

Energy Affordability

DOE Energy Innovator Fellows Boot Camp

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Roadmap

1. Defining energy affordability — including group discussion
2. Bill assistance strategies
3. Reducing customer bills through technology adoption
4. Promoting affordability through load management
5. Reflection: group discussion
6. Questions



Defining energy affordability

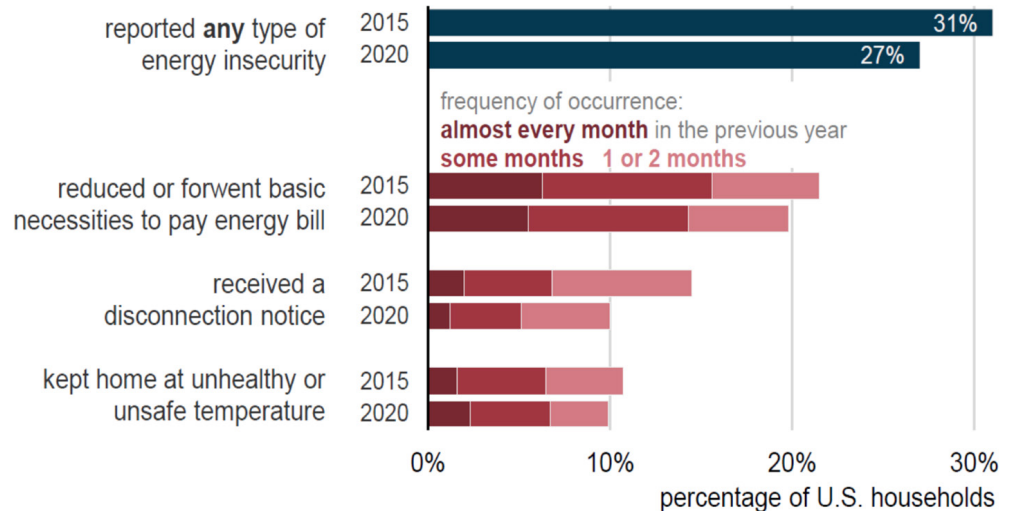


Defining Energy Affordability

Energy affordability is the ability of consumers to pay for their energy bills in addition to other basic household expenses without feeling overburdened

- [Household energy insecurity](#) is a broader but related concept. It describes the inability to adequately meet basic household energy needs and describes households who face challenges in purchasing the energy they need, or other basic necessities, because of energy costs.

U.S. household energy insecurity measures (2015 and 2020)



[2020 Residential Energy Consumption Survey](#)

Challenges Are Compounded by Rising Electricity Rates

- Retail electricity prices have [risen rapidly](#) in nominal terms in recent years
- These increases largely tracked inflation until 2023 but are [expected to outpace inflation](#) through 2026
- [State-level trends](#) vary widely, with some states experiencing price increases exceeding inflation while others saw reductions in inflation-adjusted prices
- Utilities have [requested \\$29 billion](#) in rate increases in the first half of 2025, already exceeding the 2024 total
- [Drivers](#) of recent price increases included but were not limited to:
 - Infrastructure costs
 - Shrinking customer loads
 - Renewable portfolio standard (RPS) programs that require incremental supplies of renewable electricity*
 - Extreme weather, natural disasters, and wildfires
 - Fluctuations in gas prices, particularly after the onset of the Ukraine-Russia war

*75% of recent utility-scale wind and solar deployment occurred outside of RPS programs and had no broadly discernible positive impact on retail prices and had suggestive (weak) evidence of reducing prices



Affordability Metrics (1)

Energy burden is measured by the percent of a household's income spent on an energy bill. Energy burden is the most common way that energy affordability is measured.

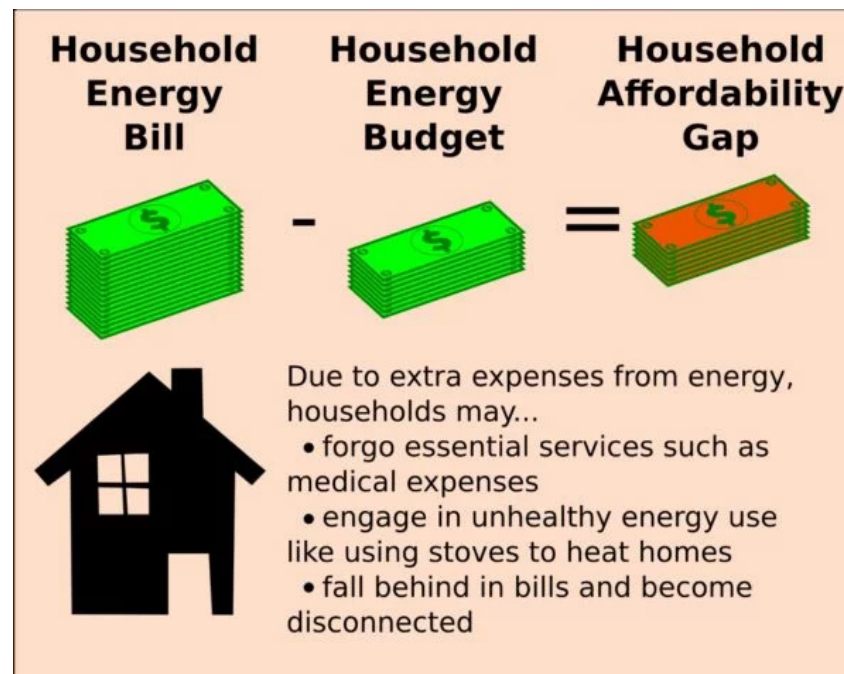
- Households spending more than 6% of their income on energy costs are considered to have high energy burdens, and households spending more than 10% of their income on energy costs are considered severely energy burdened.
- Energy burden targets may be used to cap energy costs to a certain percentage of income. For example, [Virginia's percentage-of-income payment plan](#) sets the energy burden target level at 6%.



