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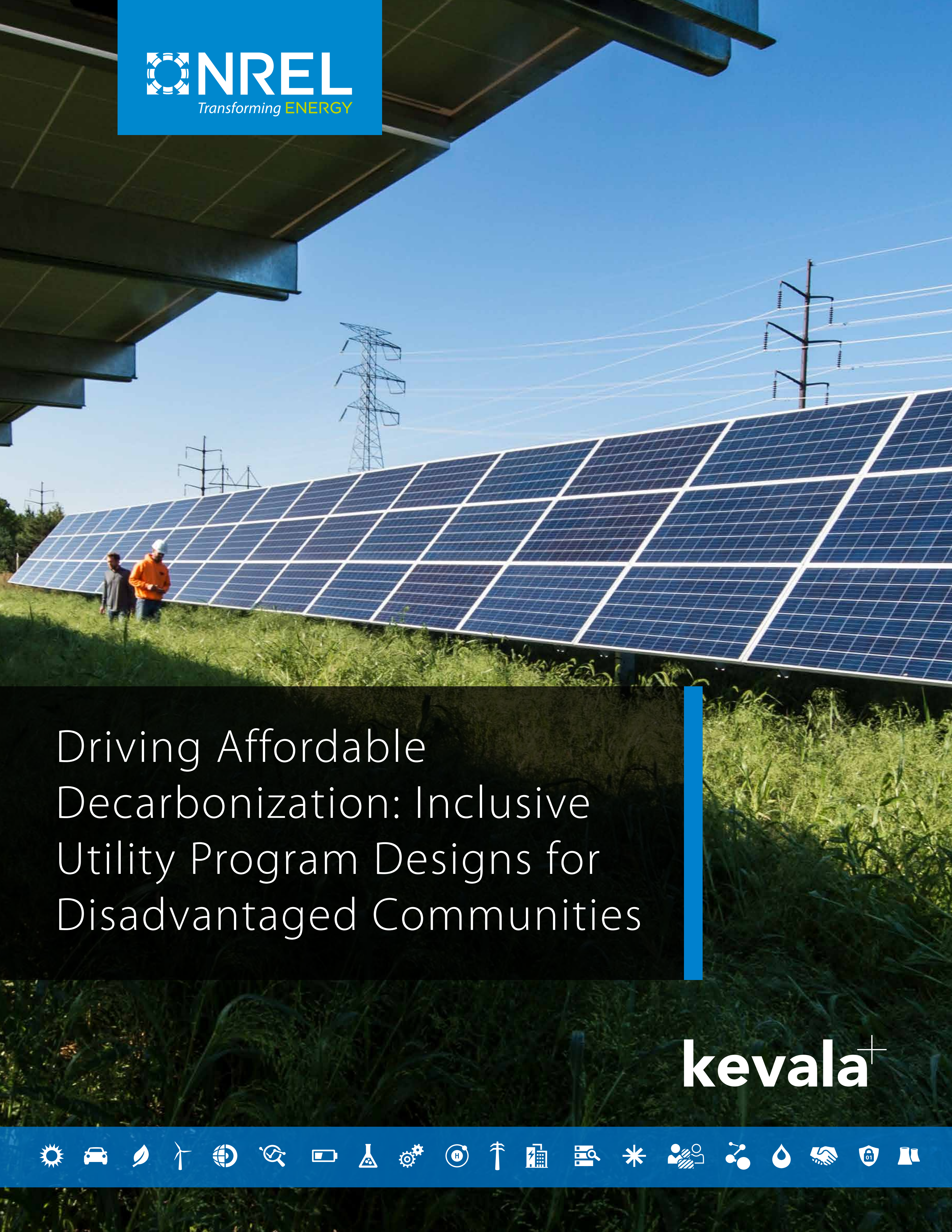

Driving Affordable Decarbonization: Inclusive Utility Program Designs for Disadvantaged Communities

kevala

Can Electrification and Decarbonization Drive Affordability

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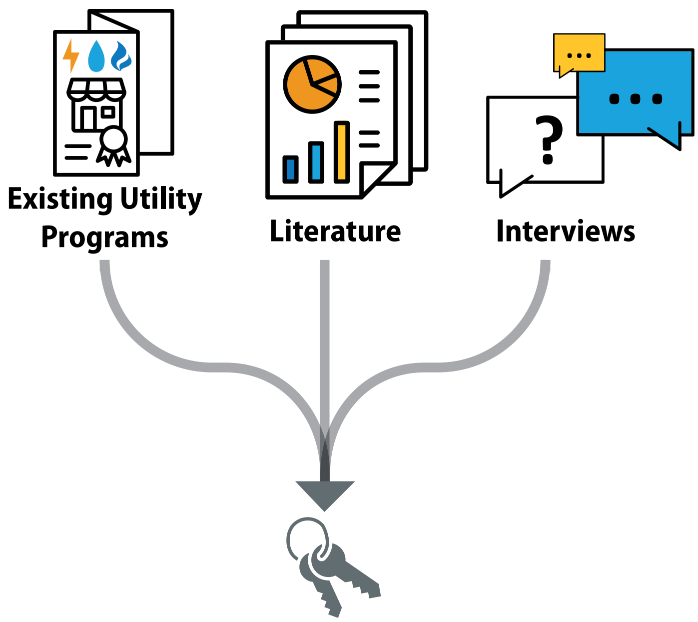
EXECUTIVE SUMMARY

Electrical grids are highly complex and benefit from strategic management and investment

Photo by Werner Slocum, NREL

Access to utility programs and incentives is a critical pathway for reaching holistic decarbonization. However, utilities encounter challenges in addressing the needs of historically disadvantaged communities and ensuring energy justice. This report aims to understand the key characteristics for utility programs that serve disadvantaged communities.

Our research team worked with 17 utility partners from various U.S. regions to study current utility program practices. We identified the key characteristics of these programs and the challenges and opportunities in implementing them. Through our research, we provide a pragmatic, design-oriented, and customer-centered perspective for effective program design and implementation. We identify 13 characteristics of successful program design that may be considered by utility partners, as shown in **Table 1**.



The key characteristics of utility program design fit in five categories:

- **Identifying Customer Needs**
- **Bottom-Up Program Design and Evaluation**
- **Funding**
- **Equitable Service Offerings and Outreach**
- **Metrics and Program Evaluation**

(Figure ES-1)

Table 1. Key Considerations for Utility Program Design

Key Considerations	Program Design Characteristics
Identifying Customer Needs	1. Partner with trusted community-based organizations to learn community needs, deliver utility program information, and collect customer feedback. 2. Use multiple datasets, such as data from local organizations and shared experiences from customers, to inform a grounded and timely understanding of community needs. 3. Remove barriers that inhibit participation of disadvantaged customers. This, in turn, can reveal greater opportunities for participation among other customer classes.
Bottom-Up Program Design and Evaluation	1. Use timely, focused, and strategic communication to different customer segments. 2. Develop a framework to continually evaluate programs in terms of customer impact, energy justice, and community resiliency that includes methods to listen to and empower customers in decision-making, defining metrics, evaluating program success, and accepting continual feedback.
Funding	1. Provide accessible and inclusive financing mechanisms for building improvements with energy efficiency and decarbonization incentives. Providing pathways for contractors to leverage these financing mechanisms can also increase program participation. 2. Design owner-financing mechanisms to maximize tenant benefits and minimize risks of tenant displacement.
Equitable Service Offerings and Outreach	1. When possible, establish opt-out program enrollment when there are clear customer benefits to participation. 2. Provide accessible information in multiple languages. 3. Partner with community-based organizations, third-party program providers, and contractors to facilitate enrollment, outreach, and implementation of programs and services. 4. Plan electrical infrastructure upgrades that prioritize neighborhoods in which utilities and governments have historically underinvested in to ensure equitable and reliable services. 5. Offer customers options for purchasing green power.
Metrics and Program Evaluation	1. Develop standardized and diverse metrics for evaluating and comparing programs. Community metrics can help evaluate impact and quality of service for customers and communities. Detective and preventive metrics provide insights into the need for course-correction and avoiding unintended consequences. Performance metrics can help inform how programs adapt to community needs and system changes.

The paper underscores the potential for affordable decarbonization, offering a roadmap based on utility program design to overcome challenges and seize opportunities in serving disadvantaged communities. The findings aim to serve as a valuable resource for policymakers, utility providers, and stakeholders involved in shaping the future of inclusive and sustainable energy programs.

In this paper, we underscore National Renewable Energy Laboratory (NREL) engineers Shanti Pless, Andrew Parker, and Kate Doubleday use a 3D visualization of energy model outputs for the Peña Station NEXT district to discuss potential energy loads of the proposed development.
Photo by Dennis Schroeder, NREL 50651

BACKGROUND: HOW DID WE GET HERE?

Photo by Josh Bauer and Bryan Bechtold, NREL 84135

To successfully decarbonize the economy, utilities need to provide clean and bulk-scale energy while customers need to change their energy habits. Program design can be a powerful tool to encourage these changes. However, utilities face challenges when designing programs that best serve historically disadvantaged and underserved communities. In this report, we seek to understand the key considerations for effective utility program designs serving disadvantaged and underserved communities.

We conducted a case study of utility program design practices by interviewing 17 utility stakeholders familiar with utility program designs in the United States, gathering and analyzing publicly available utility program information and conducting a literature review of utility program design practices (Yin 2017). By thematically synthesizing these three distinct sources of evidence, we identified key considerations for utility program designs when serving disadvantaged communities. Interviewees work with or in utilities across the United States, including the Mountain West, Pacific, New England, and Southeast, affording a wide range of cultural practices (e.g., contractor familiarity with technologies), climate zones, and state-level support. In addition, we selected interviewees from a variety of utility structures and roles to support a comprehensive study of utility program design practice across key stakeholders, as shown in **Figure 1**.

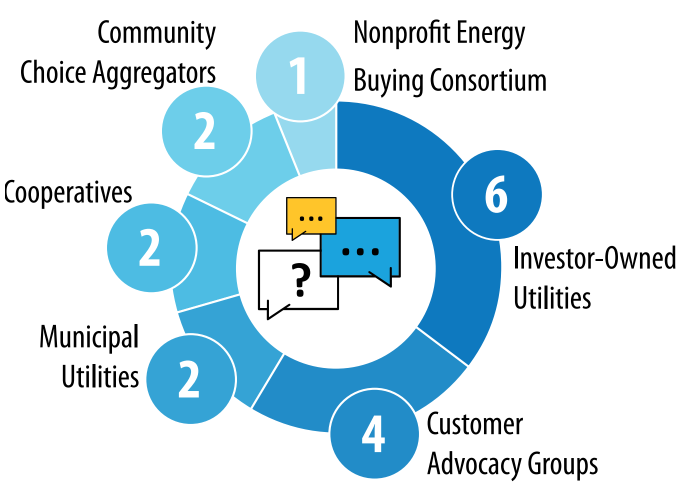


Figure 1. Utility stakeholders interviewed

Our research team was uniquely positioned to consider the pragmatic perspective while maintaining rigorous program analysis through our practitioner-researcher partnership between Kevala, Inc. (Kevala), the National Renewable Energy Laboratory (NREL), and the University of Colorado Boulder.

Stakeholders needed to have utility program design experience and a website with information about an existing program. We recruited stakeholder partners by email. Our semi-structured interview questions were informed by the research team's expertise in the utility space, as well as a review of existing utility program design information (i.e., utility program websites) and literature (Charan et al. 2024).

During the hour-long interviews, we listened to the goals stakeholders shared about utility program designs. To ensure all participants could be actively engaged throughout the interview, we assigned a note taker to transcribe key discussion points. Sharing a series of guiding questions before our interviews, we heard from stakeholders about how they maneuvered through the uncertainty of designing programs. Stakeholders shared how they identified needs for services and programs, prototyped programs, garnered motivation across in their organizations, found and sustained funding, received and integrated regulatory oversight, delivered incentives through strategic enrollment and outreach, and determined how to measure program success. Our sessions often discussed the successes and barriers stakeholders faced before, during, and after the deployment of utility program design.

