijenhuis. "The Great Carbon Arbitrage". International Monetary Fund. Working Paper, June 1, 2022. https://www.imf.org/en/Publications/WP/Issues/2022/05/31/The-Great-Carbon-Arbitrage-518464

Aguilar, Samantha. "How Freezing Rain, Tree-Lined Neighborhoods and above-Ground Power Lines Prolonged Austin Power Outages." *The Texas Tribune*, February 7, 2023. https://www.texastribune.org/2023/02/07/austin-ice-storm-power-outages-2023/.

Austin Energy. "Austin SHINES: Innovations in Energy Storage." Austin Energy, n.d. https://austinenergy.com/green-power/austin-shines.

Austin Energy. "Customer Assistance Programs Overview." Austin Energy, March 23, 2022. https://coautilities.com/wps/wcm/connect/occ/coa/util/support/customer-assistance/cap-overview.

Austin Energy. "Rebates & Incentives." Austin Energy, n.d. https://savings.austinenergy.com/.

Austin Energy. "Residential Rates." Austin Energy, March 1, 2023. https://austinenergy.com/rates/residential-rates.

Austin Energy. Presentation on August 30, 2022. Austin, Texas.

Avtar, Ruchi, Kristian Blickle, Rajashri Chakrabarti, Janavi Janakiraman, and Maxim Pinkovskiy. "Understanding the Linkages between Climate Change and Inequality in the United States." SSRN *Electronic Journal*, 2021. https://doi.org/10.2139/ssrn.3961093.

Baker, Shalanda, Subin DeVar, and Shiva Prakash. "Defining Energy Justice: Connections to Environmental Justice, Climate Justice, and the Just Transition." In *The Energy Justice Workbook*. The Initiative for Energy Justice, 2019. https://iejusa.org/wp-content/uploads/2019/12/The-Energy-Justice-Workbook-2019-web.pdf.

Batalova, Jeanne, and Michael Fix. "A Profile of Limited English Proficient Adult Immigrants." *Peabody Journal of Education* 85, no. 4 (October 29, 2010): 511–34. https://doi.org/10.1080/0161956X.2010.518050.

Bertoni, Vincent, Kevin Keller, Thomas Rothmann, Deborah Kahen, and Mary Richardson. "Solar Roof Ordinance." Los Angeles: Department of City Planning, May 25, 2017. https://planning.lacity.org/StaffRpt/InitialRpts/Solar%20Roof%20Ordinance.pdf.

Bertrand, Savannah. "Fact Sheet | Climate, Environmental, and Health Impacts of Fossil Fuels." Environmental and Energy Study Institute, December 17, 2021. https://www.eesi.org/papers/view/fact-sheet-climate-environmental-and-health-impacts-of-fossil-fuels-2021.

Bond, Kingsmill, Sam Butler-Sloss. "Peaking: A Brief History of Select Energy Transitions." *Rocky Mountain Institute* (2022). https://rmi.org/insight/how-past-energy-transitions-foretell-a-quicker-shift-away-from-fossil-fuels-today/.

Borenstein, Severin, and Lucas W. Davis. "The Distributional Effects of US Clean Energy Tax Credits." *Tax Policy and the Economy* 30, no. 1 (2016). https://www.journals.uchicago.edu/doi/10.1086/685597.

Brockway, Anna M., Jennifer Conde, and Duncan Callaway. "Inequitable Access to Distributed Energy Resources to Grid Infrastructure Limits in California." *Nature Energy* 6 (September 2021): 892–903.

Burnette, Colette Pierce, and Paul Cruz. "Mayor's Task Force on Institutional Racism and Systemic Inequities Final Report." Austin, Texas, March 13, 2017. https://www.austintexas.gov/edims/document.cfm?id=274706.

Burns, Rebecca. "The Subprime Solar Trap for Low-Income Homeowners." *Bloomberg.Com*, April 6, 2021. https://www.bloomberg.com/news/features/2021-04-06/the-subprime-solar-trap-for-low-income-homeowners.