Affordability Metrics (2)

The [energy affordability gap](#) is the amount households spend on energy bills in excess of an affordability threshold (commonly 6% of income).

- When aggregated across a population, the affordability gap represents the total dollar shortfall between what households actually pay and what would be considered affordable. This can also be [expressed](#) as an average per household or as a population-weighted measure to compare across geographies or income groups.



Source: [PSE](#)

Affordability Metrics (3)

The **affordability ratio** is a metric that quantifies the percentage of a representative's household income that would be used to pay for an essential utility service, after non-discretionary expenses such as housing and other essential utility service charges are deducted from the household's income.

Affordability Ratio (AR)



where utility services are least affordable for households at a particular point of the income distribution (e.g., AR_{20} is households at the lowest 20th percentile of income)

([California Public Utilities Commission, 2022](#))



Ways States and Utilities Can Support Affordability

State public utility commissions have statutory mandates that establish broad standards for regulation of utilities. These standards, typically including “just and reasonable” rates, may be interpreted to ensure affordable energy for customers.

State regulators and utilities have [four primary ways](#) they can support affordability:

1. **Cost control** - how utilities make expenditures and regulators approve their inclusion in rates to ensure cost of service is no more than necessary
2. **Cost responsibility** - how costs are allocated among different customer groups
3. **Predictability** - how well customers can predict their bills so they can budget for them
4. **Agency** - how much influence customers have over their bills



Discussion [7 minutes]

Questions

1. How is energy affordability showing up in your work?
2. What affordability challenges does your organization or jurisdiction face?



Bill assistance strategies



There are multiple strategies to assist customers with their utility bills

Reduce customer bills

- Discounted rates
- Inclining block rates
- Percent of income payment plans (PIPP)

Encourage regular bill payment

- Bill prepayment
- Budget billing

Help customers repay unpaid bills

- Arrearage management programs

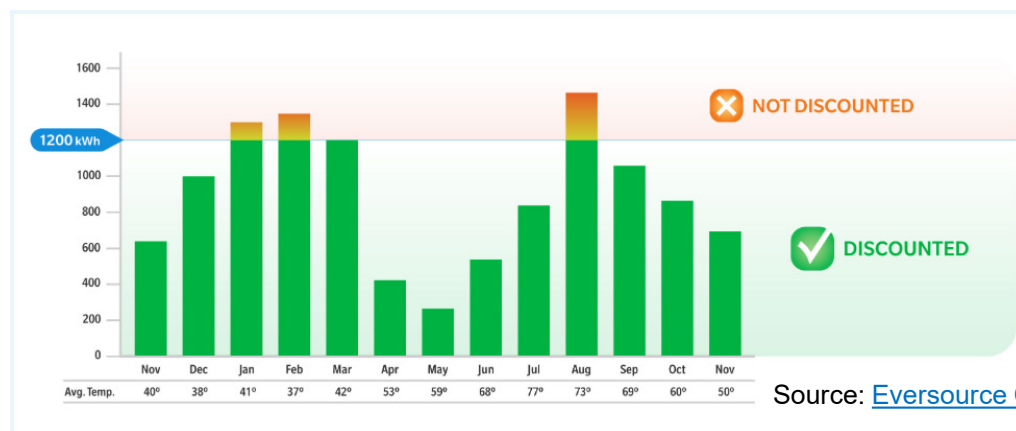
Leverage federal assistance programs

- Low Income Home Energy Assistance Program



Rate design can help reduce bills for some utilities (1)

- Discounted electricity and gas rates lower bills by a defined percentage. They may:
 - Be flat and provide the same discount to all eligible customers
 - Until Massachusetts' [low income electricity rate](#) provides a 40% discount to all eligible customers
 - Be tiered and adjust the level of discount with eligibility criteria such as income
 - Eversource Connecticut's [Electric Discount Rate](#) adjusts the discount level based on:
 - Household income and number of people in household *or*
 - The type of public assistance benefits the customer receives (e.g., Medicare Savings Programs)
 - Cover an entire bill or a defined amount of energy consumption
 - Eversource's program covers first 1,200 kWh each month



Rate design can help reduce bills for some utilities (2)

- Utilities can offer electric heating rates that reduce the cost of operating heat pumps and electric resistance furnaces relative to standard rates
 - Rates may have a declining block structure (e.g., [Versant Power](#)) or a single lower rate (e.g., [Central Maine Power](#)) in winter
- Inclining block rates can reduce the cost of baseline energy consumption
 - Rate for a level of energy consumption needed for basic energy services
 - [San Diego Gas & Electric](#) offers a lower rate for “Baseline Usage” that varies seasonally, by climate zone, and medical need

	Baseline Allowance For Climatic Zones*							
	Coastal		Inland		Mountain		Desert	
Basic Allowance								
Summer (June 1 to October 31)	9.0		10.4		13.6		15.9	
Winter (November 1 to May 31)	9.2		9.6		12.9		10.9	
All Electric**								
Summer (June 1 to October 31)	6.0	R	8.7	R	15.2	R	17.0	R
Winter (November 1 to May 31)	8.8	R	12.2	R	22.1	R	17.1	R

San Diego Gas & Electric baseline allowance for electricity bill calculation



Rate design can help reduce bills for some utilities (3)

