RESILIENT POWER
A project of CleanEnergyGroup

Identifying Potential Markets for Commercial Behind-the-Meter Battery Storage

September 19, 2017

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Innovation in Finance, Technology & Policy

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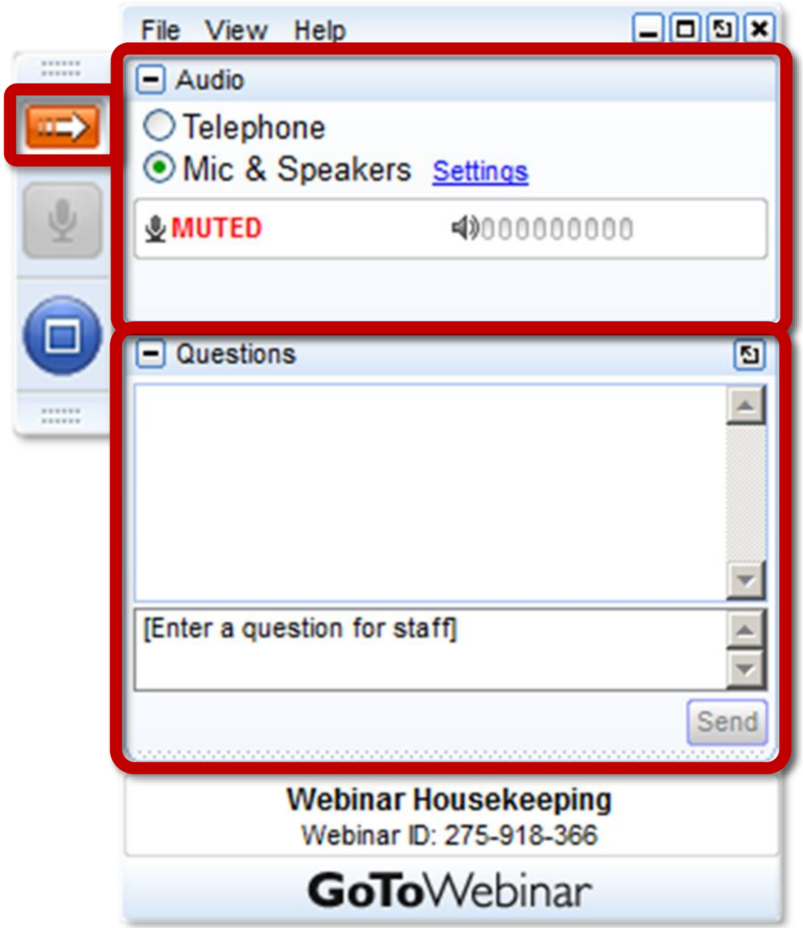

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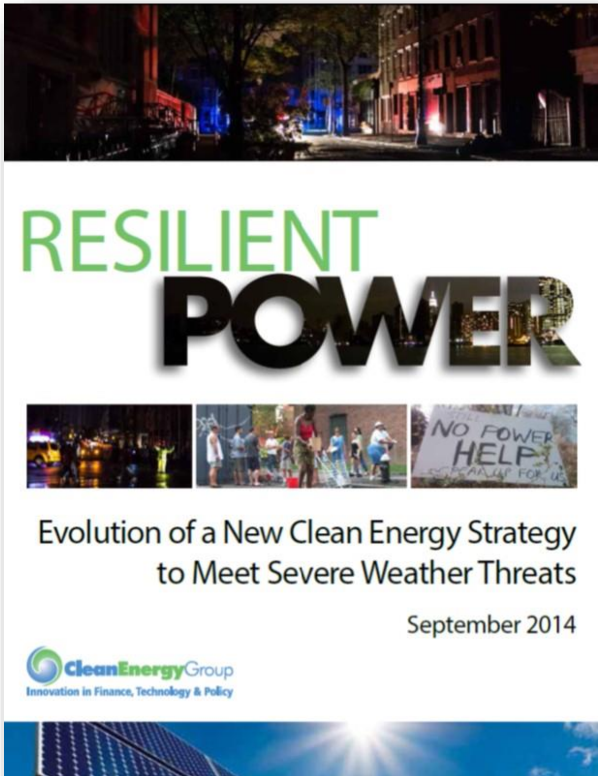

www.cleanegroup.org

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Meridian Institute
Connecting People to Solve Problems

CleanEnergy States Alliance

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THE SCHMIDT FAMILY FOUNDATION

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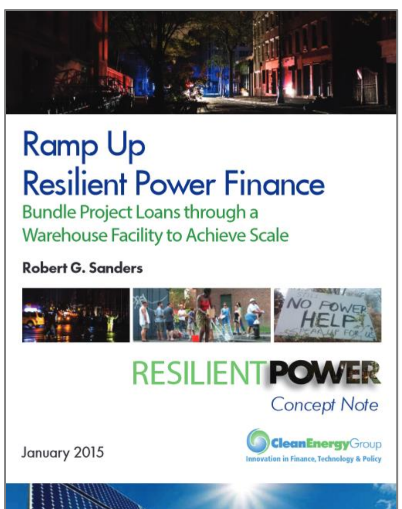
THE NATHAN CUMMINGS FOUNDATION