C40 Cities. "About C40." C40 Cities. Accessed April 23, 2023. https://www.c40.org/about-c40/.

California Public Utilities Commission. "CPUC DER Action Plan 2.0," April 21, 2022. https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M467/K470/467470758.PDF.

California Energy Commission. (2018, June 25). *Energy Equity Indicators Tracking Progress*. Home Page-California Energy Commission. Retrieved April 25, 2023, From https://www.energy.ca.gov/sites/default/files/2019-12/energy_equity_indicators_ada.pdf

Candanosa, Roberto Molar. “Reducing Emissions to Lessen Climate Change Would Yield Dramatic Health Benefits by 2030.” NASA *Global Climate Change: Vital Signs of the Planet* (blog), November 30, 2021. https://climate.nasa.gov/news/3134/reducing-emissions-to-lessen-climate-change-would-yield-dramatic-health-benefits-by-2030/.

Carliner, Michael. “Reducing Energy Costs in Rental Housing.” America’s Rental Housing. Joint Center for Housing Studies of Harvard University, December 2013. https://www.jchs.harvard.edu/sites/default/files/harvard_jchs_carliner_research_brief.pdf.

Carter, E.R., Onyeador, I.N., & Lewis Jr, N.A. (2020). Developing & delivering effective anti-bias training: Challenges & Recommendations. Behavior Science & Policy, 6(1), 57-70

Center for Sustainable Energy. “How Much Does a Typical Residential Solar Electric System Cost?” CSE, March 27, 2023. https://sites.energycenter.org/solar/homeowners/cost.

City of Austin. “Austin Climate Equity Plan.” Austin, Texas, 2020. https://www.austintexas.gov/sites/default/files/files/Sustainability/Climate%20Equity%20Plan/Climate%20Plan%20Full%20Document__FINAL.pdf.

Clements, Benedict J., and Ian Parry. “What Are Subsidies?” *Finance & Development*, September 2018. https://www.imf.org/en/Publications/fandd/issues/2018/09/what-are-subsidies-basics.

“Community Climate Ambassadors.” *City of Austin Department of Sustainability*, n.d. https://www.austintexas.gov/page/community-climate-ambassadors.

Cohen, Aiden, and Tyler Jones. “Connect w/ LBJ Student - AE’s Velocity Loam Program,” March 31, 2023.

Crago, Christine Lasco, and Ilya Chernyakhoskiy. “Are Policy Incentives for Solar Power Effective? Evidence from Residential Installations in the Northeast.” *Journal of Environmental Economics and Management* 81 (January 2017): 132–51.

Dasgupta, Susmita, Somik Lall, and David Wheeler. “Cutting Global Carbon Emissions: Where Do Cities Stand?” World Bank Blogs, January 5, 2022. https://blogs.worldbank.org/sustainablecities/cutting-global-carbon-emissions-where-do-cities-stand.

Department of Energy. “DOE Announces Goal to Cut Solar Costs by More than Half by 2030.” *Energy.Gov* (blog), March 25, 2021.

