Future Electric Utility Regulation Series Report #4:

Distribution System Pricing With Distributed Energy Resources

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Future Electric Utility Regulation Series

- A new series of reports from Lawrence Berkeley National Laboratory taps leading thinkers to grapple with complex regulatory issues for electricity
- Unique point-counterpoint approach highlights different views on the future of electric utility regulation and business models and achieving a reliable, affordable and flexible power system
- Primary funder: DOE Office of Electricity Delivery and Energy Reliability, National Electricity Delivery Division
- Reports published or underway:
  1. *Distributed Energy Resources (DERs), Industry Structure and Regulatory Responses*
  2. *Distribution Systems in a High DER Future: Planning, Market Design, Operation and Oversight*
  3. *Performance-Based Regulation in a High DER Future*
  4. *Distribution System Pricing With DERs* – **Today's topic**
  5. *Recovery of Utility Fixed Costs: Utility, Consumer, Environmental and Economist Perspectives* (June 2016)
  6. *Future of Resource Planning* (In development)
- Additional reports forthcoming: **feur.lbl.gov**
- Expert advisory group (next slide) provides guidance and review

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Housekeeping Items

- We're recording the webinar and will post it on our web site.
- Because of the large number of participants, everyone is in *listen* mode only.
- **Please use the chat box** to send us your questions and comments any time during the webinar.
- The report authors will present for about a half-hour.
- Moderated Q&A will follow, with the report authors responding to questions and comments in the chat box.
- The report and webinar slides are posted at feur.lbl.gov

About the Authors

Ryan Hledik is Principal of The Brattle Group

- Specializes in the economics of policies and technologies that are focused on the energy consumer
- Has worked with more than 50 clients across 30 states and eight countries
- Clients include utilities, policymakers, law firms, technology firms, research organizations, and wholesale market operators in matters related to retail rate design, energy efficiency, demand response, distributed generation, and smart grid investments
- M.S. in Management Science & Engineering from Stanford; B.S. in Applied Science from The University of Pennsylvania

Jim Lazar is Senior Advisor of The Regulatory Assistance Project

- 37 years of experience in 29 states and 11 countries
- Specializes in utility pricing and resource planning
- Recent publications include Electricity Regulation in the U.S., Revenue Regulation and Decoupling, Incorporating Environmental Costs in Electric Rates, Rate Design Where Advanced Metering Infrastructure Has Not Been Fully Deployed, Smart Rate Design for a Smart Future

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The four pricing models

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Conclusions and recommendations

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Background

With widespread adoption of distributed energy resources (DERs), the **nature of the relationship** between the customer and the electric utility will change.

Opportunities for DERs to improve the reliability of the electric service and reduce the cost of utility upgrades **will collide** with declining system control and declining retail revenues to utilities.

It is also possible that adoption of DERs will impose **additional costs** on the distribution system, depending largely on the degree of market penetration.

Customers, particularly those with DERs, may need **less than a "full meal deal"** from their utility and are in a position to provide certain discrete services to utilities for the benefit of other customers.

Our report addresses the following

What are the distribution services:

- provided **by** DER customers to the utility?
- provided **to** DER customers by the utility?

What are **models** for pricing and packaging these services?

How should the merits of these pricing models be **evaluated**?

What are **advantages & disadvantages** of the pricing models?

What are key **next steps** for policymakers & state regulators?

A few notes about scope

In scope

- ✓ Pricing of distribution services (including customer services)
- ✓ Assume potential future state of the world (2030 and beyond) with high adoption of DERs
- ✓ Assume any necessary changes in infrastructure have been made to accommodate this new state of the grid

Out of scope

- ✗ Pricing of generation and transmission ("supply") services (though there are interactions with distribution services)
- ✗ We do not comment on cost-effectiveness of DERs, but rather discuss pricing models that promote efficient adoption of DERs.