- PIPPs cap customer utility bill payments at some percentage of their income
- [Ohio](#) sets caps based on home heating fuel, household income, and size of household
 - If gas-heated, cap is 5% for gas and electricity, respectively
 - If electrically heated, cap is 10% for electricity
 - Eligibility is based on income for different household sizes
- Other utility customers, or non-utility funding sources, cover the differential between what the customer pays and what they would have otherwise paid

Size of Household	12-Month Income Limit	30-Day Income Limit
	175% FPG	175% FPG
1	\$27,387.50	\$2,251.03
2	\$37,012.50	\$3,042.12
3	\$46,637.50	\$3,833.22
4	\$56,262.50	\$4,624.32
5	\$65,887.50	\$5,415.41
6	\$75,512.50	\$6,206.51
7	\$85,137.50	\$6,977.60
8	\$94,762.50	\$7,786.70

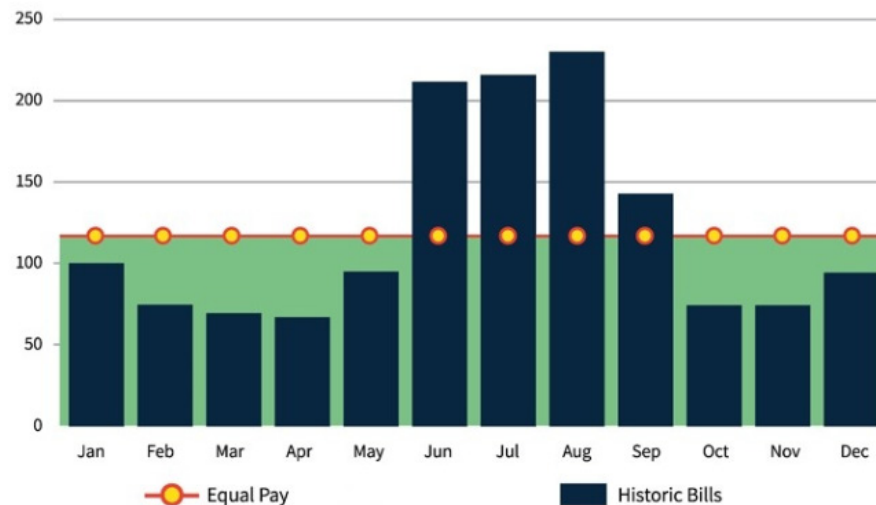
For households with more than eight members, add \$8,995 for each additional member.

Income cap lookup table from Ohio PIPP.
FPG is federal poverty guidelines.



Budget billing may encourage more regular utility bill payment

- [Budget billing](#) is a utility program that spreads out the cost of energy used during high-demand times of the year
 - Heating and cooling needs drive higher bills in the summer and winter
 - Customers may struggle to afford the most expensive bill(s) of the year
 - Paying the same amount each month mitigates bill spikes and may improve payment rates
 - Budget billing often sets bills based on usage in the preceding 12 months and may make regular adjustments (e.g., every 6 months)
 - Monthly payments may be higher and lower in some months than they otherwise would be, but in the long run there is no net reduction in total bills

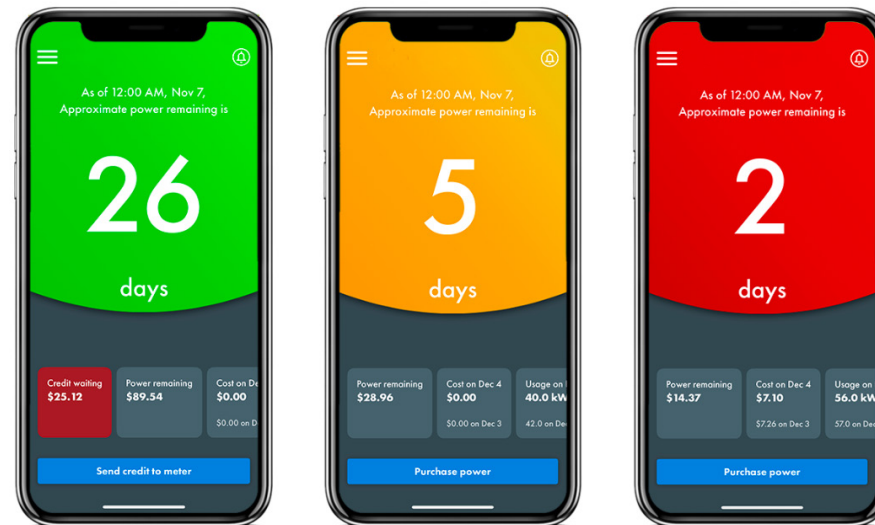


Source: [NVEnergy](#)



Prepayment may help customers manage energy bills

- Customers can budget their energy expenditures by paying upfront
 - Energy consumption draws down the account balance
 - Service to customer is shut off when [balance is zero](#)
 - Customers may [self-ration](#) energy usage to remain within budget, which can create risks in [cold weather](#)
- Prepayment may require special equipment or advanced metering infrastructure and changes to utility billing systems
- Most common for [cooperative and municipal utilities](#)



Source: [Salt River Project](#)

Arrearage management programs forgive unpaid bills

- Customers reduce arrears by paying future bills on time over a defined period, such as 1 year
 - Each on-time payment reduces the arrearage balance (e.g., Pacific Gas & Electric [Arrearage Management Plan](#))
 - Utilities set the maximum amount of arrears that can be forgiven (e.g., [National Grid Massachusetts](#) forgives up to \$12,000)

