NATIONAL ACADEMIES Sciences Engineering Medicine

The Role of Net Metering in the Evolving Electricity System

Consensus Study

Sponsored by U.S. Department of Energy

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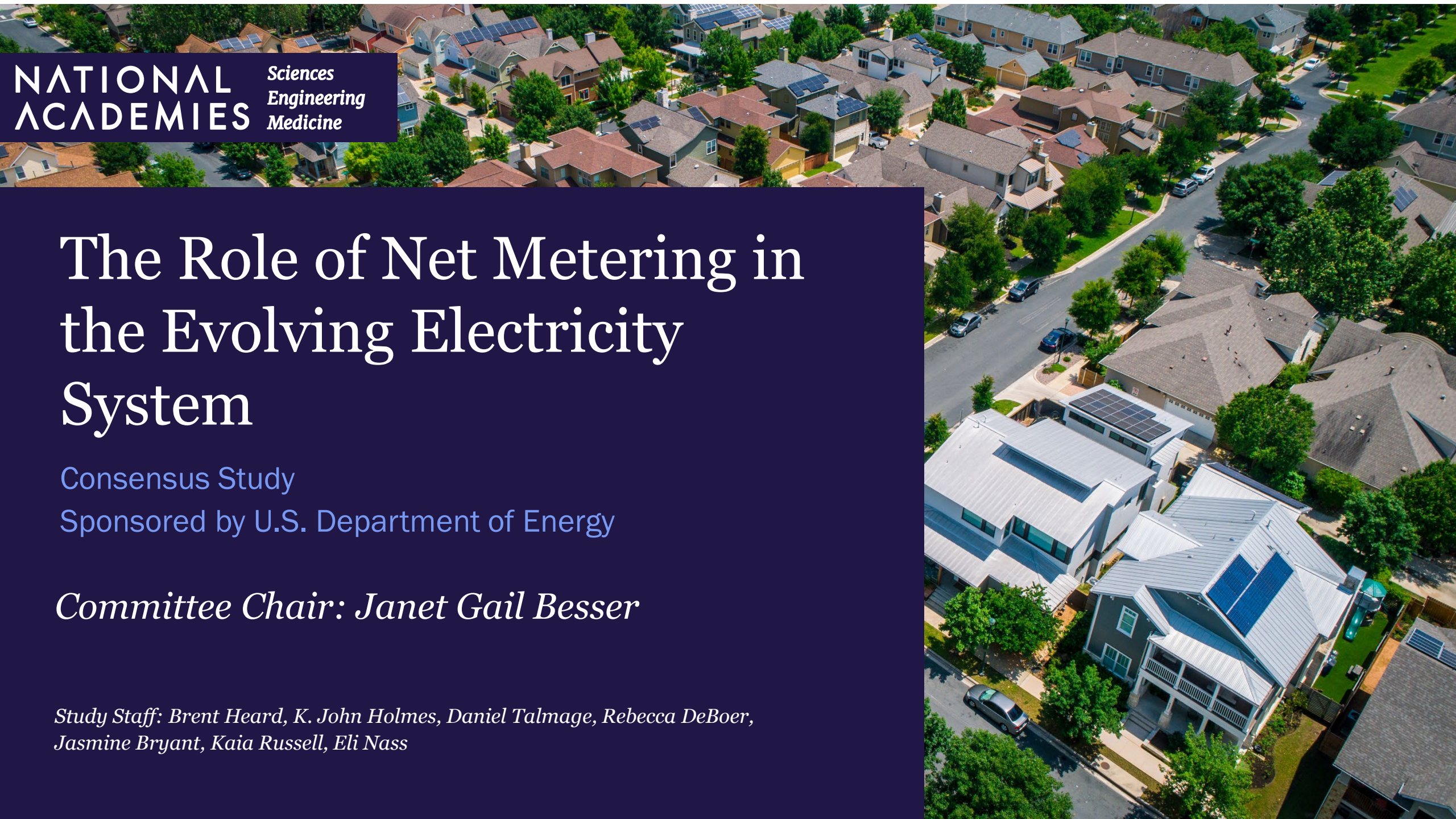

Committee Membership

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Study Statement of Task

The study committee was asked to examine the medium-to-long term impacts of net metering on the electricity grid and consumers. This report provides key principles and guidance for redesigning net metering to better meet the needs of all stakeholders.

In developing its report, this committee was tasked to consider:

- How Net Metering and Alternatives May Affect the Evolution of the Electricity System
- Performance and Effects of Net Metering and its Alternatives on Business Models, Consumers, Technology Suppliers, Electricity Markets, and Grid Operations at High Penetrations of Distributed Renewables
- Emergence of New Technologies, and Effects on Consumer and Industry Transactions and Incentives
- Alternative Metering Systems that Promote Equitable Distribution of System Resources and Costs

Study Context: The Electricity System is Undergoing Major Change

Changing economics including declining costs for current and new technologies as well as increasing needs for investment in the grid to integrate these new technologies.

Technology innovations influencing the economics, occurring both on the customer side of the meter and on the utility side. These include distributed generation (DG), demand management, storage, information and communications, and power electronics.

New demands on the system as policymakers are asking utilities and electricity system operators, as well as the economy as a whole, to reduce carbon emissions, address equity, and enhance resilience in the face of more frequent extreme weather events and other electricity system disturbances.

Changing customer expectations for new electricity-related products and services to help them manage their energy use and bills, as well as participate in the clean energy transition.