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The four pricing models

Pricing Model	Description
Granular Rate	Highly disaggregated rate in which each distribution service is priced separately and avoided through self-supply or otherwise paid for by the DER customer
Buy/Sell Arrangement	A bifurcated rate in which the DER customer pays a simple, bundled price for use of the distribution system and is separately paid for distribution services provided to the utility under a different pricing structure
Procurement Model	Utilities procure distribution services from non-regulated third parties who aggregate the services provided by individual DER customers and compensate those customers accordingly
DER-Specific Rates	A different rate is offered to each class of DER customer to reflect the costs of serving that type of customer as well as the value of the services that the specific class of DER customers provide

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There is no single prototypical utility

Electric utilities are inherently diverse:

- Vertically integrated, wires-only
- Investor-owned, public power, cooperatives
- Different resource mix, customer mix, policy objectives, regulatory environment

Many factors will determine the extent to which the pricing models are applicable to individual circumstances.

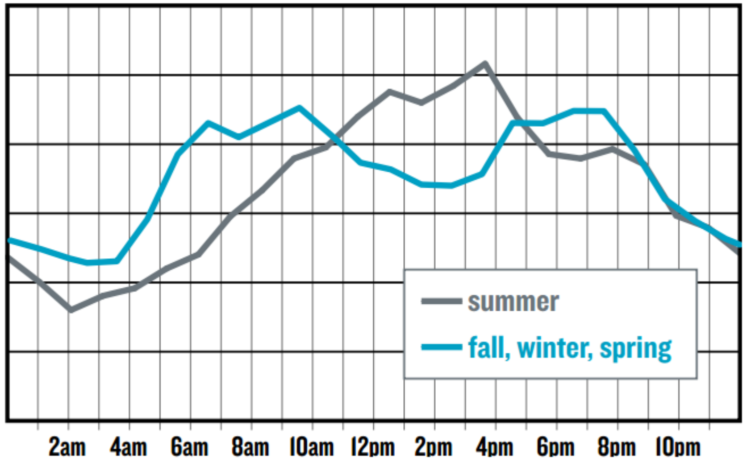
The following is one possible vision for the future, based on the author's experience assisting utilities in distribution pricing matters.

The granular pricing model

Vision for 2030

- Modestly increase granularity in distribution rates for all customers
- For residential, consider introducing demand charge and/or time-varying volumetric charge
- For commercial & industrial, consider hourly or sub-hourly pricing
- Key challenge: Balancing simplicity with improvement in fairness & efficiency for all customers

Example: ComEd's RRTP Rate



**Based on average prices for January 2012 through April 2014. Nonsummer months include October through May. Summer months include June through September.*

Source: ComEd website.

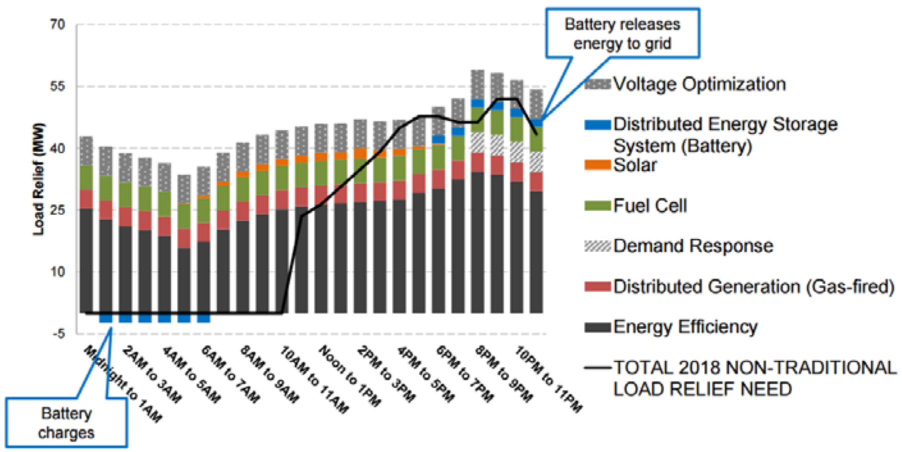
Hourly real-time pricing rate with day-ahead notification for residential customers (includes supply services)

The procurement model

Vision for 2030

- Establish RFP-based procurement model to encourage location-specific adoption of DERs
- Works best where there is a robust market for aggregators
- As experience improves, could eventually transition to auction-based approach with well-defined products
- Integrate into distribution resource planning activities

Example: Con Edison BQDM Project



Source: Con Edison, "Brooklyn Queens Demand Management Program" (BQDM) program update briefing, Aug. 27, 2015.