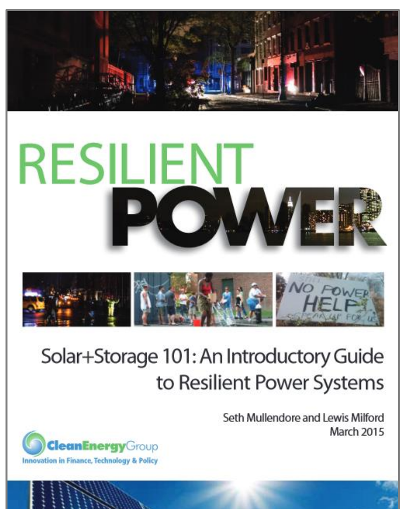
THE KRESGE FOUNDATION

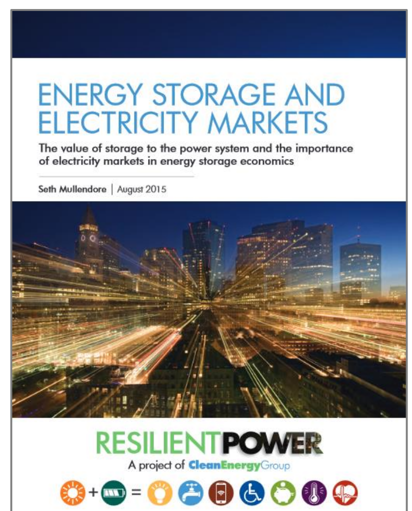
SURDNA FOUNDATION
Fostering sustainable communities in the United States

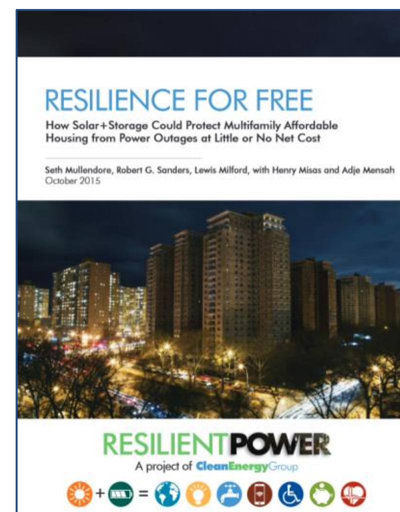
Resilient Power Project

- Increase public/private investment in clean, resilient power systems
- Engage city officials to develop resilient power policies/programs
- Protect low-income and vulnerable communities
- Focus on affordable housing and critical public facilities
- Advocate for state and federal supportive policies and programs
- Technical assistance for pre-development costs to help agencies/project developers get deals done
- See www.resilient-power.org for reports, newsletters, webinar recordings









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Resilient Power Project

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RESILIENT POWER PROJECT

To reduce impacts and dangers of power outages in communities now and in the future, the Resilient Power Project works to provide technology and policy solutions to address three challenges: Community Resiliency, Climate Adaptation, and Climate Mitigation.

Overview | Toolkits | Publications | Webinars | Blog | Newsletters | FAQs | Project Map | Featured Installations

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The Resilient Power Project, a joint initiative of Clean Energy Group and Meridian Institute, is focused on accelerating market development of resilient, clean energy solutions for affordable housing and critical community facilities in low-income and disadvantaged communities. The Project is targeted to the deployment of solar PV combined with energy storage (solar+storage) – to power essential services during extended power outages and to reduce the economic burden of energy costs in vulnerable communities. The goal is to further clean energy equity by ensuring that all communities have access to the economic, health, and resiliency benefits that solar and energy storage technologies can provide.

Clean Energy Group's role in this process is to inform, coordinate, and assist in the planning and implementation of resilient power projects in underserved communities, in both rural and urban areas, across the country. In addition to providing program guidance to policy makers and technical assistance to developers and community organizations, we also prepare reports and analysis on resilient power programs and projects, clean

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Panelists

- **Joyce McLaren**, Senior Energy Analyst, National Renewable Energy Laboratory
- **Seth Mullendore**, Project Director, Clean Energy Group (Moderator)

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Identifying Potential Markets for Behind-the-Meter Battery Energy Storage: A Survey of U.S. Demand Charges

