MASSACHUSETTS
DEPARTMENT OF ENERGY RESOURCES

Alternative Rate Design

Expert Presentation Series | June 9, 2025

This expert level presentation series session will provide the Massachusetts Electric Rate Task Force an opportunity to learn from experts and/or other jurisdictions on the above topic.

Note: The contents of this presentation do not necessarily reflect the views or positions of the Massachusetts Department of Energy Resources.

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Massachusetts Electric Rate Task Force Goals

The Rate Task Force brings together diverse stakeholders to reimagine how electric rates and the regulatory framework can drive an affordable, equitable, and decarbonized energy future.

Through targeted conversations, expert presentations, and thoughtful exploration of complex issues, the Task Force aims to deepen understanding, surface critical questions, clarify challenges, and build the foundation for durable regulatory reform and action.

The Rate Task Force will use the Massachusetts Interagency Rates Working Group's Long-Term Ratemaking Study and Recommendations as a starting point for discussion and knowledge building on rate designs, ratemaking, and regulatory mechanisms.

Build technical knowledge

Provide an opportunity for **knowledge-building** by and amongst stakeholders, including those who have not traditionally been involved

Develop shared understanding

Converge towards **shared understandings** of the challenges and priorities

Today's Focus

Facilitate open, inclusive dialogue

Engage in **open, inclusive dialogue** about complex ratemaking and regulatory issues outside of a regulatory proceeding

Frame critical questions and opportunities

Empower stakeholders to identify **critical questions and opportunities** for the advancement of rate design and ratemaking reform

Ground Rules & Engagement

This work is complex – and your insight matters; let's focus on learning, listening, and shaping together!

Participation, Engagement, & Respect

- Everyone's perspective is valuable – this space works best when all voices are heard
- Respect differences in background, experience, and priorities
- Bring curiosity – ask questions and offer potential answers
- Focus on understanding others' goals and values, not just their positions
- <u>It's okay not to have a solution – help us shape the right questions</u>

Collaboration, Not Consensus

- This body is deliberative, it is not a decision-making space
- <u>We don't need to agree on everything, but we should work toward shared understanding</u>
- Where we disagree, help clarify what the tension is and why it matters

Transparency & Trust

- We'll be clear about how input is used
- Share what you can; identify when you're speaking on behalf of your organization or personally
- Materials, summaries, and key findings will be shared openly to support accountability

Focus & Productivity

- <u>Stay on topic and honor the scope of the Task Force</u>
- Raise related concerns, but help us stay anchored in the rate design and regulatory issues at hand
- Use the structures provided (i.e., expert sessions, targeted conversations, office hours) to deepen discussion
- Avoid discussion about open and ongoing proceedings at the DPU

IRWG Recommendations

Enable load management and peak demand reductions

- Consider an opt-in critical peak pricing as a supplement to a default time-of-use rate
- The focus of the analysis was on residential rate design, but the IRWG noted that rate designs and programs for commercial and industrial (C&I) customers were critical
- Consider further advanced rate designs following deployment of AMI and default seasonal TOU rates
    - Examples included: demand charges, export tariffs, non-firm or limited import tariffs, day-ahead tariffs, real-time pricing

Reduce the disincentive to adopt heat pumps and electric vehicles

- Expand non-ratepayer funding (i.e., fund certain programs outside of electric rates)
    - Costs of many decarbonization and affordability polices are recovered from electric ratepayers through volumetric charges
- Consider funding certain programs through a fixed charge or through a combination of fixed and variable charges
    - Consider a non-bypassable monthly charge for certain public benefits programs

Expert Presentations

I. Policy Fixed Charge: 1:30-2:00pm

Department of Energy Resources, Mike Giovanniello

Present on IRWG's recommendation to consider nonbypassable fixed charge for policy costs

II. Overview of Long-Term Advance Rate Designs: 2:00-2:30pm

Current Energy Group, Ron Nelson

Present a high-level overview of advanced rate designs, including critical peak pricing, export tariffs, non-firm tariffs, real-time pricing, and day-ahead tariffs

III. Residential Demand Charges: 2:30-3:00pm

Electric Distribution Companies

Present on the use and the implications of demand charges for residential customers

II. Key Concepts and Options of Advanced Rate Design: 2:00-2:30pm

Regulatory Assistance Project, Mark LeBel

Present an overview of key background and theory of advanced rate design and associated concepts and options

Reminder

Expert presentation sessions are not for substantive deliberation amongst participants. Questions for each speaker will be taken as time allows.

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Policy Fixed Charge

Massachusetts Electric Rate Task Force

June 9, 2025

This presentation explores the Massachusetts Interagency Rates Working Group’s recommendation to further consider a non-bypassable public benefits fixed charge.

Note: The contents of this presentation do not necessarily reflect the views or positions of the Massachusetts Department of Energy Resources.

Presented by

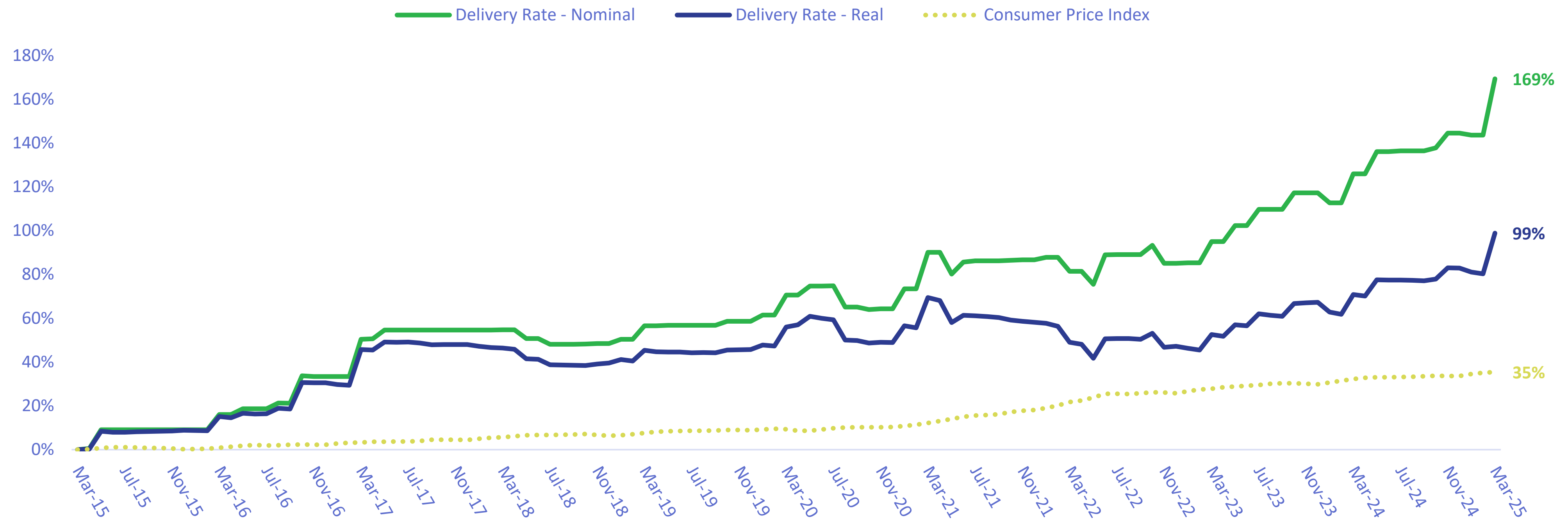
Mike Giovanniello
Energy Data Analyst

Electricity rates have outpaced inflation; increasing faster than general consumer prices over the past ten years

Consumers are experiencing a strengthening price signal for conservation or self-generation

Residential Electric Delivery Rate and Inflation

% Change, Relative to March 2015



Source: National Grid Delivery Rates

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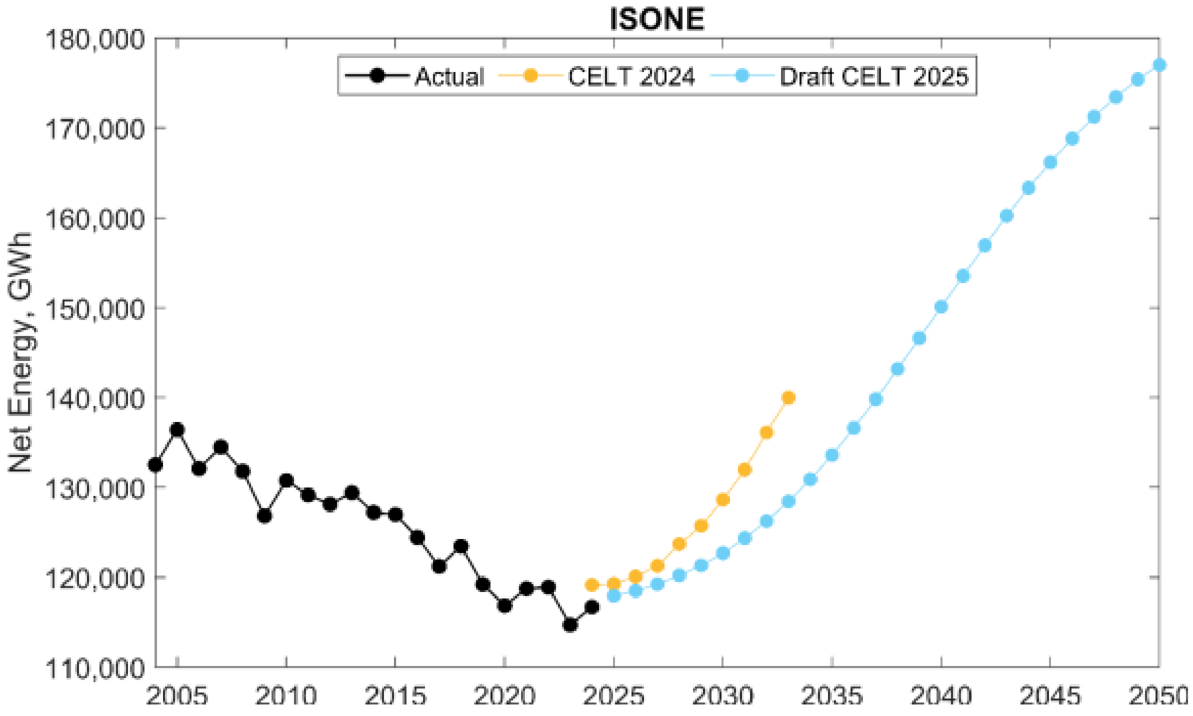
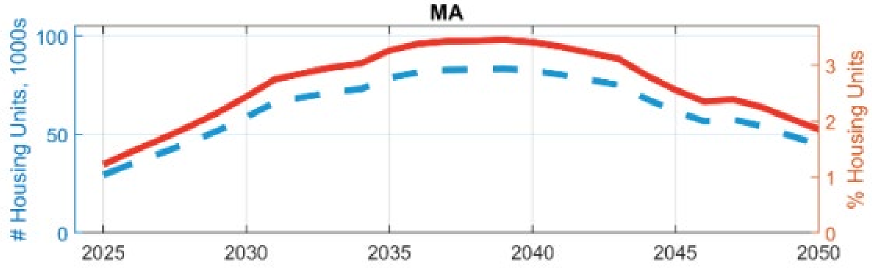
High electric rates are stifling electrification

ISO-NE's most recent load forecast scales back EV and heat pump deployment expectations

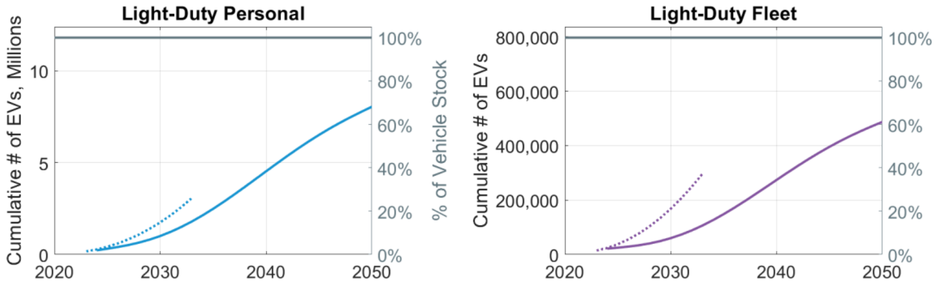
Total Load Forecast, New England



Incremental Heat Pump Adoption, Massachusetts



Electric Vehicle Adoption, New England

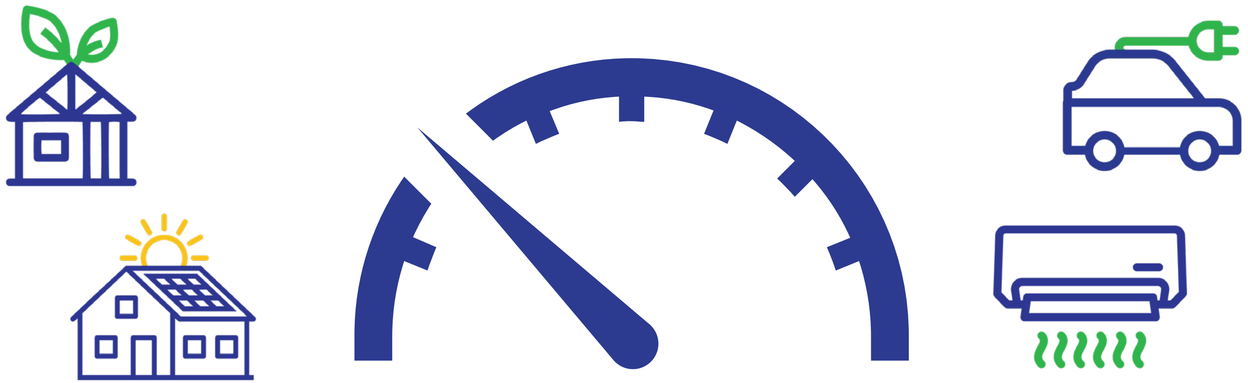


Source: ISO-NE Update on the CELT 2025 Forecast (March 19, 2025)

Rate design implications

Rate design impacts the attractiveness of various technologies and rate design choices have implications for the pace and scale of decarbonization strategies

- Massachusetts currently has relatively high electric rates and nation-leading success in deploying energy efficiency and behind-the-meter solar
- Massachusetts needs to accelerate its adoption and deployment of electric vehicles, heat pumps, and other electric end-uses

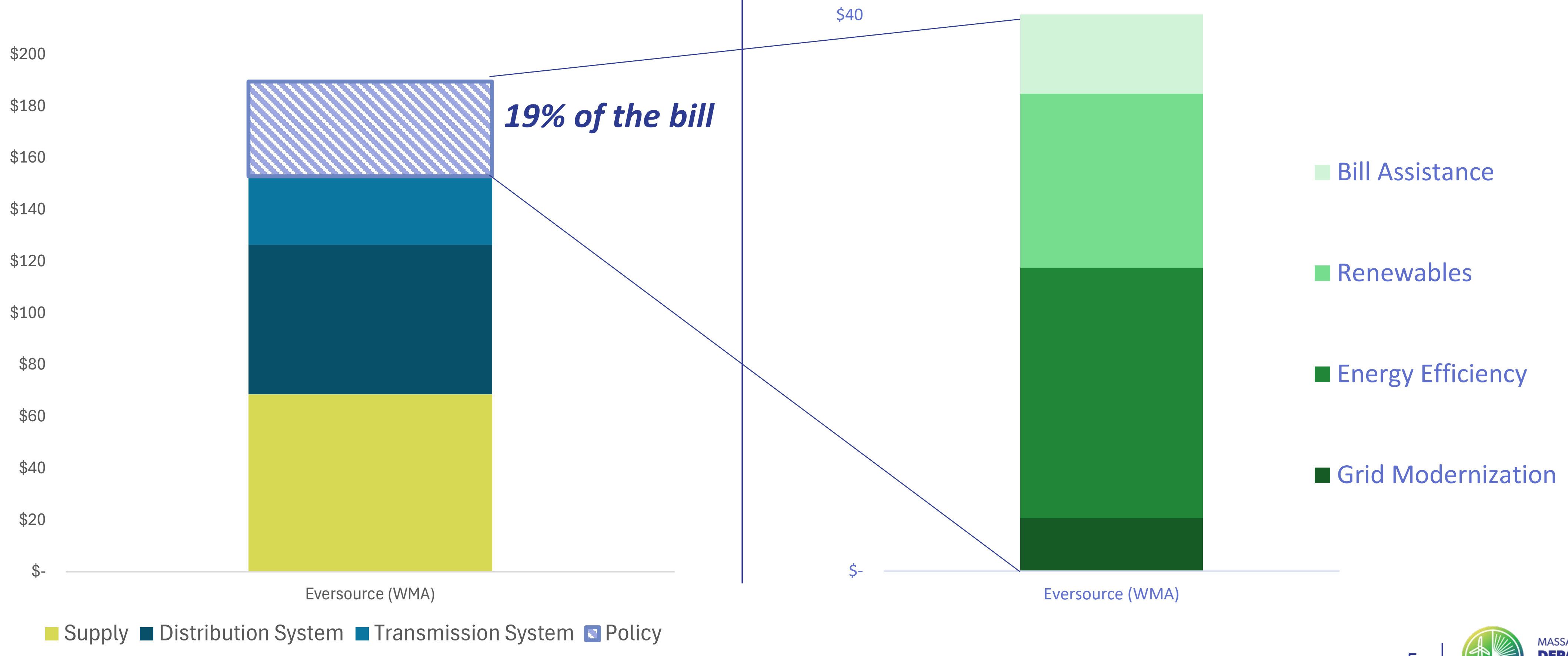


High Electric Rates	Low Electric Rates
May increase conservation or energy efficiency solutions	May reduce incentive to conserve
Makes solar more attractive since it reduces the amount of energy a customer purchases	Makes electrified end-uses (e.g., electric vehicles, heat pumps) attractive choices to consumers

Electric bills include costs of essential climate and affordability policies

Monthly Bill for Eversource West Customers

Breakdown of Policy Costs on Monthly Bill



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How do we design rates?