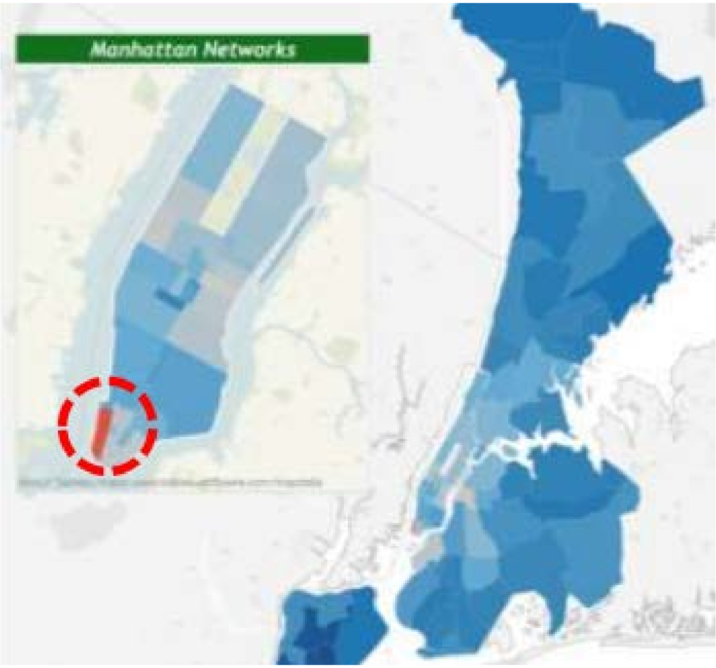
56 MW of load reduction procured from DERs to defer upgrade in substation capacity

Buy/sell arrangement

Vision for 2030

- Use buy/sell model to ensure that under-represented customer segments have an incentive to adopt DERs efficiently
- Target customer base should be those with economic potential who are not pursued by aggregators (perhaps smaller customers)
- Compensation should be technology-neutral and based on avoided costs

Example: Con Edison DLRP



Source: Con Edison, Demand Response Forum presentation, February 4, 2016

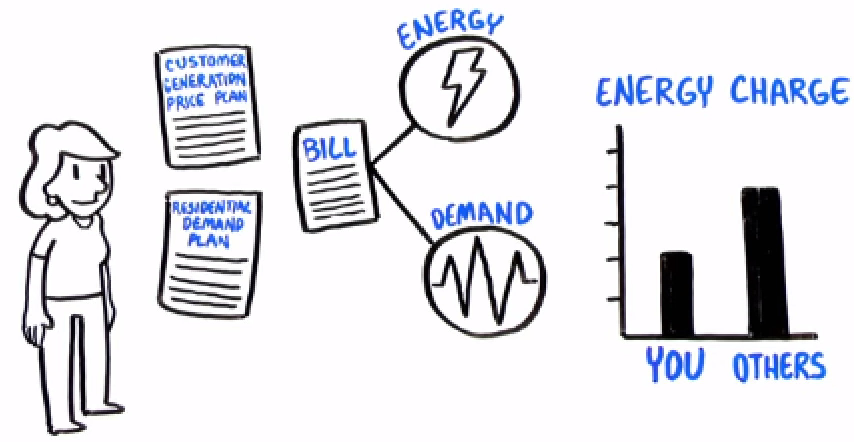
Demand response program with premium paid to participants in network locations with greater need

DER-specific rates

Vision for 2030

- Limit DER-specific rates to important, unique applications
- For example, an optional smart home rate for customers with grid-connected appliances or an EV rate to encourage off-peak vehicle charging
- The specific applications and whether mandatory or voluntary will depend on policy objectives of each jurisdiction