Seth Mullendore
Clean Energy Group
September, 19 2017

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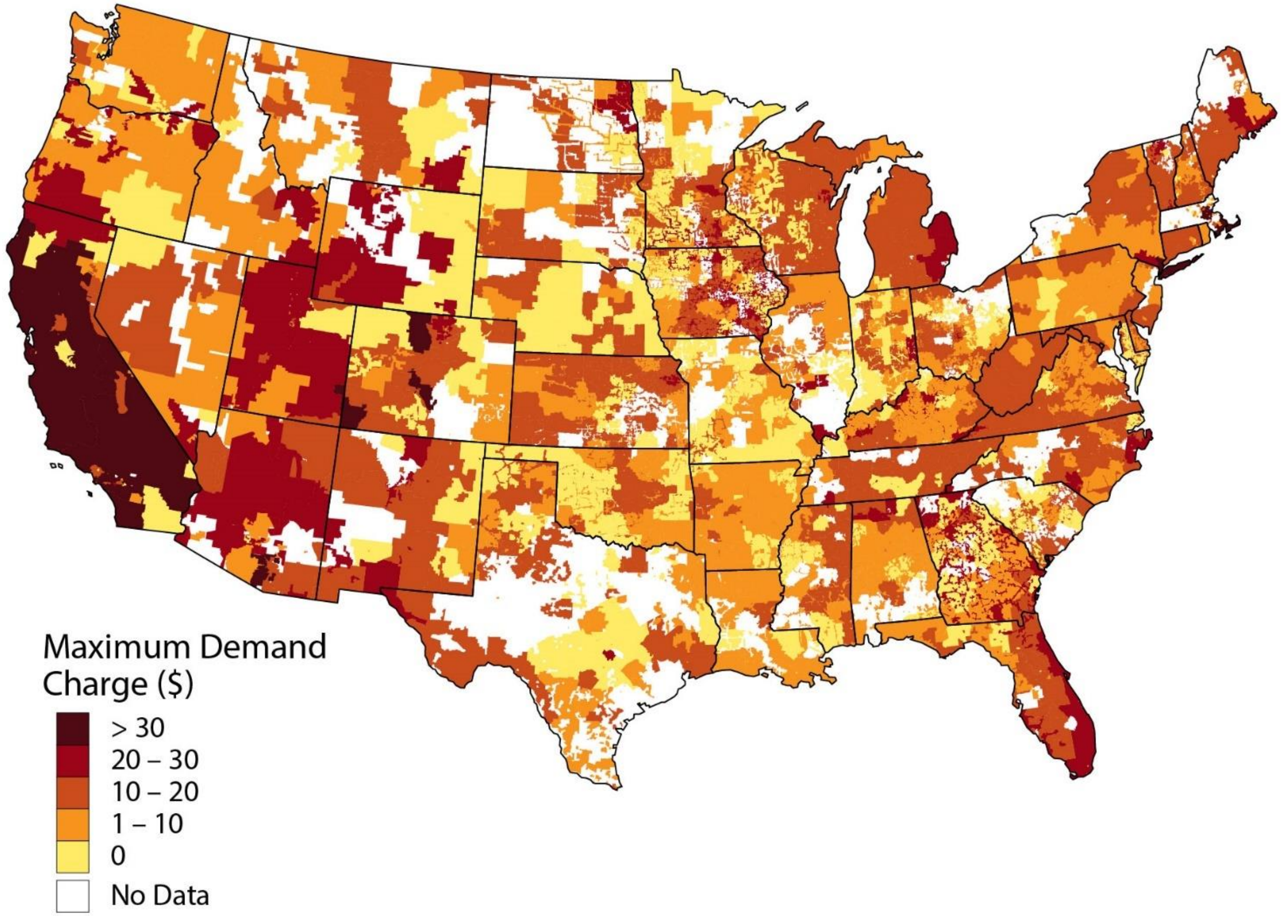
A Survey of U.S. Demand Charges

Analysis of more than 10,000 utility tariffs
Available to 70% of commercial buildings



