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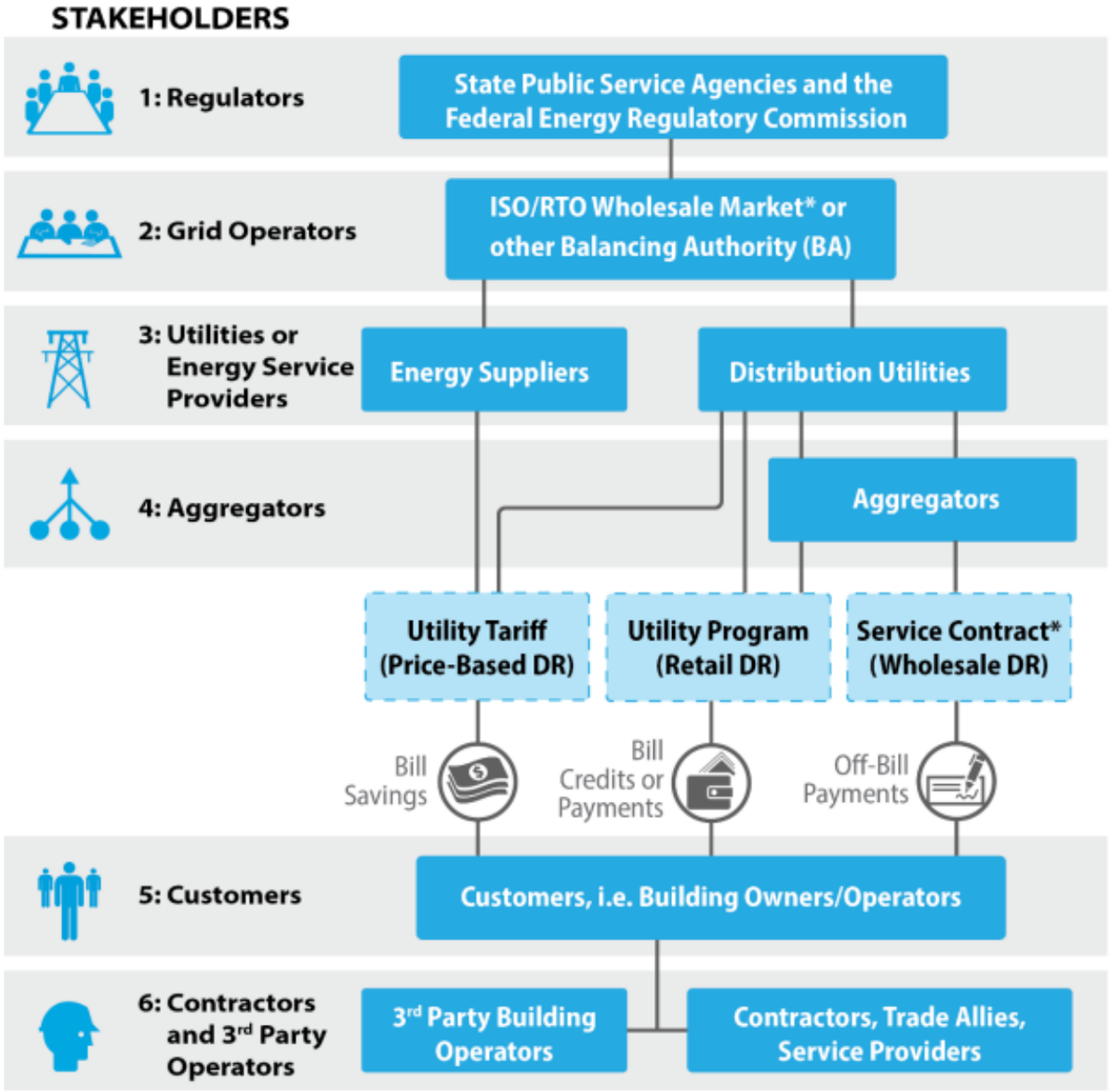
Guidehouse