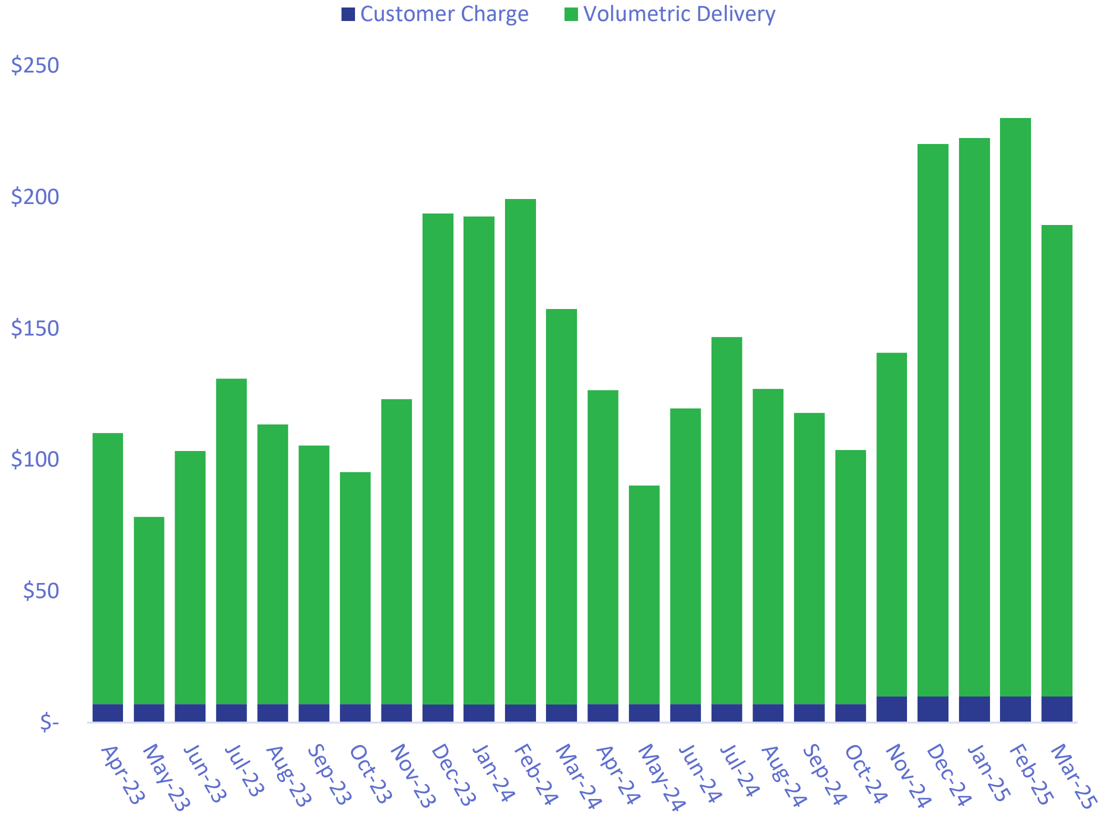
How are we paying for it?

Rate design is an exercise in deciding how we recover the costs associated with supplying and delivering electricity, traditionally through a combination of **volumetric** and **fixed** charges

- **Volumetric charges** scale with how much electricity a customer uses. For example, a customer who consumes 300 kWh will pay half as much in volumetric charges as a customer who consumes 600 kWh
- **Fixed charges** are paid by customers regardless of how much they consumer. For example, the 300kWh and 600 kWh customers will pay the same fixed charge

Most costs are charged volumetrically for residential customers

Illustrative All-Electric Residential Electric Bill (delivery-only)
$/month



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Policy Fixed Charge

Options for reducing volumetric policy charges

Downsides of recovering policy costs through volumetric charges

- **Not cost reflective** – many of the costs recovered through volumetric rates exist regardless of a consumer's volumetric consumption
- **Arbitrary, inequitable, and counter to electrification**
  - Policy costs represent **~$40 on the average customer bill** and are recovered entirely through volumetric charges, increasing inter-seasonal bill volatility
  - Customers who electrify or don't have access to efficient technologies pay more than others
  - Discourages safe or healthy levels of electricity consumption for vulnerable customers
  - Enables customers with solar and energy efficiency to avoid contributing to essential climate and affordability policies

Solutions explored by the IRWG

- **Best solution:** Recover certain policy costs through more "progressive" alternatives to ratepayer funding (e.g., federal or state funds), to address affordability, equity, and cost causation concerns.
- **Second best:** Fund certain programs through a fixed charge or through a combination of fixed and variable charges, to better align rates with cost causation and reduce disincentive to electrify. Pairing fixed charges with a tiered discount rate approximates more progressive, income-based structures for recovering policy costs

Source: Near-Term Rate Strategy Recommendation and Long-Term Ratemaking Recommendation

Volumetric rates vs. fixed charges

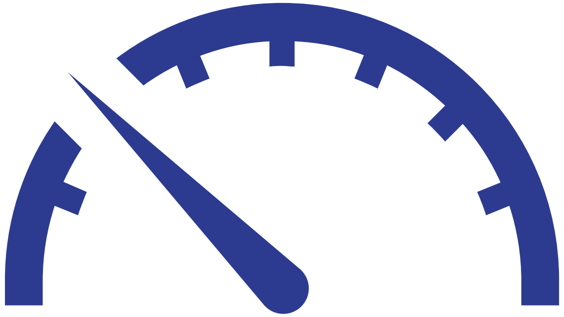
Arguments for volumetric rates

High volumetric rates send a stronger signal to conserve electricity

- "the cheapest kilowatt hour is the one you don't use"
- Promotes distributed generation (e.g., solar) and energy efficiency

Customers have more control over their bills

- Customers can avoid costs by consuming less, and their ability to do so is reduced when more of the bill is a fixed charge



Volumetric Fixed

Argument for *cost reflective* fixed charges

Promote electrification

- Heat pumps and electric vehicles are less competitive against fossil fuel alternatives when volumetric rates are high

Reduce bill volatility

- Under volumetric recovery, customers pay more for policy during high consumption months when their bills are already highest

Certain customers can avoid contributing to critical infrastructure/programs, despite enjoying the benefits

- Customers with solar and energy efficiency contribute less because their volumetric consumption is lower but still enjoy the benefits of the grid

Reduce barriers to using safe and healthy levels of electricity

- A growing body of literature reveals that low-income customers engage in unsafe and unhealthy "energy limiting behaviors" to minimize volumetric electricity bills

Approximate a "progressive" recovery structure when paired with tiered discounts

- Discounts apply to fixed charges. As a customer's discount rate increases, their contribution to policy costs decreases

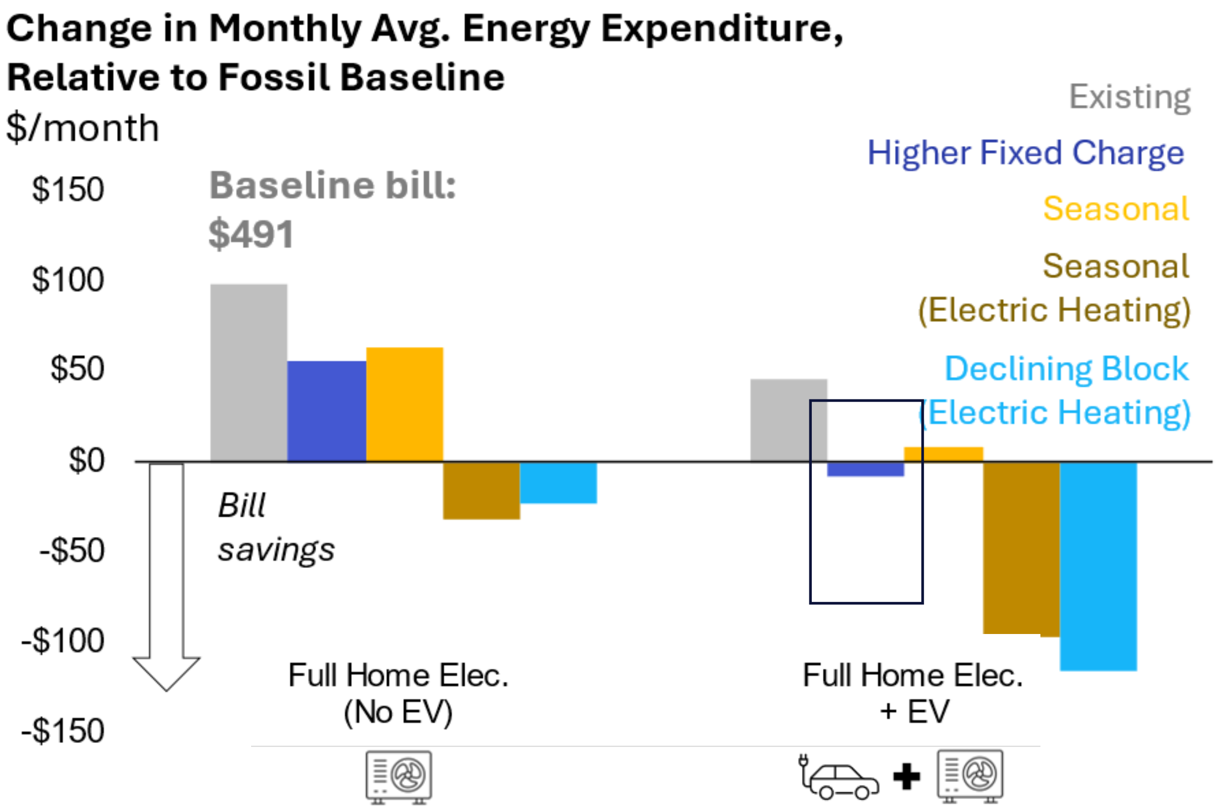
Illustrative fixed charges for energy efficiency

Residential	Eversource	National Grid	Unitil
Total Energy Efficiency Revenue Requirement	$196,489,951	$240,010,988	$5,696,725
Forecasted Kilowatt-hours (kWh)	6,865,600,740	8,649,044,623	170,121,790
Average Monthly Usage (kWh)	548	600	530
Current Volumetric Energy Efficiency Reconciliation Factor ($/kWh)	$0.02861	$0.02775	$0.03348
Fixed Charge Energy Efficiency Reconciliation Factor ($/month)	$15.68	$16.66	$17.75

Source: Eversource, D.P.U. 24-35 Exh. ES-ANB-1 (Revision 3); National Grid, Current Effective EERF, Forecasted kWh from D.P.U. 24-99, NG-Elec Exh. 3; Unitil, D.P.U. 24-47 Compliance Filing Exh. 2
Note: Eversource excludes an estimated 205,000 Cape Light Compact customers

Fixed charges allow reductions in volumetric rates

Higher fixed charges improve electrification affordability and cost-reflectiveness by shifting non-volumetric costs out of the volumetric rate



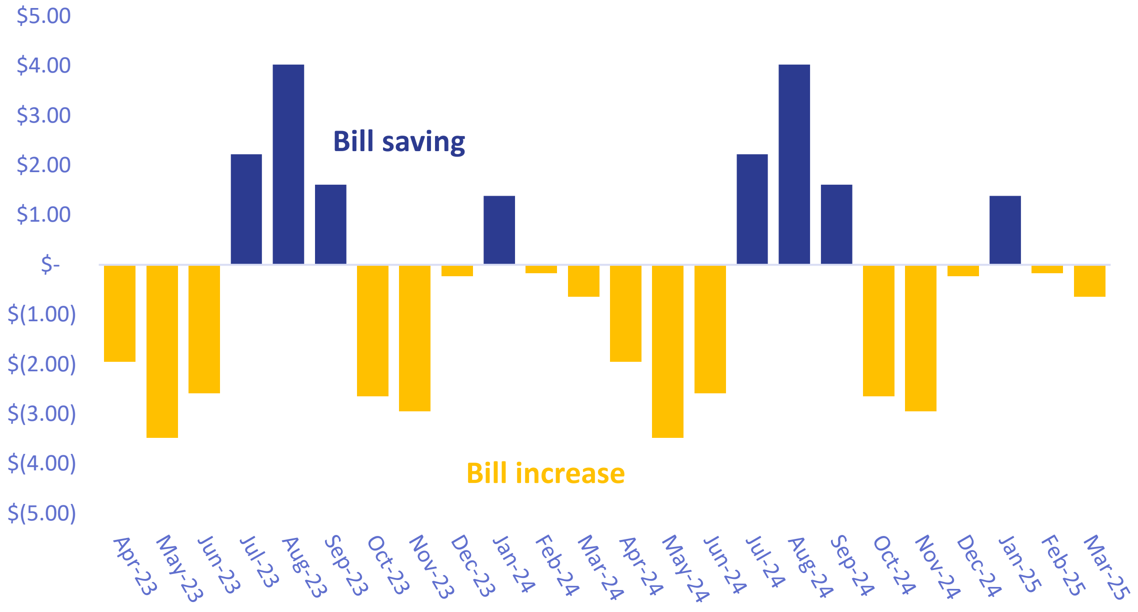
Source: Energy and Environmental Economics, Inc., Near-Term Rate Strategy Report, ES Figure 4

- The Near-Term Rates report found that a $30 fixed charge (+$20) was sufficient to make full home electrification competitive against fossil fuel technologies