- Programs may require that customers:
 - Use budget billing during the program period (e.g., [United Illuminating](#))
 - Have a minimum amount of arrears (e.g., [\\$500](#))

- Funds from other utility customer, or non-utility funding sources, can cover the cost of forgiving arrears

- Utilities also may offer bill payment programs that do not include arrearage forgiveness
 - [Xcel Energy](#) (Colorado) allows customers to pay arrearages over time
 - Customers pay full utility bill while repaying arrearages



Federal assistance programs can reduce energy bills

- LIHEAP is a federally-funded block grant program that:
 - Reduces the cost of utility bills by providing payments to utilities on behalf of customers
 - Provides emergency support during weather emergencies
 - Helps households reconnect utility services after disconnection
 - Funds weatherization projects

- Participation is income-qualified

- States, tribes, and territories administer grant funds



Key program design considerations

- Eligibility requirements
 - Household income, based on the number of people in the household, is common
 - Qualification in another means-tested program (e.g., Supplemental Nutrition Assistance Program in [California CARE rates](#))
 - May exclude customers who participate in other utility programs
 - e.g., customers with net-metering can not participate in [NV Energy's budget billing](#)

- Enrollment
 - May be automatic (e.g., New Jersey [Fresh Start](#)) or application-based

- Funding sources
 - Other utility customers
 - State budgets (e.g., [Illinois PIPP](#))
 - LIHEAP

- Administrative effort
 - Some programs and eligibility criteria require more effort (e.g., income verification)
 - Eligibility based on receipt of other services reduces administrative burden



Measuring impacts of bill assistance and rates

- Studies on impacts of bill assistance programs and rates designed to promote affordability are limited. The following examples may be helpful reference points when assessing utility programs and rates:
 - [Customer bill impacts of California inclining block rates](#)
 - [Impacts of pre-payment on electricity usage](#)
 - [Impact of LIHEAP on energy consumption](#)
 - [Evaluation of Illinois Percent of Income Payment Plan](#)
 - [PEPCO Arrearage Management Program Evaluation](#)



Reducing customer bills through adoption of grid-edge technologies



Grid-Edge Technologies Can Improve Energy Affordability

- Improved access to distributed energy resources (DERs) like energy efficiency, demand response, and distributed generation and storage can provide household-level benefits
 - Household bill savings
 - Grid benefits
 - Co-benefits (e.g., physical and mental health, home comfort)
 - Reduced cost to administer bill assistance programs, utility credit & collections, and disconnection & reconnection costs
- There are significant barriers to DER access for low-income households
 - Home ownership (renters vs. landlords split incentives)
 - Housing type (single-family vs. multi-family split incentives)
 - High upfront costs
 - Access to financing with robust consumer protections
- An increasing number of programs increase DER adoption for underserved markets (e.g., income-qualified customers)



Energy Efficiency & Demand Response

- Benefits
 - Modest upfront costs with lasting savings
 - Co-benefits (e.g., home comfort, property value)
- Challenges
 - Savings may be limited; deep savings may require pricier upgrades
 - Housing conditions may prevent participation
- Best practices
 - Ensure net bill savings
 - Braid various funding sources
 - Cross-eligibility with other affordability programs (e.g., home repair)- some solar/battery programs require EE/DR enrollment
- Examples
 - Federal Weatherization Assistance Program
 - Smart thermostat programs

EmPOWER Maryland Limited Income Energy Efficiency Program



Community/Shared Solar

- **Benefits**
 - Allows access to solar without a rooftop or upfront costs, even for renters
 - May guarantee bill savings
- **Challenges**
 - Not all programs offer low- or moderate-income (LMI) households carve-outs or underwriting or subscription models conducive to their adoption
- **Best practices**
 - Flexible subscription model without penalties
 - Ensure net bill savings
 - Alternative underwriting criteria
- **Examples**
 - Solar for All (DC, IL, NY)
 - Solar on Multifamily Affordable Housing (CA)

California's Solar on Multifamily Affordable Housing (SOMAH) Program benefits participants on many levels:



Tenants

Helps tenants save money on their electricity bills



Property Owners

Helps property owners in disadvantaged communities affordably install solar



Contractors

Helps local contractors build their solar businesses



Job Seekers

Provides paid on-the-job training and employment opportunities

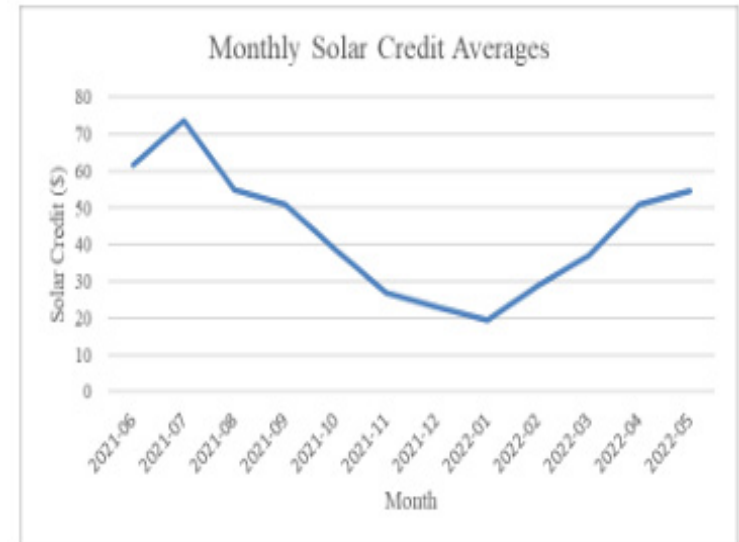


Resources

Makes solar accessible to more Californians

Rooftop Solar

- Benefits
 - Potential for ownership, larger savings than community/shared solar or energy efficiency
- Challenges
 - Rooftop solar is costly
 - Barriers for renters, multi-unit dwellings
 - Potential barriers related to permitting or interconnection (e.g., delays, added costs)
- Best practices
 - Education and awareness
 - No upfront costs with net bill savings
 - Financing with credit enhancement, alternative underwriting criteria, robust consumer protection
- Example: Upfront or production incentives