Example: SRP's Customer Generation Price Plan



Source: SRP website. http://www.srpnet.com/prices/home/customergenerated.aspx

Three-part rate for residential customers with distributed generation

Key considerations in the transition

- ❑ What are future distribution system needs?
- ❑ How “deep” is the market opportunity?
- ❑ What are the technical constraints?
- ❑ Will it reduce costs?
- ❑ What are the distributional bill impacts?
- ❑ **Is it worth the effort?**

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Three Guiding Principles

- **Principle 1:** A party that is in control of a DER function should bear the economic consequences of exercising that control; correspondingly, the party (or its agent) who bears the economic consequences of exercising control over a DER should exercise control over the DER.

- **Principle 2:** A party in control of a DER should be presented with appropriate economic opportunities and consequences so that efficient choices will be made.

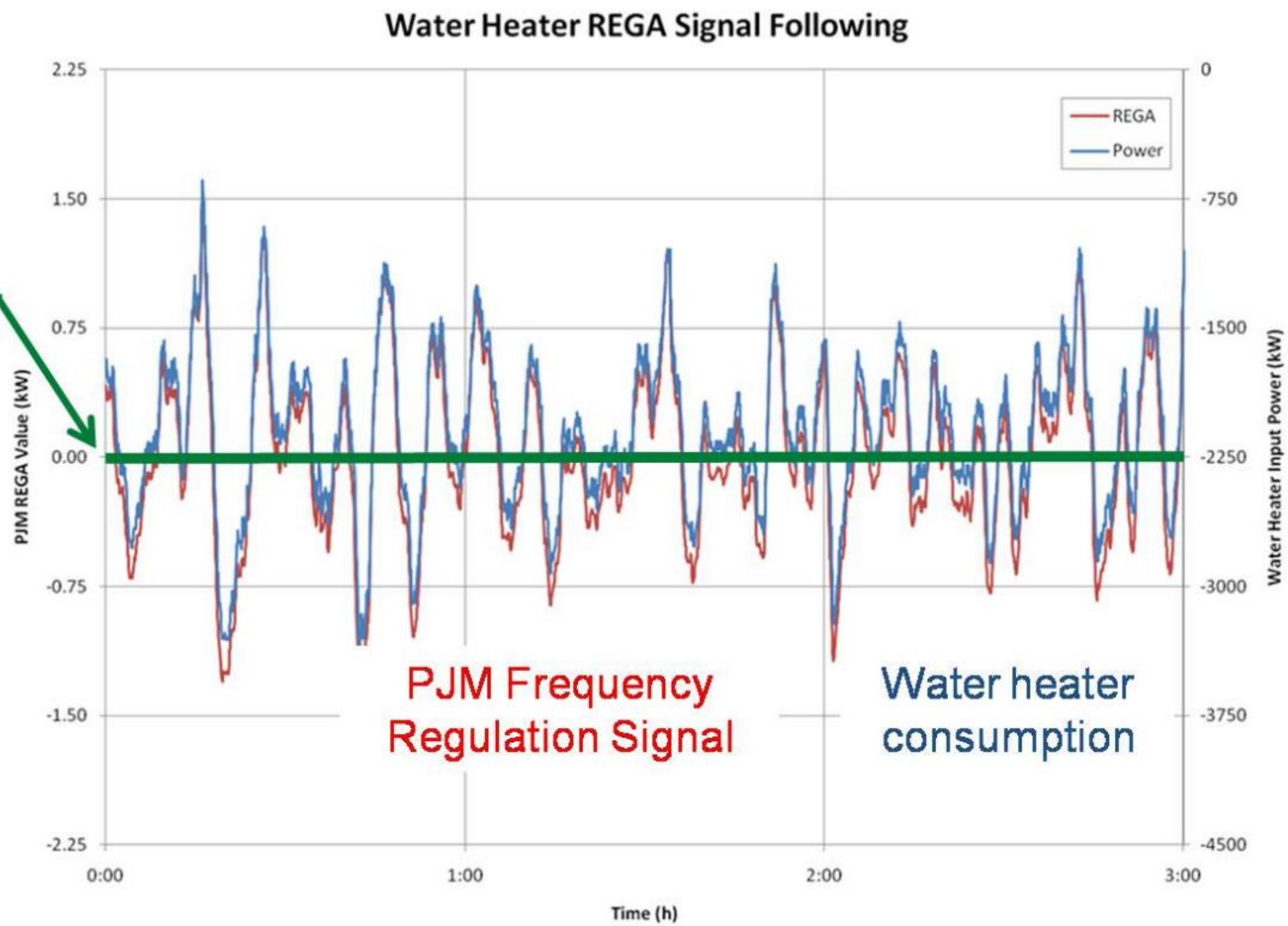
- **Principle 3:** The owner of a DER should be appropriately compensated when another party exercises control of the DER for that party's own or another's benefit.