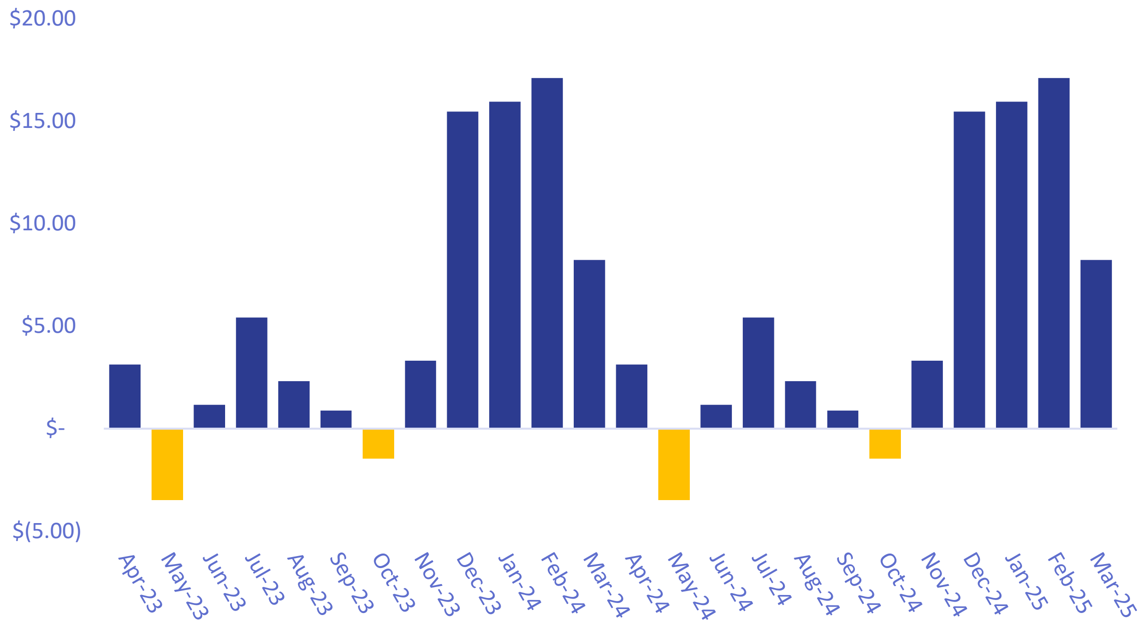
Fixed energy efficiency reconciliation factor charges would smooth customer bill impacts, providing greater bill stability

A fixed EERF charge dampens bill volatility by reducing the electric rate subject to consumption; customers will tend to pay less during high-usage months and pay more during low-usage months

Illustrative Customer Savings for Average Customer
$/month



Illustrative Bill Savings for All-Electric Residential Customer
$/month



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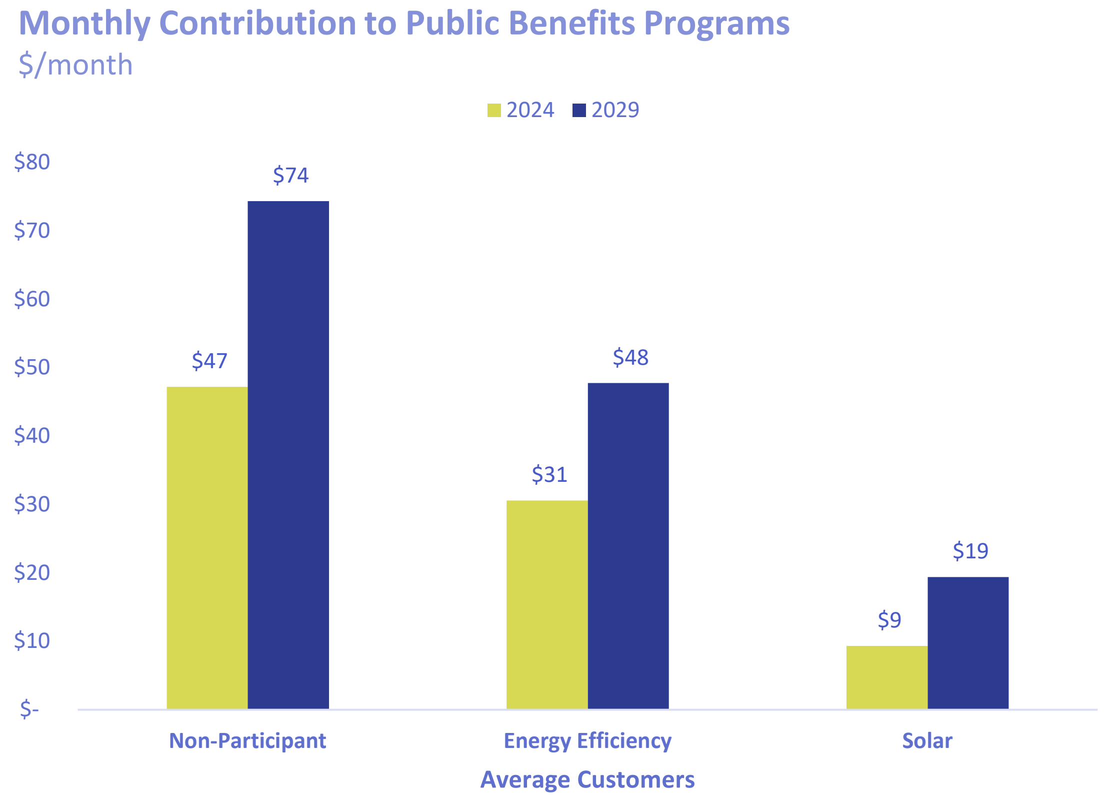
Fixed charges can ensure equitable contribution

A non-bypassable fixed charge makes sure that all customers, especially affluent customers with solar and/or energy efficiency, contribute to public benefits programs

- As the energy efficiency program and low-income discount rate expand to help more people, a shrinking share of consumers who don't/can't access EE and solar are left to foot the growing bill
    - Households with solar and high levels of EE do not contribute as much to these program costs
    - Households that electrify contribute more
- Fixed charge ensures that non-participating and electrified customers aren't disproportionately burdened by these costs
    - Impacts on low-income, low-consumption customers can be mitigated via anticipated reforms to the low-income discount rate



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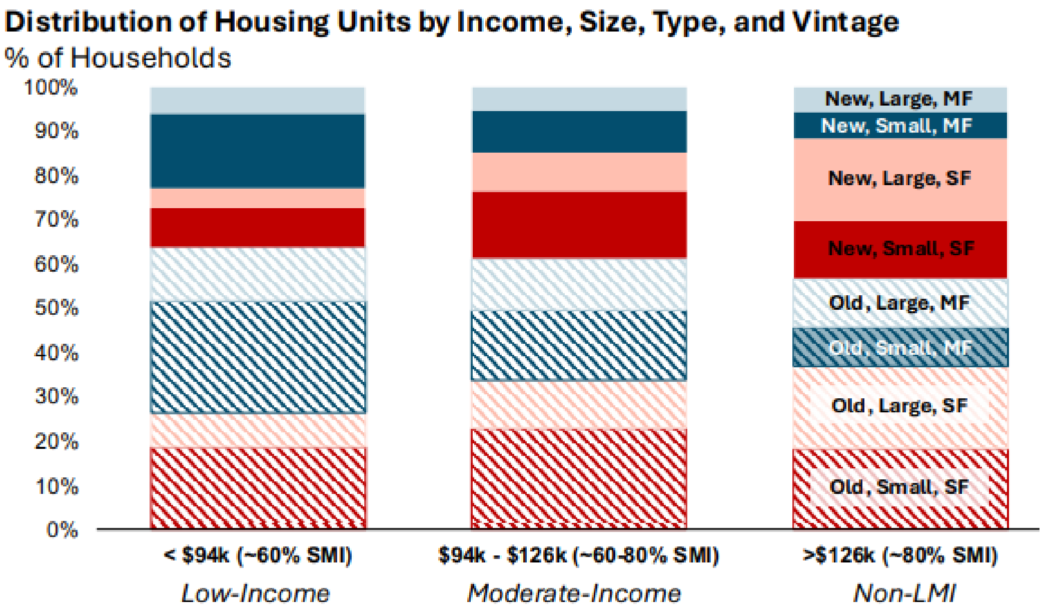
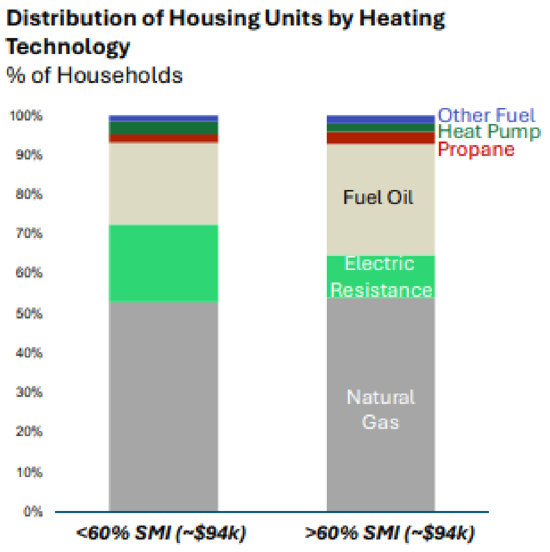
Differences in housing and temperature control technologies by income

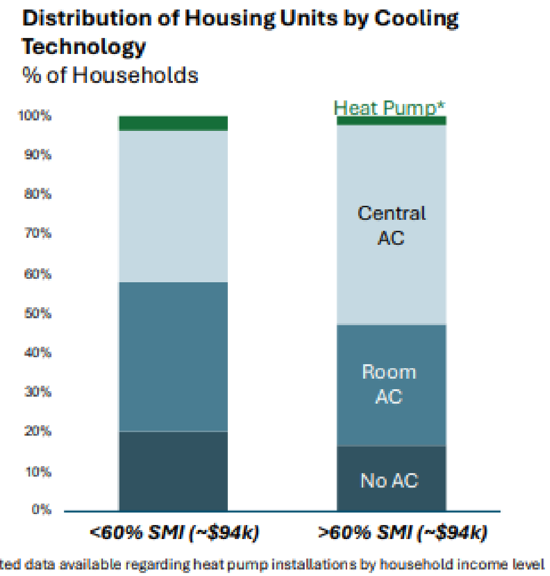
Housing



- Low-income customers have smaller, but older houses

Temperature Control





- Low-income customers have less efficient electric heating and cooling
- Greater share without cooling

Source: *Energy and Environmental Economics, Inc., Near-Term Rate Strategy Report, Figures 25 & 26*

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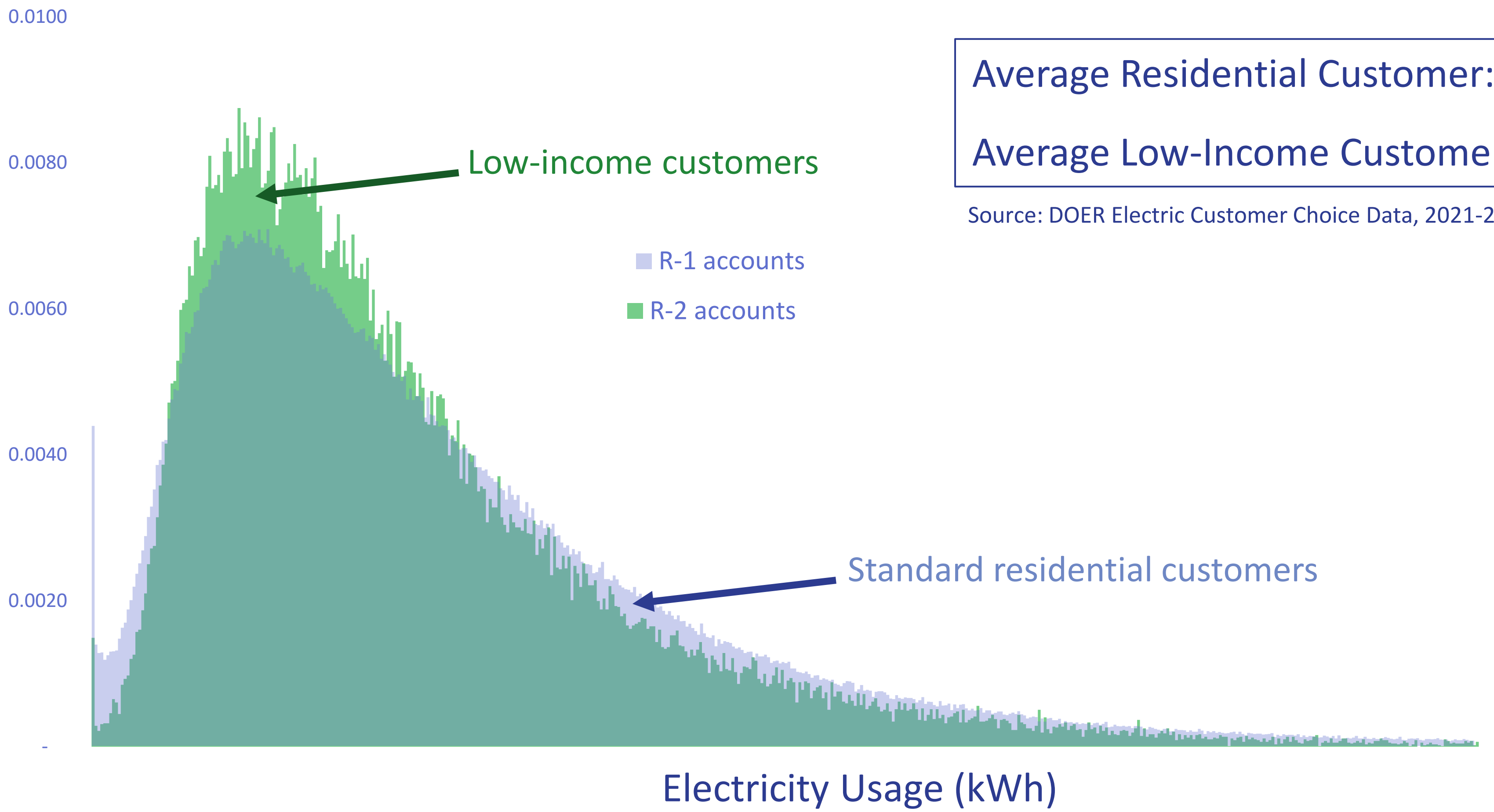
How much does consumption vary by income?

Frequency Distribution of Household Consumption for R1 and R2 Customers, Eversource East



Average Residential Customer: **556 kWh/month**
Average Low-Income Customer: **553kWh/month**

Source: DOER Electric Customer Choice Data, 2021-2024

Source: DPU 24-15 Attachment 2, EMA

How much does consumption vary by income?

Low-income customers use more electricity in the winter and less in the summer

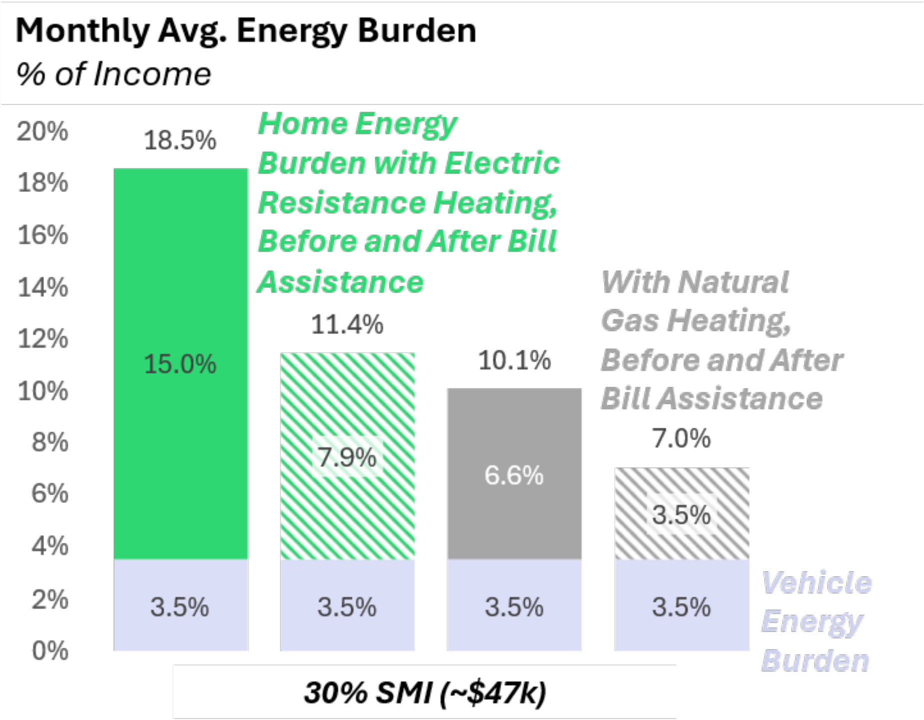
Average Monthly Electricity Consumption
kWh/month

- Low-income customers use more electricity in the winter, likely due to less efficient housing/heating
- Low-income use less electricity in the summer, likely due to limited cooling access and energy rationing behaviors

Source: Massachusetts Electric Customer Choice Data (2023)

High volumetric rates can harm vulnerable customers

High volumetric rates force vulnerable customers to forgo safe and healthy levels of electricity consumption



- Low-income customers wait longer to start cooling and heating their homes and restrict use as temperatures rise

- "After controlling for income and race… severely energy insecure households had"
  - 2.0x greater odds of lifetime asthma
  - 4.7x greater odds of pneumonia
  - 1.8x greater odds of depressive disorder
  - 1.6x greater odds for poor-quality sleep

Huang et al. (2023). *Inequalities across cooling and heating in households: Energy equity gaps*

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Thank You!