Chapters

1. Introduction
2. Net Metering 101
3. Background & History, Current Status, Near-Term Future of Net Metering
4. Economic Considerations Related to Net Metering
5. Equity Considerations Related to Net Metering
6. Technology Considerations Related to Net Metering
7. Regulatory, Legal, and Market Considerations
8. The Future of Net Metering in an Evolving Electricity System

“Net Metering” Can Refer to a Constellation of Terms

TRADITIONAL “NET METERING” is a billing mechanism that effectively credits production from behind the meter distributed generation at the retail rate, by offsetting consumption and providing credits for electricity exported to the grid.

Prominent Variants Include:

NET BILLING

A tariff designed to compensate customers with distributed generation for exported production at a netting interval (a defined time period) and/or at a rate which may differ from the retail rate (e.g., an administratively determined avoided cost rate or wholesale market price).

VALUE OF SOLAR (VOS, OR VALUE OF DER {VDER}) TARIFF

Customers are compensated for their behind-the-meter generation at a rate based on the value of the solar (or other DER) to the utility, the distribution grid, the electric system and/or society, rather than the retail rate. The VOS rate may be applied to both generation that offsets consumption and generation that is exported, or only exported generation.

INFLOW / OUTFLOW RATES

A variation on net billing where a customer avoids paying for electricity at the retail rate when the customer’s own generation is consumed on-site, but outflow to the grid is credited at a rate different from the retail rate.

FEED IN TARIFF

Customers are compensated for generation sold to the grid under a tariff at administratively-set prices.

BUY ALL / SELL ALL RATES

Customers with distributed generation purchase electricity from the utility at the same retail rate as other customers, and sell electricity back to the grid at a rate that could be administratively determined, set at avoided cost or wholesale market price. With buy all, sell all rates, customers are not treated as if they directly consume any of the energy generated by their BTM DG.

How Does Net Metering Work?