Source: [Groundswell Research Report on DC's Solar For All program](#)



Storage

- Benefits
 - Reliability & outage protection
- Challenges
 - Batteries are costly
 - Barriers for renters, multi-unit dwellings
 - Potential barriers related to permitting or interconnection (e.g., delays, added costs)
- Best practices
 - Pair with program that increases grid benefits
 - Pair with other measures/programs to improve cost-effectiveness
- Examples
 - Incentive programs (CA Self-Generation Incentive Program)
 - Community Resilience Hub (VA)

Haven Energy offers no-cost solar, batteries to income-qualified California customers

Under a Self-Generation Incentive Program framework for low- and moderate-income customers, Haven has deployed more than 1,000 residential batteries, co-founder and CEO Vinnie Campo said.

Published April 22, 2025

Source: [Utility Dive](#)

By Brian Martucci



Financing

- Benefits
 - Enables no upfront costs
 - May guarantee bill savings at the start
- Challenges
 - Not everyone may qualify
 - Taking on debt creates risk, and customer protections may vary by program
- Examples
 - Income-qualified loan support
 - On-bill programs, including loans and tariffed on-bill
 - Revolving loan funds



Interest Rate Buy Down

At program launch, a 3% interest rate reduction was available to all customers, with additional loan support available to residents who were income- or credit-score-qualified. Over time, this buy down was reduced and eligibility for it was restricted to income-qualified participants.



Income-Based Principal Reduction

For qualifying customers, the Mass Solar Loan program offered an incentive applied directly to the loan principal. This was paid directly to the lender to reduce the borrower's principal when the project reached completion. For most of the program, income-qualified customers were eligible for a reduction of up to 30%, capped at \$10,500.

Source: [Mass Solar Loan Toolkit](#)



Best Practices

- Cross-eligibility across affordability programs and other application features to simplify process, reduce program administration costs
- Robust consumer protection
- Education and awareness
- Access to friendly capital
- Net savings at month one
- Encourage co-benefits
- Well-defined goals and metrics aligned with iterative, third-party evaluation



Evaluations

- Types of evaluations
 - Progress report
 - Impact evaluation
 - Program performance evaluation
- Process
 - Reporting requirements (specify frequency, where it will be made available)
 - Third-party evaluation vs. internal
 - Iteration (incorporating feedback into program design)
 - Scope
- Metrics
 - Affordability-specific metrics, connected to relevant goals
 - Qualitative vs. quantitative metrics
 - Verification, quality assurance



Main Takeaways

- Grid-edge technologies can improve energy affordability
 - By reducing load, shifting load to lower cost time periods, or using distributed generation and storage
- A variety of income-qualified programs reduce barriers to technology adoption by extending reach to markets underserved by other DER programs
 - May focus on one or more technology
 - May focus on a specific grid service (e.g., improving reliability)
- Funding one program versus another may require weighing various tradeoffs
- Best practices include transparency, design features that improve household savings, clear goals and aligned metrics, and consumer protection
 - Need more examples of thorough program evaluations and clear and iterative program design to achieve well-defined goals to understand impacts, progress, and best practices



Promoting affordability through load management



Most utility costs are recovered through volumetric rates

- Utilities—or public utility commissions for regulated utilities—establish a *revenue requirement* to recover their allowed expenditures plus a rate of return on their capital investments
- Most of the revenue requirement is spread across the utility’s electricity sales to set rates
- If a utility’s revenue requirement increases by more than its electricity sales do, then rates rise. If sales increase by more than the revenue requirement, rates fall.