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High-Level Overview of Long-term Advance Rate Designs

Massachusetts Electric Rate

Ron Nelson, Partner
rnelson@currentenergy.group
With Jeff Zethmayr, Senior Consultant

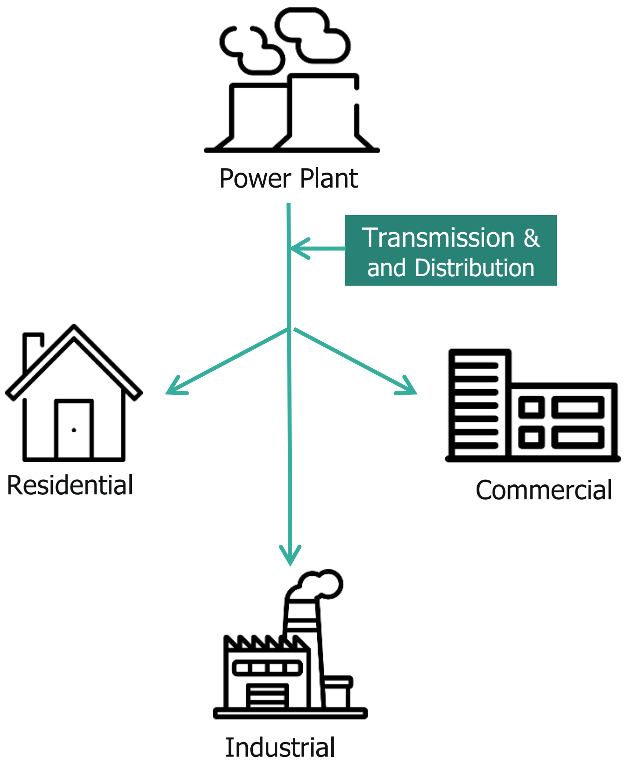
Overview

- Introduction and Background
- Critical Peak Pricing
- Export tariffs
    - Flexible connections
- Non-firm tariffs
- Real-time pricing
- Day-ahead tariffs (Dynamic Operating Envelopes)

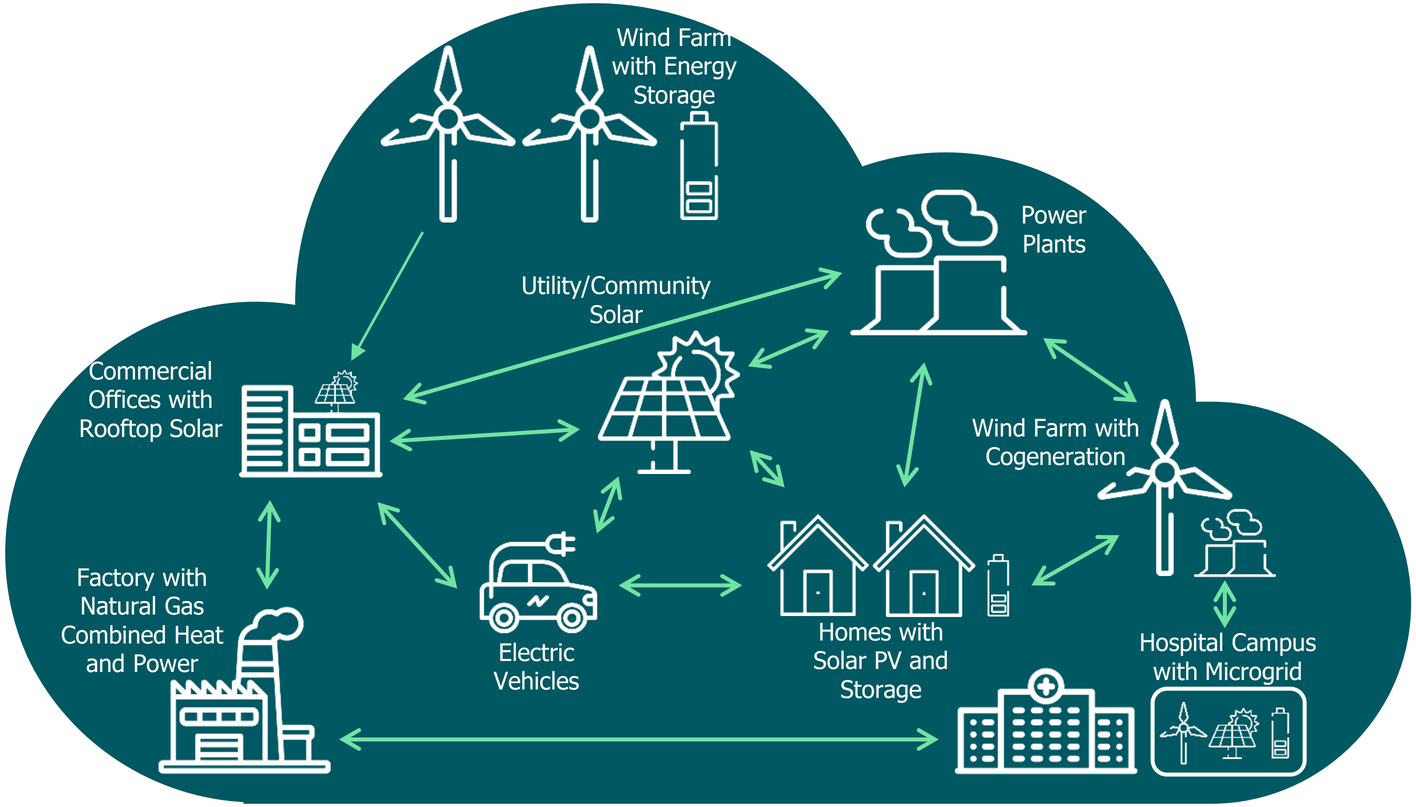
Introduction + Background

Ratemaking frameworks need to evolve to reflect a two-way electricity system

PAST: Traditional Power Grid
Central, One-Way Power System



TODAY: The Energy Transition
Distributed, Cleaner, Two-Way Power Flows

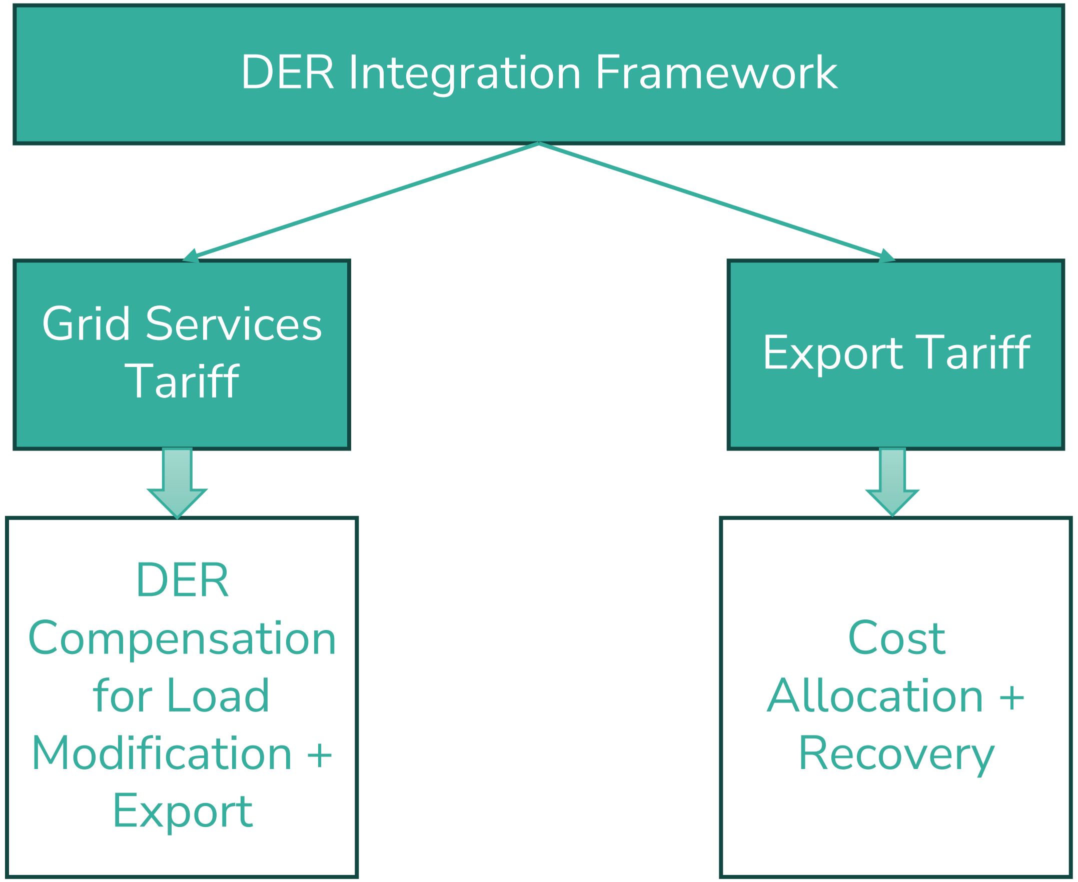


Goal of Advanced Rate Design

DER integration and bi-directional pricing

Two primary elements to DER integration within ratemaking structure:

1. **Compensation** for services provided to the grid
2. **Allocation and recovery of costs** for interconnection and use of the grid for export



Source:

Critical Peak Pricing

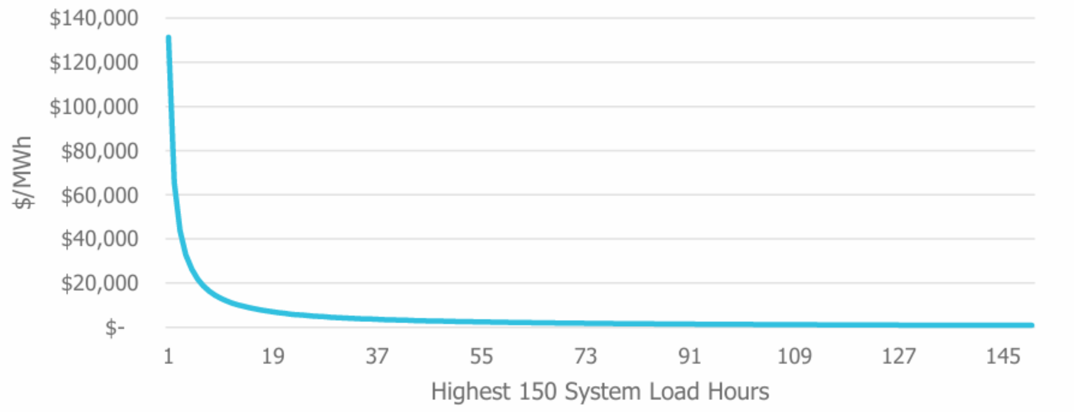
Capturing value of extreme peak events

- Peak demand events create marginal costs far in excess of average volumetric rates
- CPP allows utilities to initiate high-rate periods when forecast conditions suggest super peak events

Benefits

- Better assigns peak costs to customers who contribute to peak events
- Lowers on- and off-peak rates for all other hours
- Encourages conservation during peak load periods

Figure 1. Xcel's System Cost Duration Model from Forecasted 2025 Load Data[1]



Graphic reference: Petition of Northern States Power Company for Approval of General Time-of-Use Service Tariff, MPUC Docket E002/M-20-86

CPP Example

Xcel Energy TOU Proposal, including CPP

- A three-period TOU (peak, base, and off-peak periods)
- Up to 75 hours per year of CPP
  - With notification, utility can announce critical peak period, with significant increase in volumetric rate

	Applicable Period	Rate
On-Peak Period	3pm to 8pm on non-holiday weekdays	7.8 ₵/kWh
Off-Peak Period	12am to 6am every day	1.9 ₵/kWh
Base Period	All other hours	4.1 ₵/kWh
Critical Peak Pricing	Up to 75 hours per year	55.9 ₵/kWh

Export Tariff Framework

What is an Export Tariff?

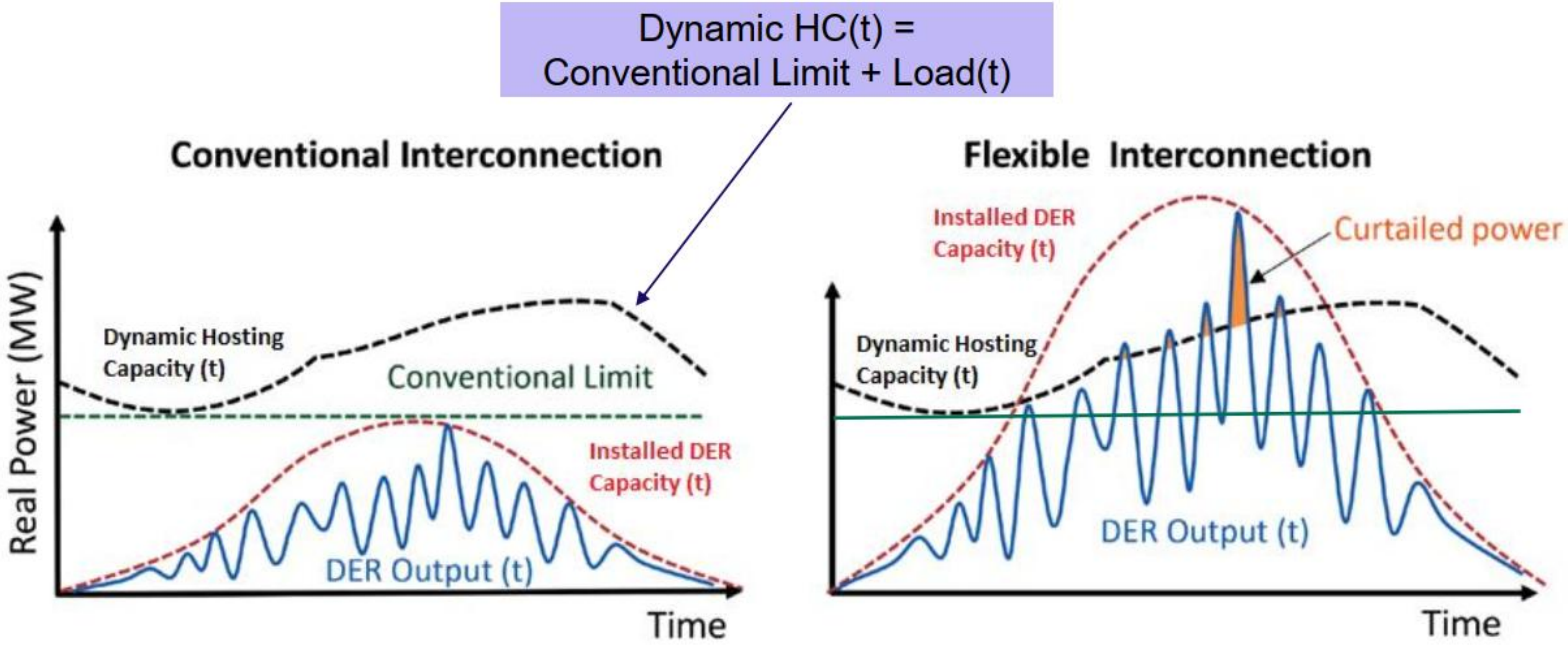
- An export tariff is a contractual agreement for DER operating on the distribution system that enables cost allocation and recovery for exported related impacts (e.g., capacity upgrades, new monitoring and control systems)
- Align DER cost allocation with traditional ratemaking principles and cost-of-service modeling
- Reflect a bidirectional ratemaking structure that services both import and export