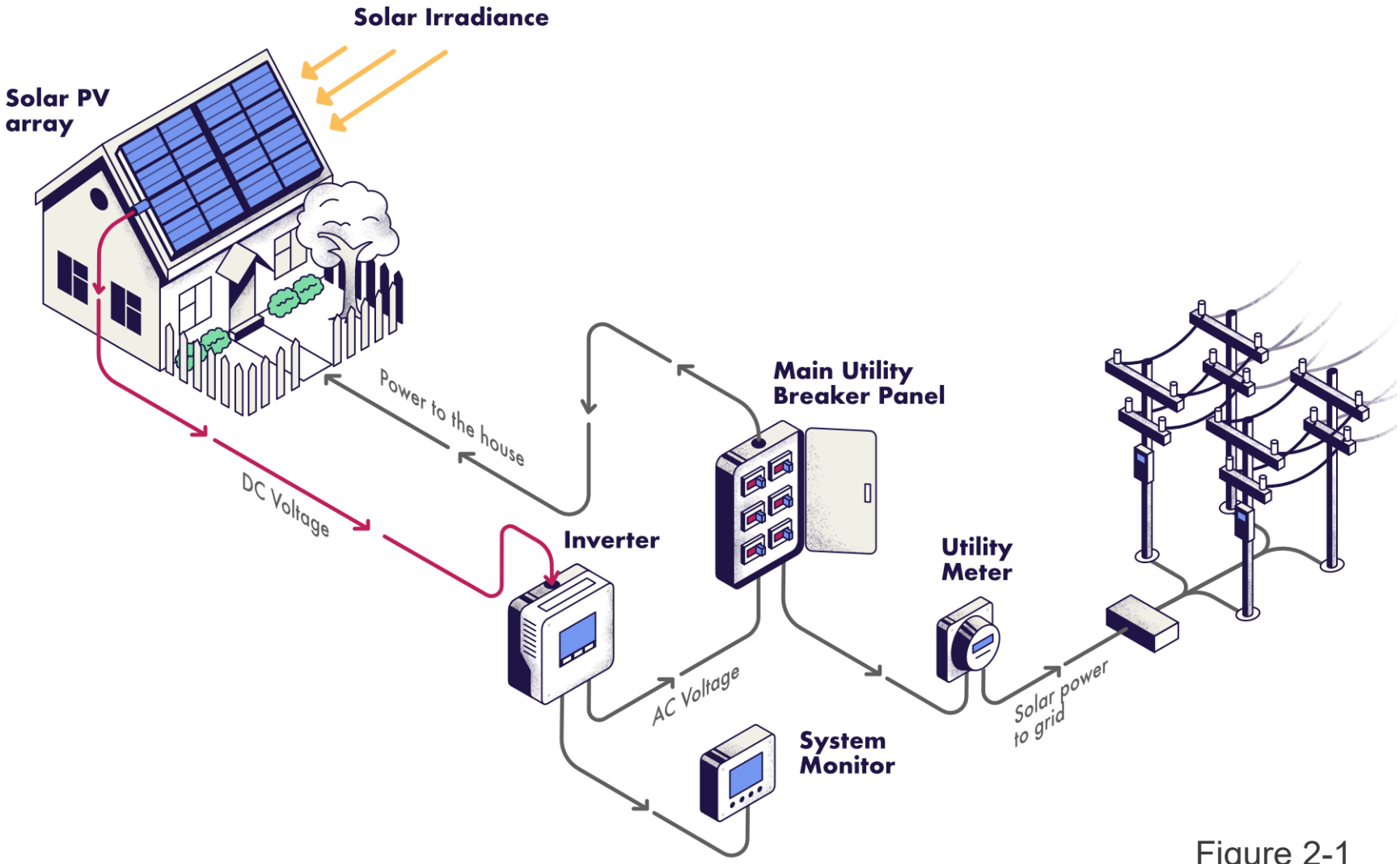


Figure 2-1

Recent Decades Have Seen Substantial Growth in Customer-Side Solar & Storage

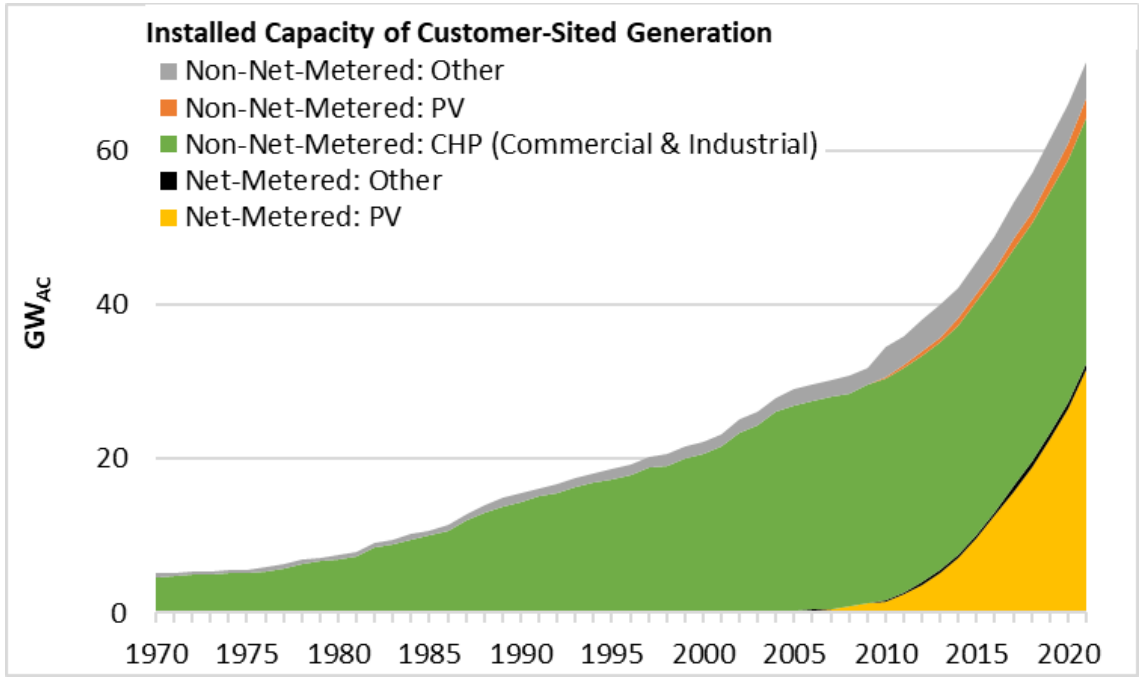


Figure 3-3

Historical Growth of U.S. Customer-Sited Generation

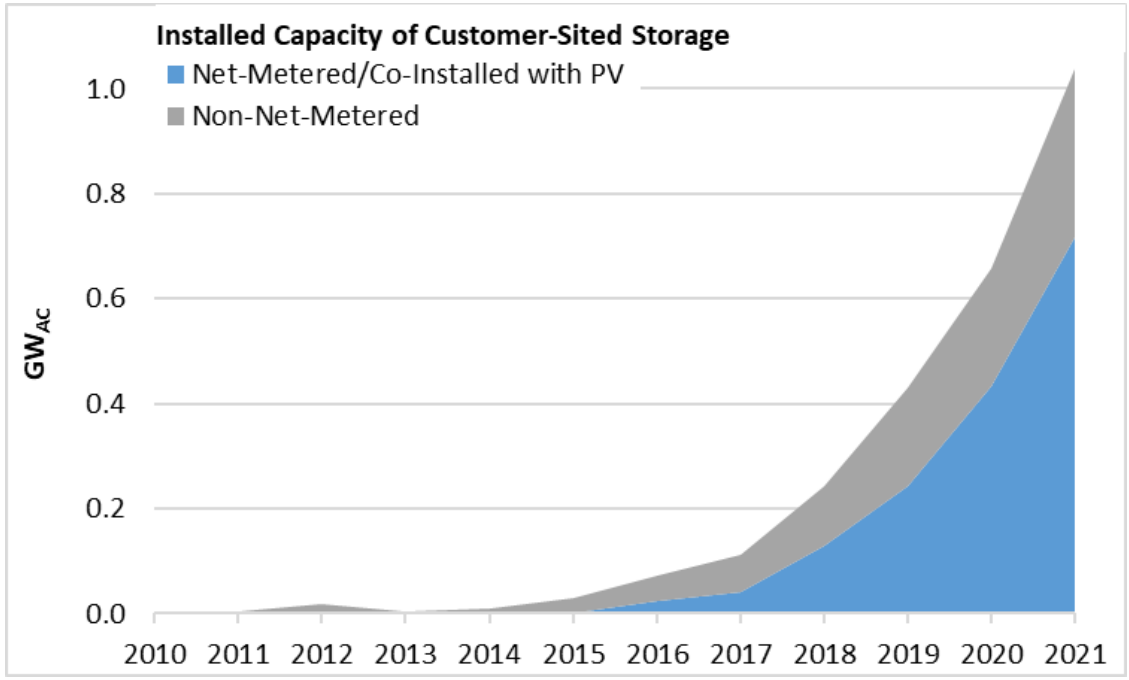
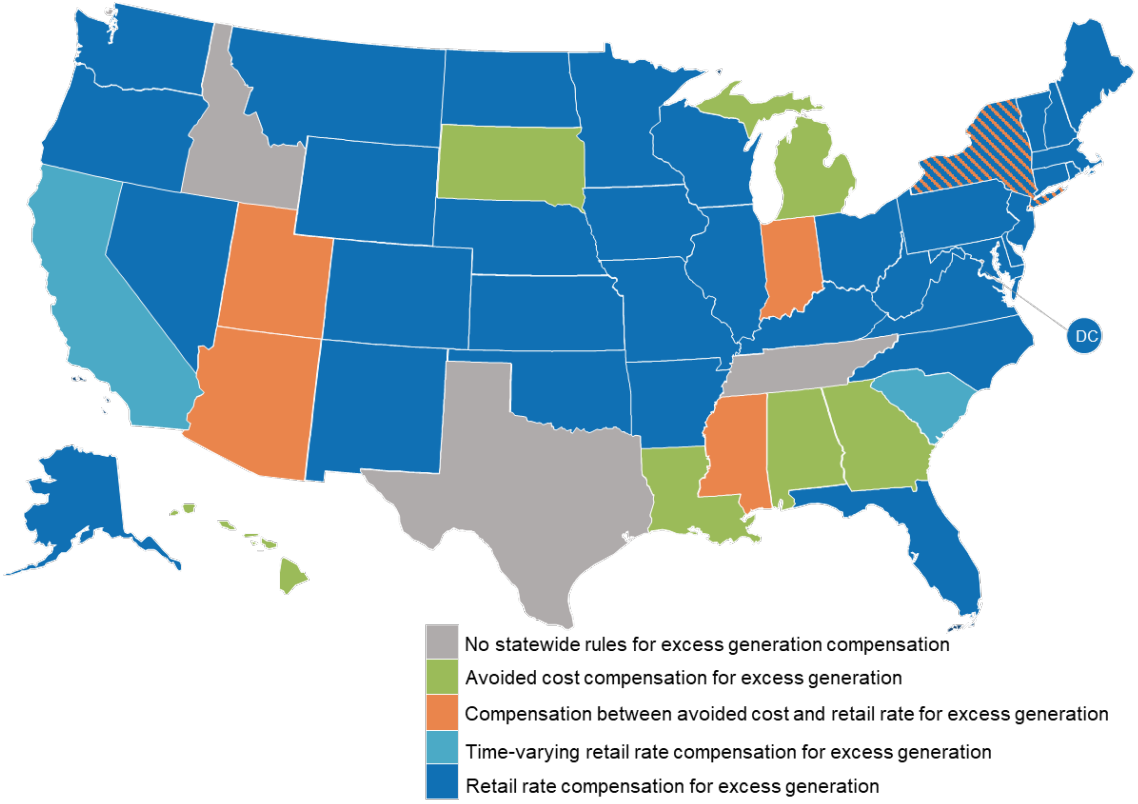