“Valuing and Incentivizing Demand Flexibility as a Grid Asset

October 5, 2021

Incentive Ecosystem

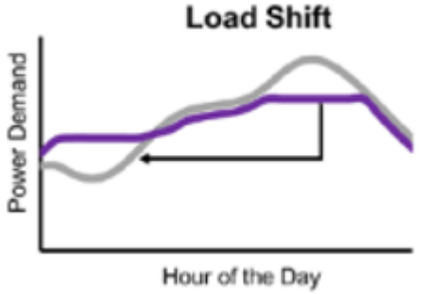
1. **Regulators:** State and federal (FERC) regulators that oversee aspects of rate, program, and market design.
2. **Grid Operators** (balancing authorities): ISOs and RTOs where wholesale markets exist and other balancing authorities (typically vertically integrated utilities) where ISOs or RTOs do not exist, all of which balance supply and demand in a specific portion of the electric grid.
3. **Utilities:** The utilities enable and manage access to provide demand flexibility to grid operators and are responsible for paying customers for their services.
4. **Aggregators:** DR aggregators (i.e., aggregators or curtailment service providers) enroll groups of individual customers in wholesale or retail DR to provide firm capacity to the utility or the market. They serve as a provider in addition to utilities and are responsible for paying customers for services.
5. **Customers (building owners/operators):** The organization or individuals that may provide demand-flexibility services (including advanced services enabled through investment in advanced demand-flexible controls) and seek financial benefits in exchange.
6. **Contractors and third-party operators:** The organization or individuals that design, install, and manage the building's energy systems for participation in grid services via demand flexibility.



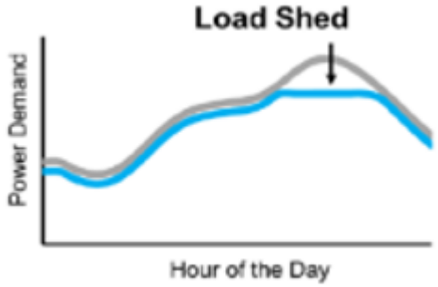
GEB Operational Capabilities

In its recent report series, DOE defined five GEB demand-side management strategies (GEB strategies)

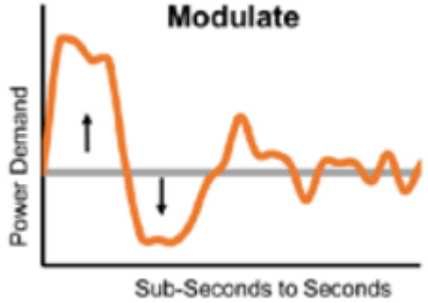
Efficiency: Ongoing reduction in energy use while providing the same or improved level of building function.



Load shift: Ability to change the timing of electricity use. The focus is on intentional, planned load shifting.



Load shed: Ability to reduce electricity use for a short time and often on short notice. Shedding is typically used during peak demand periods and during emergencies.