Through multiple rounds of analysis and conversation, our research team thematically synthesized the evidence using concept boards and mapping (Kinchin, Streatfield, and Hay 2010; Thomas and Harden 2008). We identified successes, barriers, and motivations for utility programs from the complementary stakeholder viewpoints. After these barriers, motivations, and successes were identified, we took a more abductive and design-oriented posture, in which we considered how we might remove barriers and increase motivations to promote successful program designs (Timmermans and Tavory 2022). These rich discussions and ideations embodied the practice of research-through-design (Frayling 1994) and informed a path forward for utility program designers.

DEFINING DISADVANTAGED COMMUNITIES

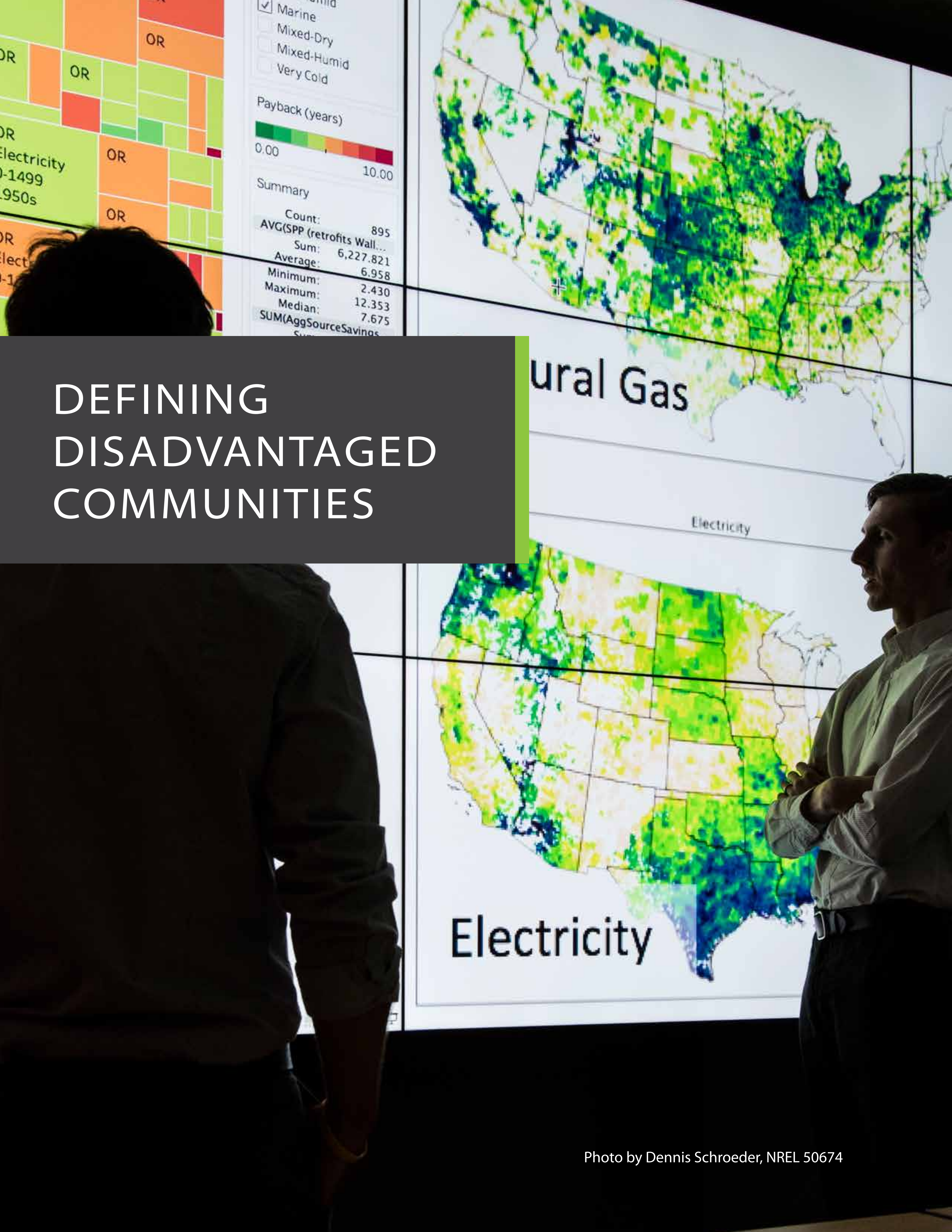


Photo by Dennis Schroeder, NREL 50674

By not including or prioritizing disadvantaged communities in decarbonization planning and implementation, utilities and policymakers make reaching 100% decarbonization goals impossible, and perpetuate the challenges of using, distributing, and maintaining costly fossil fuel infrastructure (Payne 2020).

Disadvantaged communities have been disproportionately impacted by pollution from energy systems because of discriminatory policies such as redlining and racially restrictive covenants (Fears 2022). Fossil fuel infrastructure and resulting pollution harms disadvantaged communities with poorer air quality and higher risks of cancer (Pastor, Morello-Frosch, and Sadd 2005; Johnston and Cushing 2020). Equitably phasing out fossil fuels can protect disadvantaged communities that have been at the forefront of historical and ongoing fossil fuel-generated pollution (Donaghy et al. 2023), but decarbonizing inequitably may continue existing harms (S. Baker 2021).

Pollution stunts economic growth, exacerbates poverty and inequality in both urban and rural areas, and significantly contributes to climate change. Poor people, who cannot afford to protect themselves from the negative impacts of pollution, end up suffering the most (The World Bank 2023).

Defining disadvantaged communities is critical for providing the legal framework to prioritize disadvantaged communities in policies and utility programs. For this reason, we compare existing definitions to showcase how disadvantaged communities can be prioritized and served through utility programs. A summary of disadvantaged community definitions in legislative, utility program, and federal contexts are provided in the text box to the right.

Environmental, economic, and health burdens are common characteristics of disadvantaged community definitions. Geography can be used in definitions, though these characteristics do not account for population migration; the people affected may have left the location or been displaced as a result of pollution. Low and moderate incomes qualify many households as disadvantaged in utility, state, and local programs. Utility definitions tend to coordinate with federal definitions, regulation requirements, and local or state government legislation. Some utilities have also taken measures to ensure their definitions of disadvantaged communities do not introduce unintended bias toward demographics that are more affluent.

Definitions of "Disadvantaged Community"

- **U.S. federal government**: Defines disadvantaged communities in Executive Order (EO) 14008, Tackling the Climate Crisis at Home and Abroad, as "those that are marginalized, underserved, and overburdened by pollution," and recognizes the White House Climate and Economic Justice Screening Tool for geographically defined communities (CEJST 2022).
- **California**: The California Public Utilities Commission defines disadvantaged communities as "the areas throughout California which most suffer from a combination of economic, health, and environmental burdens. These burdens include poverty, high unemployment, air and water pollution, presence of hazardous wastes as well as high incidence of asthma and heart disease" (Public Utility Commission 2023).
- **New York**: Con Edison's PowerReady Electric Vehicle Program defines disadvantaged community areas as areas that meet either of two criteria: (1) "Top quartile of census block groups in New York, ranked by the percentage of low-middle income households in each census block, that are located within the Department of Environmental Conservation Potential Environmental Justice Areas," and (2) "New York State Opportunity Zones," (Con Edison 2023).
- **Illinois**: "Economically disadvantaged communities," are described as "areas of one or more census tracts where average household income does not exceed 80% of area median income" (Illinois General Assembly 2022).
- **Oklahoma**: As defined within the state's Intended Use Plan created for programs and projects utilizing Drinking Water State Revolving Funds, a "Disadvantaged Community" means those communities that serve a population whose median household income is greater than 80%, but less than 90% of the national median household income, according to the U.S. Census Bureau (Oklahoma Environmental Quality 2023).

The Biden-Harris Administration's Justice40 Initiative defines communities as "either a group of individuals living in geographic proximity to one another, or a geographically dispersed set of individuals (such as migrant workers or Native Americans), where either type of group experiences common conditions," and disadvantaged as "a consideration of appropriate data, indices, and screening tools to determine whether a specific community is disadvantaged based on a combination of variables" (The White House 2023).

Prioritizing disadvantaged communities is paramount to ensuring a just energy transition. The Initiative for Energy Justice defines energy justice 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 ("frontline communities"). Energy justice explicitly centers the concerns of marginalized communities and aims to make energy more accessible, affordable, clean, and democratically managed for all communities. The practitioner and academic approaches to energy justice emphasize these process-related and distributive justice concerns (Cooper 2019).*

The Four Dimensions of Energy Justice

1. **Energy burden,** the expense of energy expenditures relative to overall household income.
2. **Energy insecurity,** the hardships households face when meeting basic household needs.
3. **Energy poverty,** a lack of access to energy itself.
4. **Energy democracy,** the notion that communities should have a say and agency in shaping their energy future (Cooper 2019).

The Initiative for Energy Justice describes the goal of energy justice as "achieving equity in both the social and economic participation in the energy system, while also remediating social, economic, and health burdens on those disproportionately harmed by the energy system" (Office of Energy Justice and Equity 2022). While an increased focus on decarbonization is not new, designing policies for energy justice processes and outcomes is relatively nascent.

> *A just transition requires a whole-systems approach for decarbonization (Abram et al. 2022).*

A just transition requires a whole-systems approach to decarbonization (Abram et al. 2022). Program, rate, and policy decisions can support affordable energy prices. From our review, energy burden was a central focus of energy justice, primarily through a measure of residential energy burden (Brown et al. 2020). Some utility partners shared they were concerned that decarbonization would be expensive for both customers and utilities and wanted to focus on the affordability of the transition. Expanding measures and considerations of energy justice can provide a more comprehensive policy and program approach. By addressing energy insecurity, energy poverty, and energy democracy in the development, deployment, and iteration of utility programs, rates, and policies, utilities and policymakers can prioritize ameliorating the hardships, lack of access, and lack of voice when generating, distributing, and using energy.

While "disadvantaged communities" has become a legislative term, it has also been criticized as patronizing and condescending (Pérez-Almendros, Espinosa-Anke, and Schockaert 2020). We invite future policymakers and utility program designers to consider a more inclusive term, such as "priority communities," which emphasizes how communities with environmental and economic injustices have not been prioritized in previous policies and can be better prioritized and invested into by policies and programs. Given the prevalent use of "disadvantaged communities" in legislation and utility program documentation, we use it in the context of this paper.

Joe Spreer with Veterans Green Jobs drills holes to blow cellulose insulation in the interior walls of this Lakewood, Colorado, home. This home is part of the Department of Energy's Weatherization Assistance Program that supports energy efficiency upgrades to low-income homes in Denver.

Photo by Dennis Schroeder, NREL 17966

DECARBONIZATION CAN BE AFFORDABLE

Photovoltaics on the roof of Denver Water s new administration building and parking garage move the project closer to its aspirational goal of zero energy

Photo from Frank Ooms for Denver Water

We heard from utility partners that decarbonization was viewed as expensive for both customers and utilities. Yet, the cost metrics chosen can have a large impact on the perceived costs of decarbonization (Cole et al. 2023). In response, we show how supply- and demand-side decarbonization can be affordable, decrease energy burden, and increase bill savings for residential and commercial customers.

Energy affordability, a common goal among regulators and utilities, is the idea that consumers should be able to pay for their home electricity use—lighting, heating, cooling, powering appliances—while also paying for other basic living expenses, such as food and medication, without having to choose or feel overburdened (DOE 2023a). From this view, customers should have a reasonable price for their electricity needs.

Investor-owned utilities and other agencies that monitor municipal and cooperative utilities set the price for customers (Charan et al. 2024). Regulators establish rates for IOUs by first determining the overall revenue needed for the utility to cover its service costs. The decision of who pays and how they pay is determined by the cost to serve each customer, following Bonbright's principles concerning the combined costs to generate and deliver electricity (Bonbright 1960). These costs are a combination of capital expenditures for assets, such as power plants, substations, and feeders, as well as expenses for maintaining those assets and administering the services to customers. Such services include billing, customer service, and working with regulators and stakeholders to set rates. Rates also depend on the number of sales (kWh or kW) the utility provides using those assets. To make rates more affordable, the costs to generate and deliver electricity must be kept low and the utilization of the assets (or sales) high.