Figure 3-4

Historical Growth of U.S. Customer-Sited Storage

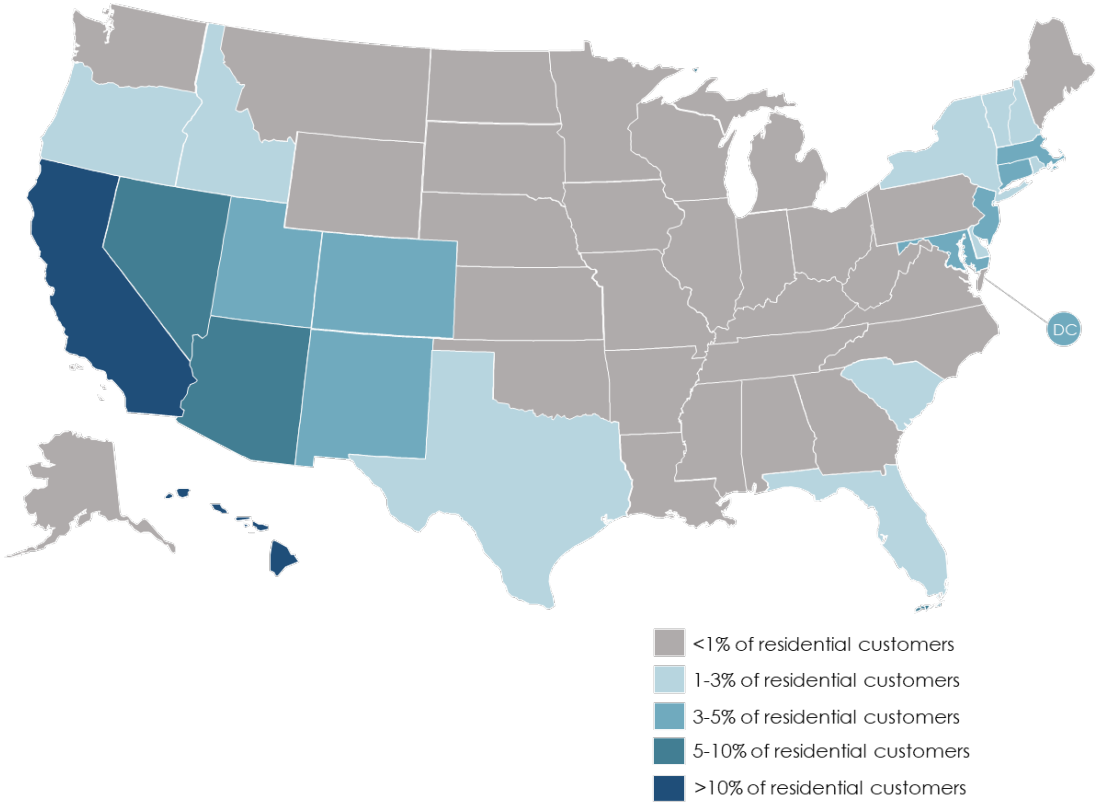
Compensation Structures for Distributed PV Have Evolved with Adoption Levels and Changing State Policies