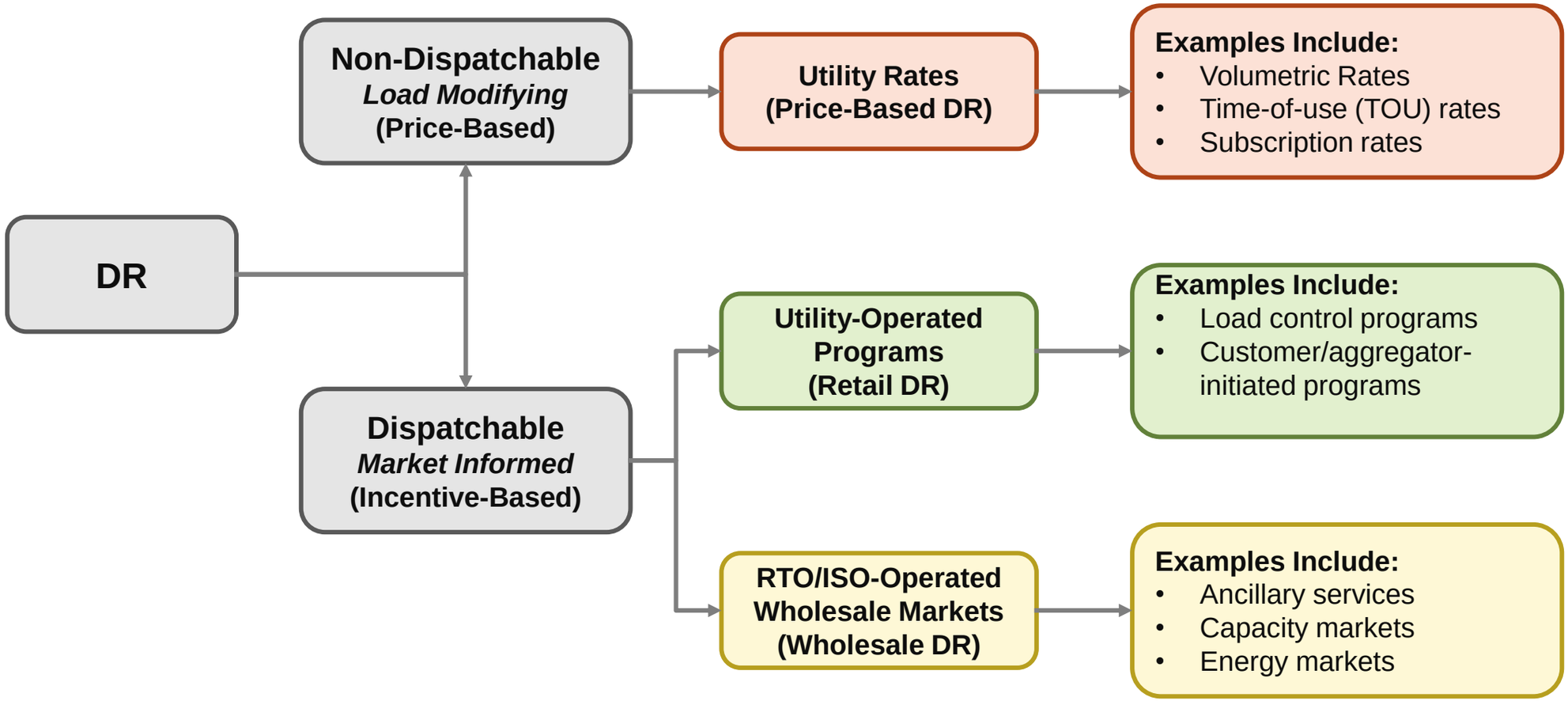


Modulate: Ability to balance power supply and demand or reactive power draw or supply autonomously (within seconds to sub-seconds) in response to a grid operator's signal.

Generate: Ability to generate electricity behind the meter for onsite consumption or export to the grid upon dispatch from the operator. Batteries are often included here.

Source: DOE, Overview of Research Challenges and Gaps report, available at https://www1.eere.energy.gov/buildings/pdfs/75470.pdf.