https://www.energy.gov/articles/doe-announces-goal-cut-solar-costs-more-half-2030.
Dinan, Kinsey Alden. "Budgeting for Basic Needs: A Struggle for Working Families – NCCP." *National Center for Children in Poverty* (blog), March 2009. https://www.nccp.org/publication/budgeting-for-basic-needs-a-struggle-for-working-families/.
District of Columbia. "Solar for All Implementation." Department of Energy and Environment, March 10, 2017. https://doee.dc.gov/sites/default/files/dc/sites/ddoe/service_content/attachments/DOEE-%20Report-%20Solar%20for%20All%20Implementation-%20Final%20for%20Transmittal.pdf.
Donald, Jess. "Winter Storm Uri 2021." *Fiscal Notes*, October 2021. https://comptroller.texas.gov/economy/fiscal-notes/2021/oct/winter-storm-impact.php#:~:text=Winter%20Storm%20Uri%20far%20exceeded,Snow%20later%20followed%20on%20Feb.
Drehobl, Ariel. "ACEEE's Leading With Equity Initiative: Key Findings and Next Steps," *American Council for an Energy Efficient Economy* (December 2021). https://www.aceee.org/sites/default/files/pdfs/Leading%20with%20Equity%20final%201-28-22.pdf.
Dubin, Kenneth. "EIA Projects Renewables Share of U.S. Electricity Generation Mix Will Double by 2050." U.S. *Energy Information Administration* (blog), February 8, 2021. https://www.eia.gov/todayinenergy/detail.php?id=46676.
"Duke and Dominion Energy Neighborhood Energy Saver Program: Program Profile." *Environmental Protection Agency*, n.d. https://www.epa.gov/sites/default/files/2017-06/documents/duke_energy_profile_508.pdf.
Elmallah, Salma, Tony G. Reames, and C. Anna Spurlock. "Frontlining Energy Justice: Visioning Principles for Energy Transitions from Community-Based Organizations in the United States." *Energy Research & Social Science* 94 (December 2022). https://www.sciencedirect.com/science/article/pii/S2214629622003589.
ERCOT. (2023). *About ERCOT*. About Ercot. Retrieved March 30, 2023, from https://www.ercot.com/about
Ewing, Jack. "Electric Vehicles Could Match Gasoline Cars on Price This Year." *The New York Times*, February 10, 2023, sec. Business. https://www.nytimes.com/2023/02/10/business/electric-vehicles-price-cost.html.

Feldman, David, Vignesh Ramasamy, Ran Fu, Ashwin Ramdas, Jal Desai, and Robert Margolis. "U.S. Solar Photovoltaic System and Energy Storage Cost Benchmark (Q1 2020)," January 2021. https://doi.org/10.2172/1764908.

Fitzpatrick, Alex, Joann Muller, and Erin Davis. "EV Chargers Are Easier to Find in White, Wealthy Neighborhoods." Axios, January 17, 2023. https://www.axios.com/2023/01/17/electric-car-ev-chargers-neighborhood-disparity.

Forrester, Sydney, Galen Barbose, Eric O'Shaughnessy, Naïm Darghouth, and Cristina Crespo Montañés. "Residential Solar-Adopter Income and Demographic Trends: November 2022 Update." Presented at the Residential Solar-Adopter Income and Demographic Trends: Data Through 2021, November 17, 2022. https://emp.lbl.gov/publications/residential-solar-adopter-income-1.

Gautam, Prajjwal, Prasanna Piya, and Rajesh Karki. "Resilience Assessment of Distribution Systems Integrated With Distributed Energy Resources." *IEEE Transactions on Sustainable Energy* 12, no. 1 (January 2021): 338–48.

Guerrero, Ginny. "Austin Water Seeks Community Ambassadors to Help Guide Water Forward Plan Updates | AustinTexas.Gov." Austin Water, December 7, 2021. https://www.austintexas.gov/news/austin-water-seeks-community-ambassadors-help-guide-water-forward-plan-updates.

Gundlach, Justin, and Burcin Unel. "Getting the Value of Distributed Energy Resources Right: Using a Societal Value Stack." Electricity Policy Insights. Institute for Policy Integrity, December 2019. https://policyintegrity.org/files/publications/Getting_the_Value_of_Distributed_Energy_Resources_Right.pdf.

Hall, John, Michael Jewell, and Sarah Ryan. "Encouraging the Development of Distributed Energy Resources in Texas." Environmental Defense Fund, n.d. https://www.edf.org/sites/default/files/documents/EDF%20-%20DER%20Roadmap-FINAL%209.1.20.pdf#:~:text=DERs%20have%20a%20proven%20track,be%20available%20for%20summer%202020.