Key Findings

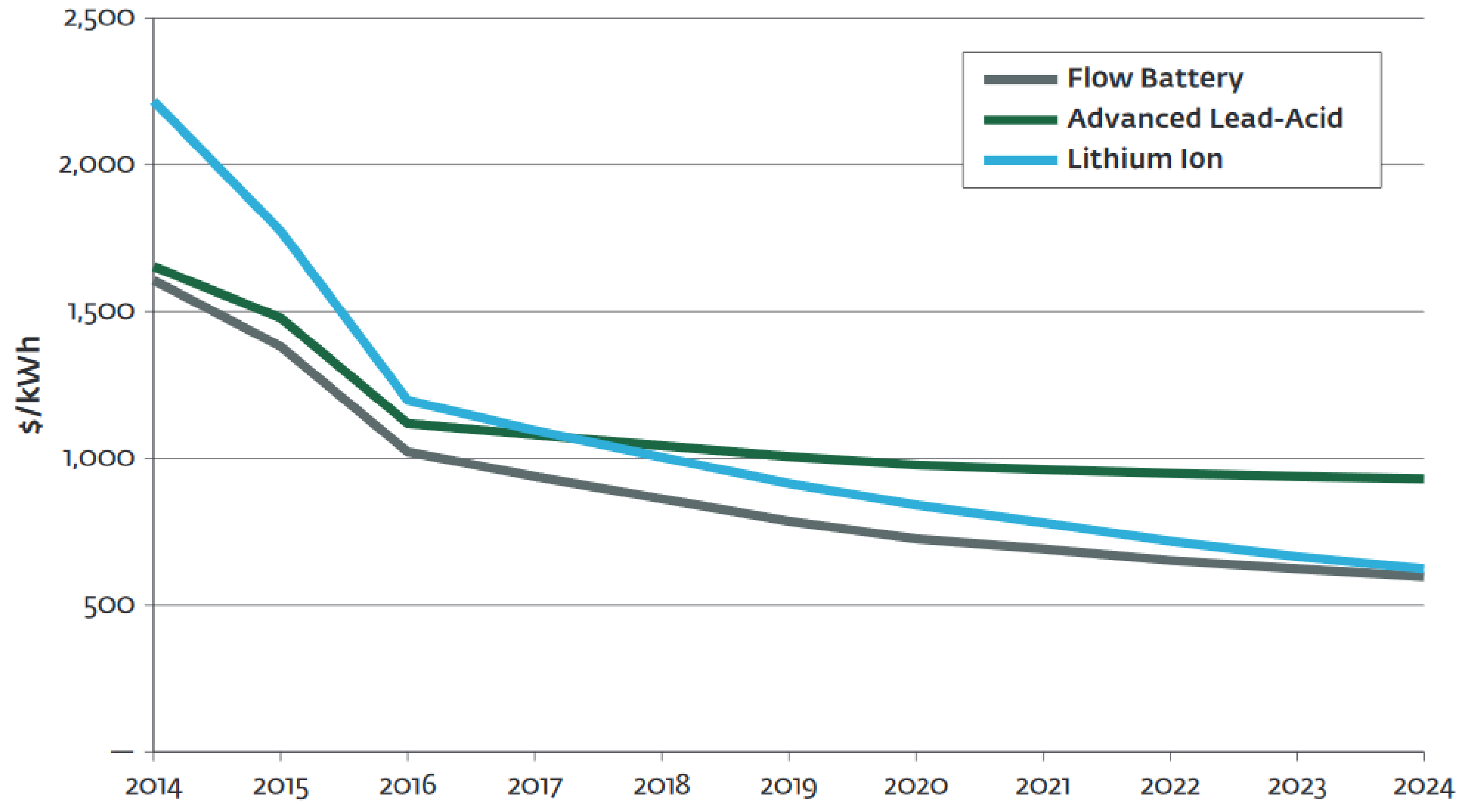
- Nearly 5 million commercial customers (more than 25% of U.S. customers) can subscribe to electricity tariffs with demand charges at a level where battery storage may make economic sense ($15/kW)

- Potential for significant market opportunities across the country, not just first-mover states

- Some of country's highest demand charges exist in states not known for high energy prices, such as Colorado, Nebraska, Arizona, Illinois, and Georgia

Battery system costs continue to fall

Chart 2.2 Behind-the-Meter Energy Storage System Cost Trends by Technology, Global Averages: 2014–2024