What DERs Are Consumers Likely to Own?

What Services Can These Provide?

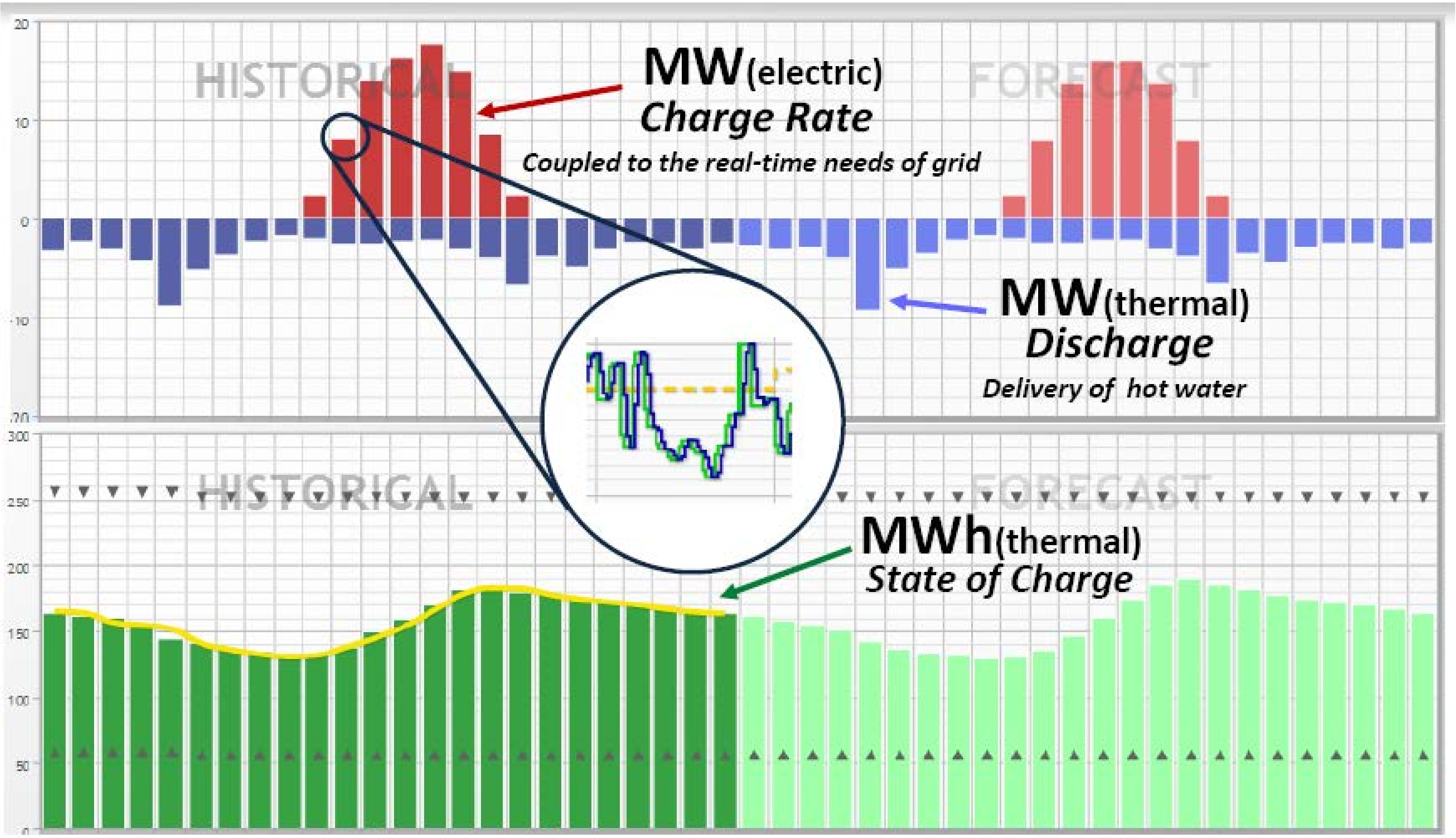
Fast Regulation

Charging is varied **UP and DOWN** from a "bid in" base line.