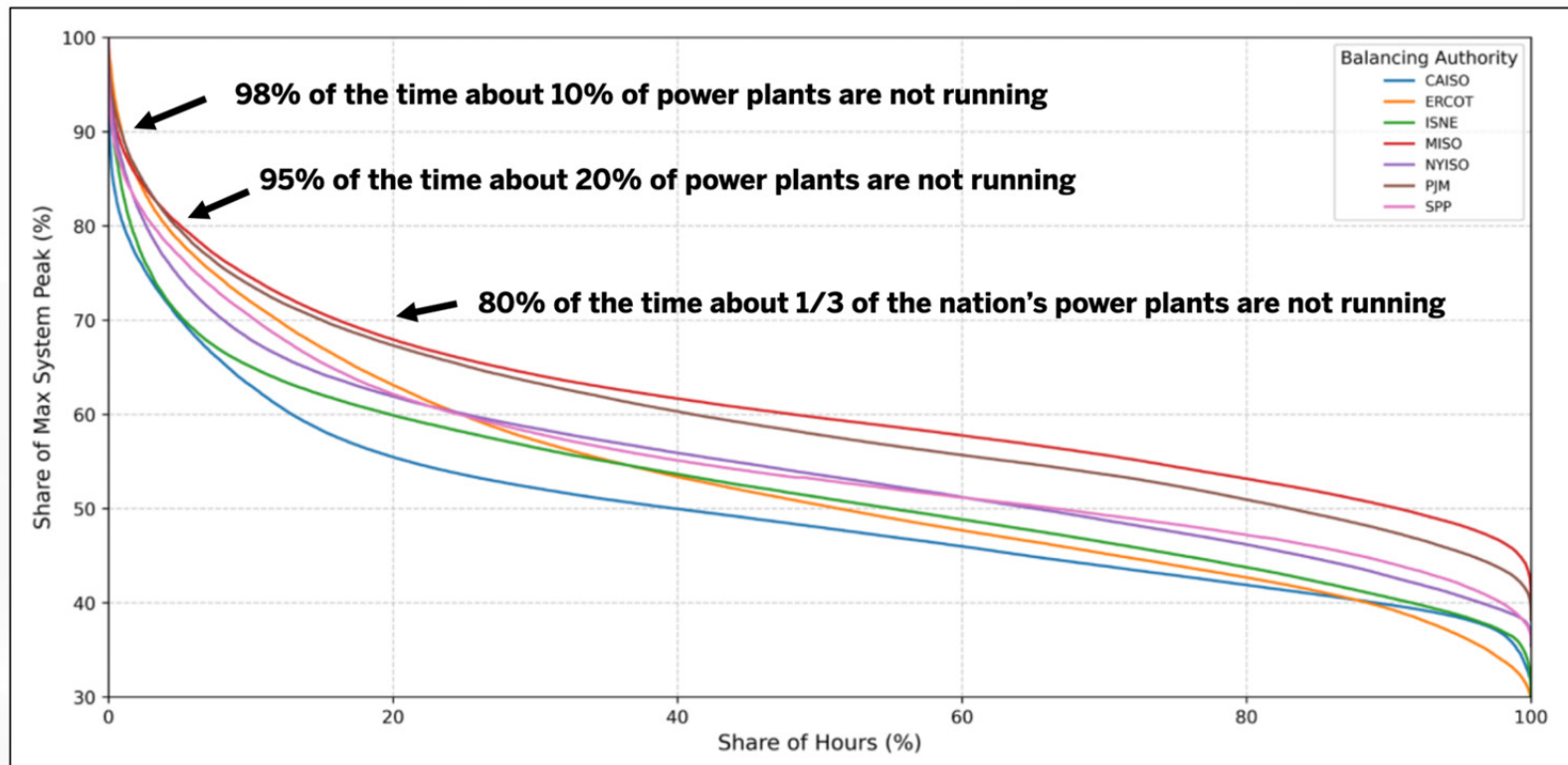
$$\text{Electricity rate (\$/kWh)} = \frac{\text{Revenue requirement (\$)*}}{\text{Sales (kWh)}}$$

*Some of the revenue requirement is recovered through fixed charges



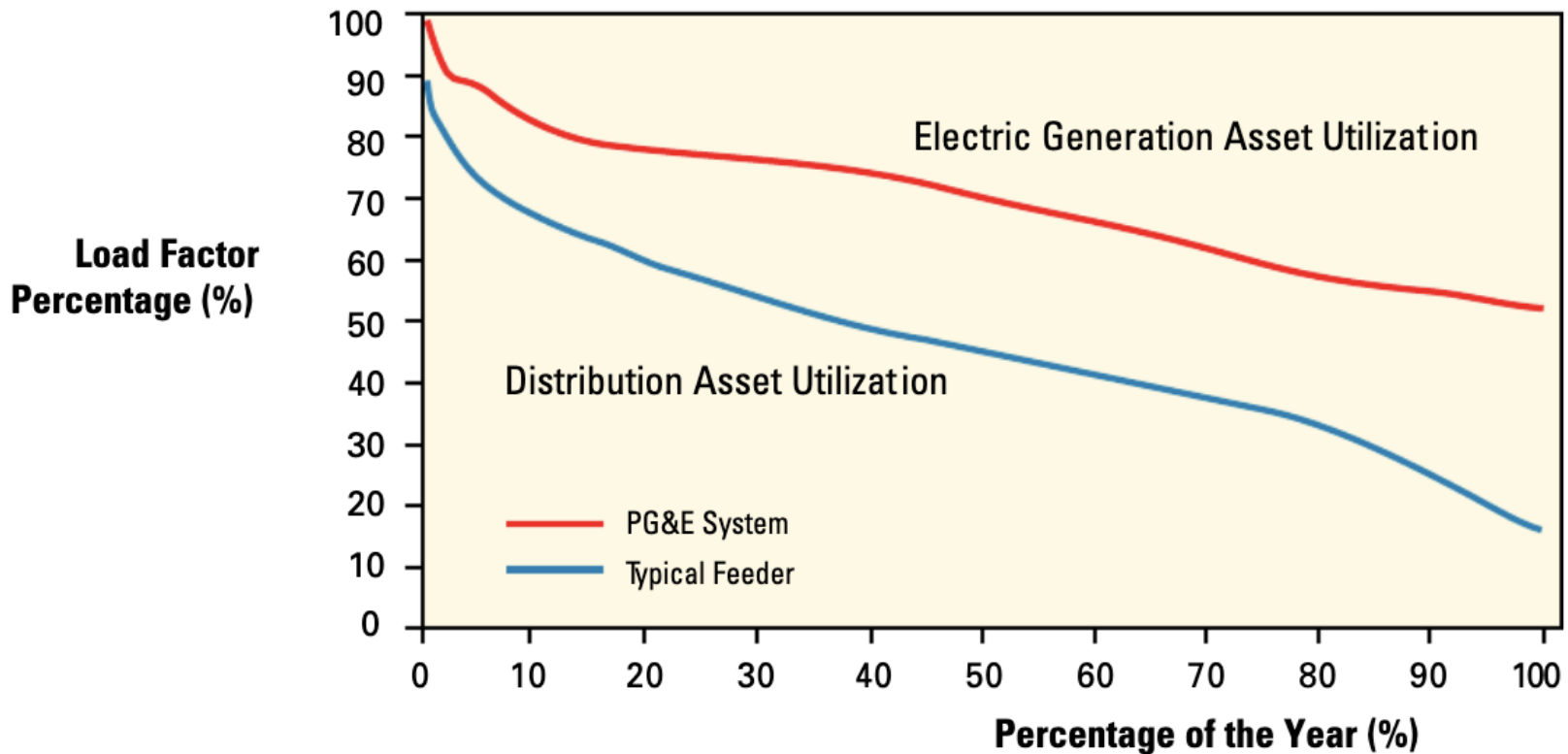
Serving electricity demand on peak costs more