The cost of renewable energy projects has been decreasing over the past decade (Armstrong 2021) to the extent that decarbonization technologies often have a lower cost than non-decarbonizing projects. The costs to build renewable energy generation have plummeted in the past decade and are now more competitive than fossil fuel-based power generation (Feldman et al. 2021; IEA 2020).

To understand the supply-side aspects driving decarbonization affordability, **Figure 2** illustrates the declining costs of renewable energy in greater detail. Levelized cost of energy (LCOE) helps to determine whether to move forward with a project; it can also be used to compare different energy-producing projects. LCOE is calculated as the sum of the discounted cash flows of capital costs, including depreciation and return on investments, operations and maintenance (O&M), and fuel of the life of the project. The capital expenditures (CAPEX) for projects are shown in conjunction with the O&M costs to operate and maintain the project. With expected year-over-year increases in utility capacity demand, utilities have the opportunity to meet the additional demand with lower-cost, emission-free generation (Scroggins and Sponseller 2021; Our World in Data 2021).

	LCOE ($/MWh)		CAPEX ($/kW)		Capacity Factor		Variable O&M ($/MWh)		Fixed O&M ($/kW-yr)		Heat Rate (MMBtu/ MWh)		Overnight Capital Cost ($/kW)	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Land-Based Wind	26	67	1,434	2,053	0.26	0.51			27	38			1,351	1,934
Offshore Wind	67	128	3,069	3,869	0.29	0.48			94	108			2,076	2,801
Commercial Distributed Wind	38	267	2,191	5,097	0.14	0.48			36	36			2,113	4,914
Large Distributed Wind	38	130	2,191	2,634	0.14	0.5			36	36			2,113	2,540
Midsize Distributed Wind	38	192	2,191	3,309	0.14	0.46			36	36			2,113	3,191
Residential Distributed Wind	38	272	2,191	6,788	0.14	0.42			36	36			2,113	6,545
Utility Photovoltaics (PV)	32	52	1,316	1,331	0.21	0.34			21	21			1,270	1,285
Commercial PV	75	120	1,826	1,848	0.12	0.19			18	19			1,761	1,782
Residential PV	120	189	2,806	2,842	0.12	0.19			30	30			2,806	2,842
Concentrating Solar Power	85	113	6,545	6,770	0.51	0.67	3.5	3.5	64	65			6,155	6,367
Geothermal	68	102	6,680	8,966	0.8	0.9			112	147			4,558	6,054
Hydropower	76	418	3,008	19,947	0.33	0.66			25	189			2,820	18,702
Utility-Scale PV-Plus-Battery	59	100	1,951	2,213	0.23	0.36			52	60			1,883	2,136
Utility-Scale Battery Storage									19	95			762	3,795
Commercial Battery Storage									28	79			1,138	3,162
Residential Battery Storage									67	108			2,667	4,328
Pumped Storage Hydropower			2,205	4,434			0.54	0.54	19	19			2,067	4,157
Coal			3,521	6,203			8.4	15	77	150	8.3	8.5	2,834	4,993
Natural Gas			1,111	1,271			1.9	6.4	24	31	6.2	9.7	995	1,137
Biopower	165	165	5,031	5,031	0.64	0.64	5.	5.	157	157	14	14	4,480	4,480
Nuclear	102	102	8,811	8,811	0.93	0.93	2.5	2.5	152	152	10	10	6,970	6,970

NREL

ATB data for technologies on the website: https://atb.nrel.gov/

Technology
All

Scenario
○ Advanced
○ Conservative
● Moderate

Cost Recovery Payback
30 years

Maturity
● Mature
○ Nascent

Case
○ Market
● R&D

Year
2023

Figure 2. Summary of minimum and maximum values of CAPEX, capacity factor, O&M, and LCOE

Source: NREL 2023

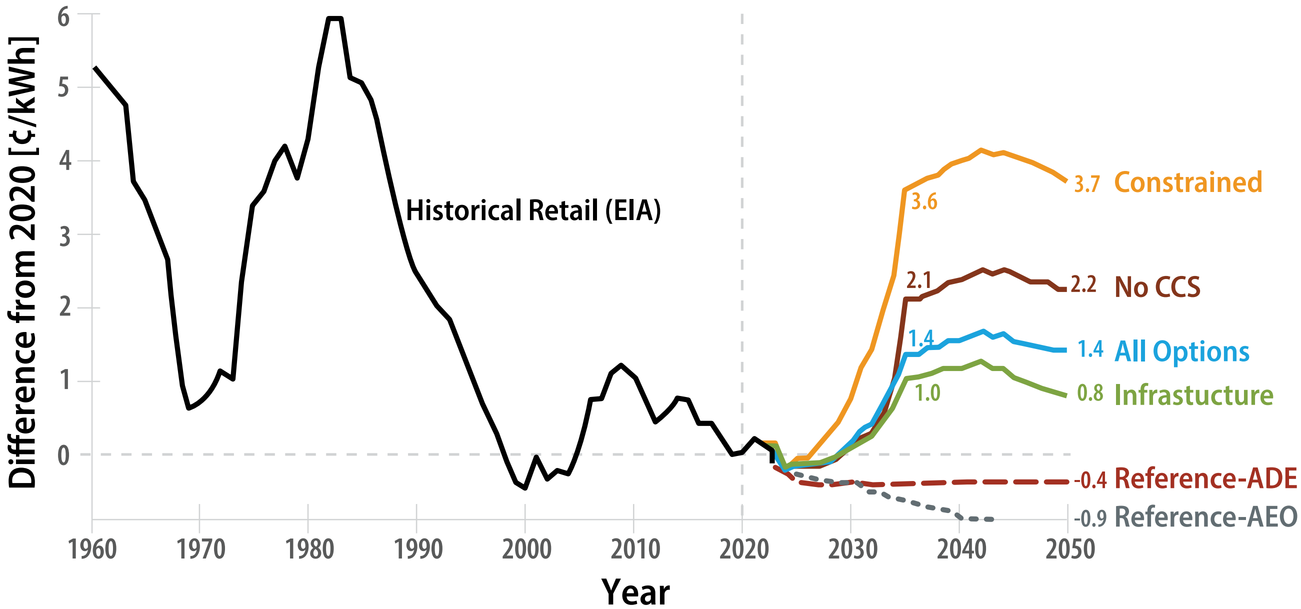


Figure 3. The increase in electricity costs associated with 100% clean electricity is within the U.S. Energy Information Administration's historical range of variations in retail costs. The Annual Energy Outlook and Accelerated Demand Electrification provide references for scenarios.

Source: Denholm et al. 2022. AEO: Annual Energy Outlook. EIA: Energy Information Administration. ADE: Accelerated Demand Electrification.

Most renewable energy sources—excluding geothermal and concentrating solar power—demonstrate a lower CAPEX than coal. Of course, levelized costs are only one metric for costs; energy costs and savings, total system costs, carbon costs, and social costs and savings provide complementary perspectives (Cole et al. 2023; Denholm et al. 2022).

Figure 3 shows the electricity costs associated with 100% clean electricity scenarios. While costs rise through 2035 as the system transitions to 100% clean electricity, it stabilizes afterward and remains within historical ranges of energy prices. The infrastructure scenario, the lowest rate of the 100% clean electricity scenarios, assumes improved transmission technologies and new permitting and siting approaches to allow greater levels of transmission deployment with higher capacity. In contrast, the constrained scenario, the highest increase in rates, assumes additional constraints to the deployment of new generation capacity and transmission that limits the amount of clean energy deployable. "No CCS" assumes carbon capture and storage are not cost-effective. All options assumes all technologies see improved costs and performance. In all scenarios, 100% clean electricity proves to be attainable and within historical rate prices.

The costs of renewable energy are also decreasing. **Figure 4** shows the global weighted-average utility-scale LCOE by technology between 2010 and 2020.

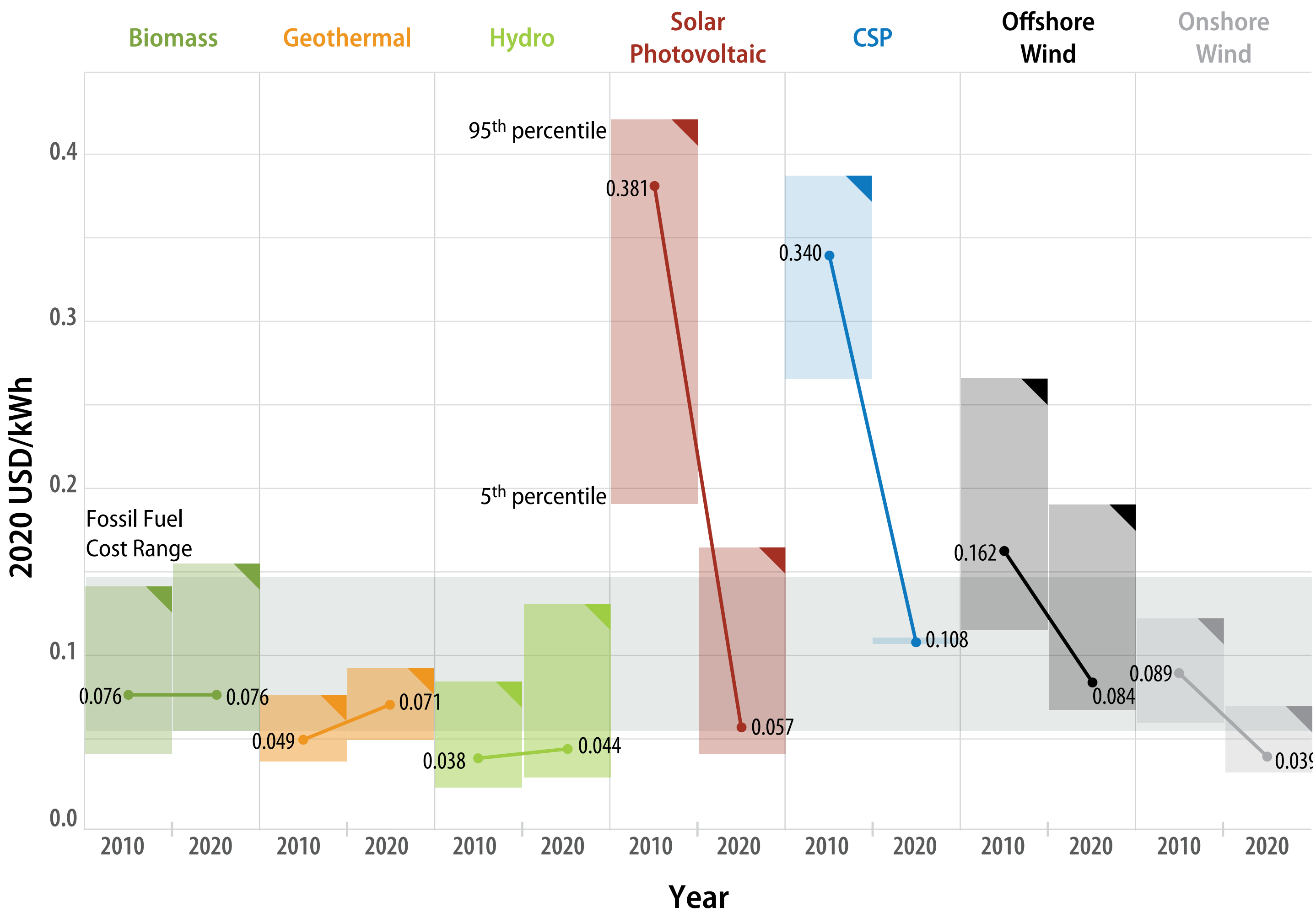


Figure 4. Global weighted-average utility-scale LCOE by technology from 2010 to 2020
Source: IRENA Renewable Cost Database. CSP (concentrating solar power)