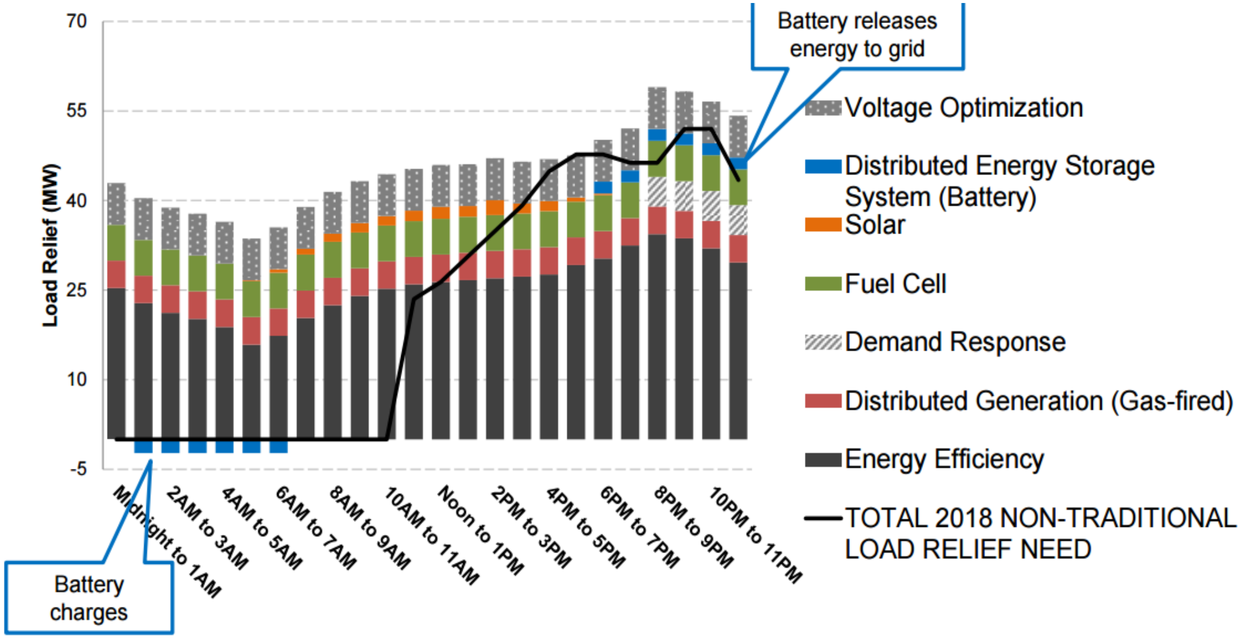
What Services Can These Provide?

Diurnal Storage and Load Shifting



What Services Can These Provide?