A substantial share of bulk power system infrastructure operates only a small portion of the time. These hours contribute significantly to utility revenue requirements, but comprise a small share of electricity sales.



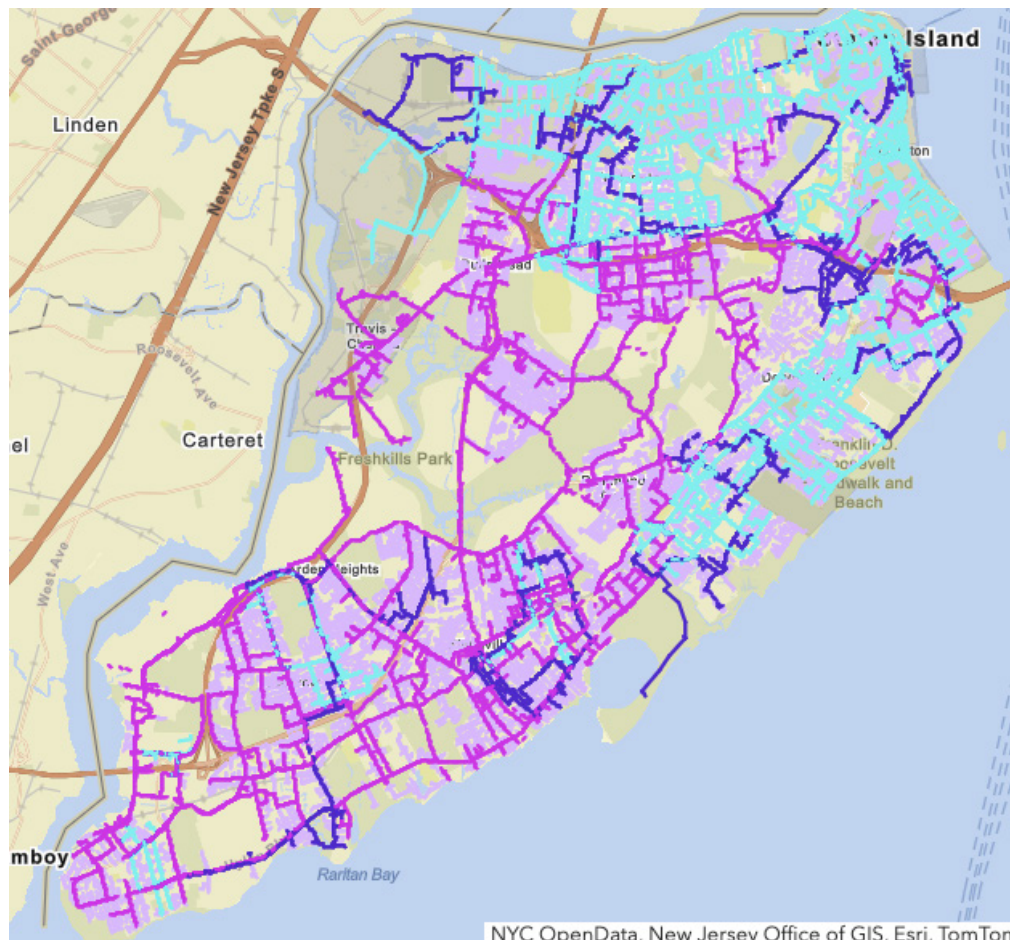
Source: [Constellation Energy](#), adapted from [Norris et al.](#)

Much available distribution system capacity also is not frequently used



Source: [Swisher](#)

There is substantial locational variation in grid capacity to absorb new load



460v Transformers - Summer Capacity

- >1000 kVA
- 500 kVA to 1000 kVA
- 200 kVA to 499 kVA
- < 200 kVA

208v Transformers - Summer Capacity

- > 1000 kVA
- 500 kVA to 1000 kVA
- 200 kVA to 499 kVA
- < 200 kVA

Summer Load Capacity for 3PH Feeders

Summer Load Capacity

- > 1.5 MW Capacity Remaining
- .6 MW to 1.5 MW Capacity Remaining
- < .6 MW Capacity Remaining

No Load Capacity for 1PH and 2PH Feeders



Source: [Con Edison](#)

Opportunity: Manage new loads to reduce need for new generation, transmission, and distribution assets

By managing new (and existing) load such that consumption occurs at times and places where the electricity system has available capacity, load management can contain electricity rate growth or even reverse it



Related terms to know

- *Demand response*: Change in the rate of electricity consumption in response to price signals or specific requests of a utility.
- *Demand flexibility*: Capability provided by DERs to reduce, shed, shift, modulate or generate electricity; energy flexibility and load flexibility are often used interchangeably with demand flexibility.
- *Demand-side management*: The modification of energy demand by customers through strategies such as energy efficiency, demand response, distributed generation, energy storage, managed electric vehicle charging, and time-varying pricing structures.
- *Virtual power plant*: An aggregation of DERs that can balance electricity demand and supply and provide utility-scale and utility-grade grid services like traditional power plants.