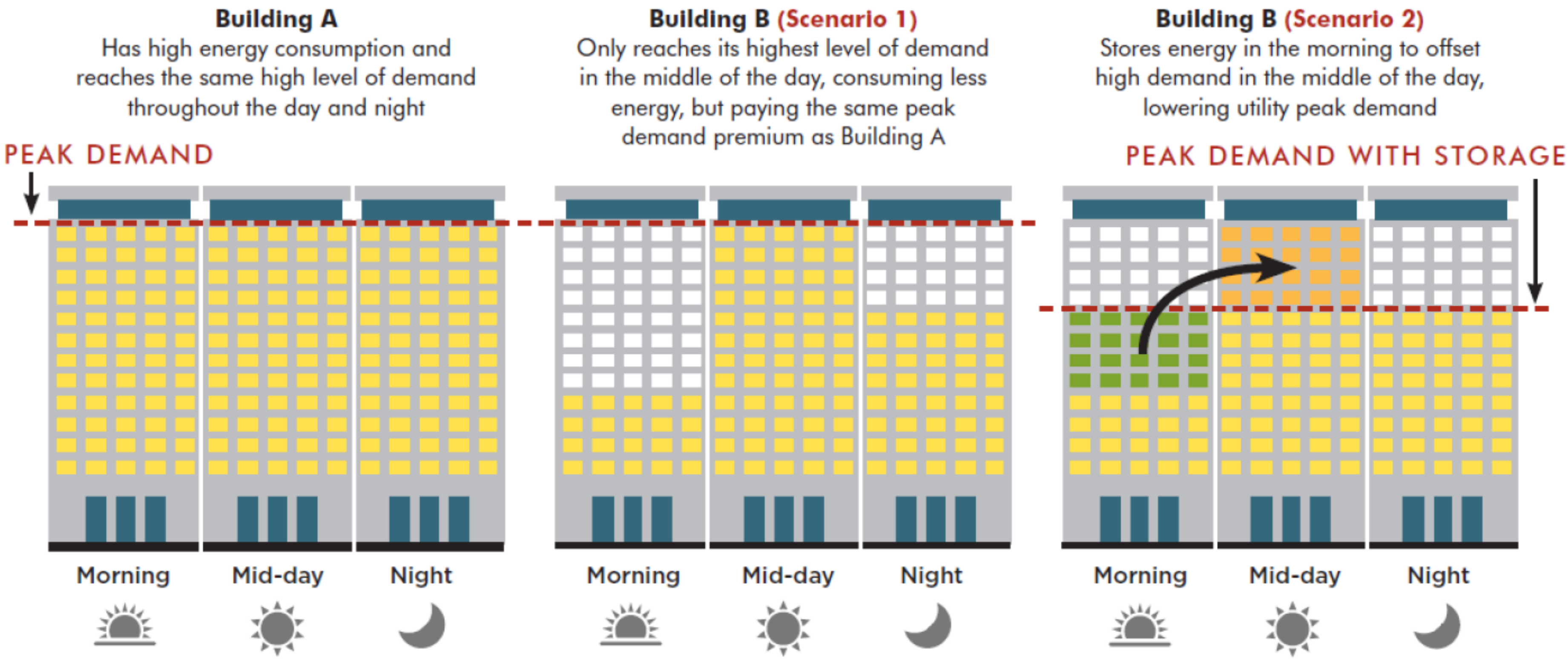
(Source: Navigant Research)

What are demand charges?

Along with fixed monthly fees, commercial customers are typically billed for electricity in two distinct ways: **consumption** (energy) charges and **demand** charges

Table 1. Types of Charges	Consumption Charge	Demand Charge
What are you paying for?	Total amount of electricity used during a billing period	Highest level of electricity used during a billing period (“peak demand”)
Customer Type	Residential and Commercial	Commercial
Unit of Measurement	Kilowatt-hours (kWh)	Kilowatts (kW)

Consumption vs Demand



In **Scenario 1**, Building A and Building B will incur the same peak demand charges over the course of the day, even though Building A will have consumed considerably more energy during that time. In **Scenario 2**, Building B can use energy storage to reduce its mid-day grid energy consumption by meeting some of its demand with on-site stored energy. **This could reduce its overall peak demand** for the period, resulting in a lower utility bill.

- **Grid Energy Consumption**
- **Stored Energy**
- **Stored Energy Consumption**

Who pays demand charges?

- Nearly all medium and large commercial customers in every state are obligated to pay demand charges

- This includes traditional commercial customers (private and nonprofit businesses) as well as a wide array of additional customer types such as community facilities, public buildings, and multifamily housing properties

How are customers billed for demand?

- Demand charges are typically based on a customer's **peak demand** during each billing period
- Peak demand is usually defined as the **highest average electricity usage** occurring within a defined time interval (often 15 minutes)
- Demand charges often account for **30% - 70%** of a customer's monthly electric bill.
- Demand charge rates **vary considerably** across utilities, locations, building sizes, and building types.

Charges on an Electric Bill

SDG1 Annual Electric Bill

ENERGY

		Usage (kWh)	Cost ($/kWh)	Total cost ($)
Max	Summer	13,085	0.11447	1,497.82
	Winter	7,827	0.10565	826.97
Peak	Summer	15,259	0.10568	1,612.59
	Winter	35,189	0.09132	3,213.46
Part-Peak	Summer	26,959	0.07920	2,135.17
	Winter	46,612	0.07160	3,337.42
TOTAL		**144,932**		**$12,623.43**

Energy Charges 49%

DEMAND

		Avg peak (kW)	Cost ($/kW)	Total cost ($)
Max	Summer	33	22.55	2,958.56
	Winter	30	22.55	5,195.52
Peak	Summer	33	19.19	2,517.73
	Winter	24	6.86	1,279.49
Part-Peak	Summer	30	0.00	0.00
	Winter	30	0.00	0.00
TOTAL				**$11,951.30**