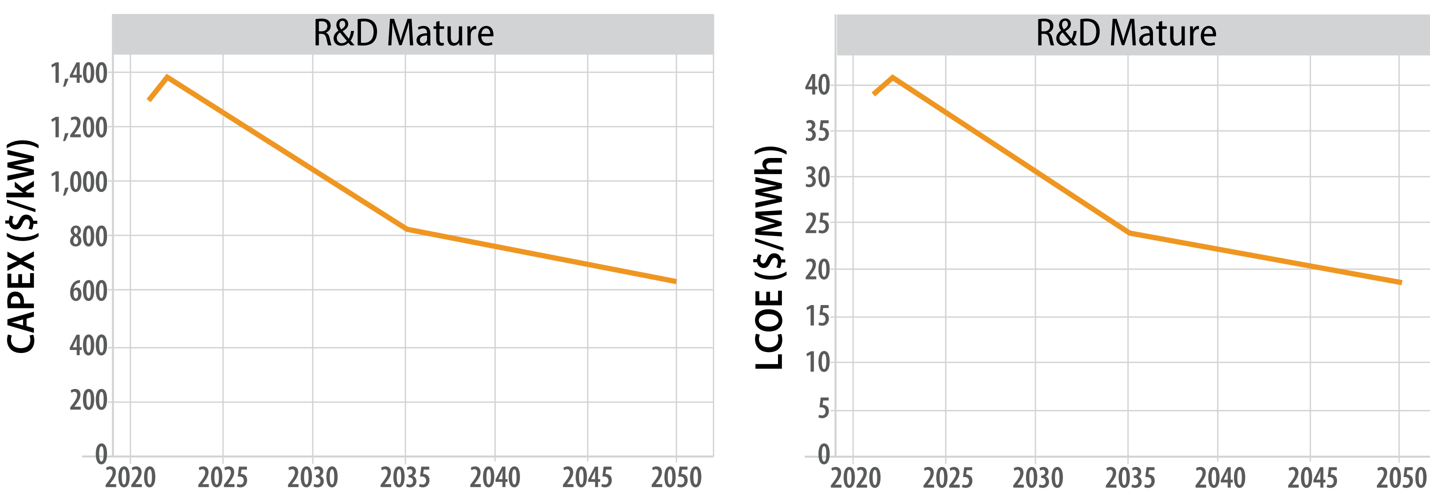


Figure 5. Utility PV CAPEX and LCOE
Source: NREL 2023

Solar PV, concentrating solar power, offshore wind, and onshore wind show decreases in LCOE. Similarly, NREL's Annual Technology Baseline report shows utility-scale PV CAPEX declining dramatically by 2030, with the LCOE estimated at $20/MWh ($0.02 per kWh) by 2045, as shown in **Figure 5** (NREL 2023). This compares to approximately $40/MWh ($0.04 per kWh) for electricity generated today.

As costs to produce renewable energy have declined and as more consumers switch from fossil fuel to electric, utilities can expect an increased load on their distribution system. Capacity to transport the electricity from generators to the load centers through transmission lines will have to be expanded. Further, the capacity on the distribution grid, including capacity needed at substations, feeder banks, feeders, and secondary transformers, may all need to be increased to serve this load. For context, Kevala estimated these additional costs between $30 and $50 billion for California's three investor-owned utilities to reach California's clean energy policy goals by 2035 (California Public Utilities Commission 2021).

While sobering numbers, the additional costs come with additional electricity consumption, which helps utilities pay for those costs. In other words, the revenue required to cover these costs is accompanied by increased energy sales and does not necessarily result in increased rates. If the marginal costs of the incremental load are less than the current average rates, which include marginal and current fixed costs, then utilities are collecting additional revenue toward those fixed costs. This phenomenon puts downward pressure on rates and can result in beneficial electrification.

Beneficial Electrification

For electrification to be beneficial, electricity to end uses must satisfy at least one condition without adversely affecting the others:

- Saves consumers money over time
- Benefits the environment and reduces greenhouse gas emissions
- Improves product quality or consumer quality of life
- Fosters a more robust or resilient grid.

Source: Dennis 2022

The $50 Billion Impact

In Pacific Gas and Electric's (PG&E's) 2023 Annual Electric True-Up Advice Letter (AL 6804-E), PG&E reported approximately $7.6 billion in revenue requirement for distribution-related costs, which also includes public purpose programs and the California Climate Credit, and kWh sales of 80 TWh in a year. This equates to a system average distribution rate of $0.097/kWh.

A California Public Utilities Commission study notes PG&E's share of the $50 billion is approximately $27 billion, with sales increasing to 146 TWh per year. Assuming a plant life of 45 years and a return on investment of 10%, the revenue requirement for the cumulative capital costs related to electrification is approximately $4.2 billion.

Adding the $4.2 billion to the current revenue required of $7.6 billion and then dividing by the 146 TWh a year yields a system average price of $0.082 per kWh, a $0.015 per kWh decrease in rates, or a 15% reduction.

Utilities, municipal utilities, cooperatives, competitive retail electricity providers, and wholesale transmission and generation developers will be investing in transformers, feeders, substations, and transmission lines, as well as renewable energy generation and storage resources. This investment from market players is driven by the expected increase in demand for electricity due to electrification. This wave of investments may provide a financial bonus to these investors, particularly utilities, but may also increase fixed costs that may be passed on to customers. However, with the declining costs for renewable energy and energy storage, there is a possible win-win situation in which utilities improve earnings from capital investments to serve the new increased load. Building owners and vendors will see increased revenue and earnings from installing and operating both behind-the-meter[1] and grid technologies,[2] and customers could get lower rates. In addition to affordability, decarbonization can lead to job creation (The White House 2023), increased resilience during extreme weather events (USGBC 2023), and improve indoor air quality and health

1 "Behind-the-meter" is an industry term that describes investments by customers at their home or business to better manage their energy use. Examples include but are not limited to rooftop solar, battery storage, energy efficiency, and building and transportation electrification.

2 Grid technologies are those installed before the customer's meter, such as battery storage.

benefits (Salimifard et al. 2022) because building energy use is a major source of greenhouse gas.

Affordability involves customers having access to a reasonable price for electricity and the ability to manage their energy use. For residential customers, renovating their dwellings with insulation, air sealing, and other weatherization upgrades as well as switching to more energy-efficient technologies can reduce energy consumption and bills (Wilson et al. 2017).

Ensuring affordability and decarbonization requires targeted deployment. As the U.S. Department of Energy's Office of State and Community Energy Programs emphasizes in their infographic, (see **Figure 6**, modified for readability), some households have greater benefit opportunities than others.

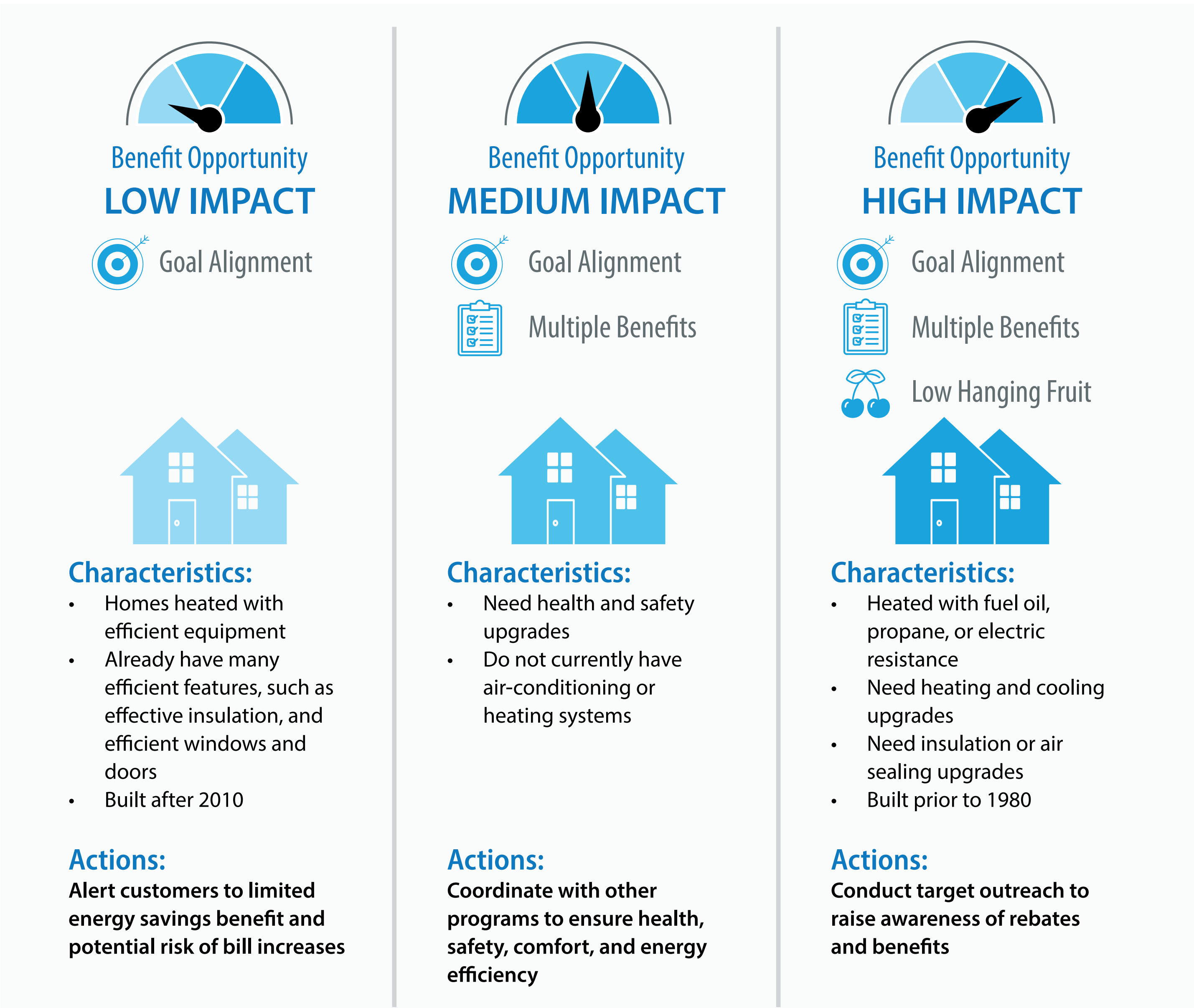


Figure 6. Benefit opportunities for decarbonization

Source: DOE 2023b

Households with the following features will most likely see significant energy bill savings from home energy upgrades (DOE 2023b):

- Heated with fuel oil, propane, or electric resistance
- Using inefficient cooling systems
- Need insulation or air sealing upgrades
- Built prior to 1980.

99% of U.S. households have at least one feature that makes them great candidates for significant energy bill savings, and more than 3.8 million homes meet all four criteria. Carbon intensity can often be higher in disadvantaged communities due to the lack of decarbonization that has historically been achieved in these areas and their closer proximity to various pollutants (including industrial manufacturing, highways, and power plants) (Goldstein, Reames, and Newell 2022). Due to these higher levels of carbon intensity, there may be more opportunities for rapid decarbonization in disadvantaged communities (Arent et al. 2022).

For commercial customers, decarbonization provides opportunities for energy bill savings. **Figure 7** demonstrates how decarbonization can provide commercial customers energy savings through a visualization of state-by-state energy savings for commercial heat pumps with an electric backup.