Sources: [National Roadmap for Grid-Interactive Efficient Buildings](#); [Pathways to Commercial Liftoff for Virtual Power Plants](#)



Key flexibility technologies

- Advanced metering infrastructure that records hourly (or sub-hourly) consumption
- Loads that can be shifted in time
 - Buildings: space heating, water heating
 - Many industrial loads
 - Data centers
- Communications devices that can facilitate or automate shifting (e.g., smart thermostats and appliances, building automation systems)
- Battery storage
- Thermal storage
- Electric vehicle charging management



Programs, pricing and procurements to manage load

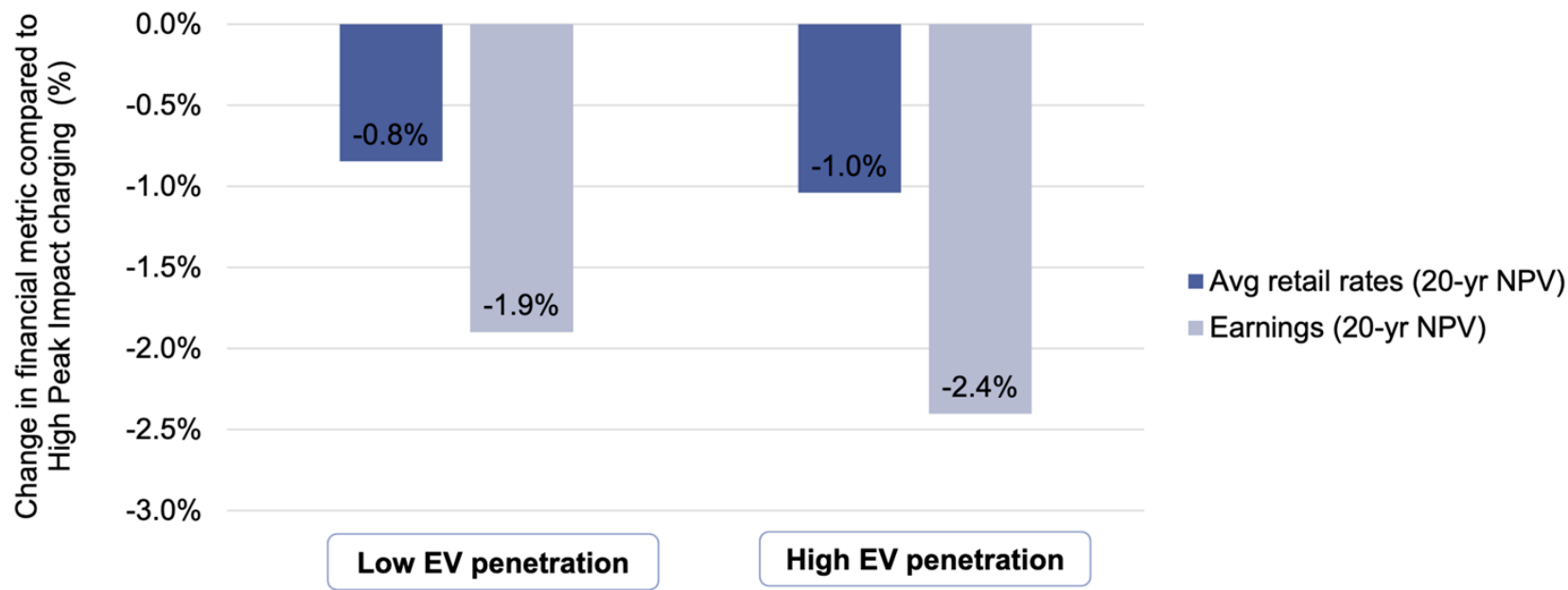
- Utility or grid operator *programs* that pay customers:*
 - For the right to directly control their loads
 - Often known as *direct load control programs* or *interruptible rates*
 - If they reduce load during events
- Changes to electricity *prices* to encourage load shifting
 - *Static* (fixed) time-of-use prices
 - *Dynamic* (variable) pricing, including critical peak pricing, variable peak pricing, and real-time pricing
- *Procurement* strategies that leverage non-wires alternatives
- Capacity and energy *markets* that allow demand reductions to bid as resources (sometimes known as *demand bidding*)

* In some cases, utilities or grid operators make payments to third-party *aggregators*, who then interface with individual customers to manage load



Example of the rate impacts of load management: Berkeley Lab study on electric vehicles

- [Satchwell et al.](#) studied the electricity rate impacts (dark blue bars) of *managed* vs *unmanaged* electric vehicle charging
- Managed EV charging that has lower impact on peak electricity consumption reduces average retail rates by ~1% by lowering required incremental costs for generation and distribution system investments



Estimates of cost-saving potential of load management

- [Brattle \(2019\)](#): Estimated \$16.4 billion in utility cost savings from load management in 2030
- [Rocky Mountain Institute \(2013\)](#): Estimated \$13 billion in utility cost savings from residential demand flexibility



Reflection



Group Discussion [10 minutes]

Questions

- What is one takeaway from the work presented today that you think is the most important for your work?
- What is one bill assistance strategy and one DER strategy that you are interested in seeing deployed or scaled up in your state or organization — and why?



Questions



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