Demand Charges 46%

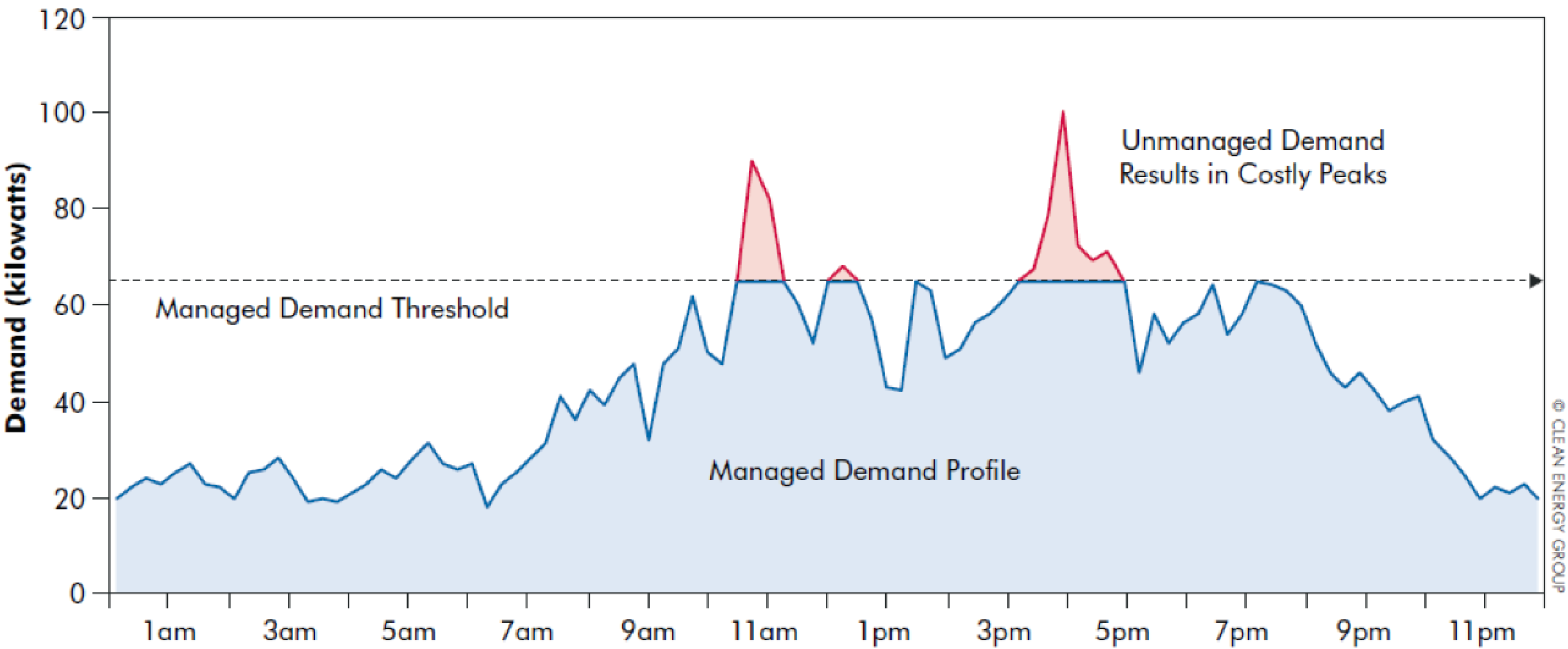
FIXED

	Total cost ($)
Meter charge	1,397.28
TOTAL	**$1,397.28**

Fixed Charges 5%

TOTAL ANNUAL BILL $25,972.01

How can battery storage reduce demand charge expenses?



Through the deployment of an energy storage system, peak demand can be effectively capped at a specified level—significantly reducing utility demand charges. Assuming a demand charge of $15 per kilowatt and peak demand reduction from 100 kilowatts to 65 kilowatts each period (as shown here), energy storage could reduce the customer's demand charge by $525 per billing period, amounting to an annual savings of $6,300.

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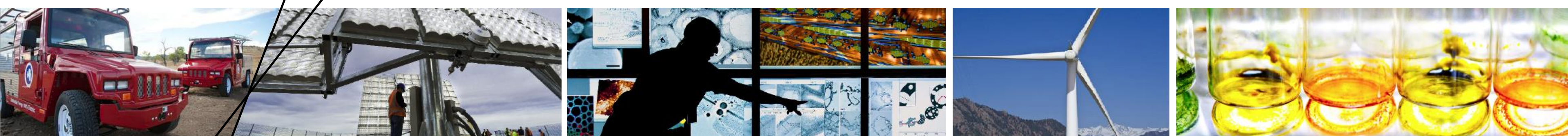
A Survey of U.S. Demand Charges



Clean Energy Group Webinar

Joyce McLaren

September 19, 2017

NREL is a national laboratory of the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, operated by the Alliance for Sustainable Energy, LLC.