Taxonomy of DR Options

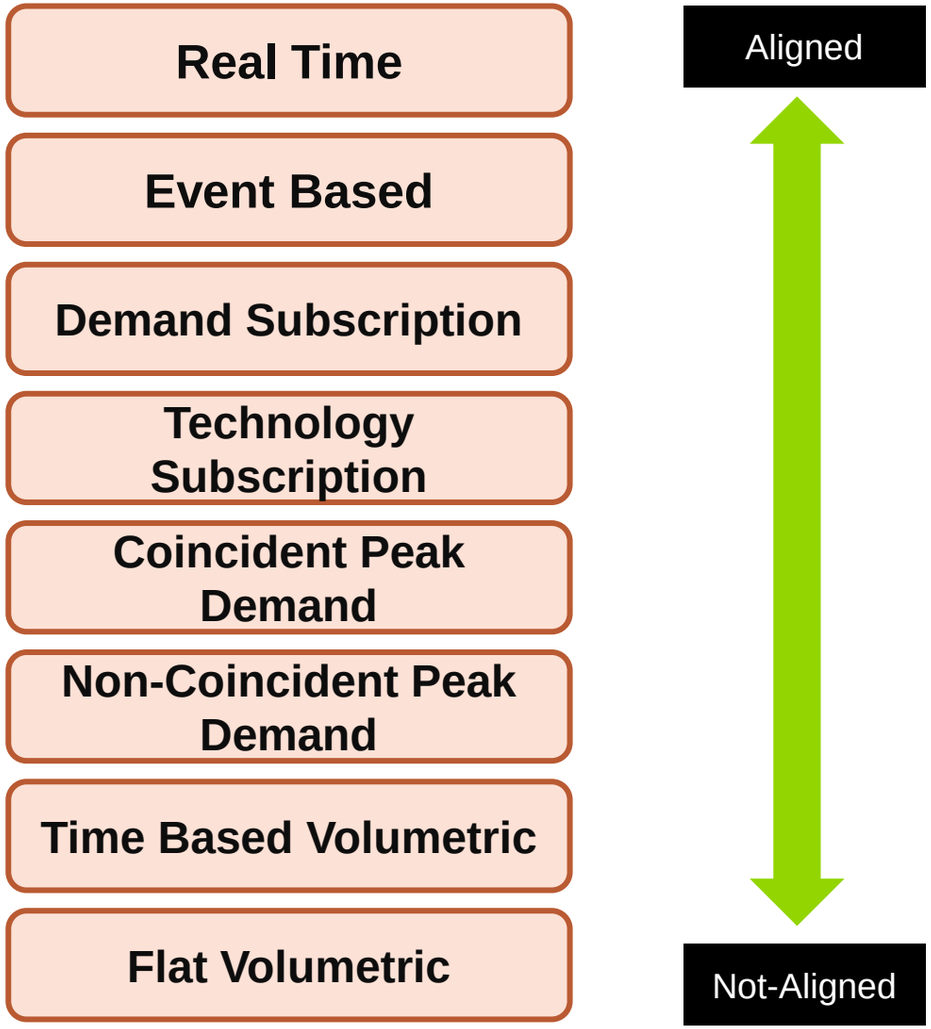


Fundamentally, the key to success regardless of the incentive mechanism is optimal design and price setting to ensure building operators and owners are motivated to make the investments and take the actions that will benefit grid operators and other stakeholders, improve grid efficiency, and help achieve sustainability goals.

Utility Rates (Price Based DR) Overview

Traditional		Alternative	
Volumetric Charge ***Per kWh use charge***	**Demand Charge** ***Per kW charge***	**Dynamic** ***Per kWh use charge***	**Subscription** ***Per Month charge***
Flat Volumetric *(Same price regardless of season or time of day)*	**Coincident Peak Demand** *(Customer's peak at time of system peak)*	**Real Time** ***(Price based on hourly market prices)***	**Demand Subscription** *(Monthly Charge based on customer's choice of level of demand service)*
Time Based Volumetric *(Price varies by season and/or time of day)*	**Non-Coincident Peak Demand** *(Customer's peak)*	**Event Based** (Significantly higher price during critical peak events)	**Technology Subscription** *(Monthly Charge based customer's energy efficiency)*

Alignment with GEB Strategies



Rate Structure Component	Efficiency	Load Shift	Load Shed	Generate	Modulate	Notes
Volumetric Charge	●	○	◔	◔	○	*Definition: Independent of timing (per kWh)* • Creates imprecise price signals; value limited to efficiency investments. • Commonly used for energy supply charges.
TOU Volumetric Charge	◕	◑	◑	◑	○	*Definition: Prices vary depending on time of day/week (per kWh)* • Incentivizes load shifting or shedding during peak hours.
Demand Charge	◔	◕	◑	◑	○	*Definition: Independent of timing (per kW)* • Incentivizes peak load reductions, load shifting or shedding, and onsite energy generation when feasible and beneficial for the customer, not necessarily the grid. • May apply separately to distribution utility charges and energy supply charges for large C&I customers in wholesale market regions.
Time-Differentiated Demand Charge	◑	●	◕	◕	○	*Definition: Prices vary depending on time of day/week (per kW)* • Incentivizes load shifting or shedding during peak hours.
Event-Based Pricing	○	●	●	●	○	*Definition: Prices change during critical grid peak periods (per kWh or per kW)* • Overlaps with retail DR in concept; includes CPP (a penalty) and critical peak rebate (a reward) pricing.
Dynamic Pricing	◕	●	◕	●	○	*Definition: Prices vary each hour reflecting wholesale variation (per kWh)* • Effective and flexible in communicating load shifting needs but does not always allow customers enough time to prepare (e.g., charging energy storage). Generally only suitable for advanced customers willing to bear risk.
Subscription Rates (Plus Enabling Tech)	◑	◕	◑	◑	○	*Definition: Prices fixed based on customer characteristics (per month)* • Provides predictable bills to customers while yielding some operational or technology decisions to the utility. • Coupling subscription rates with appropriate incentives for enabling technologies can create significant customer response benefits to the utility.
Legend	Increasing alignment of incentives between rate structure component and GEB strategy. ○ ◔ ◑ ◕ ●, where the empty circle represents no alignment and the full circle represents optimal alignment.					