Export Tariff Example

Conceptual Framework

	Applicable time	Consumption Charge	Export Reward/Charge
Peak import period	2pm - 8pm everyday	Peak charge 25.37 c/kWh	Reward equal to -25.37 c/kWh
Solar soak period	10am-2pm everyday	Off-peak charge 3.77 c/kWh	Off-peak charge 1.85 c/kWh
Off-peak	8pm to 10am everyday	Off-peak charge 3.77 c/kWh	
Fixed charge		Fixed charge 48.72 c/day	

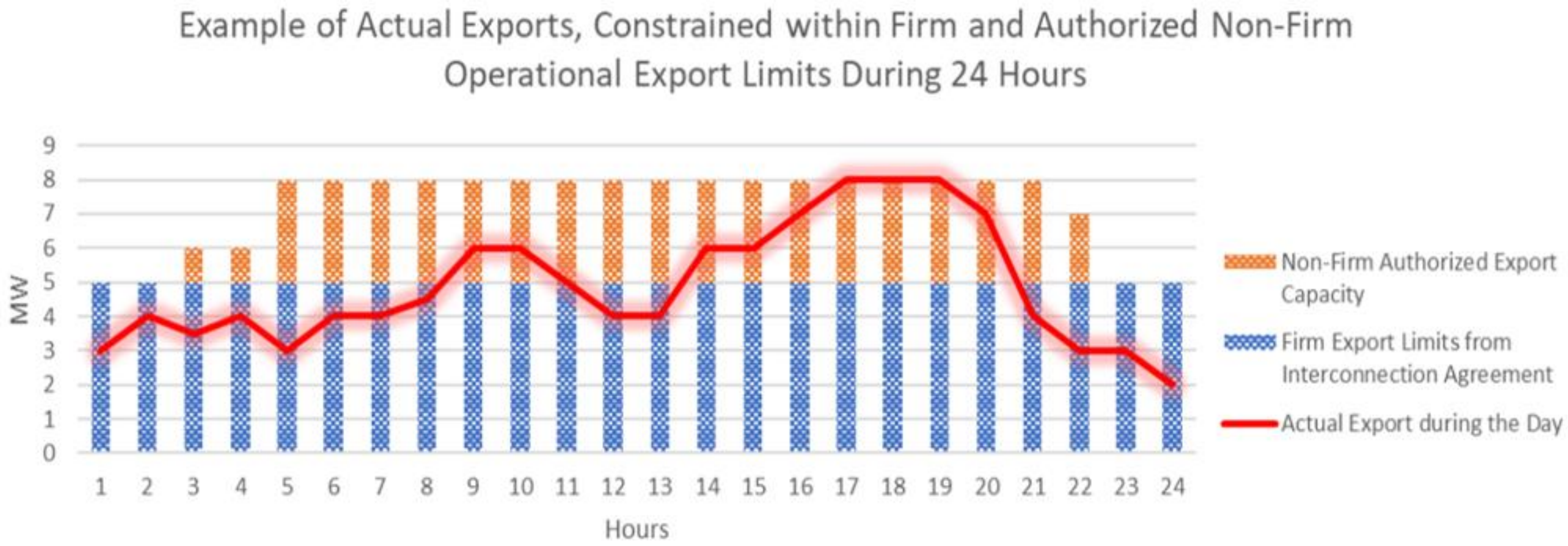
Flexible Interconnection



- Flexible connections can greatly increase the utilization of the distribution network for both load and export
- To scale flexible connections, more certainty around potential curtailment is needed as well as service options for customers outside of constrained areas

Graphic reference: EPRI Understanding Flexible Interconnections

Firm and Non-Firm Export Tariffs



- Export tariffs can create a paradigm with firm and non-firm rate options
- Using a rate option could embed non-firm capacity that goes beyond “a bridge to wires” because non-firm rates can be offered to all facilities, not just those in constrained areas

Graphic reference: EPRI Understanding Flexible Interconnections

Real-Time Pricing

Marginal Price-Based Supply Recovery

- Supply rates vary hour-by-hour based on day-ahead LMPs
- Next-day hourly prices published daily through utility dashboard

Benefits

- Gives customers greater control over bills
- Encourages conservation during peak load periods

ComEd Real-Time Hourly Pricing Dashboard

Graphic reference: Live Prices - ComEd's Hourly Pricing

Dynamic Operating Envelopes

Automating Dynamic Import/Export Limits

- Flexible Import/Export allows for higher DER utilization, but DSO control equipment is capital intensive investment
- Dynamic Operating Envelopes compute iterative safe system parameters, communicated to network through APIs to allow limit flexibility without expensive LSE command/control hardware

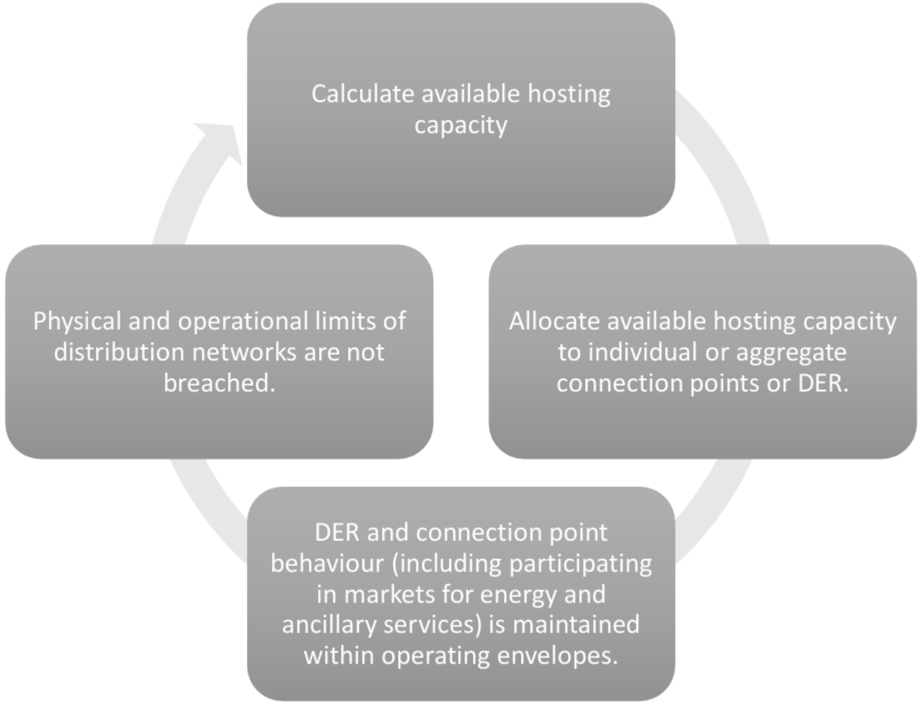


Figure 1. The lifecycle of an operating envelope in each time interval.

Graphic reference: [On the Calculation and Use of Dynamic Operating Envelopes]

DOE Example

SA Power Networks Advanced VPP Grid Integration Project

- Project developed API-based data framework to coordinate 1,000-customer South Australian VPP
- Implementing DOE allowed higher wholesale market participation, increased NPV across network by $1.7 mm

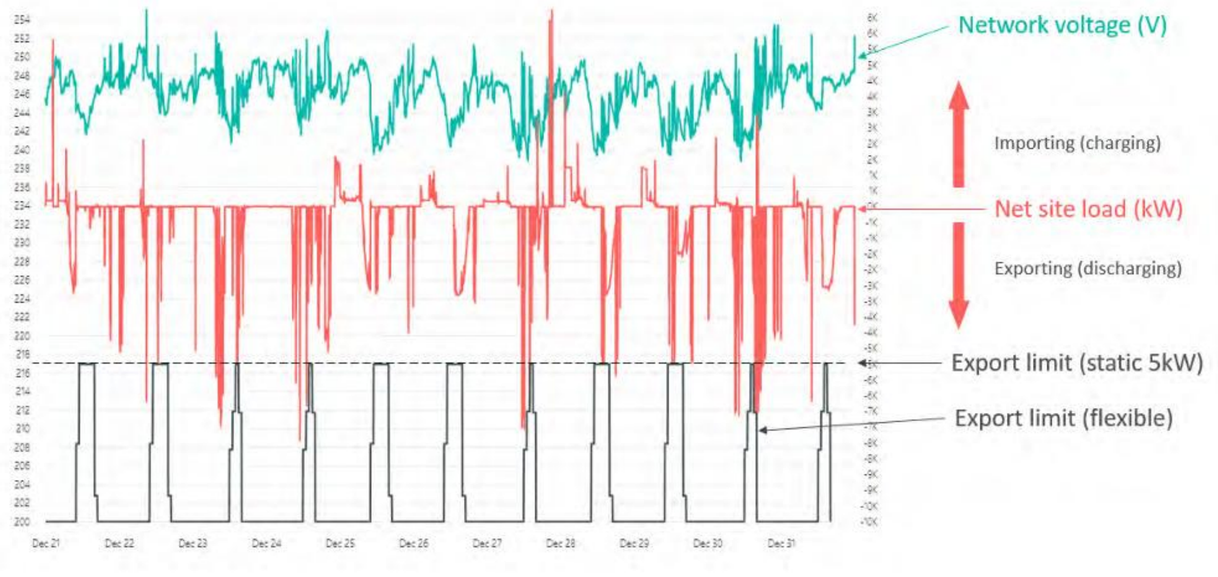


Figure 4-4: site conforming to provided export limits

Graphic reference: [Advanced VPP Grid Integration Final Report]

Closing Thoughts

- There are several types of advances rate designs
  - Each requires different utility investments
  - Each has different pros and cons
- Iterative, transparent processes are needed to chart the path forward for long-term rate design planning

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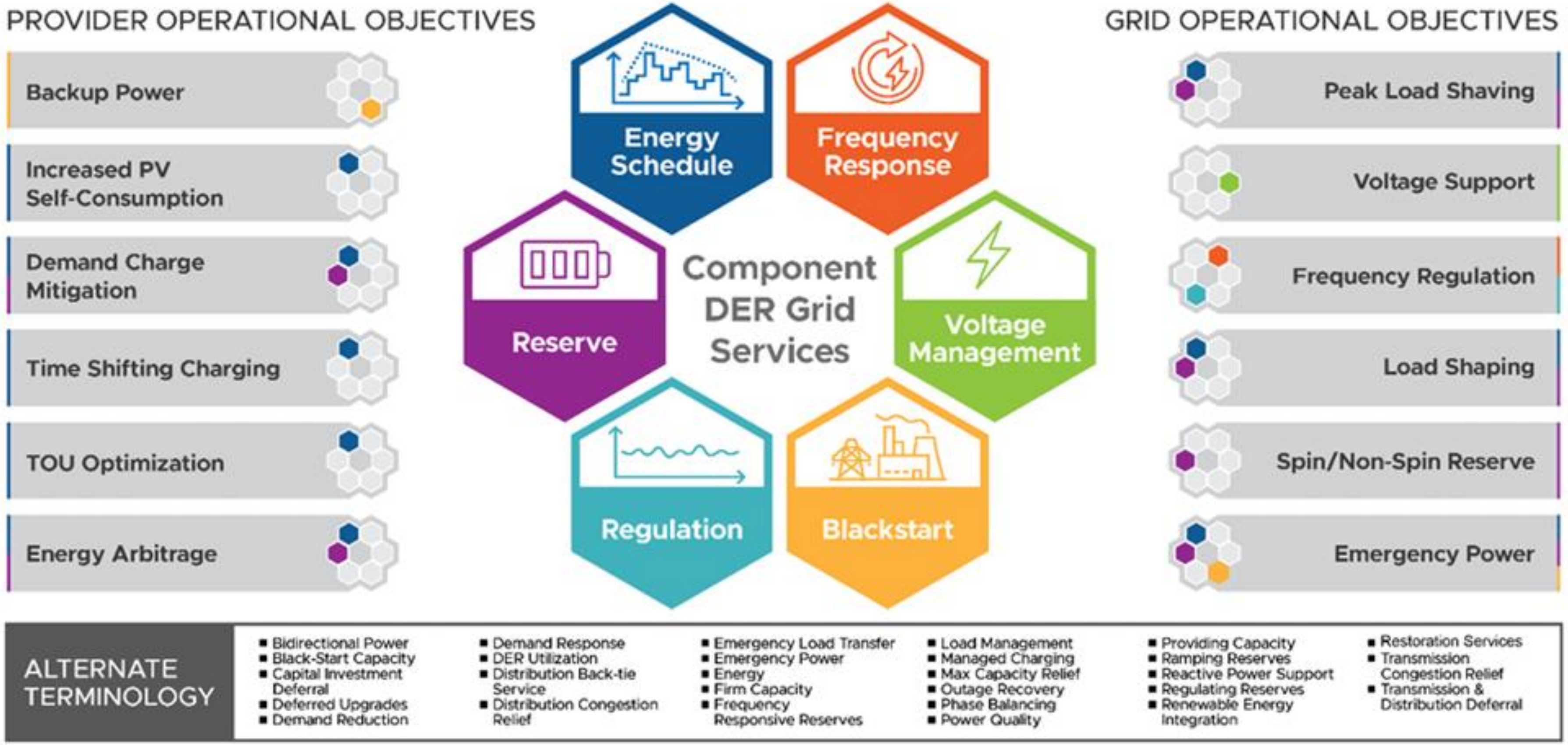
Shaping the Path Forward

Thank you

Standard Grid Service Definitions

Common terms and definitions of grid services support standardization at grid edge



Source: PNNL (2023). "Common Grid Services Terms and Definitions Report."

EVERSOURCE nationalgrid Unitil

Alternative Rate Designs

Residential Demand Charges

Massachusetts Electric Rate Task Force

June 9, 2025

Agenda

- Background on distribution rates and demand charges
- Illustrative three-part rate and design considerations
- Example residential demand charges and customer outreach
- Closer look at demand and energy
- C&I demand rates today
- Implications of electrification for residential load profiles
- Example demand charge and sample customer
- Considerations relevant to rate design changes

Background on distribution rates

- **EDC distribution rates are intended to recover the revenue requirement in a manner that:**
  - fully and predictably compensates the utility for the investments and services it provides;
  - allocates embedded costs fairly across customers based on their usage of the distribution system, while limiting the potential for rate/bill shock; and
  - sends signals to encourage efficient use of the system.
- **Using the following principles:**
  - Effectiveness at yielding the total revenue requirement
  - Revenue and cash flow stability from year to year
  - Stability of rates themselves
  - Fairness in apportioning cost of service among different consumers
  - Avoidance of "undue discrimination"
  - Promotion of efficient use of energy by the customer (e.g., such that utility's infrastructure and resources are not strained)
- **And with attention to the following attributes:**
  - Cost-reflectiveness
  - Transparency
  - Simplicity
  - Understandability
  - Feasibility of application and interpretation

What is demand and why consider demand charges?