Harmon, Dana, Erick Jones, Emery Wolfe, and Jacquie Moss. "Pathways to DERs to Reduce Energy Burdens in Low-Income Households - Harris County Full Report." Texas Energy Poverty Research Institute, March 19, 2021. https://tepri.org/2021/03/pathways-for-ders-to-reduce-energy-burdens-in-low-income-households-harris-county-full-report-2/.

Hawaiian Electric Company. "Customer Energy Resources for Hawai'i-Hawaiian Electric's CER Strategy." Hawaiian Electric Company, May 2021. https://www.hawaiianelectric.com/documents/products_and_services/customer_renewable_programs/20210503_customer_energy_resources_for_hawaii.pdf.

Heeter, Jenny, Ashok Sekar, Emily Fekete, Monisha Shah, and Jeffrey J. Cook. “Affordable and Accessible Solar for All: Barriers, Solutions, and On-Site Adoption Potential.” Golden, CO: National Renewable Energy Laboratory, September 2021. https://www.nrel.gov/docs/fy21osti/80532.pdf.

Hoffman, Michael, and Cameron Freburg. “Austin Energy Policy Research Project Proposal to UT LBJ School.” Presented at the Prospective Client Presentations, Austin, Texas, August 30, 2022.

International Coaching Federation. “CPS Energy: Save for Tomorrow Energy Plan (‘STEP’) Program Review.” San Antonio, TX: International Coaching Federation, November 2019. https://www.cpsenergy.com/content/dam/corporate/en/Documents/STEP%20Review%20Report_19-11-1.pdf.

Jina, Amir. “Climate Change and the U.S. Economic Future.” *EPIC* (blog). Accessed April 23, 2023. https://epic.uchicago.edu/area-of-focus/climate-change-and-the-us-economic-future/.

Jones-Albertus, Becca. “Replacing Your Roof? It’s a Great Time to Add Solar.” *Office of Energy Efficiency & Renewable Energy* (blog), July 28, 2021. https://www.energy.gov/eere/solar/articles/replacing-your-roof-its-great-time-add-solar.

Kellison, B. (2020, June 23). *The next five years will see Massive Distributed Energy Resource Growth*. Wood Mackenzie. Retrieved March 30, 2023, from https://www.woodmac.com/news/editorial/der-growth-united-states/

Lee, Cheng-Chun, Mikel Maron, and Ali Mostafavi. “Community-Scale Big Data Reveals Disparate Impacts of the Texas Winter Storm of 2021 and Its Managed Power Outage.” *Humanities and Social Sciences Communications* 9, no. 335 (September 13, 2022). https://doi.org/10.1057/s41599-022-01353-8.

Levite, Brian. “The Moving Targets of Reliability and Resilience.” *Electric Energy Online*. https://electricenergyonline.com/energy/magazine/1285/article/The-Moving-Targets-of-Reliability-and-Resilience.htm#:~:text=Reliability%20is%20typically%20defined%20as,online%20after%20a%20major%20outage.

Light, Tricia, E. Carrie McIntosh, and Oliver L. Stephenson. “Advancing Equity in Access to Distributed Energy Resources in California.” *Journal of Science Policy & Governance* 20, no. 1 (March 2022). https://doi.org/10.38126/JSPG200106.

Lukanov, Boris, and Elena Krieger. “Distributed Solar and Environmental Justice: Exploring the Demographic and Socio-Economic Trends of Residential PV Adoption in California.” *Energy Policy* 134 (November 2019). https://www.sciencedirect.com/science/article/abs/pii/S0301421519305221?via%3Dihub.

Millerbernd, Annie. “Solar Loans: Compare Solar Financing Options.” NerdWallet, February 23, 2023. https://www.nerdwallet.com/best/loans/personal-loans/solar-loans-solar-panel-system-financing-options.

NASA Global Climate Change: Vital Signs of the Planet. “Vital Signs: Carbon Dioxide.” NASA *Global Climate Change: Vital Signs of the Planet* (blog), n.d. https://climate.nasa.gov/vital-signs/carbon-dioxide/#:~:text=Carbon%20dioxide%20in%20the%20atmosphere,in%20less%20than%20200%20years.