Dispatchable Capacity



Granular Rate: Demand Charges Inappropriate

Table 12. Application of Garfield and Lovejoy Criteria to Demand Charges

Garfield and Lovejoy Criteria	CP Demand Charge	NCP Demand Charge	TOU Energy Charge
All customers should contribute to the recovery of capacity costs.	N	Y	Y
The longer the period of time the customer preempts (uses) the capacity, the more the customer should pay for the use of that capacity.	N	N	Y
Any service making exclusive use of capacity should be assigned 100% of the relevant costs.	Y	N	Y
The allocation of capacity costs should change gradually with changes in the pattern of usage.	N	N	Y
Allocation of costs to one class should be affected by how remaining costs are allocated to other classes.	N	N	Y
More demand costs should be allocated to usage on-peak than off-peak.	Y	N	Y
Users of interruptible service should be allocated less capacity costs, but still contribute something.	Y	N	Y

Source: Garfield and Lovejoy (1964), 163–164.

CP - Coincident Peak; NCP - non-coincident peak; TOU – time-of-use. Y indicates that the rate option meets the criterion; N indicates that the rate design does not meet the criterion.

Granular Rate Not Pragmatic

Table 11. Illustrative Granular Rate

	Systemwide Average Rate [A]	Locational Rate Adjustment [B]	Total Rate [C]=[A]+[B]	Amount Used [D]	Total Charge [C] x [D]
Capacity Need for Consumption					
System Peak Charge ($/kWh)	$0.0108	$0.0100	$0.0208	300	$6.24
System Off-Peak ($/kWh)	$0.0020	$0.00	$0.0020	700	$1.40
Class Peak Charge ($/kWh)	$0.0064	$0.01	$0.0164	400	$6.56
Class Off-Peak Charge ($/kWh)	$0.0010	$0.00	$0.0010	600	$0.60
Grid Connection Charge ($/kWh)	$0.0050	$0.00	$0.0050	1,000	$5.00
Capacity Need for Net Excess Generation					
System Peak Charge ($/kW)	$0.00	$0.00	$0.00	0	0
Local Distributed Generation Coincident Peak Export Charge ($/kW)	$0.00	$1.50	$1.50	0	0
Power Quality and Reliability					
Frequency Control ($/kWh)	$0.0005	$0.00	$0.0005	1,000	$0.50
Voltage Support ($/kWh)	$0.0003	$0.00	$0.0003	1,000	$0.30
Power Factor Control ($/kWh)	$0.0010	$0.00	$0.0010	1,000	$1.00
Other Power Quality Services ($/kWh)	$0.0002	$0.00	$0.0002	1,000	$0.20
Other Services					
Maintenance ($/kWh)	$0.0005	N/A	$0.0005	950	$4.75
Metering and Billing ($/Month)	$5.00	N/A	$5.00	1	$5.00
Other Administrative ($/Month)	$1.00	N/A	$1.00	1	$1.00
Taxes and Fees					
Sales Tax (%)	3.0%				$0.98
Total					$33.53

Buy/Sell Is Workable

Table 13. Buy/Sell Arrangement: Charges and Payments

Distribution System Use Charges			
	Price	**Amount Used**	**Total Charge**
Volumetric charge ($/kWh)	$0.03	1,000	$30.00
Customer charge ($/month)	$10.00	--	$10.00
		Total Charges	$40.00
Location-Specific Distribution Services Payments			
			Credit
Capacity services ($/month)			($3.00)
Power quality services ($/month)			($2.00)
		Total Credits	($5.00)
Total Bill			$35.00

Buy/Sell Addresses Concerns With NEM

Solar Advocate View of Net Metering

Buy/Sell Addresses Concerns With NEM

Utility View of Net Metering

Buy/Sell — Value of Solar Approach

Procurement Model Can Work

- Incentive to Install Controlled Water Heater — **$200**
- Monthly bill credit for Controlled Water Heater — **$10/month**
- Per-incident over-ride fee — **$1/day**