Barriers to Rate Design as GEB Enabler

Barrier		Opportunity
Muddled market signals – lack of transparency and clarity in rate design that disconnects the incentive from the intended action and reduces effectiveness of financial incentive mechanisms	→	Support for progressive rate design approaches (see section 3.1.4, below) Applies to: Regulators & utilities
State Regulations – Regulators in many states maintain utility business models that encourage load growth and infrastructure build-out to improve returns instead of maximizing demand-flexibility value	→	Support for progressive utility business models at the state regulatory level based around resiliency, reliability, and decarbonization (e.g., de-coupling sales volumes from financial returns) Applies to: Regulators & policy makers
Inconsistency – customers with multiple locations must deal with inconsistency by operating buildings in different ways	→	Development of standardized practices for modern rate design enabling improved consistency between rate structures (despite necessarily differing prices) Applies to: Regulators & utility industry associations

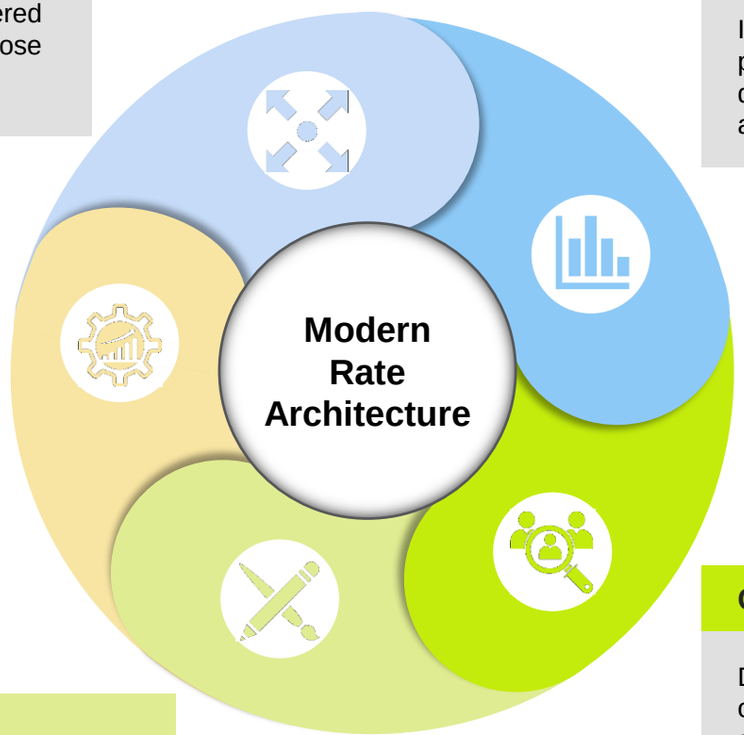
Modern Rate Architecture

Product Differentiation

Determination of the actual products and services offered and identifying which of those offerings are ‘standard’ vs ‘optional’

Cost Allocation

Identifying costs of services or products provided and further differentiating those costs not associated with product



Incentive Design

Designing incentives (both positive and negative) that result in achieving a goal outside of cost of service rate design

Customer Segmentation

Differentiate customers by cost of service and other factors, such as how the customer wants to pay

Pricing Design

Designing pricing for products delivered based on cost of service

The MRA framework ensures rates and cost-recovery mechanisms are:

- **Transparent:** costs are clearly **allocated by driver** to product offerings
- **Equitable: affordable** rates that are fair and minimize cost shifts
- **Sustainable:** rates **stand the test of time** and reflect costs and customer preferences
- **Accessible:** customers have **equal access** to options