NREL. “Net Metering.” NREL. Accessed April 24, 2023. https://www.nrel.gov/state-local-tribal/basics-net-metering.html.

NREL. “Residential Battery Storage.” Annual Technology Baseline, 2021. https://atb.nrel.gov/electricity/2021/residential_battery_storage.

Osborne, Margaret. “Hawaii Closes Its Last Coal-Fired Power Plant.” *Smithsonian Magazine*, September 6, 2022. https://www.smithsonianmag.com/smart-news/hawaii-closes-its-last-coal-fired-power-plant-180980707/.

O’Shaughnessy, Eric. “Rooftop Solar Incentives Remain Effective for Low and Moderate-Income Adoption.” *Energy Policy* 163 (April 2022). https://www.sciencedirect.com/science/article/pii/S0301421522001069?via%3Dihub.

Our World in Data. “Per Capita Electricity Generation by Source.” Our World in Data, 2022. https://ourworldindata.org/grapher/per-capita-electricity-source-stacked?stackMode=relative&time=earliest&country=OWID_WRL~CHN~IND~USA~JPN~DEU~GBR~BRA~FRA~CAN~SWE~ZAF.

Patel, Priya. “Energy Equity: A Framework for Evaluating Solar Programs Targeting Low-Income Communities.” *Energy Law Journal* 43, no. 2 (2022): 299–338.

Pellegrini-Masini, Giuseppe, Alberto Prini, and Stefano Maran. “Energy Justice Revisited: A Critical Review on the Philosophical and Political Origins of Equality.” *Energy Research & Social Science* 59 (January 2020). https://www.sciencedirect.com/science/article/abs/pii/S2214629618303906.

Pforzheimer, Adrian, and Johanna Neumann. “Shining Cities 2022.” Frontier Group, April 18, 2022. https://frontiergroup.org/resources/shining-cities-2022/#:~:text=Honolulu%20leads%20the%20United%20States,nationally%20for%20solar%20energy%20development.

Pillay, Kamleshan, Curtis Probst, and Jessica Luk. “Establishing a City Green Bank: Best Practice Guide.” C40 Cities, 2020.

https://www.c40knowledgehub.org/s/article/Establishing-a-City-Green-Bank-Best-Practice-Guide?language=en_US.

Portland General Electric. (2021). *Advancing our clean energy future*. 2021 ESG Report . Retrieved April 25, 2023, from https://assets.ctfassets.net/416ywc1laqmd/5aLMRJup0FHiMTf0EpgzYO/9e384dc5c6422147ddadbd821913163a/PGE_ESG21_Web.pdf

Pörtner, Hans-O., Debra C. Roberts, Helen Adams, Carolina Adler, Paulina Aldunce, Elham Ali, Rashwan Ara Begum, and Richard Betts. "Summary for Policy Makers." IPCC, 2022. https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_SummaryForPolicymakers.pdf.

Point2Homes. "Austin Demographics." Point2, n.d. https://www.point2homes.com/US/Neighborhood/TX/Austin-Demographics.html.

Poudel, Shiva, and Anamika Dubey. "Critical Load Restoration Using DERS for Resilient Power Distribution System." *IEEE Transactions on Power Systems* 34, no. 1 (January 2019): 52–63.

Sechler, Bob. "Elon Musk's Influence? Travis County Tops Texas in Electric Vehicle Ownership." *Austin American-Statesman*, April 25, 2022. https://www.statesman.com/story/business/2022/04/25/electric-austin-travis-county-tops-texas-electric-vehicle-ownership/7368608001/.

Shaban, Hassan, and Lacy Stockton. "Quantitative Energy Equity." Empower Dataworks LLC, 2020. https://pubs.naruc.org/pub/F7E7EDC7-155D-0A36-31CA-49A77302407D.