Figure 3-2 Credit Rates Used for Excess Generation in November 2022



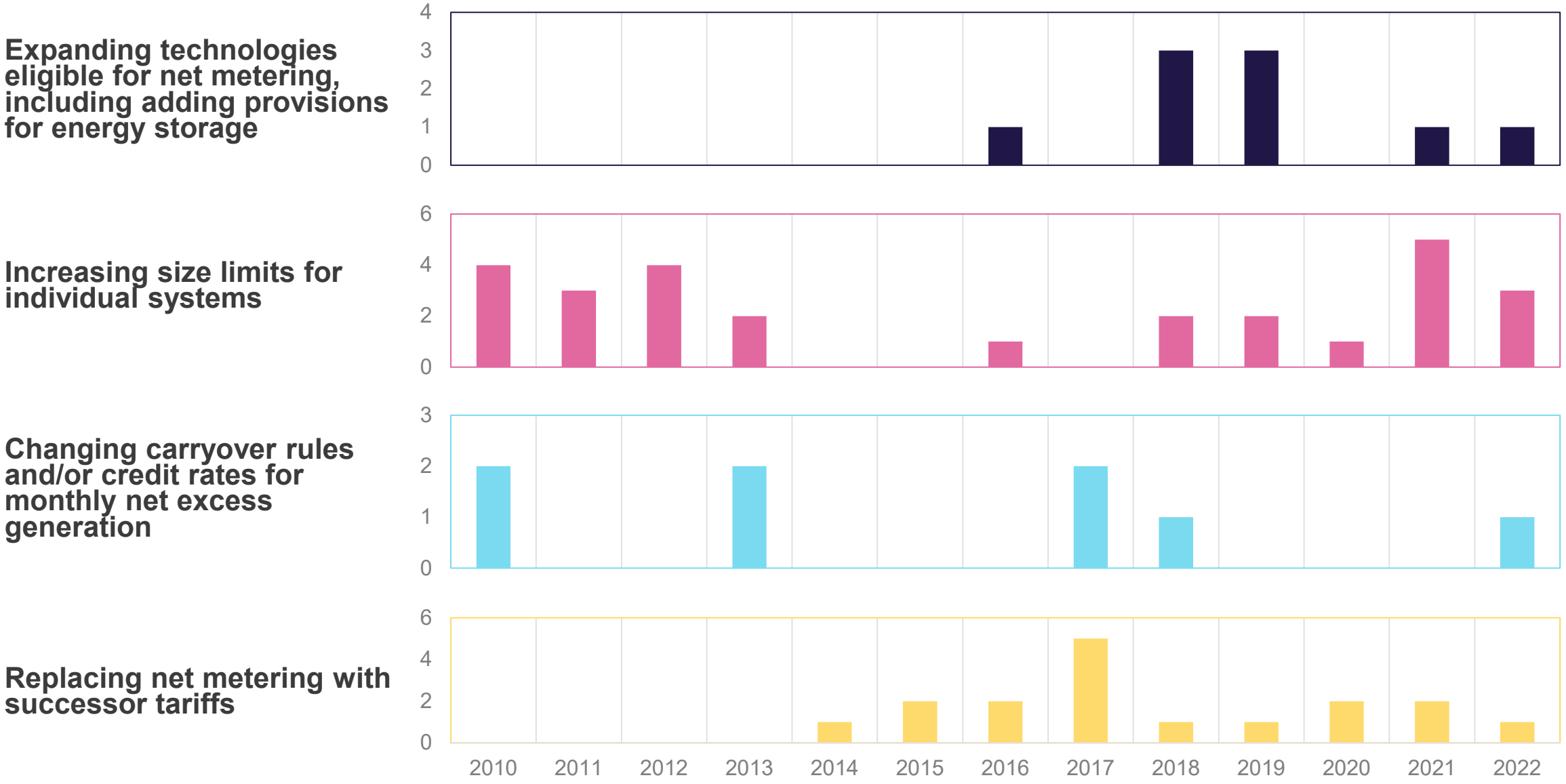
NOTE: Illinois is set to transition to compensation at the energy supply rate in 2025. Idaho and Texas do not have statewide rules for DG compensation, but several utilities offer net metering.
SOURCE: NC Clean Energy Technology Center. 50 States of Solar: Q3 2022 Report. October 2022. Available at: https://www.dsireinsight.com/publications

Figure 3-6 2021 Statewide Residential PV Penetration



NOTE: Values are calculated from statewide residential PV system counts (Wood Mackenzie 2022) and from the total number of residential electricity customers in each state (EIA 2022c)

Major State Actions on Net Metering Policy, 2010-2022



Adapted from Table 3-1

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Data Recommendations Based on Trends

Recommendation 3-1: Utility regulators and decision-makers of publicly owned utilities should work with stakeholders to explore and implement solutions to technical, legal, proprietary, or privacy concerns about the collection and release of information about the performance of behind-the-meter technologies and their interactions with the grid.

Recommendation 3-2: Data about participation in net metering and alternative and supplemental DG policies should be collected and reported so that policymakers can monitor how policies are interacting with energy market conditions in wholesale and retail, as well as regulated and unregulated, energy markets.

Economics Considerations Related to Net Metering

Committee presents the importance of basing electricity prices on social marginal costs to achieve economic efficiency.

This may be challenging given other important ratemaking considerations related to cost-causation, simplicity, fairness, and revenue adequacy.

An alternative solution may be implementing changes to the net metering mechanism, such as net billing or buy-all/sell-all rates, with DG compensation levels set at, or near the social marginal cost of electricity production and delivery.

The major components of the social marginal cost are the costs of generating electricity, delivering it to the customer, and any environmental externalities – greenhouse gases and air pollution – incurred.

Economics Recommendations

Recommendation 4-1: Regulators should strive to develop retail rate structures—for both DG and non-DG customers—with usage-based energy prices that correspond as closely as possible to the social marginal cost of producing and delivering electricity, inclusive of time- and location-specific environmental or other externality costs (insofar as they are not already internalized), while recognizing other competing rate-design objectives. Under this condition, net metering will generally result in economically efficient levels of investment in DG technologies, albeit with some rate impacts to non-participating customers.