Utility Operated Program (Retail DR) Overview

Control

- **Direct load control** – Curtailment of opt-in customer load is initiated by the utility or aggregator via automation (e.g., smart thermostat); may be called "asset-based" when controlling a battery or generator
- **Customer-Initiated** – Curtailment is initiated by the opt-in customers at a time specified in a text or mobile-app notification from the utility or aggregator; may be called "behavior-based"

Incentive

- **Reward (Carrot)** – customers may opt out of a customer-initiated dispatch if they deem the incentive to be insufficient (may be applied with or without a penalty)
- **Penalty (Stick)** – penalties may be instituted due to underperformance or failure to perform in a customer-initiated dispatch (commonly applied alongside a rewards)

Segment

- **Residential** – historically focusing on HVAC (A/C switch or smart thermostat integration) and water heating equipment
- **C&I** – wide array of end use equipment may be curtailed, with more advanced integration with building automation systems

Credit

- **Participation credit** – fixed credit or payment for participating when utility has direct load control (e.g., A/C switch or smart thermostat); reduced need for high-accuracy EM&V
- **Performance credit** – variable credit or payment based on performance during the actual event, requiring advanced metering infrastructure and associated EM&V (may also receive participation credit)

Performance Based

Participation based

Voluntary Behavioral

Alignment with GEB Strategies

Performance Based

Participation Based

Voluntary Behavioral

Aligned

Not-Aligned

Utility Program Types	Efficiency	Load Shift	Load Shed	Generate	Modulate	Notes
Performance-Based	○	●	●	◔	○	*Definition: Payment/credit based on measured performance* • Includes programs with customer/aggregator-initiated curtailment, with compensation improving as customer modifies behavior and optimally operates their equipment.
Participation-Based	○	●	◕	◑	◑	*Definition: Payment/credit based on participation regardless of performance* • Includes direct load control programs (e.g., AC switch, controlled by utility) where eligibility requirements ensure performance, with compensation preset based on expected performance. • Modulation is primarily from generation and storage, but research suggests viability via large-scale coordinated load control.[28]
Voluntary Behavioral	○	◔	◔	○	○	*Definition: Voluntary communication-based programs, generally with no financial incentive* • Sole focus is load shedding or shifting during emergency events.
Legend	Increasing alignment of incentives between rate structure component and GEB strategy, ○ ◔ ◑ ◕ ●, where the empty circle represents no alignment and the full circle represents optimal alignment.					

Barriers to Utility Programs as GEB Enabler

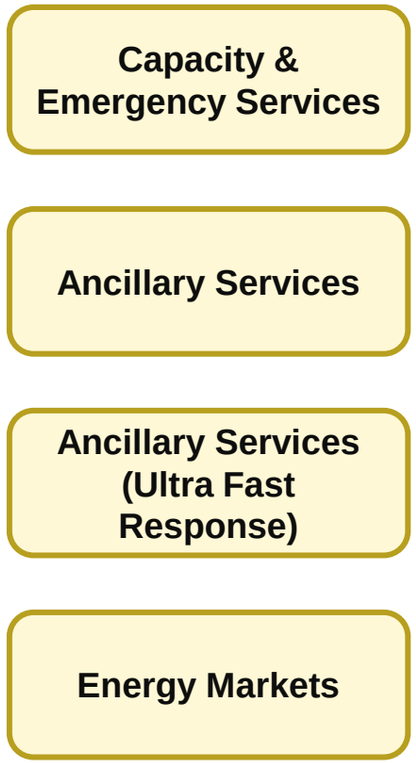
Barrier		Opportunity
State policies – Regulators in many states maintain utility business models that emphasize load growth and infrastructure build-out to improve returns instead of maximizing demand-flexibility value	↔	Support progressive utility business models with state regulators, with focus on resiliency, reliability, decarbonization (e.g., de-coupling sales volumes from returns) Applies to: Regulators & policy makers
Inconsistent designs – Aggregators and building owners that have multiple locations face substantive burden in entering new programs due to inconsistency. Customers also then face operations inconsistency between buildings	↔	Support development of industry standards or best practices for DR program design and implementation, improving consistency between utilities Applies to: Utilities & utility industry organizations
Implementation complexity/burden – outdated IT systems and unnecessarily complex participation processes (e.g., modeling requirements) introduce administration burden (time and cost) that hinder participation, especially burdening small resources and Aggregators	↔	Support modernization and simplification of IT systems and processes for participation, including enrollment, data sharing (e.g., green button), and M&V Applies to: Utilities & regulators
De-centralized regulation – with primary regulatory oversight of utilities residing at the state level, expansion of DR relies on initiative at the state and/or utility level, resulting in slow growth of DR programs	↔	Support development of industry standards or best practices for coordinated and consistent policy and regulatory treatment Applies to: Regulators & utility industry organizations