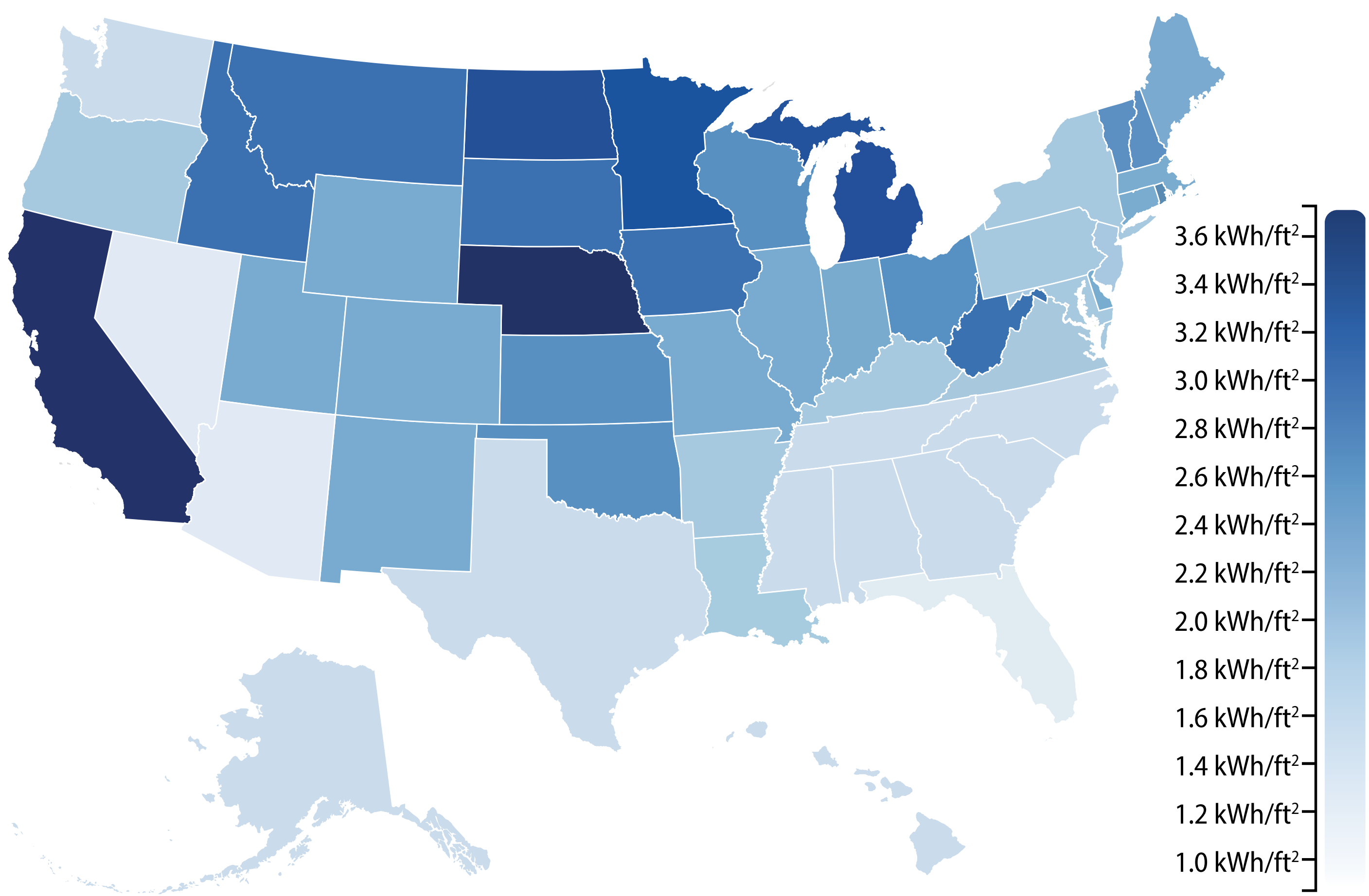


Figure 7. Energy savings for a heat pump with an electric backup normalized by square footage

Source: NREL ComStock

Utility program stakeholders need to consider the risks of bill increases because of decarbonization upgrades, particularly for energy burdened, energy insecure, and/or disadvantaged communities and customers. Ensuring affordability is paramount for a just energy transition.

Based on our thematic analysis, we found that utilities use technology-based programs—load shifting or shedding, demand management, peak shaving, and demand response—and energy efficiency programs to move toward affordable decarbonization. Utility partners also shared that enrollment into these programs was lower than expected. They shared that customers need access to information, time, and money to learn about new technologies and enroll in programs based on their needs. Long enrollment processes increase administrative burdens for eligible customers and can hinder enrollment and program impact (Herd and Moynihan 2019).

The California Energy Commission selected Oak View, a low-income community in Huntington Beach, California, as a good candidate for an Advanced Energy Community demonstration project and funded a Phase I feasibility study. The goal of the Oak View project was to improve grid reliability and resilience by achieving zero energy through deep energy efficiency, on-site renewables, and storage paired with advanced community-scale energy system control. Oak View consists of mostly multifamily residential rental properties. The Oak View Advanced Energy Community focuses on developing community-scale technical tools to ensure that the benefits of reduced energy use and renewable energy production accrue to all utility customers.
Photo from Dr. Laura Novoa, University of California, Irvine

OPPORTUNITIES IN PROGRAMS SERVING DISADVANTAGED COMMUNITIES

In the remote village of Unalakleet, Alaska, NREL has created a new model of housing—an affordable, energy efficient, adaptable house—that meets the myriad of challenges facing rural Alaska, including high transportation costs, skilled labor shortages, and the accelerating march of climate change A shipping container placed on the home s foundation houses a pre wired and pre-plumbed kitchen, bathroom, and mechanical room. Three ski-like skids along the bottom of the foundation can be incorporated to carry the home to an entirely new location if necessary.

Photo by Werner Slocum, NREL 74034

This section summarizes the current state of program design specific to disadvantaged communities and the associated challenges. We also present key insights from stakeholder interviews that inform what some utilities are doing to combat these limitations, leading to successful program design. We identify common characteristics of utility program designs, innovative approaches to rate and program design, and opportunities to reduce barriers to scale programs. These approaches tackle issues such as program design and evaluation, funding, identification and outreach to community members, capturing the needs of the community, and facilitating easier access to the programs. These innovative ideas should be brought to the forefront of the industry so that the collective can learn from them, integrate them, and continue to improve on them.

Existing Utility Programs Designed for Disadvantaged Communities

Generally, utility programs serving disadvantaged communities can be divided into two groups: bill assistance programs and energy use modifier programs. These programs are similar in that they apply discounts to customer electricity bills, but they differ in the calculation of the discount provided. In **Table 2**, we show the difference between bill assistance and energy use modifier programs.

Program Design Key Considerations

The following sections outline key considerations for building on current program design targeted toward disadvantaged communities. **Table 3** summarizes the key takeaways from each consideration based on our thematic synthesis with utility program stakeholders.

Table 2. Bill Assistance and Energy Use Modifier Programs

	Bill Assistance Programs	Energy Use Modifier Programs
Customer Segment	• Often disadvantaged communities and low-to-medium income families.	• Program-dependent.
Aim	• Increase energy affordability.	• Modify or decrease consumption of energy.
Common Outcomes	• Reduced utility bill.	• Changed customer load program • Program-dependent but may reduce utility bills, improve air quality, increase energy security, and improve health quality.
Common Program Barriers	• Enrollment • Income verification.	• Enrollment • Aligning with community needs • Complexity of implementing program • Customer identification and administrative costs • Skilled workforce • Capital to cover equipment costs • May require updated distribution system infrastructure.
Program Examples	• Percentage of income payment plan: Ensure that bill payments are capped at a predetermined percentage of customer income. • Flat percentage discount: Flat rate discounts apply the same percentage discount or dollar amount discount to all the customers identified as members of the community. • Tiered discount plans: Tiered discount programs are tailored to tiered income levels to relieve some energy burden from lower-income customers.	• Weatherization assistance programs • Integrated design assistance programs • Peak reduction programs • Electric vehicles and PV integration programs.

Table 3. Key Considerations for Utility Program Design

Key Considerations	Program Design Characteristics
Identifying Customer Needs	1. Partner with trusted community-based organizations to learn community needs, deliver utility program information, and collect customer feedback. 2. Use multiple datasets, such as data from local organizations and shared experiences from customers to inform a grounded and timely understanding of community needs. 3. Remove barriers that inhibit participation of disadvantaged customers. This, in turn, can reveal greater opportunities for participation among other customer classes.
Bottom-Up Program Design and Evaluation	1. Use timely, focused, and strategic communication to different customer segments. 2. Develop a framework to continually evaluate programs in terms of customer impact, energy justice, and community resiliency that includes methods to listen to and empower customers in decision-making, defining metrics, evaluating program success, and accepting continual feedback.
Funding	1. Provide accessible and inclusive financing mechanisms for building improvements with energy efficiency and decarbonization incentives. Providing pathways for contractors to leverage these financing mechanisms can also increase program participation. 2. Design owner-financing mechanisms to maximize tenant benefits and minimize risks of tenant displacement.
Equitable Service Offerings and Outreach	1. When possible, establish opt-out program enrollment when there are clear customer benefits to participation. 2. Provide accessible information in multiple languages. 3. Partner with community-based organizations, third-party program providers, and contractors to facilitate enrollment, outreach, and implementation of programs and services. 4. Plan electrical infrastructure upgrades that prioritize neighborhoods that prioritize neighborhoods in which utilities and governments have historically underinvested. 5. Offer customers options for purchasing green power.
Metrics and Program Evaluation	1. Develop standardized and diverse metrics for evaluating and comparing programs. Community metrics can help evaluate impact and quality of service for customers and communities. Detective and preventive metrics provide insights into the need for course-correction and avoid unintended consequences. Performance metrics can help inform how programs adapt to community needs and system changes.

Identifying Customer Needs

Because of the complexity in customer classes and needs, we found that utilities identify customers for assistance programs based on prioritized characteristics such as income, community type, technology types, and building types.

We found that many utilities partner with trusted local community organizations to communicate with and listen to communities.

Relying on the existing processes used by utilities to identify customers for assistance will likely produce no difference in program participation among underserved or disadvantaged communities. As such, changing how engagement and program design occur can promulgate different program designs and outcomes. We found that many utilities partner with trusted local community organizations to communicate with and listen to communities. These relationships are important to utilities, as they provide an understanding of what is and is not helping disadvantaged communities. Utilities could work to bolster these relationships and provide space and time to co-design utility programs (e.g., town halls, focus groups, and program co-design sessions). In doing so, utilities can build trust and allow for customers to advocate and voice their own needs, which has been successfully implemented for strategic planning of energy programs (Robinson, Halford, and Gaura 2022).

In addition, using multiple datasets, shared experiences from customers, and data from local organizations and community trustees informs a more grounded and timely understanding of community needs. Using enrollment records of other programs, such as Medicaid and the Supplemental Nutrition Assistance Program, can help to expedite eligibility requirements set out by top-down policies. We also recognize the need to consider how enrollment processes might work for customers that are undocumented, such as those experiencing limitations with immigration documents.

Using multiple datasets, shared experiences from customers, and data from local organizations and community trustees informs a more grounded and timely understanding of community needs.

Common customer segments such as commercial, industrial, residential, and low-income residential encompass a diverse range of customer needs and conditions. Being more specific about whom the programs serve and prioritize can help programs be implemented more responsively and effectively. Focusing on disadvantaged communities is expected to bring added benefits, as these communities often have the least access to various financing options, resources, and time, and by addressing these challenges, programs can be designed to be more accessible and effective for all customers. For instance, utility websites and application processes that are not smartphone-compatible create friction and barriers for participation based on the infrastructure most easily accessible to customers. Redesigning a website to center the experiences of a disadvantaged community customer who has a cell phone but no laptop raises the floor for who can participate in the program to include other customer classes. This examination of the systems and processes that surround the decision to enroll (i.e., choice infrastructure) can be vital for increasing participation and also serving disadvantaged communities (Schmidt and Stenger 2021; Schmidt 2022).

Focusing on disadvantaged communities is expected to bring added benefits, as these communities often have the least access to various financing options, resources, and time, and by addressing these challenges, programs can be designed to be more accessible and effective for all customers.

When disadvantaged communities are well-defined, utilities can more easily target customers in those communities. However, defining disadvantaged communities does not reduce the risk of overlooking customer classes that are also marginalized. For example, using a geographic census block definition of historically disadvantaged communities does not account for how disadvantaged communities are often displaced, particularly as many historically disadvantaged communities in U.S. cities are the primary site of gentrification (Summers 2023). Even when definitions are provided, utilities can be caught between the top-down mandated definitions of disadvantaged communities and the bottom-up lived experiences and needs of their customers. In short, determining which customer classes to prioritize is no easy task.

Enabling Bottom-up Program Design and Evaluation Guided by Energy Justice

Utilities play a key role in a just decarbonization transition. Federal, state, and local governments often push top-down policies to electrify and decarbonize the energy system, which directly influences utilities to decarbonize their energy generation and reduce energy consumption. Leveraging these mandates, utilities provide vital policies and structures to enable and empower communities to influence and benefit from these programs.

Programs that effectively serve disadvantaged communities require timely and ongoing communication with local organizations that provide space for different customer segments' voices.