Resource-Specific Rates Can Work

Table 15. Illustrative GIWH-Specific Residential Rate

Standard Residential Rate			
	Price	Amount Used	Total Charge
Volumetric charge ($/kWh)	$0.03	1,000	$30.00
Customer charge (fixed $/month)	$10.00	—	$10.00
		Total Bill:	**$40.00**
Rate for Customers With Uncontrolled Electric Water Heating			
	Price	Amount Used	Total Charge
Volumetric charge ($/kWh)	$0.04	1,000	$40.00
Customer charge (fixed $/month)	$10.00	—	$10.00
		Total Bill:	**$50.00**
Rates for Customers With Controlled Electric Water Heating			
	Price	Amount Used	Total Charge
Volumetric charge ($/kWh)	$0.025	1,000	$25.00
Customer charge (fixed $/month)	$10.00	—	$10.00
		Total Bill:	**$35.00**

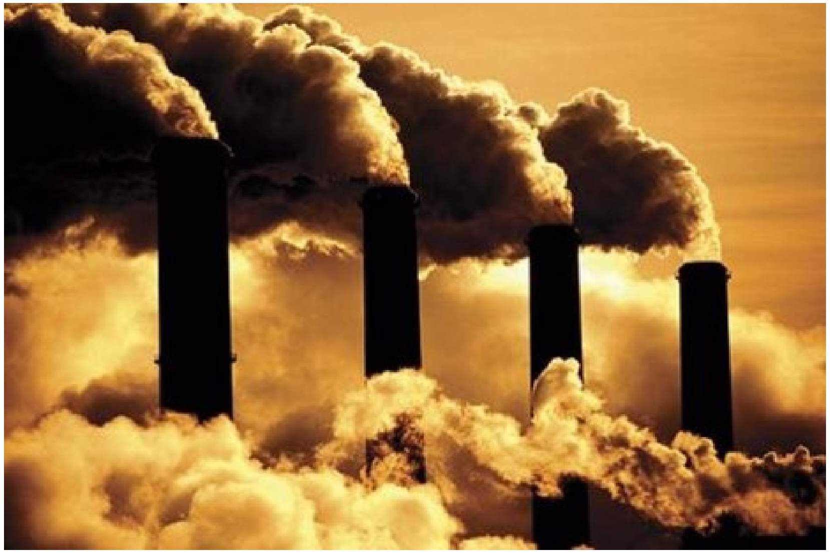
Utilities Already Have Resource-Specific Rates

Table 16. Lake Country Electric Cooperative's "Energy Wise" Rate

Rate Component	Rate
Summer Energy Price (June–August)	$.1198/kWh
Winter Energy Price (December–February)	$.1098/kWh
Shoulder Energy Price (Other Months)	$.0998/kWh
Off-Peak Space Heating; Off-Peak Water Heating	$.0465/kWh
8-Hour Interruptible Water Heating; Cycled Air-Conditioning	$.058/kWh

Assess Power Supply Impacts

- This paper only addresses distribution system costs and benefits.
- Most DERs have upstream impacts — and the benefits may be greater on the power supply side.
- Environmental and health benefits are significant for power supply impacts.



A Vision for 2030 and Beyond

- **Universal Service:** Customers should be able to connect to the grid for no more than the cost of connecting to the grid.
- **Time-Varying:** Customers should pay for grid services (and power supply) in proportion to how much they use and when they use it.
- **Fair Compensation:** Customers supplying power and other services to the grid should be compensated fairly for the value they provide.

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Conclusions and Recommendations

- Gather stakeholder input
- Conduct market research and measure customer response
- Quantify potential value and net value
- Implement pricing pilots
- Assess power supply impacts
- Identify specific categories of distribution services and (power supply) ancillary services that can be most economically provided through DERs

Gauge Consumer Acceptance and Response

Gauge Consumer Acceptance and Response

Pilot Programs Are Needed

- Test multiple concepts
- All four models
- Seek compatible service territories
- Measure response to opt-in, default and mandatory options

What Services Are Best Provided by DERs?

- Specific ancillary services
  - Smart inverters: voltage support
  - Water heaters: fast regulation, diurnal storage
- Role for federal coordination of research
  - Development of appliance standards
- Some differences across geographic areas
  - Southern states have high electric water heating penetration

Questions?

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