Market Structure Types

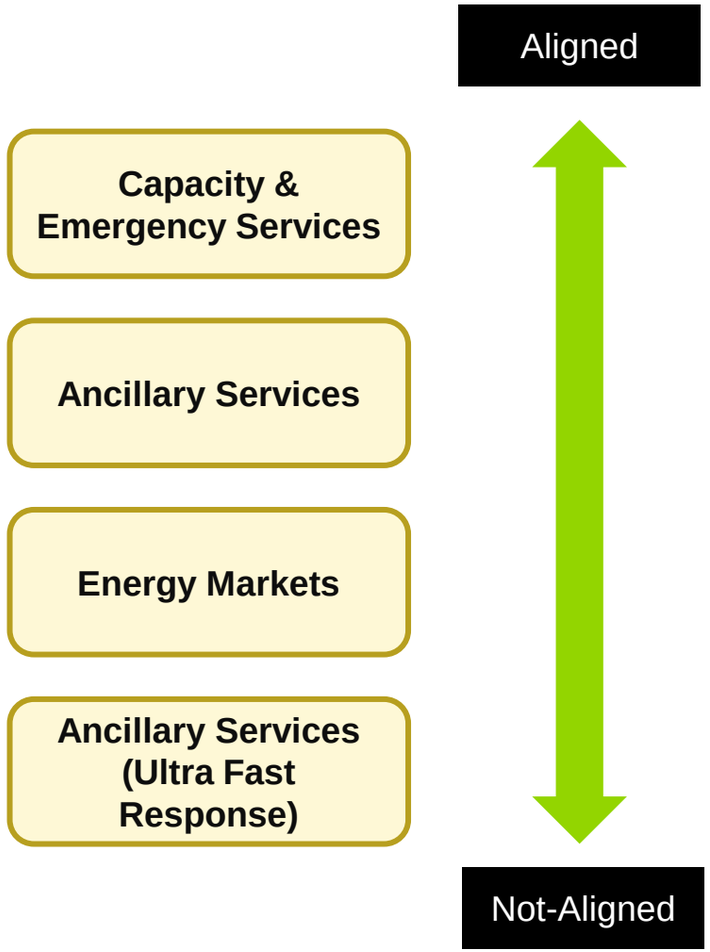
Capacity or emergency services: Capacity (kW) markets to assure future resource adequacy, typically for use in emergency situations (e.g., summer heat wave) where additional capacity is required for a relatively small number of hours per year to ensure sufficient capacity to serve the load.

Ancillary services: Reserve markets, frequency regulation, and ramping services, which each serves different objectives to help manage supply and demand over different timeframes and has its own rules and requirements.

Energy markets: Real-time and day-ahead markets for energy (no capacity payments); best suited for advanced customers having advanced dispatchable asse



Alignment with GEB Strategies



Market Service Types	Efficiency	Load Shift	Load Shed	Generate	Modulate	Notes
Capacity Market	●	●	●	◑	○	*Definition: Load reduction tools for securing future capacity to ensure resource adequacy (often emergency DR)* • Acceptability of generation assets depends on local emissions regulations that can be challenging for some backup fossil generators.
Ancillary Services	○	●	●	●	○	*Definition: Reserves for balancing supply and demand* • Includes ramping, spinning reserves, non-spinning reserves, and other ancillary services with response times of minutes to hours.
Ancillary Services (Ultra-Fast Response)	○	○	○	◑	●	*Definition: Ultra-fast response for maintaining grid frequency* • Frequency regulation, primarily from generation and storage, but research suggests viability via large-scale coordinated load control.[32]
Energy Market	○	◑	◑	●	○	*Definition: Wholesale merchant energy, or economic DR* • Includes real-time and day-ahead markets; curtailment may interrupt operations so it is less appealing than other services for building owners.
Legend	Increasing alignment of incentives between rate structure component and GEB strategy, ○ ◔ ◑ ◕ ●, where the empty circle represents no alignment and the full circle represents optimal alignment.					