Recommendation 4-2: In the absence of economically efficient rate structures for all customers, the alternative solution may be to implement changes to the net metering mechanism—either buy-all and sell-all or net billing tariffs—for DG customers, with DG compensation levels set at or near the social marginal cost of electricity production and delivery.

Recommendation 4-3: When evaluating the economic implications of current or proposed changes to net metering rules, decision-makers should consider specific conditions in their jurisdiction (e.g., the generation mix and costs, DG penetration levels, clean energy policies, etc.), while also anticipating how those conditions may evolve over the lifetime of DG resources. Environmental benefits should be carefully weighed alongside any rate impacts to non-participating customers.

Economics Recommendations

Recommendation 4-4: In some cases, additional compensation for DG customers may be warranted above and beyond what can be provided through net metering or other DG tariffs. In these circumstances, any additional incentives for DG customers should be provided through transparent incentives designed to achieve a specified outcome (e.g., to encourage adoption by low-income customers, to relieve constraints in specific localized regions of the grid, to meet legislative DG targets, etc.) and, if appropriate, funded from sources outside of electricity rates.

Recommendation 4-5: In determining DG compensation, policymakers should explicitly account for the environmental and other externalities that DG reduces when it displaces fossil fuel generation. To fairly compensate DG for this clean energy attribute, policymakers should consider whether to do so based upon the monetary value of the environmental externalities that the DG is likely to abate or the cost to achieve the same reduction in environmental harms through alternative technologies or policies.

Equity Considerations Related to Net Metering

There are multiple aspects to equity in the context of electricity access, products and services, net metering, and DG, including:

- Demographics of net metering participants
- The interaction of net metering with broader inequities associated with the electricity and energy systems
- Equity considerations associated with net metering non-participants
- Environmental, health, and societal equity effects from net metering policies
- Resilience considerations connected to net metering

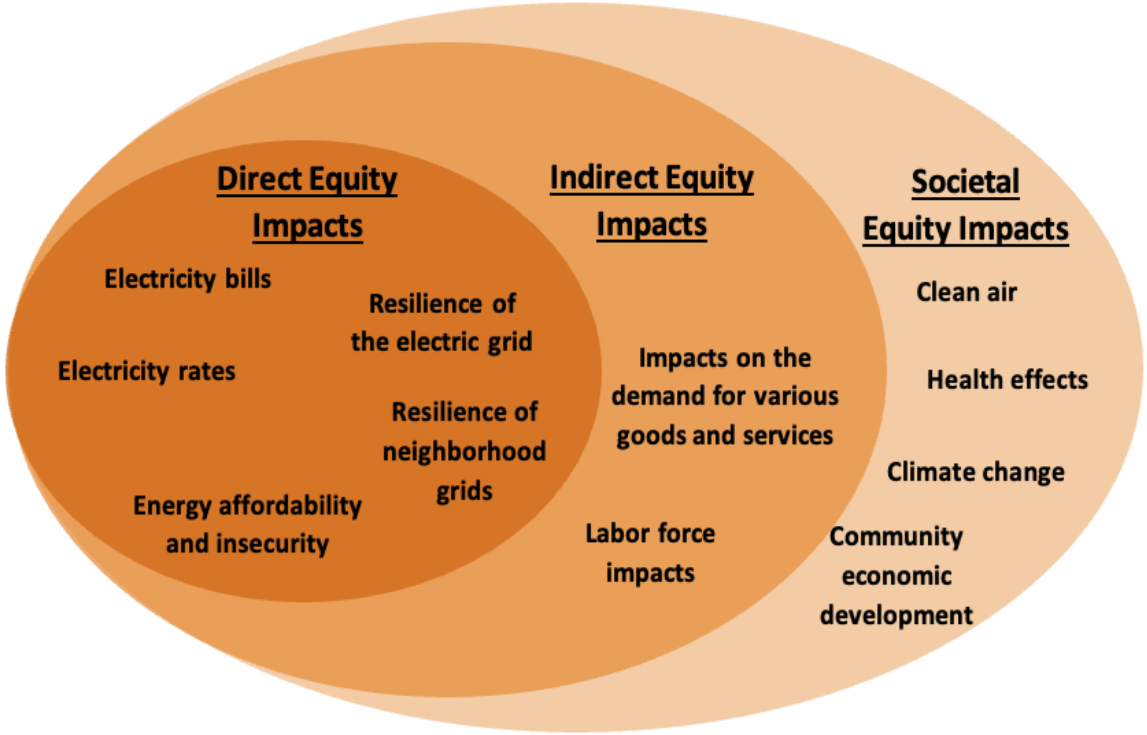

Figure 5-1

Dimensions of Equity

Distributional equity refers to fairness in the allocation of benefits, costs, rights, resources, and information, across all segments of a community (including participants and non-participants), prioritizing those with the greatest need (can include both accessibility and affordability).

Procedural equity refers to fairness and transparency of the processes that allocate resources and resolve disputes. Procedural equity focuses on who is represented, and who is engaged.

Intergenerational equity considers society's obligations to future generations. Actions that serve to increase rather than limit the options of future generations can be said to improve intergenerational equity.

Structural equity involves making decisions with the recognition of historical, cultural, and institutional dynamics including structural racism, gender bias, and other dimensions of long-standing discrimination.

Enhancing Procedural Equity with Knowledge Co-Production

On-line and in-person surveys in focal neighborhoods	Facilitated focus groups to identify needs, vision, and build consensus	Scenario co-development including equity framing, program and policy identification	Outreach to organizations and neighborhoods by trained connectors	Participatory co-assessment to explore outcomes and implications of their programs and policies

Figure 5-3
NOTE: Dollar signs indicate steps where incentives to participants should be considered due to the significant effort which may be needed for success.