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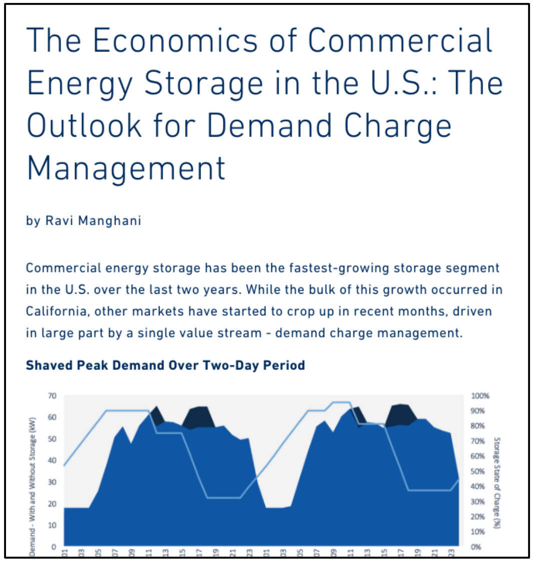
High demand charges are a critical factor in battery project economics

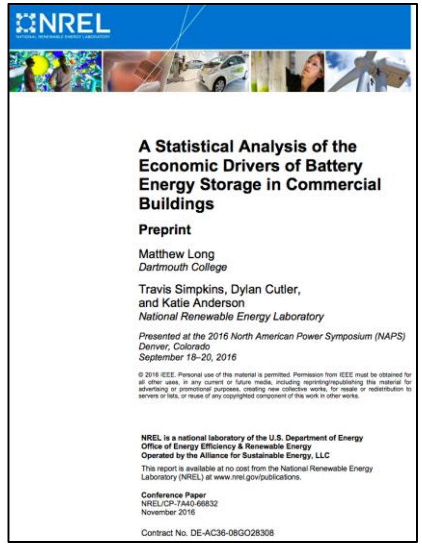


The Economics of Commercial Energy Storage in the U.S.: The Outlook for Demand Charge Management

by Ravi Manghani

Commercial energy storage has been the fastest-growing storage segment in the U.S. over the last two years. While the bulk of this growth occurred in California, other markets have started to crop up in recent months, driven in large part by a single value stream - demand charge management.

Shaved Peak Demand Over Two-Day Period



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A Statistical Analysis of the Economic Drivers of Battery Energy Storage in Commercial Buildings

Preprint

Matthew Long
Dartmouth College

Travis Simpkins, Dylan Cutler, and Katie Anderson
National Renewable Energy Laboratory

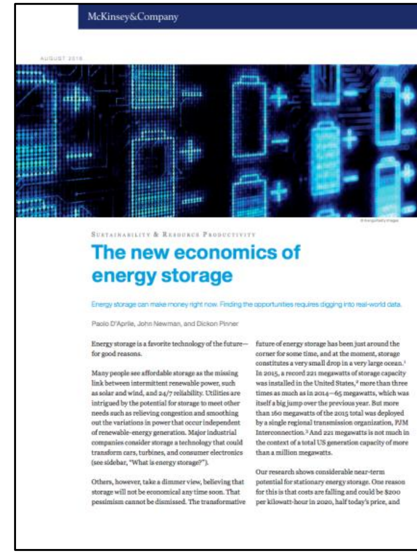
Presented at the 2016 North American Power Symposium (NAPS) Denver, Colorado September 18–20, 2016

NREL is a national laboratory of the U.S. Department of Energy Office of Energy Efficiency & Renewable Energy Operated by the Alliance for Sustainable Energy, LLC

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

Conference Paper
NREL/CP-7A40-66832
November 2016

Contract No. DE-AC36-08GO28308



McKinsey&Company

The new economics of energy storage

Energy storage can make money right now. Finding the opportunities requires digging into real-world data.

“Commercial energy storage has been the fastest-growing storage segment. . . driven in large part by a single value stream — demand charge management.”

–GTM 2016

“It is observed that demand charge is the strongest predictor and battery cost is the second strongest predictor of whether or not a BESS will be economically viable.”

–NREL 2016

“Our model calculates that in North America, the break-even point for most customers paying a demand charge is about $9 per kilowatt.”