Stakeholder engagement determines the motivation, design, approval process, and implementation stages for utility programs. Utility commissions, investors, and customers can provide key input and direction to utility programs when utilities partner with organizations and use iterative program design processes. Our review found programs that effectively serve disadvantaged communities require timely and ongoing communication with local organizations that provide space for different customer segments' voices. We also found that effective stakeholder engagement processes occur throughout program design life cycles, from goals to evaluation. We found that feedback through customer calls was not sufficient to integrate customer needs into utility program goals and design. Exploring alternative sources of feedback, such as surveys, outreach phone calls or texts, and after-work town hall meetings, especially with childcare provided, would likely widen customer participation in utility program design, particularly for disadvantaged communities. The Energy Democracy Project's ***People's Utility Justice Playbook*** critically examined energy utility practices through a lens of energy justice and called for greater accessibility to energy decision-making and decarbonization (The Energy Democracy Project 2021). In addition, customer advocacy groups could participate in public utility commission meetings and hearings to influence rules and regulations around the structure of utility programs to ensure that all customers are equitably served. Restructuring and expanding the process of integrating and co-designing utility programs (Blomkamp 2018) with disadvantaged communities is one clear step utility program designers can take toward what the environmental justice movement calls "energy democracy," a state in which energy consumers participate more directly in energy-related policymaking (Szulecki and Overland 2020).

Developing and using an energy justice and community resiliency framework also provides an opportunity to hold ongoing utility programs accountable to program goals and to all customer segments.

Developing and using an energy justice and community resiliency framework also provides an opportunity to hold ongoing utility programs accountable to program goals and to all customer segments. The NAACP Guidelines for Equitable Community Involvement in Building and Development Projects and Policies offers best practices for utility stakeholders when involving customers in understanding needs, desires, and program performance (NAACP 2021). Hundreds of community resiliency frameworks that span physical, social, economic, and natural systems are cataloged by the National Institute of Standards and Technology (NIST 2021). Building on the program design process, utilities and their stakeholders could develop a method to listen to community members, define evidence and metrics, and evaluate and iterate programs based on metrics and the experiences of community members.

Aligning top-down regulatory and policy requirements with community needs can accelerate equitable decarbonization.

Aligning top-down regulatory and policy requirements with community needs can accelerate equitable decarbonization. The rules and regulations for utilities differ by state and utility structure. These structures constrain what is considered successful and feasible for each utility (Charan et al. 2024). For instance:

- In an investor-owned utility structure, the utility board and the commission need to approve proposed programs. The utility board and commission often require the programs to be profitable.

- Community choice aggregators work with different power suppliers to create desirable bundles for their client base, such as clean and affordable power. Community choice aggregators programs are impacted by the choice of supplier and the distribution network they operate within.
- In rural communities and co-ops, the choice of power supplier could be narrow due to lack of access to multiple suppliers and the tendency to adhere to a business-as-usual operation.
- In vertically integrated utilities, the type of generators they own and operate could be a limiting factor on the type and variety of programs they offer.

Navigating these utility structures and partnering with stakeholders can enable effective program design.

Funding

We found that funding for administration, incentives, equipment, and other costs must be established prior to a program's launch. Often, incentives provided to customers by utility programs have a cap that cannot be exceeded per customer and can require significant documentation to be paid out. These caps may make it difficult to implement energy use modifier programs when implementation cost assumptions differ from reality, such as on-site asbestos preventing commercial building weatherization or drastically increasing associated costs.

Programs successfully serving disadvantaged communities consider how to provide benefits to tenants while collaborating with property owners.

Program funding strategies can also widen or limit the feasibility of the program. The most common way to pay for programs is through bill riders. Some utilities apply a flat bill increase to all customers to fund programs, regardless of their participation in the programs; because customers are paying for a program, the rate increase needs to be approved by the commission. In these instances, non-participants of a program are paying to fund the program, presenting a potential issue. To resolve this issue, we explore in the **New Opportunities** section how a modern rate architecture (MRA) can solve some of these issues. We also found that programs successfully serving disadvantaged communities consider how to provide benefits to tenants while collaborating with property owners.

Most energy use modifier programs, which include programs for energy efficiency, distributed energy resources, and electric vehicles, provide incentives for new equipment and technologies, but usually do not cover the entire cost to purchase and install the equipment. Having access to capital for these incentivized building improvements and electrical infrastructure upgrades is often still out of reach for many disadvantaged community members. In addition, if these programs are funded by bill riders, the underserved members of the customer group end up paying for the programs, usually without any benefit to them. It is important to create pathways for all customers to have more equitable and easier access to these programs. Mechanisms such as tariff on-bill financing and other inclusive utility investments can provide a pathway to provide energy use modified programs without requiring credit scores or covering upfront equipment costs (EPA 2023).

We find that financing mechanisms for regular building improvements are compatible with energy efficiency and decarbonization incentives are included in contractor offerings.

We also found that multiple utilities are working with third-party providers, non-profits, and contractors to carry the burden of initial cost. These organizations typically cover these costs through some combination of grants, donations, and city, state, or federal funds. As another critical approach, a few utilities have investigated analyzing customer load profiles to apply more appropriate rates. Our review found that financing mechanisms for regular building improvements are compatible with energy efficiency and decarbonization incentives are included in contractor offerings.

Equitable Service Offerings and Outreach

The administrative effort of implementing the details of a program, enrolling customers, and advertising the program in ways that are accessible to all can also be a barrier. For example, income-proportioned discounts are complex to implement and require high administrative planning and costs on the utility side, so many utilities opt for flat-rate discounts.

Auto enrollment makes the program more attainable for community members because it removes barriers around language and lack of access to computers, email, and online applications.

Several utilities have started auto-enrollment practices with opt-out options as an efficient way to remove barriers and reach members of disadvantaged communities. Auto enrollment makes the program more attainable for community members because it removes barriers around language and lack of access to computers, email, and online applications. Auto enrollment also reduces administrative costs and administrative burden by avoiding the need for marketing to the target group and evaluating each application for eligibility. These methods of minimizing the administrative costs rely on proper identification of the various segments of the customer population. Providing accessible program information in multiple languages and accommodating various levels of computer and application proficiency are also important considerations. In addition, collaboration with third-party program providers and contractors can help.

Providing accessible program information in multiple languages and accommodating various levels of computer and application proficiency are also important considerations.

We also found that "in successful utility programs" utilities partnered with community-based organizations, third-party program providers, and contractors to facilitate enrollment via outreach and implementation of programs and services. Contractors and developers have been successful in submitting complex enrollment applications, which also positions them to be effective in marketing the program. When providing rebates through contractors and third-party providers, clients can benefit from the implementation of energy efficiency and decarbonization program infrastructure without the upfront costs, removing a financial barrier for customer classes without access to financing. Third-party administration and inclusive utility investments can also remove the need for background and credit checks of individuals, increasing program accessibility for all members of the community. Ensuring that customers do not take a loan out on their assets and minimize financial risk is equally important to prevent predatory practices such as those exhibited by the solar PACE program in California, which under-delivered carbon benefits and harmed low-income homeowners (Polsky et al. 2021).

In successful utility programs, utilities partnered with community-based organizations, third-party program providers, and contractors to facilitate enrollment via outreach and implementation of programs and services.

Some technologies require additional infrastructure, electric panel upgrades for electrified heating, and charging stations for electric vehicles. If infrastructure upgrades are planned after the implementation of decarbonization programs, then the infrastructure improvements often target early adopters in affluent neighborhoods. Some utilities perform regular infrastructure upgrades all over their territories, making them more successful in offering and implementing these suites of programs to all customers. We found that planning electrical infrastructure upgrades within a utility territory could prioritize neighborhoods in which utilities and governments have historically under-invested to ensure equitable, reliable services to ensure equitable, reliable services. This ensures that services can be provided to all customers without being limited by the distribution system's lack of capacity and lays the groundwork for electrification and decarbonization in disadvantaged communities.

Planning electrical infrastructure upgrades within a utility territory could prioritize neighborhoods in which utilities and governments have historically under-invested to ensure equitable, reliable services.

Metrics and Program Evaluation

Metrics and evidence help to assess the affordability and accessibility of programs. Metrics can be categorized as follows:

- **Community metrics** can help evaluate impact, quality of service, and decision-making for customers and communities.
- **Detective and preventive metrics** provide insights into the need for course-correction and avoiding unintended consequences.
- **Performance metrics** can help inform how programs adapt to community needs and system changes.

Metrics are used to justify the cost of a program and increase reliability and accountability of the utility from the regulator's view. They also increase transparency for customers, which may increase trust in programs.

Utility rate and program design success are often measured differently by each utility. Each program offered by a single utility is often held to different metrics and standards. We found a binary evaluation (i.e., successful or not successful) tendency in our interviews with utility partners. Utilities rely heavily on performance metrics, reporting on how many customers participated and the level of "benefits" created from customer participation. Common metrics used by utilities include program costs, enrollment count, and cost per installation.

By employing detective and preventive metrics, utilities could understand the direction of a program and opportunities to course-correct toward desired outcomes, rather than killing a program outright after post-program implementation evaluations have deemed the program to be unsuccessful. Regulatory changes could also help; the degree of leeway afforded to utilities to modify their programs without oversight is highly variable and is significantly limited in many states (Shea 2023).

The use of community metrics can help stakeholders understand who is benefiting and how.

Finally, the use of community metrics can help stakeholders understand who is benefiting and how—for example, metrics that show the amount of utility spending on grid infrastructure to meet electrification needs is going to assets that serve disadvantaged communities. In addition, metrics for decision-making in energy justice can identify vulnerabilities, wealth creation, energy poverty, life cycle, and comparative county-level dynamics (E. Baker et al. 2023).

Designing and collecting program metrics holistically can help better ascertain whether the program is providing intended benefits.

Designing and collecting program metrics holistically can help better ascertain whether the program is providing intended benefits, such as environmental impacts (reduction in energy/carbon), improving resilience, reliability, affordability, and health. An example of aligning program benefits with metric design could be measuring energy saved, reduction in utility bills, and the customer's perceived comfort after a weatherization retrofit.

Metrics and evidence that inform equitable program design, support effective implementation, drive customer engagement and outreach, and establish feedback mechanisms would ensure there are adequate checkpoints for a comprehensive and equitable program.

These communities may also be served through non-energy measures such as improving health and safety within buildings, improving durability, gaining protection against discontinuation of utility services due to non-payment of bills, and improving resilience during extreme weather and natural disasters.

It is also essential that the metrics represent the needs and objectives of the stakeholders involved in utility program design, whether those are regulators, legislators, the utility itself, or the utility's customers. Metrics can be developed collaboratively by a working group representing diverse interests that is responsible for the program design. While communities would benefit from energy-saving measures leading to a reduction in energy bills and alleviating energy poverty, in certain cases these communities may also be served through non-energy measures such as improving health and safety within buildings, improving durability, gaining protection against discontinuation of utility services due to non-payment of bills, and improving resilience during extreme weather and natural disasters. These other goals can quickly look like political policy, but utilities and their regulators still have a role to play in supporting their customers more holistically.

Translating benefits and value provided by a program into measurable metrics can be challenging. In many cases, utilities can leverage publicly available records and existing data collection mechanisms to design metrics. From our interviews, we found that several utilities considered the rate of enrollment in a program and turnaround time between applying and getting program rebates as measures of a program's success. In other cases, utilities may need to spend additional time and resources to measure benefits and analyze energy savings.