Solar Energy Technologies Office. "Homeowner's Guide to the Federal Tax Credit for Solar Photovoltaics." *Department of Energy Office of Energy Efficiency and Renewable Energy*, March 2023. https://www.energy.gov/eere/solar/homeowners-guide-federal-tax-credit-solar-photovoltaics.

Solar Energy Technologies Office. "Sustainable and Holistic Integration of Energy Storage and Solar PV (SHINES)." Office of Energy Efficiency & Renewable Energy, January 2016. https://www.energy.gov/eere/solar/sustainable-and-holistic-integration-energy-storage-and-solar-pv-shines#:~:text=The%20Sustainable%20and%20Holistic%20Integration,reliable%2C%20and%20cost%2Deffective.

"Solar for All." *Washington D.C. Department of Energy and Environment*, n.d. https://doee.dc.gov/solarforall.

"Solar Works D.C." *Washington D.C. Department of Energy and Environment*, n.d. https://doee.dc.gov/service/solar-works-dc.

Texas Energy Poverty Research Institute. "Energy Equity Primer: Terminology and Concepts to Promote Equitable Energy Opportunities," June 2022. https://tepri.org/wp-content/uploads/2022/08/Energy-Terms-Primer-v2.pdf.

Tierney, Susan. "The Value of 'DER' to 'D': The Role of Distributed Energy Resources in Supporting Local Electric Distribution System Reliability." Analysis Group, Inc., March 31, 2016. https://www.analysisgroup.com/globalassets/content/news_and_events/news/value_of_der_to-_d.pdf.

Understanding Global Change, UC Berkeley. "Burning of Fossil Fuels." Understanding Global Change. Accessed April 23, 2023. https://ugc.berkeley.edu/background-content/burning-of-fossil-fuels/

U.S. Census Bureau. "U.S. Census Bureau QuickFacts: Austin City, Texas." U.S. Census Bureau, 2021. https://www.census.gov/quickfacts/austincitytexas.

US Department of Transportation. "Electric Vehicle Charging Speeds." US Department of Transportation, February 2, 2022. https://www.transportation.gov/rural/ev/toolkit/ev-basics/charging-speeds.

U.S. Energy Information Administration. "Hawaii State Profile and Energy Estimates." U.S. Energy Information Administration, n.d. https://www.eia.gov/state/?sid=HI.

U.S. Energy Information Administration. "Texas State Profile and Energy Estimates." U.S. Energy Information Administration, n.d. https://www.eia.gov/state/?sid=TX.

U.S. Energy Information Administration. "Renewables Became the Second-Most Prevalent U.S. Electricity Source in 2020." U.S. Energy Information Administration, July 28, 2021. https://www.eia.gov/todayinenergy/detail.php?id=48896.

U.S. Energy Information Administration. "Annual Energy Outlook 2022." U.S. Energy Information Administration, March 3, 2022. https://www.eia.gov/outlooks/aeo/pdf/AEO2022_ReleasePresentation.pdf

Way, Heather, Elizabeth Mueller, Jake Wegmann, Amelia Adams, Nichols Armstrong, Ben Martin, Alex Radtke, and Alice Woods. "Uprooted: Residential Displacement in Austin's Gentrifying Neighborhoods and What Can Be Done About It." Austin, Texas: The University of Texas Center for Sustainable Development in the School of Architecture & the Entrepreneurship and Community Development Clinic in the School of Law, 2018. https://sites.utexas.edu/gentrificationproject/files/2019/10/AustinUprooted.pdf.

"What is U.S. Electricity Generation by Energy Source?" *Energy Information Administration* (November 8, 2022). https://www.eia.gov/tools/faqs/faq.php?id=427&t=3

Woolf, Tim, Melissa Whited, Erin Malone, Tommy Vitolo, and Rick Hornby. "Benefit-Cost Analysis for Distributed Energy Resources." Synapse Energy Economics, September 22, 2014. https://www.synapse-energy.com/sites/default/files/Final%20Report.pdf.