- **Demand essentially measures electricity consumption at a specified moment rather than the total amount of electricity consumed during a billing period.**
  - Distribution costs (costs of building, running and maintaining the entire grid and serving customers) are primarily driven by demand and capacity
  - Distribution systems are sized to serve system and local demands
  - Local area usage patterns and peaks are likely to be different from the system in aggregate and also drive investments.
  - Rates would ideally send signals to support management of both coincident peak (demand at the time of the system peak) and individual customer maximum demands

- **Cost-reflective rate design allows for a fair allocation of existing costs and creates efficient price signals to minimize future costs over the energy transition.**
  - Demand charges provide a rate design option that better align with customer contributions to system costs than current per kWh delivery rates, and in doing so reduces a potential disincentive to electrification.
  - Under current per kWh rate design – customers who have relatively low demands are likely paying more than their share of distribution costs while customers with high demands are likely paying less than their share of distribution costs, even if they use the same kWh.
  - Distribution system costs reflected in the revenue requirement are already incurred/approved and thus not avoidable – but appropriate rate designs can help to limit growth in system costs by encouraging efficient use of the system.
  - A demand charge would be a partial or full substitute for a volumetric delivery rate. Addition of a demand charge would mean a reduction in or elimination of, a volumetric delivery charge.

What might more cost-reflective rate design look like?

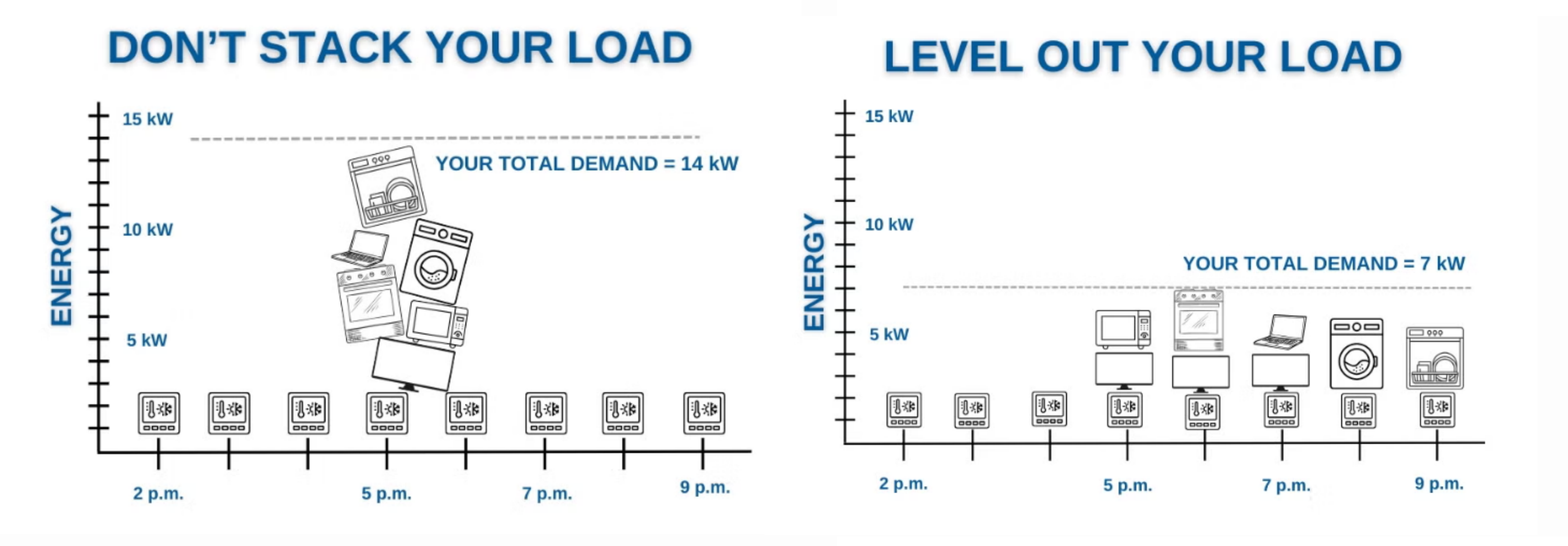
- **For example, a more cost-reflective distribution rate could have three parts:**
  - **Customer charge** (fixed): for customer-related costs (billing, meter, service drop, etc)
  - **Customer maximum demand charge** (per kW): for costs related to customer maximum demand;
    - ✓ Could be designed as a tiered fixed per kW rate and applied based on customer max demand (similar to a subscription charge)
  - **Peak demand charge** (per kW): for costs related to system peak demand
    - ✓ A peak period demand charge with predetermined on- and off-peak periods.
- **Like per kWh TOU rates, demand charges can be designed in many ways to balance efficiency and predictability**
- **More predictable costs/muted signal:**
  - Per kW capacity charge based on previous demand, adjusted yearly;
  - Per kW charge based on monthly average max demand
- **Less predicable costs/sharper signal**
  - Demand charge on max kW of measured demand over 15 min interval
- Many options in between – e.g., averaging x highest days of demand; longer measurement intervals, etc.

Some examples of residential demand charges

- **Examples of default residential rates with demand charges:**
  - CORE Cooperative (Colorado): Customer max kW during the hours of 4-8PM measured over 60-minute interval. CORE Electric Cooperative, Rates and Regulations (Effective May 1, 2025)
  - Fall River Rural Electric Coop (ID): Customer max demand (15 min interval) May 2025 Rate Summary Sheet.docx
  - ANEC (VA): Access charge based on service level; monthly demand charge based on customer max demand (15 minute interval) ANEC-A-1-Residential.pdf
  - BKK (Norwegian utility): Monthly capacity tariff based on average of 3 highest customer demands (1 hour interval). Our grid tariffs | BKK.no/en.
- **Examples of opt-in residential rates with demand charges:**
  - APS (AZ): "Time-of-Use 4pm-7pm with Demand Charge plan" has a monthly demand charge for the highest hour of usage during on-peak hours, 4pm-7pm weekdays. Residential Service Plans | APS
  - Xcel (CO): Residential Demand Service includes demand charges applied to customer max demand (varies by summer and winter) Residential Plan | Billing & Payment | Xcel Energy
  - Alliant (WI): "Peak Nights and Weekends" (Residential Demand Service) includes monthly peak demand charge for highest hourly energy demand peak that happens between the hours of 10 a.m. and 8 p.m. Monday through Friday. Alliant Energy - Wisconsin residential rate options

How do utilities with demand charges support customers?

- Utilities with demand charges typically provide outreach/education to customers that explains typical demand use of household appliances and recommending they stagger usage to the extent possible.



Example from Beltrami Electric Cooperative: [Understanding Demand | Beltrami Electric Cooperative]

- Utilities may also support the customer transition to a new rate design by:
    - Ensuring customers have access to and understand their demand data in advance of implementing rate changes; and
    - Enabling access to supporting technologies

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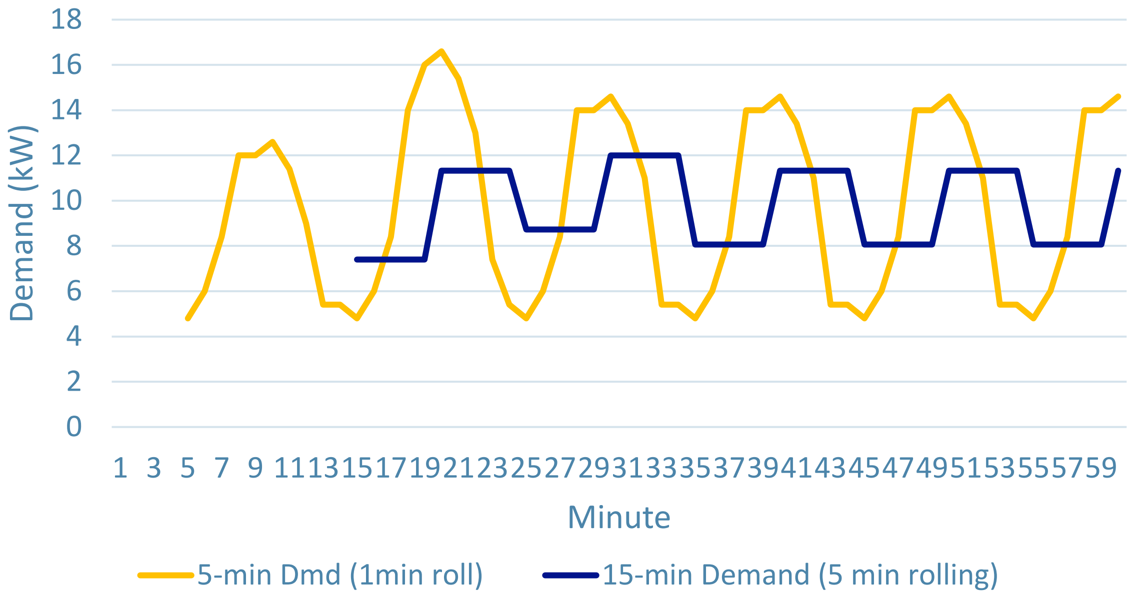
Demand is a measure of usage over a brief interval of time within an hour

- Demand can be measured in different ways based on the level of desired granularity
- For example, 15-minute demand may be the rolling average of 5-minute demands over the 15-minute interval and 5-minute demand may be the rolling average of 1-minute demands over a 5-minute interval
- A one-hour demand could be the average of 5-minute demands over that one hour
- A shorter interval allows for more precise measurement of demand and a more accurate price signal to the customer
- Broader intervals means demand is averaged over a longer period which mutes the measurement
- Muted measurements will minimize bill impacts but send a weak price signal



EVERSOURCE nationalgrid Unitil

Energy is a measure of usage over the course of the billing month

- Hourly demands are summed across the billing month to determine the energy consumed by the customer
- Volume of energy is not a constructive price signal to customers for system planning purposes because the distribution system is sized on capacity needs
  - The size of the wires, transformers, and stations need to handle the maximum amount of power required at any point in time
- The volume of energy is more relevant to supply where the utility or the customer needs to procure the quantity of energy needed to serve their needs
  - Energy supply pricing is market-based and fluctuates based on supply and demand
  - Volumetric time-of-use pricing is often tied to this dynamic
- Energy has historically been the billing determinant for residential customers
  - Historically, metering demand required more sophisticated and costly equipment than what was practical for small residential loads
  - AMI and electrification is changing these circumstances

Efficient high-volume C&I customers benefit from demand charge rate designs and lower volumetric rates

Rate Component (pricing for June 2025)	Rate G-3 (Eversource Boston)	Rate G-3 (National Grid – Mass Electric)	Rate GD-3 (Unitil)
Customer ($/month)	$370.00	$350.00	$370.00
T&D Demand ($/kVA)	$30.61	$10.31	$10.00
T&D Energy ($/kWh) - Peak	$0.01196	$0.06093	$0.08779
T&D Energy ($/kWh) – Off-Peak	$0.01196	$0.05834	$0.06729
Basic Service ($/kWh)	$0.12551	$0.13233	$0.11757
Demand Basis	*Max 15-min demand, but off-peak demand reduced by 70%*	*Max 15-min peak demand*	*Max 15-min peak demand*

- Larger high load factor customers typically ~~prefer~~ benefit from a demand charge rate design because their volume of energy consumed is high relative to their demand
- High volumetric rates and high usage will disadvantage larger customers
- Customers who are efficient (i.e. high load factor) benefit from demand charge rate designs which are also more cost reflective

EVERSOURCE nationalgrid Unitil

Electrification goals are changing the profiles of a residential customer

- Based on 2022 load research for Eversource Rate R-1 (non-heat), typical customer demand ranges from 3kW to 5kW with demand peaking in July and August
- Electrification goals that transition away from natural gas and delivered fuel will drive up winter peaks and will likely result in a dual peaking electric system
- Residential customer loads have the potential to be quite large in this future context
  - Level 2 EV chargers can range from 3 kW to 20 kW
  - Heat pump for a 2,000 sq. ft. home could be another 5 kW
  - Electric oven capacity ranges from 2 kW to 5 kW
- Typical house load could be as much as 25 kW under a total electrification scenario
- Such large house loads means that customers really should be more sensitive to demand if we want to reduce the pace at which the electric system grows to meet this demand
- How efficient will customer loads be? In other words, will customers have very high demand, but consume energy in short durations?

Illustrative revenue-neutral residential demand charge

Rate Component	Illustrative Price (no dmd charge)	Illustrative Price (with dmd charge)	Charges (no dmd charge)	Charges (with dmd charge)
Customer ($/month)	$10.00	$10.00	$10.00	$10.00
T&D Demand ($/kW)	N/A	$9.55	N/A	$238.73
Delivery Energy ($/kWh)	$0.19122	$0.12858	$698.39	$472.89
Supply Energy ($/kWh)	$0.13241	$0.13241	$476.68	$476.88
Total			$1,175.07	$1,188.30
Bill Impact				**$13.23 or 1.1%**

- Assumes demand charge of $9.55/kW, 25kW demand, and load factor of 20%
- Demand charges could be phased in over time to lessen bill impacts
- Trade-off of a demand charge is a potentially higher cost for some customers (while lower for others), but better price signal
- Better price signal would hopefully stabilize the need for further system investment in the long term

If customer load factors increase, a demand charge rate design would yield cost savings

Rate Component	Illustrative Price (no dmd charge)	Illustrative Price (with dmd charge)	Charges (no dmd charge)	Charges (with dmd charge)
Customer ($/month)	$10.00	$10.00	$10.00	$10.00
T&D Demand ($/kW)	N/A	$9.55	N/A	$238.73
Delivery Energy ($/kWh)	$0.19122	$0.12858	$1,386.78	$1,174.51
Supply Energy ($/kWh)	$0.13241	$0.13241	$953.35	$953.35
Total			$2,340.13	$2,127.86
Bill Impact				**($212.27) or -9.1%**

- Assumes demand charge of $9.55/kW, 25kW demand, and load factor of 40%
- Load factor increases as customer usage increases, but the maximum demand remains the same
- Demand doesn't change from previous example so demand charge on bill remains constant
- Usage increases, but lower kWh rate under demand charge rate design allows customer to realize saving

Employing demand charges in a TOU rate design cold make the rate more cost-effective for customers

Rate Component	Illustrative Price (no dmd charge)	Illustrative Price (with peak dmd charge)	Charges (no dmd charge)	Charges (with peak dmd charge)
Customer ($/month)	$10.00	$10.00	$10.00	$10.00
T&D Demand ($/kW)	N/A	$9.55	N/A	$143.24
Delivery Energy ($/kWh)	$0.19122	$0.12858	$698.39	$472.89
Supply Energy ($/kWh)	$0.13241	$0.13241	$476.68	$476.88
Total			$1,175.07	$1,092.81
Bill Impact				**($82.26) or -7.0%**

- Assumes demand charge of $9.55/kW, 15kW demand, and load factor of 20%
- Customer is now assumed to shift 10 kW to off peak
- Savings come from demand charge rate design, but is dependent on customer flexibility
- Usage remains unchanged, but system benefits from demand charge incentive to not stack load
- Impact of TOU periods has upstream system benefits, but has a weakened local price signal

Key considerations relevant to ANY & ALL changes to rate design

- How to balance efficiency or price signal and stability/predictability for residential customers?
- AMI data will allow the EDCs to better evaluate customer usage profiles as electrification proceeds
- What are the anticipated bill impacts or the design change and how does this inform the degree of gradualism needed?
  - All else equal, a revenue-neutral change in rate design will reduce bills for some customers and increase bills for others, before any customer response is factored in.
- To what extent will customers be provided with technology that supports behavioral response?
  - Load management will continue to play an important role especially in controlling local system impacts
- An opt-out rate design change strengthens the intended goals of demand management
  - If rate is opt-out, do certain groups of customers require additional protections or options?
- Opt-in rates mute the intended effect but will reveal specific customer types