Equity Recommendations

Recommendation 5-1: Rates should be designed consistent with updated ratemaking principles, with particular attention to the equity impacts for customers least able to afford them. To help accomplish this, utilities and policymakers should ensure that information about utility rates is easily available to all customers (e.g., not just through postings on websites), and that all customers have a voice and can participate in the design of rates.

Recommendation 5-2: Decision makers on electricity rates should consider both the impacts of the distribution of benefits and costs, as well as total benefits and costs when designing net metering policies, and ensure that adequate data is collected and made publicly available to do so. These benefits and costs should include and balance among other things: public health impacts, job impacts, land use impacts, and the future options that will be enabled or precluded.

Equity Recommendations

Recommendation 5-3: Fair ratemaking should allow for affected consumers to have a meaningful voice in the process (so as to ensure procedural equity) and take into consideration (among other things) the potential impacts of rates on various customer segments (from an economic efficiency and equity point of view), and on customers' decisions about adopting BTM technologies or load or grid defection in the context of technology trends. Regulators and decision makers of publicly owned utilities should ensure that such information is provided to the public and is easily understandable and accessible.

Equity Recommendations

Recommendation 5-4: Investments to reverse historic structural inequities, such as grid upgrades in historically disinvested communities to increase hosting capacity, should be considered to enable broader adoption of BTM DG and participation in net metering.

Recommendation 5-5: Policymakers should consider expanding community and government-funded programs, such as low- or no-interest financing, to expand access to BTM DG by low- and medium-income (LMI) customers and their participation in net metering. In addition, incentives that focus on income-qualified customers and renters can help reduce inequities due to lack of access.

Technology Considerations Related to Net Metering

This chapter lays out the technology implications of increasing amounts of behind the meter (BTM) distributed generation (DG) and describes the ongoing technological advances that enable the integration of BTM DG/distributed energy resources (DER), leading to a reliable and resilient grid

Grid modernization and the integration of renewables

- Power physics-based constraints
  - Balance of supply and demand
  - Increased complexity of Planning & Operations
- Emerging advances in power electronics, storage, communications, and controls technologies
- Cybersecurity and Privacy Considerations

Technology Recommendations

Recommendation 6-1: There need to be ***direct investments*** in the distribution system to ***integrate*** increasing amounts of *BTM DG* such as rooftop solar, as well as other *DER* including smart buildings management systems, electric vehicles (EVs), and charging infrastructure, to ensure the continued safe and reliable operation of the grid and provision of grid services. Investments will also be required to suitably ***site and operate*** BTM DG, as well provide ***efficient price signals***, such that the DG can provide system benefits, particularly ***local and grid resilience*** when normal service is disrupted. A key first step in this direction is to improve ***grid visibility to the operators*** at the distribution level. These investments in the distribution grid have to occur simultaneously with BTM DG deployment.

Technology Recommendations

Recommendation 6-2: In order to make the best use of DG and DER, utilities must make ***investments to integrate these technologies***, ***increase their visibility, manage them*** (either directly or indirectly through price signals), and reduce barriers to their management by customers and DG providers. With either utility or non-utility control, or intelligent management of DG, DG can provide greater value. The corresponding compensation through net metering and its variants could reflect this higher value. Overall, the democratization of the grid, with increased public-and private partnerships, can be very valuable.

Recommendation 6-3: Investments in distribution system technologies aimed towards integration of DG and DER must be accompanied by ***revisions in policies and state and federal utility regulations*** to facilitate cost recovery of these investments.

Regulatory, Legal, and Market Considerations

Policy and regulation guides customer, utility and non-utility investments in BTM DG and the distribution system. This chapter explores:

- State regulatory issues that intersect with net metering policy, including traditional electric utility ratemaking principles, power acquisition principles, and other policies related to relationships between electricity customers and their utility service providers
- Net metering's interactions with local penetration levels of BTM DG, different electric utility ownership forms, electric industry structure, and other regulatory policies, including complementary federal/state policies
- Principles for the design of policies to launch and invigorate markets for the supply and demand for new technologies, including clean DG

Regulatory, Legal, and Market Recommendations

Recommendation 7-1: Decision makers about electric utility rates—including state legislators, utility regulators, and governing boards of publicly owned electric utilities—should take into account that ***DG technology costs and market maturity are at a stage both technically and economically, where traditional net metering policies to support the deployment of DGs need to be assessed and revisited***. This recommendation applies both to instances where a utility operates in a state that previously adopted net metering and regulators are considering variants to it, as well as in parts of the country that have not yet adopted net metering, and seek to advance BTM technologies, and have the option to leapfrog beyond net metering and adopt other ratemaking variants.

Recommendation 7-2: ***Decision makers should rely on important, traditional ratemaking principles as updated to reflect the application of new technologies and service offerings***. These updated principles include cost-causation, rate simplicity, fairness, revenue adequacy, a simple customer experience even if underlying rate structures become significantly more sophisticated, and compensating resources based on their value.

Regulatory, Legal, and Market Recommendations

Recommendation 7-3: ***Decision makers should design compensation approaches*** for the export of power from BTM generation according to principles that are ***consistent with how the utility values other sources of power*** that offer comparable energy, capacity, and other grid services to the system (which may vary by time and location). External impacts (such as pollution) from some sources of power are unpriced, and in many jurisdictions, there are constraints on the ability of regulators to reflect externalities in utility planning and/or ratemaking. Sound economic principles would support the consideration of such externalities in utility regulation; policymakers should consider how to address such impacts in utility and other energy policies.