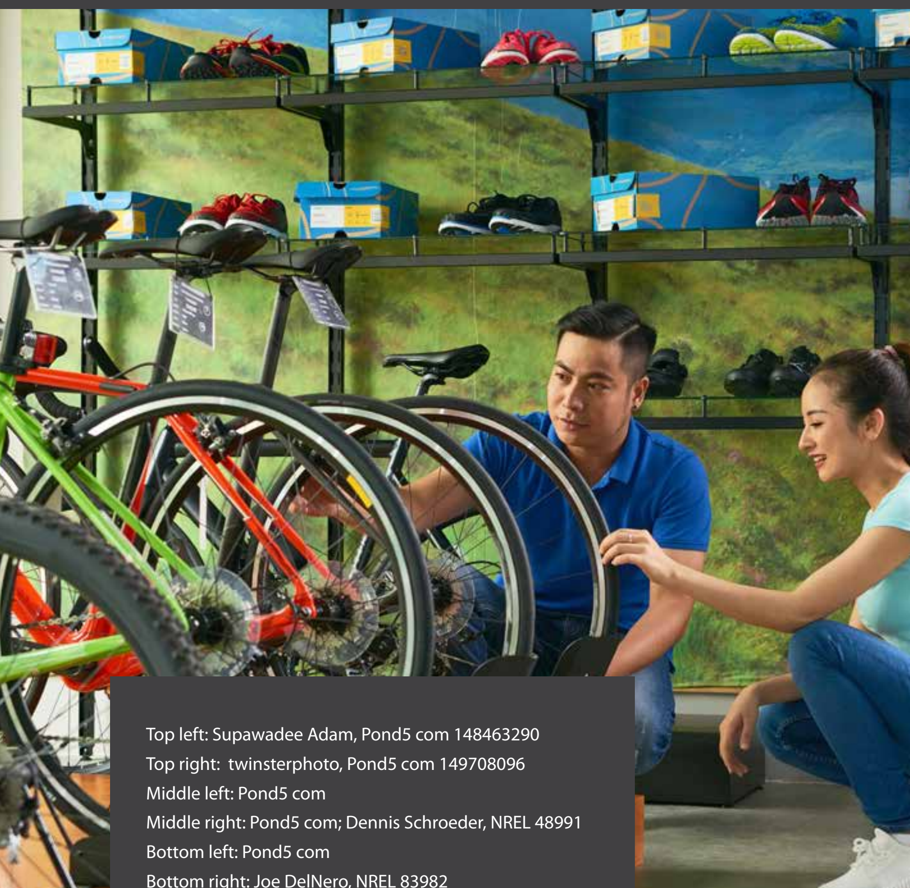
Metrics inform longitudinal program performance. As programs evolve, utilities and their partners would do well to document program changes to understand how changes in design or implementation have promoted desired outcomes in the past. Metrics can also be used to advocate for continued funding with regulatory bodies, which may justify additional costs for gathering and managing metrics and evidence. Metrics need to be recorded to meet top-down requirements, such as state legislative and policy goals (Goldenberg and Wilson 2022). For example, New York's Climate Leadership & Community Protection Act requires at least 35%, with a goal of 40%, of benefits of investments in clean energy and energy efficiency programs or projects to go to disadvantaged communities (NYS Agencies 2023). Utilities in New York can compare the number of program applicants from disadvantaged communities for energy efficiency programs against this goal to assess a program's performance.

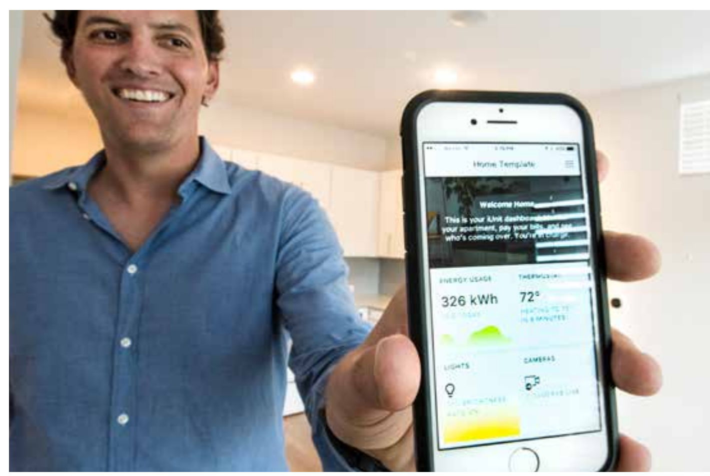
Program metrics can be sensitive to benefits and risks, particularly for disadvantaged communities. Social and environmental justice metrics should be included as measures of a program's success, such as access to and use of cooling equipment during hot months (Sandoval et al. 2024) or indoor temperatures during a power outage (Stenger et al. 2023). Economic, energy use, and environmental impact factors also inform the success of a program and future opportunities for successful programs. For example, utilities that collect the percentage area median income will be well-situated to deliver key measures and validation for programs that require this metric, such as the Inflation Reduction Act's requirements for home energy rebates (The White House 2023).

A few utilities have institutionalized focus groups and customer interviews to understand customers' experiences.

The social impacts of a program can be difficult to measure, and gathering continuous feedback from the community and other qualitative data should be included in program success evaluation. This difficulty also highlights the importance of energy democracy throughout the utility program process. A few utilities have institutionalized focus groups and customer interviews to understand customers' experiences. Some utilities have also implemented data science and machine learning methods to analyze and evaluate the impact of the program from various points of view.

NEW OPPORTUNITIES





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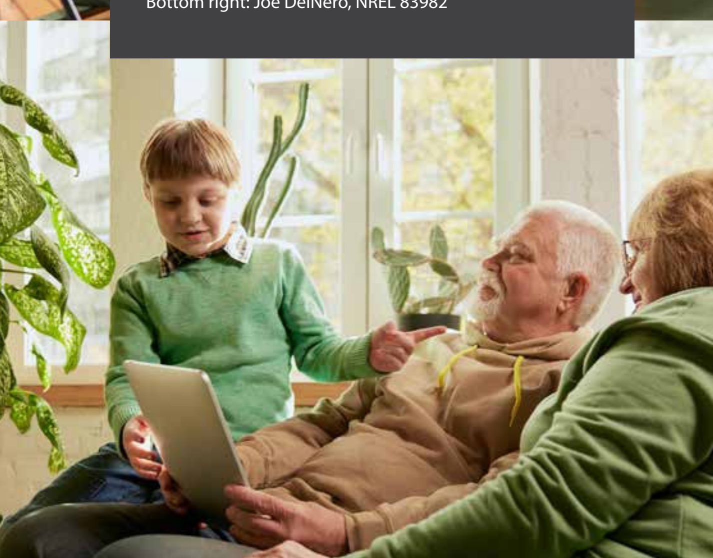

Traditional utility rate and program design processes are not reaching disadvantaged communities. To improve on rate and program design methodologies so that energy justice is a primary consideration and disadvantaged communities can benefit from these rates and programs, traditional methods must be updated. What innovative approaches can be taken to ensure all customers are equitably served? Answering this question will require outside-the-box thinking.

Customer-Centered Processes

The current process creates multiple opportunities that benefit some customers at the expense of others, rather than creating a competitive environment in which utilities and third parties work to put customers at the center of program and rate design to create beneficial offerings to all customers and drive down costs of electrification. For utilities, we imagine a customer-centered process that includes different types of customers to support equitable programs, as shown in **Figure 8**.

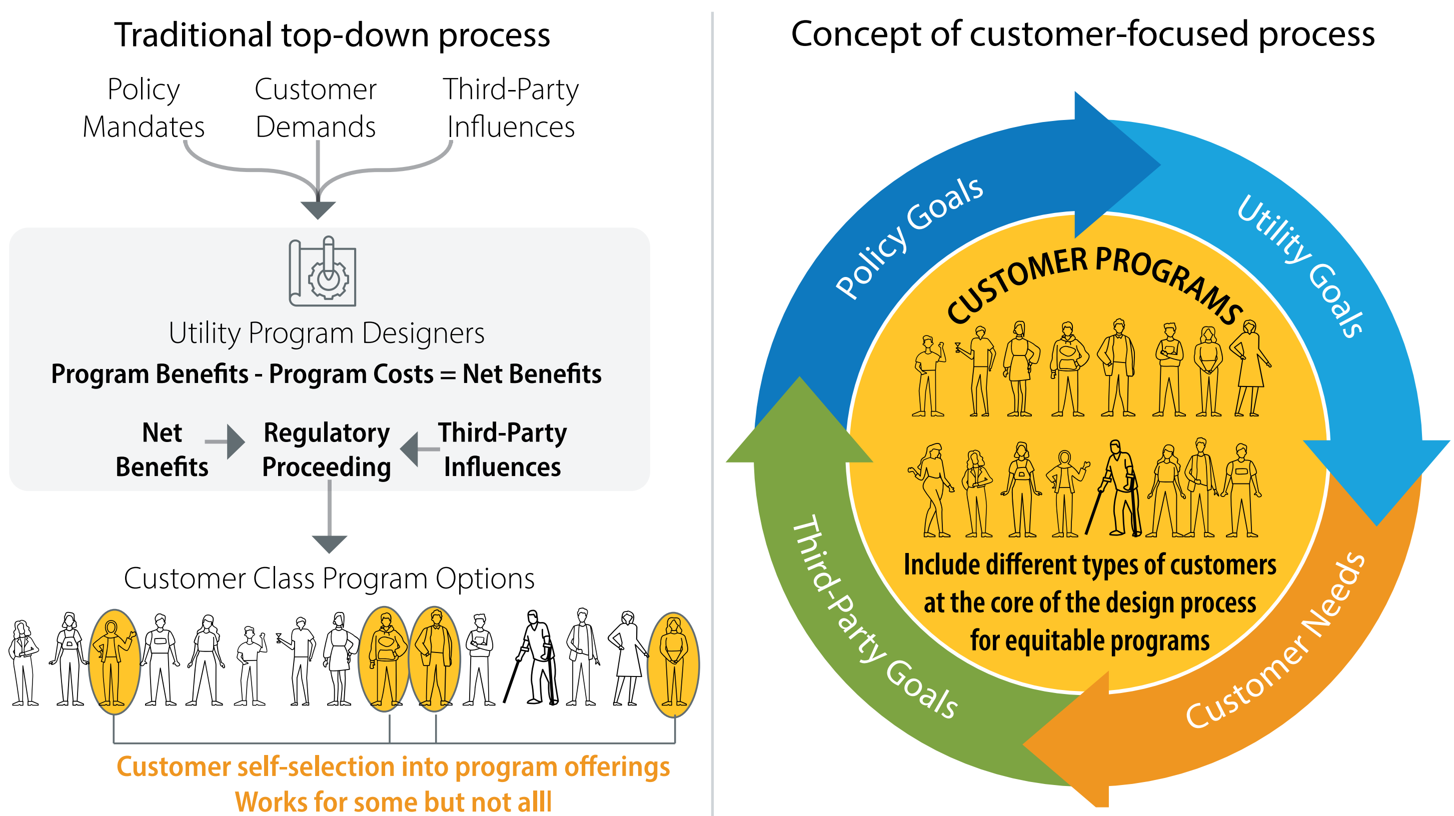

Figure 8. (Left) Traditional top-down process for utilities in creating customer class program options. This process works for some but not all. (Right) Concept of customer-focused utility program and rate design in which customer needs are at the forefront of the design process.
Source: Kevala, Inc.

There are many limitations to the top-down approach. First, we found that the customers who benefit most from energy efficiency and renewable energy solutions are those who can afford to invest in these solutions—not only financially but through knowledge and time availability—saving themselves money in the long term. These customers also avoid the costs they create for the utility (i.e., administrative costs) that become dispersed to other customers. As we have pointed out, customers who would most benefit from a utility program are often the ones who are not participating in such programs and who end up paying for the programs through rate structures.

Top-down approaches can neglect disadvantaged communities and other customer classes.

We also find that top-down approaches can neglect disadvantaged communities and other customer classes. Utility rate and program designs are highly influenced by state and local legislature and policy, regulatory bodies, and decisions by a utility on perceived needs of its customer base. While the approach can deliver on certain measures, it falls short on prioritizing disadvantaged communities and can often dismiss a wider range of customer needs.

Finally, while traditional rate and program designs often embed a goal of preventing discrimination among customers, program participation—particularly in energy use modifier programs—demonstrates the opposite outcome, with an overrepresentation of wealthier customer classes and underrepresentation of disadvantaged communities. We found that utilities and their regulators often view customers through outdated lenses, with customers classified by building type (residential or commercial and industrial) and their size (small, medium, and large) rather than by their need and infrastructure. In this view of program design, programs become designed for "typical customers" in each class, which dismisses any outliers or unmeasured customer classes (i.e., undocumented or neglected).

Expanding beyond a top-down approach, utilities may recenter the customer, intentionally prioritizing and engaging with disadvantaged communities and other customer classes that have been underrepresented in utility program enrollment through an iterative and dialogic approach to utility program design.