Thank You

June 9, 2025

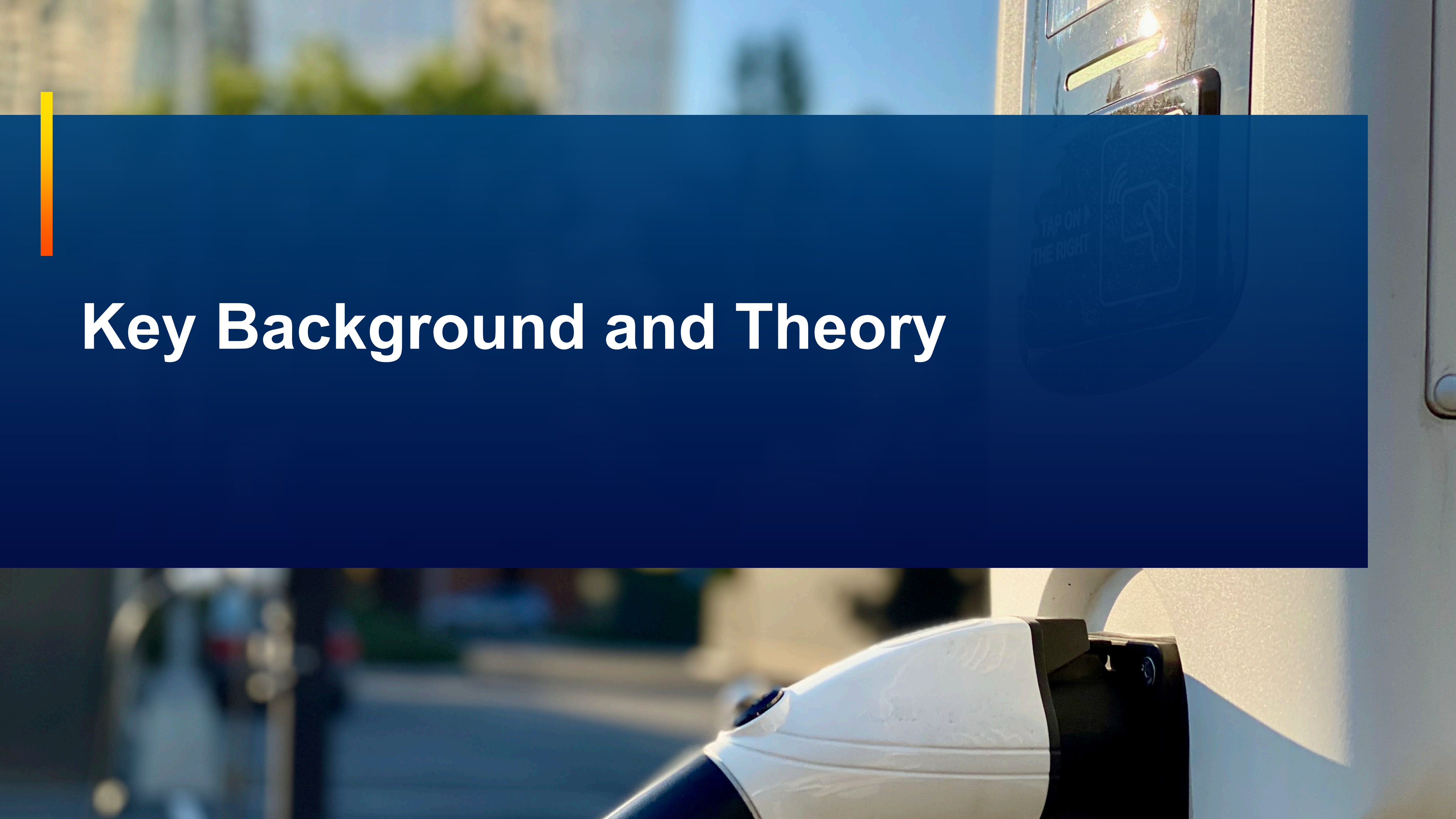
Advanced Rate Design: Key Theory and Options

Massachusetts Electric Rate Task Force convened by Department of Energy Resources

Mark LeBel
mlebel@raponline.org
Principal, Research & Strategy

Overview

- Key Background and Theory
- Deep Dive on Demand Charges and Cost Causation
- Concepts and Options
  - Two technology-neutral residential customer classes
  - Site infrastructure charge
  - Distribution flow charge
  - Putting the pieces together



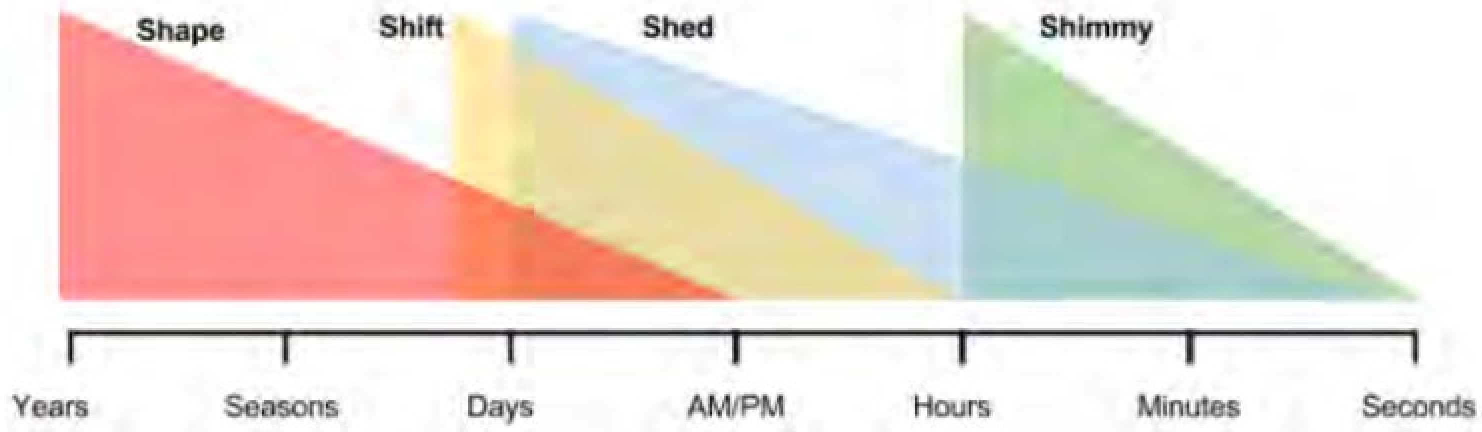
Key Background and Theory

Policy Goals and Rate Design Objectives

- Public policy goals
  - Cost control and affordability
  - Safe and reliable service
  - Societal equity (e.g., universal access and low-income protections)
  - Environmental and public health requirements
  - Economic development and employment
- Objectives for setting utility prices
  - Effective recovery of revenue requirement
  - Customer understanding and acceptance
  - Equitable allocation of costs
  - Efficient forward-looking price signals

Technologies and Timescales

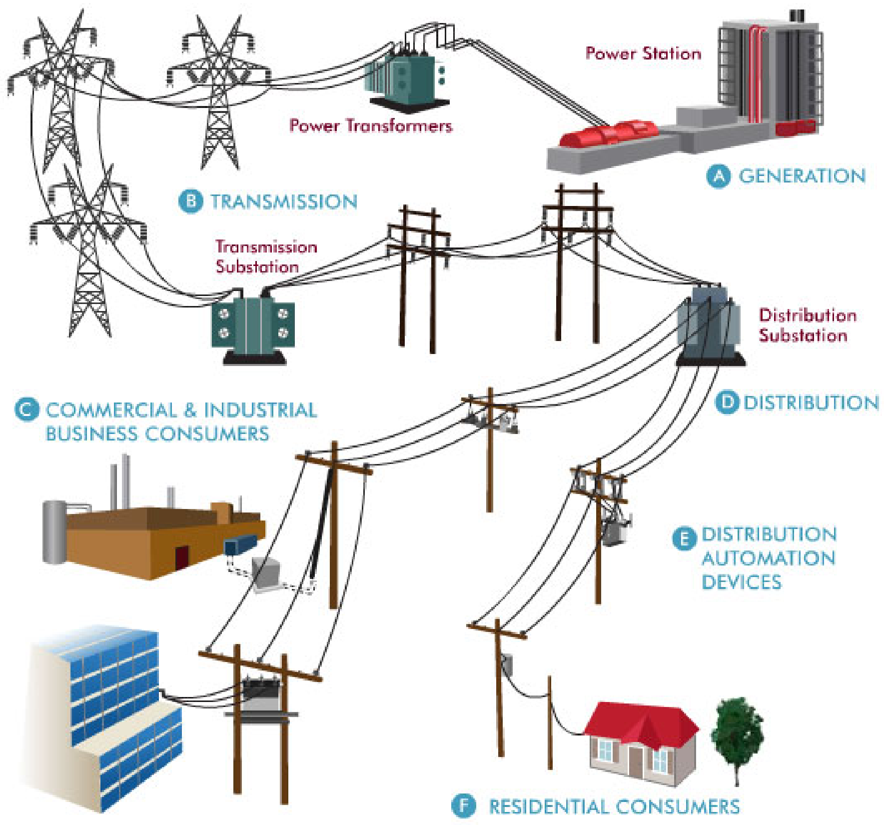
- Energy efficiency and load management
  - Investments and behavioral choices
- Clean distributed generation
- Energy storage
- Electric vehicles
  - Choice of vehicle and charging efficiency
- Electric heating and cooling
  - Investment and weatherization options



Source: LBNL, 2025 California Demand Response Potential Study: https://eta-publications.lbl.gov/sites/default/files/lbnl-2001113.pdf

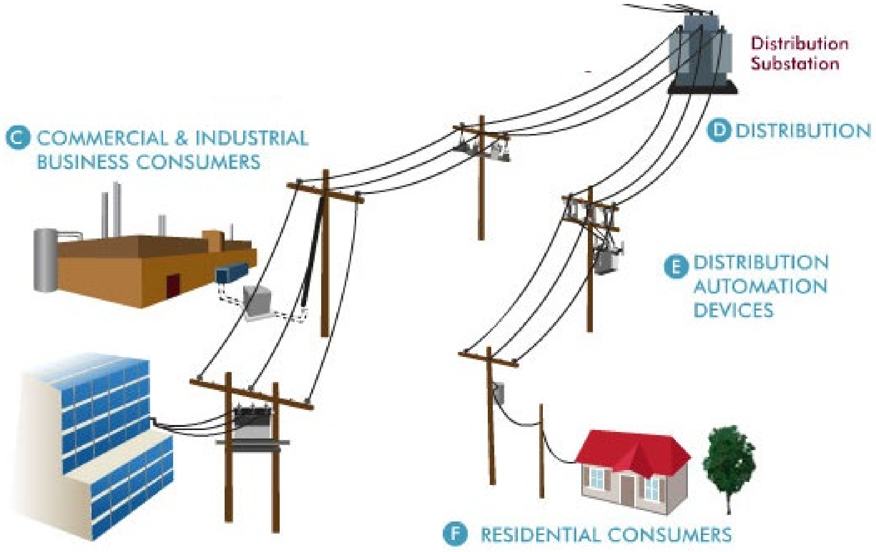
Cost Causation for Electric System

- System serves joint needs of all customers across all hours of the year
- Each function has distinct cost drivers
  - Generation costs are time-differentiated
  - Transmission lines serve multiple purposes
  - Distribution is built only where there is load to support it
  - Basic meters are for billing, but the costs of AMI are incurred for a broad array of purposes
- Administrative and general costs scale with size of the business
- Public policy programs reflect a mix of motivations
  - Electric system benefits
  - Broader societal goals

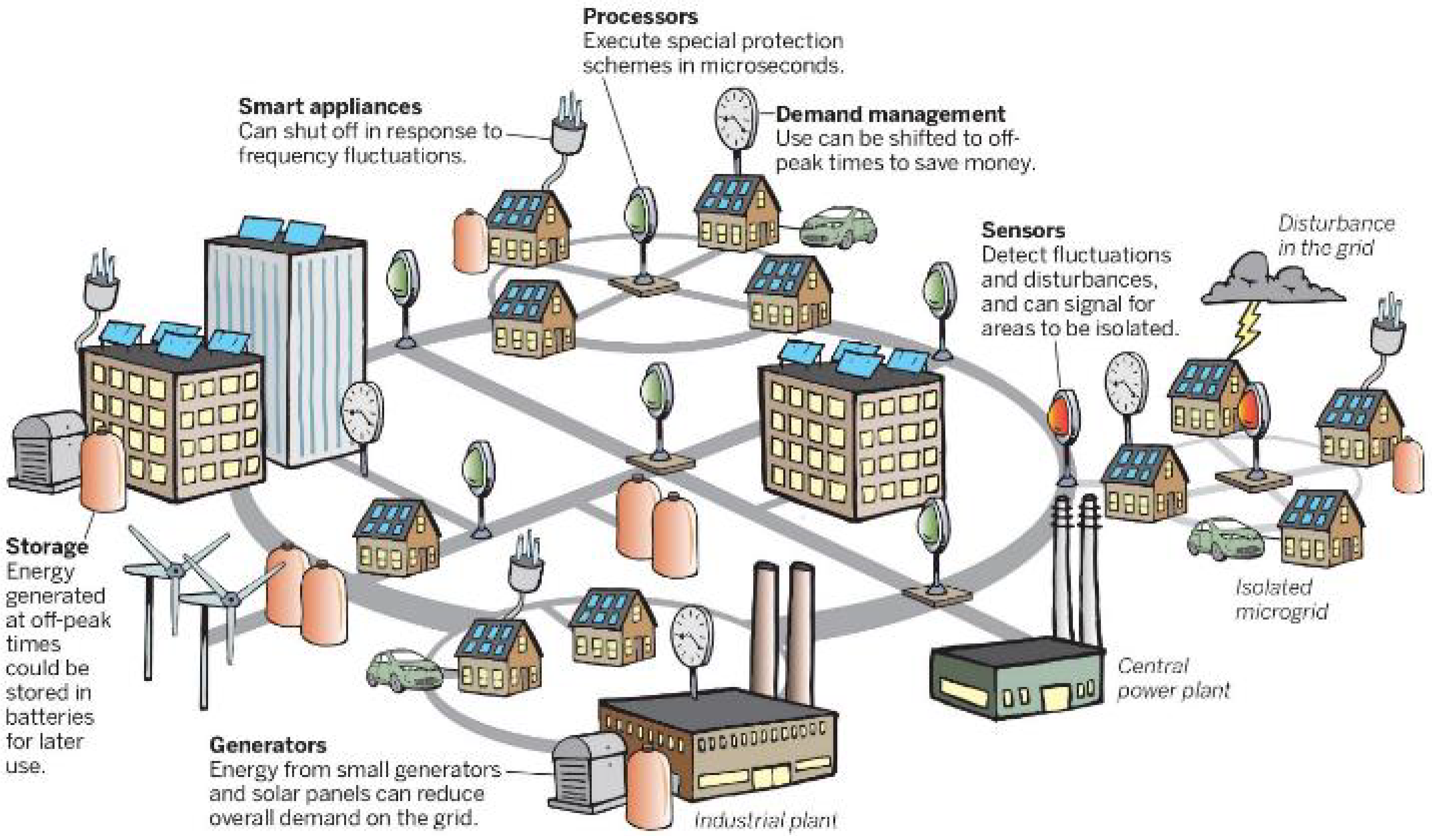


Detail on Distribution

- Primary Voltage Distribution System - below the substation
  - Partly designed to meet peaks and reduce line losses
  - Minimum system is the remainder – geographic span of lines is the cost driver
- Line Transformers and Secondary Voltage Lines
  - Some customers are served directly at primary voltage
  - Some customers have dedicated line transformer
    - Larger commercial customer
    - Rural residential customer
  - Many customers share line transformers
    - Building of separately metered apartments
    - 5-10 houses located nearby
- Service lines
  - Many customers have dedicated service line
  - Some customers share service lines
    - Separately metered apartments or offices



Electric System of the Future



Source: Adapted from U.S. Department of Energy. (2015). *United States Electricity Industry Primer*

Algorithm for Socially Efficient Price Signals

1. Start with short-run marginal costs where you can
2. Layer in incremental long-run marginal costs
3. Add any unpriced externalities
4. End by allocating and pricing “residual” costs that must be recovered through rates

Elasticities matter, but many complexities to consider…

Key Evaluation Criteria

- Fair cost allocation
  - Do customers contribute to system and program costs that they use and benefit them? In a reasonable proportion?
- Efficient customer price signals
  - Does customer behavior help lower future system costs?
- Customer understanding and acceptance
  - Can customers manage their bill?
  - Can they understand why they are paying a different amount than their neighbor?
- Administrative feasibility
  - What are the incremental costs for new analysis, new proceedings, and new education efforts?