Recommendation 7-4: Given the economic and equity challenges associated with using net metering—and with financial incentives and programs recovered in electricity rates more generally—to promote investment in and deployment of DG technologies, ***policymakers should also consider and where appropriate use other policy instruments***, such as tax incentives, building codes, attractively priced loans (or even grants) to low-income households, and other complementary policies.

Conclusions

Given the evolution of the electricity system, net metering must also evolve, with attention to:

- Technology, cost and policy context, and trends
- Economic and rate-making principles
- Equity implications
- Technology requirements for the system
- Legal, regulatory, and policy precedent and guidance

To ensure that net metering evolves to support a decarbonizing, equitable, and resilient electricity system, its design and policy need to:

- Recognize that the future electricity system is and will become even more interdependent among its constituent parts, including DG at the grid edge.
- Build upon and balance among the generally accepted principles of electricity system regulation: efficiency, simplicity, stability, fairness, and revenue adequacy.
- Be informed by the electricity system context, policy objectives related to decarbonization, equity, and system resilience, the locational, temporal, and scale impacts of DG, and input from affected stakeholders.

Pillars for Net Metering Redesign

A more ***intentional and integrated approach*** than traditional net metering policies is required ***to support a more resilient, equitable, and decarbonized electricity system.***

Future net metering will need to be:

Integrated

The committee recognizes a more ***interdependent future for customers and utilities*** and other energy product and service providers, as well as distributed and grid scale generation, that ***integrates DG with the rest of the electricity system.***

Consistent

Redesigned rate structures and net metering need to be ***consistent with the basic principles of electricity rate design***, balancing efficiency, simplicity, stability, fairness, and revenue adequacy.

Well Informed

Net metering redesign will need to be informed by electricity system context, policy objectives, and history. ***Policymakers and regulators should design net metering programs specific to the circumstances of their systems and markets***, with input from affected stakeholders.

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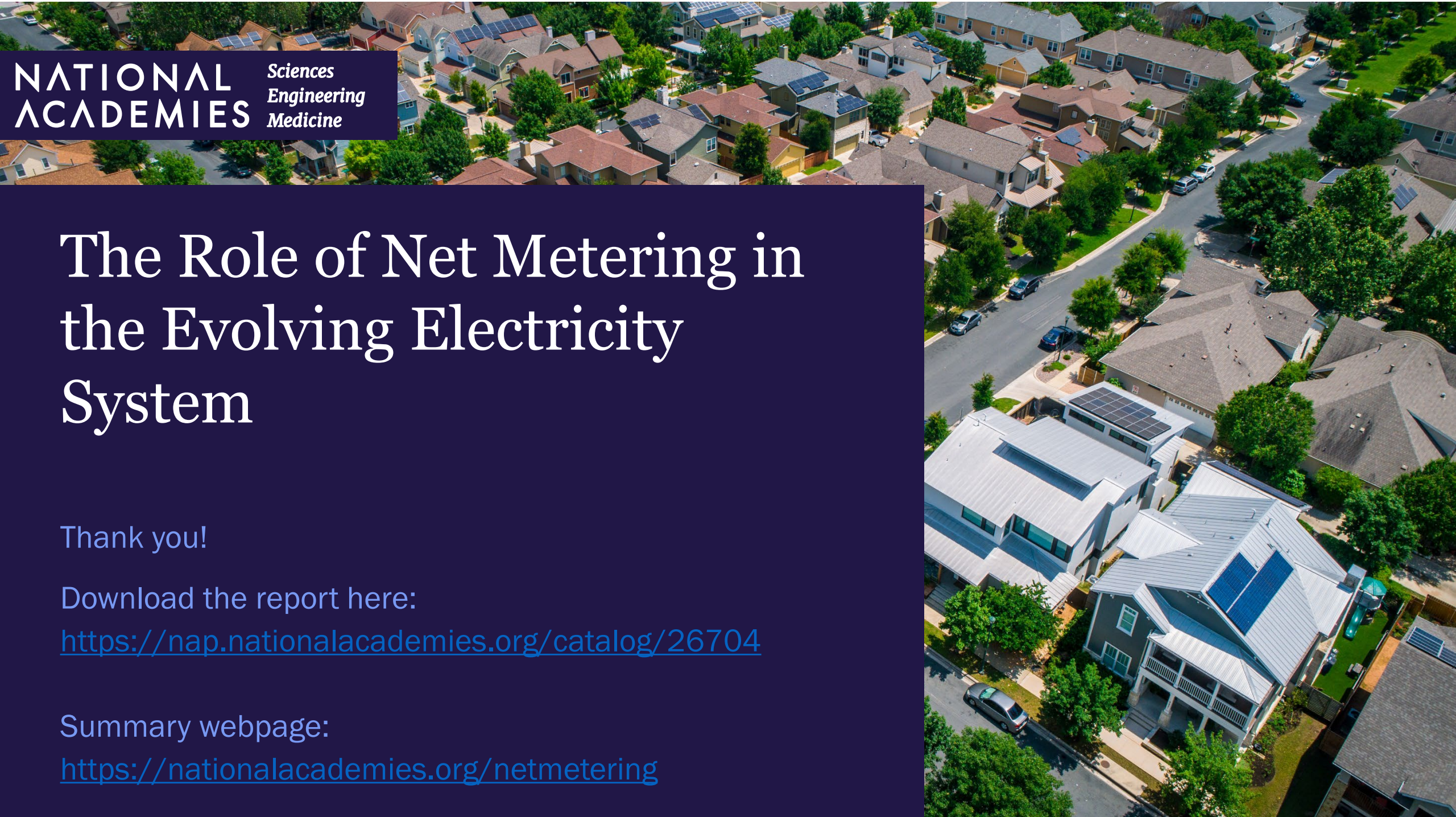

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Thank you!

Download the report here:
https://nap.nationalacademies.org/catalog/26704

Summary webpage:
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