Barriers to Utility Programs as GEB Enabler

Barrier		Opportunity
Limited availability – Lack of wholesale markets across large swaths of the US.	↔	Support federal regulatory change to expand reach of wholesale markets across entire US. Applies to: Regulators & policy makers
Inconsistent DER treatment (including building load)	↔	Unified market treatment (as sought by FERC Order 2222) and market/service standardization Applies to: Regulators & policy makers
Implementation complexity/burden – outdated IT systems and unnecessarily complex participation processes (e.g., modeling requirements) introduce administration burden (time/cost) that hinder participation, especially for small resources and Aggregators	↔	Support modernization and simplification of IT systems and processes for participation, including enrollment, data sharing (e.g., green button), and M&V. Applies to: Market operators, regulators & policy makers
State Opt-outs – FERC, via Order 719 and 719a from 2008, currently allows states to opt out of third-party Aggregator DR for wholesale markets (see discussion of progress in Section 3.3.1)	↔	Support regulatory change to eliminate opt-outs and improve participation consistency across markets/states/regions. Applies to: Regulators & policy makers
Utility inertia – lack of utility incentive to support or facilitate wholesale DR limits collaboration; utility involvement is typically required during registration	↔	Support regulatory alignment of incentives to improve stakeholder collaboration and streamline participation Applies to: Regulators & policy makers
Inconsistent market structures – includes penalties, M&V, performance definitions, etc.	↔	Support standardization of market design and/or unification of markets Applies to: Regulators & policy makers

Stakeholder Goal Alignment

	Incentive Mechanism-Related Goal	Goal Description	Stakeholder → Regulator	Grid Operator	Utility	Aggregator	Customer	3rd-Party Operator	Contractor
Good Alignment	**Reliability**	Protection from grid outages	X	X	X				
	High Power Quality	Maintaining appropriate voltage and/or frequency		X					
	Resource Adequacy	Sufficient capacity to ensure power availability for peak periods		X					
	Cost Reflective	Alignment with actual costs incurred to provide utility service	X		X				
Greatest Alignment	**Predictability**	Consistency and ability to anticipate bill savings				X	X	X	X
Good Alignment	**Bill/Cost Savings**	Customer OR utility ability to reduce costs			X	X	X		
	Maximize Revenue	Utility opportunity to generate revenue			X			X	
Good Alignment	**Occupant Satisfaction**	Comfort and productivity of people in the building					X	X	X
	Payment Structure Satisfaction	Comfort with the way in which bills/payments occur					X		

Opportunities for Expanded Use of Demand Flexibility

Financial Incentive Mechanism	Opportunity to Improve Access and Value of Demand Flexibility	Support For:
Cross Cutting	Consistency and standardization [All Incentive Mechanisms]	See below items with asterisk*
	Progressive utility business models [Rates/Markets]	Progressive state regulatory frameworks focusing on resiliency, reliability, decarbonization
	Modernization of IT systems and processes [Programs/Markets]	Modernized enrollment, data sharing (e.g., green button), and M&V for reduced administrative burden
Rate Structures	Alternative/modern rate design	Modern rate design approaches
	Standardized practices for modern rate design	*Increased consistency in rate design approaches and structures between utilities (despite necessarily differing prices)
Utility Program Structures	Standardized program models	*Increased consistency in DR program design and implementation between utilities
	Standardized policy	*Increased consistency of regulatory and policy treatment by states
Market Structures	Expanded wholesale markets	Federal regulatory change to expand reach of wholesale markets across entire US
	Standardized treatment across markets	*Unified markets and/or DER treatment (as sought by FERC Orders 2222/2222-A) and market/service standardization
	Regulatory changes	*Elimination of state opt-outs and enable consistent participation across markets/states/regions
	Improved stakeholder collaboration	Regulatory alignment of incentives with utilities to streamline participation

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