Deep Dive on Demand Charges and Cost Causation

Traditional Case for Demand Charges

- Customer NCP demand could be a proxy for contribution to peak
- Prerequisites include:
  - High correlation between customer NCP and system peak
  - High cost of time-differentiated metering
  - Little or no economically shiftable load

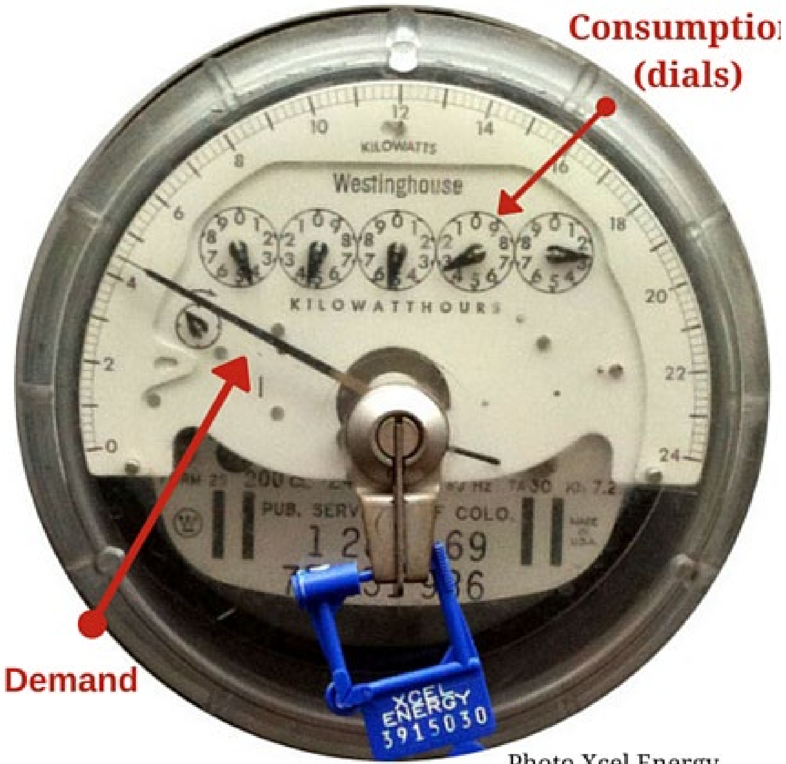
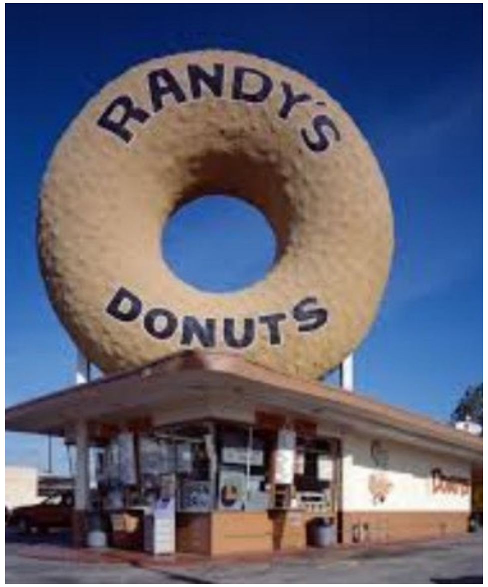
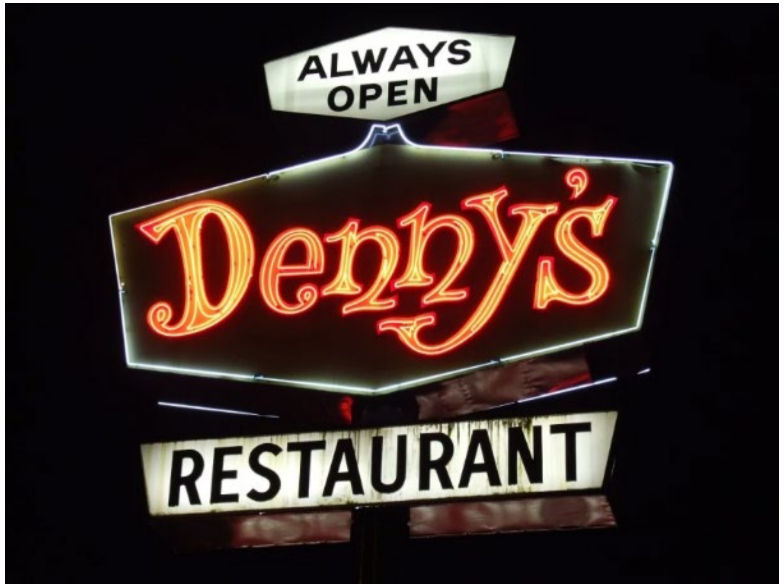


Photo Xcel Energy

Diverse Customers Share Capacity





- Morning uses
- Evening uses

Capacity Sharers

- 24/7 loads

Capacity Hog

Costs of Metering and Shifting Load

- Advanced metering means that time-based rates are just as easy as demand charges
- Energy management technology and low-cost storage make it easier for customers to shift load

Does the “peak window” demand charge solve the problem?

- Peak window demand charges provide a better incentive to reduce at peak times than traditional monthly demand charges
- Peak window demand charges share other faults of demand charges
  - Hogs versus sharers
  - Arbitrary unless there are high correlations between individual peaks and system peaks
  - Inaccurate customer response

Potential Narrower Roles for Demand Charges

- Dedicated Site Infrastructure
- Risks from Customer Variance at Peak Times
- Timer Peaks

What happens if load diversity isn’t present?

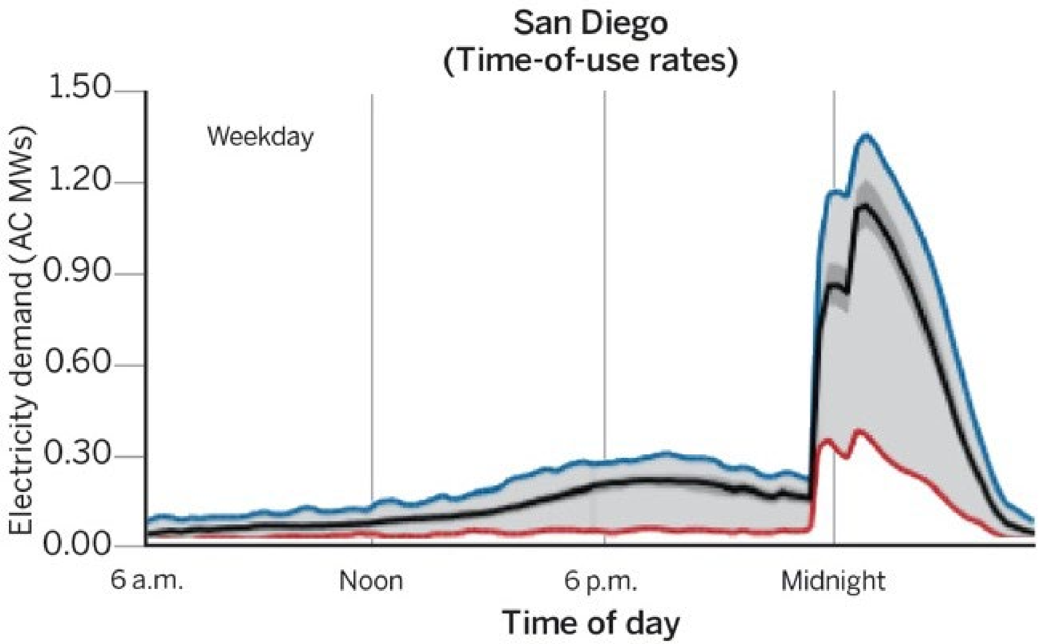
Cost Causation for Site Infrastructure

- Load diversity towards the customer end of the grid is lower
  - Line transformers
  - Secondary voltage lines
  - Service drops
- Heat build-up over time is still key issue for line transformers
  - Doesn't necessarily correspond well to demand charge structure

Risks at Peak Times

- Veall (1983) defines a set of conditions where a peak window demand charge is an efficient marginal cost incentive as a price on variance, which requires that either:
  - Customers are “large” relative to the system or component; or
  - Load fluctuations are correlated
- Boiteux and Stasi (1952) make a risk argument for demand charges for shared distribution costs for industrial customers

Timer Peaks



Source: Jones, B., Vermeer, G., Voellmann, K., and Allen, P. (2017). *Accelerating the Electric Vehicle Market*

Evaluation of New Roles

- Dedicated site infrastructure is modest portion of system costs
  - Typical demand charges do not necessarily correspond with how wear and tear is incurred on transformers and service drops
- Risks at peak times are real but many questions remain about details
  - Which customers?
  - What kind of correlation?
  - Is TVR still better?
- Timer peaks can possibly be addressed through other means
  - Adjustments to time periods
  - “Feathering” of time periods – customer choice or assignment
  - Load management programs

Key Takeaways

- In the modern electric system, a traditional monthly demand charge is no longer a good proxy for shared system capacity costs, even for industrial customers
- Demand charges are an inefficient way to price shared system capacity generally
  - Overcharge customers with load diversity and undercharge customers that hog capacity
- Simple time-varying rate structures are likely superior to peak window demand charges for most purposes
- Narrower applications for demand charges may have cost justification
  - Likely a proxy for a more sophisticated system of time- and location-varying rates

Concepts and Options

Multiple Technology-Neutral Residential Customer Classes

- Allows new flexibility on multiple dimensions but must be non-discriminatory
- For purposes of rate design, allows increased complexity for some but not all customers

Basic Residential	Advanced Residential
Low-income	EV/heat pump customers
Multi-family	Single-family
Low gross usage	High gross usage
Other vulnerable customers	DER customers

Site Infrastructure Charge

- New rate structure explicitly for line transformers, secondary voltage lines and service drops
  - For customers who share the relevant asset, this is a proxy
- Options
  - Tiered customer charge based on customer characteristics
    - City of Burbank (CA) municipal electric utility
  - kW subscription
    - Electricité de France
  - Demand charge

The Distribution Flow Charge

- There is not a good marginal cost basis for charging primary voltage distribution backbone (“minimum system”) costs
  - Costs follow benefits instead
- Distribution flow charge is a kWh rate on both imports and exports in a non-discriminatory manner
  - Potentially also some A&G costs and public policy costs
- Natural method for asymmetric DER rates and credits
- Higher billing determinant for DER customers leads to a lower effective rate for all customers for the relevant costs

Putting the Pieces Together

- Create two residential customer classes: basic and advanced
- Basic residential customer class has moderately simple rate
  - Tiered customer charge
  - Seasonal TOU rate
  - Peak-time rebate
- Advanced residential rate class moves to more sophisticated rates
- Gradualism, customer education and technology assistance matter for everyone
- Improved cost studies will be needed for certain kinds of rates

Advanced Residential Rate Class

Cost Recovery Only	
Customer charge ($/month)	$10
Site infrastructure charge ($/individual NCP kW with 2-hour integration)	$1
Distribution flow charge (cents/kWh on imports & exports)	2 cents

Symmetric Charges and Credits	Winter	Summer
Off-peak (cents/kWh)	8 cents	12 cents
Mid-peak (cents/kWh)	15 cents	18 cents
On-peak (cents/kWh)	30 cents	35 cents
Critical peak (cents/kWh)	75 cents	75 cents

Resources from RAP

- Smart Rate Design for Distributed Energy Resources
- Demand Charges: What are They Good For?
- Electric Cost Allocation for a New Era
- Smart Rate Design for a Smart Future

About RAP

Regulatory Assistance Project (RAP)® is an independent, global NGO advancing policy innovation and thought leadership within the energy community.

Learn more about our work at raponline.org

Mark LeBel

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Appendix

“But if the hypothetical cost of a minimum-sized distribution system is properly excluded from the demand-related costs for the reason just given, while it is also denied a place among the customer costs for the reason stated previously, to which cost function does it then belong? The only defensible answer, in my opinion is that it belongs to none of them…. But the fully distributed cost analyst dare not avail himself of this solution, since he is the prisoner of his own assumption that ‘the sum of the parts equals the whole.’ He is therefore under impelling pressure to ‘fudge’ his cost apportionments by using the category of customer costs as a dumping ground for costs that he cannot plausibly impute to any of his other categories.”

James C. Bonbright, Principles of Public Utility Rates (1961), p. 348-49.

Conundrum at the Heart of Rate-Making

- Marginal cost rates are unlikely to collect the correct amount of revenue
- Revenue adequacy objective has typically come first
- It is likely that marginal cost rates will under-collect revenue in many circumstances
  - The additional revenue you need to collect over marginal cost rates is called “residual” costs
- Residual cost recovery is all about which bad choice you like the most
  - ***All choices are economically distortive by definition***

Ratemaking in the Future

- Increasing importance of short-run marginal cost price signals
  - Particularly if you are relying on demand-side for generation resource adequacy or other grid needs
- As pricing becomes more granular, the class load profile is less relevant
  - Instead of accounting for cost differences at the cost allocation stage you are doing it automatically in the rate design stage!
- Technology-neutral time-varying rates of increasing complexity
  - Assigning costs to time periods for rate design is similar to the traditional cost allocation challenge
- Automated energy management and storage should help customers manage more complex rates
  - Programs and appliance codes help enable these technologies
- The problem of residual costs gets harder
  - As grid cleans up, marginal emissions rate likely goes down
  - With high penetrations of DER, traditional billing determinants stagnate, and price elasticity will likely increase across multiple dimensions
- Are there sources of funding besides ratepayers?

The Trouble with Asymmetric DER Pricing

- Need to check every pricing relationship to ensure that customer optimization leads to desired behavior

	Import Rate	Export Credit
Off-peak (cents/kWh)	15 cents	10 cents
On-peak (cents/kWh)	25 cents	20 cents

This is fine!

	Import Rate	Export Credit
Off-peak (cents/kWh)	15 cents	5 cents
On-peak (cents/kWh)	25 cents	10 cents

Potential problem!

Key Questions – Subscription Tariffs

- Does a subscription rate shift risk? To whom?
  - Competitive provider subscription tariffs are fundamentally different from utility provided ones
- Does a subscription rate introduce regulatory oversight burdens?
- Does the subscription counterparty have incentives to align consumption and DER use with grid value?
- Does a subscription tariff encourage efficient 3rd party EE and DER service provision?

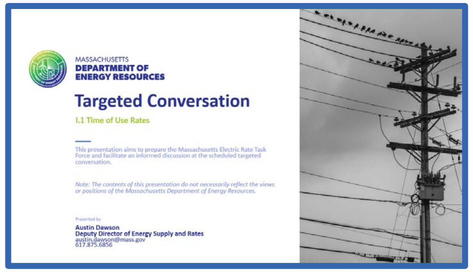
Next Steps

Targeted Conversation

June 18, 2025, 2-4pm

- Will serve as a deliberative space following related expert presentations to prompt informed discussion on policy questions and priorities

Illustrative Presentation



Optional Office Hours

June 25, 2025, 2-4pm

- Optional office hours for further conversation, serving as a structured opportunity to work towards common understandings and positions. We also encourage participants to have discussions amongst each other beside formal Task Force sessions
- Please reach out to chris.connolly2@mass.gov to request an invitation.