MRA

Another option for addressing the limitations of utility programs and rate design is for utilities to understand and practice the concept of modern rate architecture (MRA). MRA was designed to ensure that transparency, equity, sustainability, and access are addressed in each new rate or program design. Utilities are well-served by following the principles of MRA, namely:

1. **Transparency:** Thoroughly describe and account for what customers are paying for.
2. **Equity:** Ensure costs are well-characterized to keep prices fair, and that investments in technology and behavioral change are available to all customers (including via subsidies where feasible).
3. **Sustainability:** Programs must be forward-facing and account for changes to the market and customer behavior in the coming years.
4. **Access:** All customers must have the same access to the service options set forth by utility programs.

These principles, taken together, give utilities and all their customers the confidence to move through the evolution of the electric energy industry without compromising on affordability or safety. **Figure 9** shows the framework and process by which these principles can be implemented.

The first step in the MRA framework involves product differentiation and understanding the cost of delivering electrical service at a granular level through cost allocation. Products and their costs should be explicitly defined so that customers know what they are paying for. Each kWh supplied to a given customer has a value of some kind; this value is reflected on customer bills, often as a cents-per-kWh figure. Traditionally, those cents are bundled, meaning that all costs related to generating and delivering the power to the customer are folded into that cents-per-kWh figure. MRA encourages a greater degree of transparency to guide design decisions. To enable this transparency, a utility must unbundle these costs, meaning that the cost of each component of electric service (energy, generation, transmission, distribution, and customer charges) is broken out individually, as opposed to being combined into a single cost to provide service.

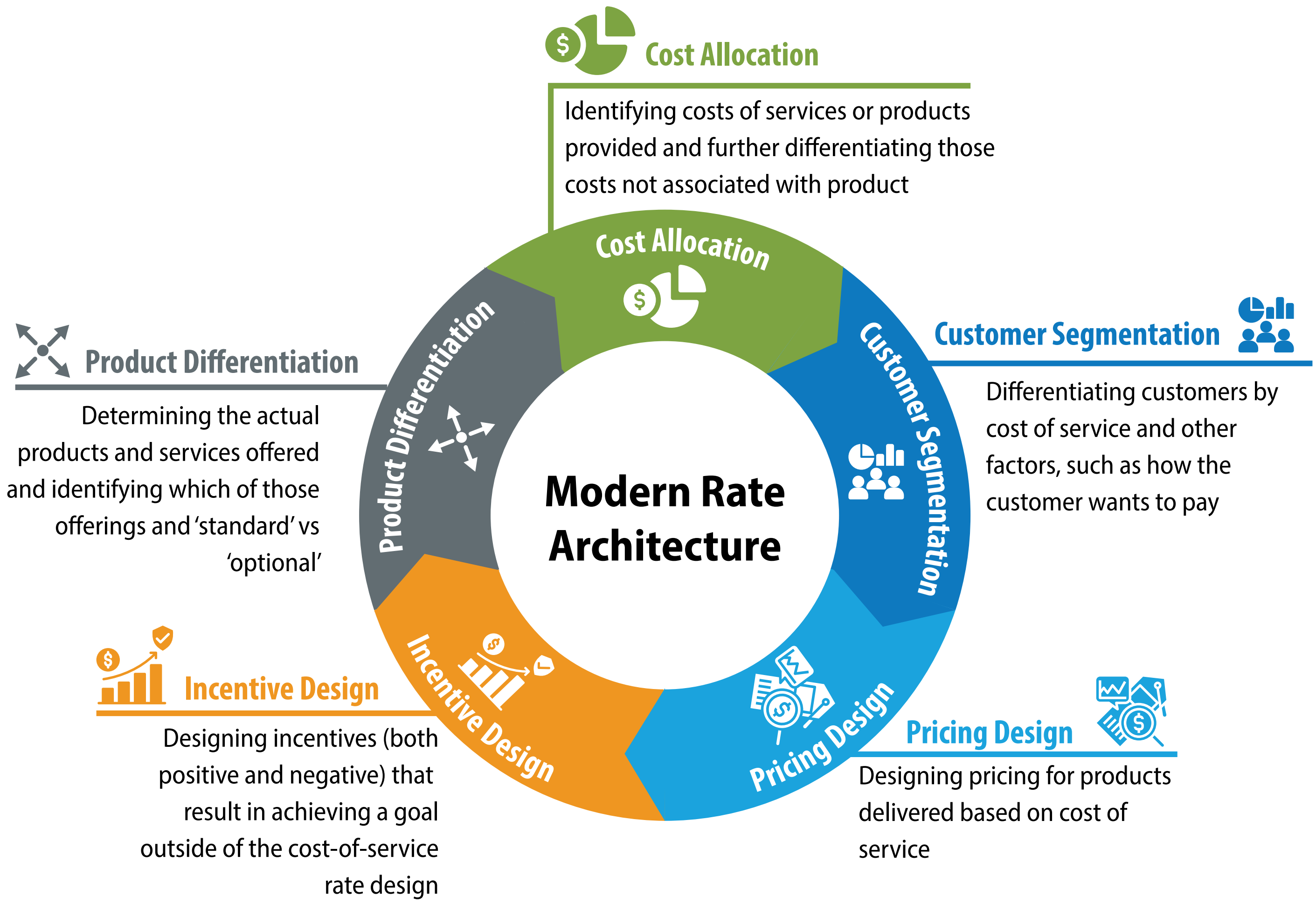

Figure 9. MRA framework

Source: Kevala, Inc

The second step in the MRA framework is segmenting customers. Traditionally, utilities have segmented customers by who they are (residential or commercial and industrial) and their size (small, medium, and large). In a changing utility landscape with distributed energy resource adoption accelerating, utilities have an opportunity to rethink customer segmentation, particularly to address evolving customer needs that include access to clean and affordable energy. Customers who have similar cost profiles, such as those with electric supply from a community choice aggregator or those with electric vehicles or PV, can potentially be grouped together and charged appropriately for how they use electricity. Programs are being designed to address customers who acquire these technologies (electric vehicles, PV). However, customers have a wide variety of needs that may not be reflected in equipment purchases alone. Further, many of these technologies are not affordable to parties in need of greatest decarbonization and affordability support. Still, there are significant barriers to rethinking customer segmentation. In many instances, local regulation does not allow for utilities to further segment their customers beyond customer class and size.

In a changing utility landscape with distributed energy resource adoption accelerating, utilities have an opportunity to rethink customer segmentation, particularly to address evolving customer needs that include access to clean and affordable energy.

The third step in the MRA framework is designing pricing based on the results of customer segmentation and cost of service, as well as the stated principles of MRA. In other words, rates should be directly tied to costs. The pricing design should further distinguish the costs of policy mandates separately from the cost of service. All costs should be included on the customer bill and easy to understand.

The final step in the MRA framework is incentive design. Closely linked to pricing design, incentive design includes any payments, discounts, or direct equipment installations for a customer via a program. Incentives should be transparent and reflect the goals of the utility over time. The customer should be able to see the cost of service separately from the incentives so they can properly understand pricing signals and react to them. Without this transparency, it is possible to unintentionally incentivize behavior that does not meet program goals in each service territory, such as consuming energy overnight when prices are lower versus during the day when there is clean, low-cost energy available.

The MRA framework allows utility program and rate designers to address inequalities in existing rate design by accurately billing customers for the services they use and the programs in which they participate (Everett et al. 2018).

Multi-Stakeholder Marketplace

We often observed neighboring utilities filing very similar programs. Typically, these programs are designed independently, based on different data for each utility's customer population, program objectives, and regulatory requirements. This fragmentation not only duplicates time and effort spent designing programs, but also silos lessons learned and can result in less data and thus information to assist in designing the program. Furthermore, the costs in administering the program are similarly incurred in parallel. Many of those costs are related to program administration, software, and billing tools.

As government-granted monopolies, neighboring utilities do not compete. Could neighboring utilities and their customer bases benefit more directly from a more detailed accounting of each other's information, successes and failures, financial models for successful program designs, and shared program administration infrastructure? This approach, which we have called a "multi-stakeholder marketplace," may prove beneficial in a variety of contexts where external contractor workforce might be lacking, and recruitment internally might be better suited. Administrative costs could be decreased, and program design impact could be extended beyond a single service territory. Further, the benefits of "market transformation" can be counted toward the success of a program when it is demonstrated that the combined programs had a "flywheel"[3] impact on the acceptance and adoption of certain technologies, reduced the costs of these technologies, and increased customer awareness of these technologies. In this model, all stages of program design are still conducted by the utility's workforce, ensuring full control of the program if desired; this model also lends itself to programs requiring third-party delivery.

Sharing successes and failures should not be a foreign concept to electric utilities. Nuclear energy production facilities regularly share lessons learned and best practices, effectively forming a coalition of these entities to benefit stakeholders both in and outside of the individual utility, or even the country, to which those facilities are tied. As an example, the International Atomic Energy Agency's Technical Cooperation Program "helps Member States to identify and meet future energy needs and assists in improving radiation safety and nuclear security worldwide" (IAEA 2024). This is, of course, primarily motivated by health and safety, whereas the focus of a multi-stakeholder marketplace would be assumed to be economics. While a nuclear accident can be catastrophic in a narrow sense, energy poverty is a different kind of danger posed to the lives and livelihoods of energy customers. Similarly, the open proceedings sponsored by regulators provide a means for stakeholders to understand—and in some instances shape—program design.

Sharing successes and failures should not be a foreign concept to electric utilities.

In the scenario in which full integration of services into a utility's operations is not feasible, utilities could partner with a one-stop-shop business model—offering products, installation, financing, and marketing—to reduce administrative burdens and maximize coordination, and thereby value, between implementers and stakeholders (Boza-Kiss et al. 2021).

3 Technically, a flywheel is a mechanical device that uses the conservation of angular momentum to store rotational energy, a form of kinetic energy proportional to the product of its moment of inertia and the square of its rotational speed. However, in business parlance, it refers to the inertia of progress and represents how small wins build on each other over time and eventually gain so much momentum that benefits almost seems to happen autonomously.

Utility-scale wind turbines at the Cedar Creek Wind Farm in Grover, Colorado
Photo by Dennis Schroeder, NREL 31194

CONCLUSION


MVOTA LOCKOUT PANEL
KEYS SHALL REMAIN IN
LOCKED
POSITION UNLESS IN USE
BWY-ACRB16
1600A AC
BWY-DCRB16
1600A DC
BWY-DCRB25
2500A DC

The partnership between NREL, Kevala, and CU Boulder has yielded valuable insights into the landscape of utility programs, incentivizing affordable electrification with a specific focus on serving disadvantaged communities. The study, which delved into the concept and definition of disadvantaged communities and evaluated existing program designs and pricing practices, provided a robust foundation for understanding the intricacies of utility initiatives.

Our approach, involving 17 utility partners from diverse U.S. regions, allowed for a nuanced examination of utility rate structures and program designs. Through evidence-based practices and practitioner insights, we thematically synthesized existing practices, identified barriers, and highlighted opportunities to enhance utility programs. The use of semi-structured interviews, literature reviews, and collaborative design-oriented methods contributed to a holistic understanding of the challenges and possibilities in serving the needs of disadvantaged communities.

Importantly, in this paper, we identified key approaches in utility programs designed for disadvantaged communities to achieve electrification and higher energy efficiency. Emphasizing customer needs, bottom-up program design guided by energy justice principles, and the role of funding in ensuring equitable service offerings and outreach emerged as crucial factors. Metrics and program evaluation were highlighted as essential elements, paving the way for customer-centered processes, MRA, and a multi-stakeholder marketplace.

Emphasizing customer needs, bottom-up program design guided by energy justice principles, and the role of funding in ensuring equitable service offerings and outreach emerged as crucial factors.

In summary, in this paper, we have not only navigated the complexities of program and rate design, but also provided actionable insights for utility partners. The identified core characteristics of program design can serve as a valuable guide for future initiatives, fostering a more inclusive and equitable energy landscape. The collaborative effort between NREL, CU Boulder, and Kevala aims to contribute to the practices on utility programs, paving the way for a path forward that prioritizes the needs of disadvantaged communities.

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