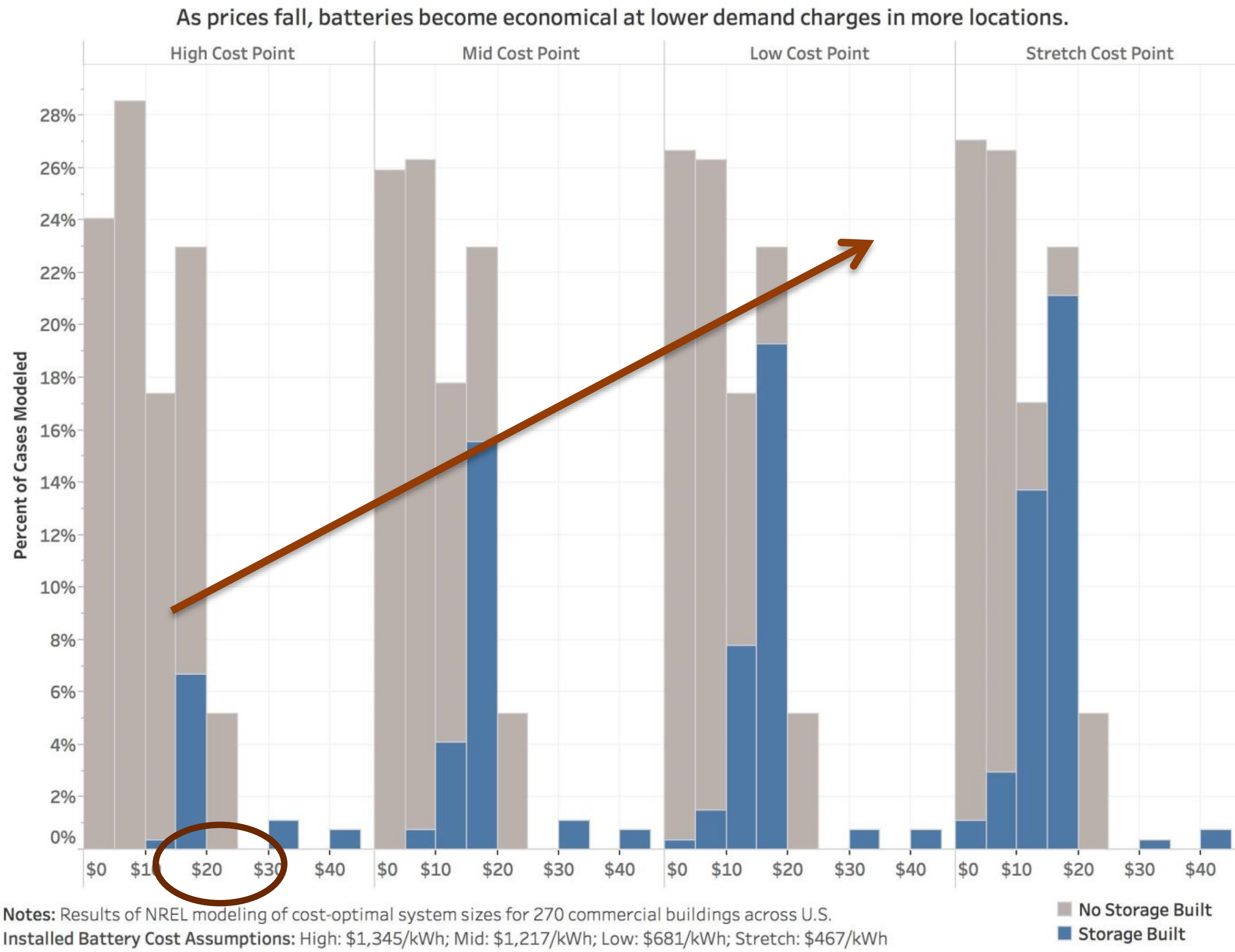
-McKinsey & Company 2016

Questions addressed by the analysis

- *How prevalent are commercial demand charges?*
- *How are demand charges dispersed across the country?*
- *How high are demand charges?*
- *How many customers are eligible for a rate with a maximum demand charge of >$15?*
- *How about >$20?*

Why a $15 threshold?

As costs decline, more storage projects are economical at the $15 demand charge range (based on NREL commercial storage cost-optimization modeling).



Demand Charge Variations

Type	Characteristics	Example	Assumption
Flat	Independent of the time, season or usage	$15	Sum of all demand charge elements, if separated.
Time of Use	Based on time of day	$15 between 2pm – 6pm $5 all other times of day	The highest time of day is used.
Seasonal	Based on season	June – August $15/kW September – May $5/kW	The highest seasonal rate is used.
Tiered (less common)	Based on usage	$5/kW first "X" kW, $10/kW for next "Y" kW $15/kW for all kW above Y.	The highest rate in the tier is used.

Each of these demand charge variations has a maximum demand charge of $15/kW, according to our methodology.

Methodology & Data Sources

Which utility rates have demand charges >$15?

Utility Rate Database
10,000+ commercial tariffs
Filtered to 8,000+ common tariffs
2,400+ unique utilities
70% of commercial load represented

How many buildings are there of each type in each location?

EIA CBECS Building Stock Data	
Education	Lodging
Food Sales	Retail
Food Service	Mall
In-patient health care	Office
Outpatient health care	Warehouse/Storage

Is a certain building eligible for a demand charge rate?

DOE Commercial Reference Buildings
DOE Commercial Reference Building Load Profiles
16 ASHRAE Climate Zones
8 building floor sizes from CBECS data
80 representative load profiles

How many commercial customers could have a demand charge?

EIA Utility Customer Counts
EIA Form 861
Customer count * fraction of buildings eligible for demand charge rate = Number of customers eligible
Fraction of utility's customers in each state → utility state assignment for the top 10 tables

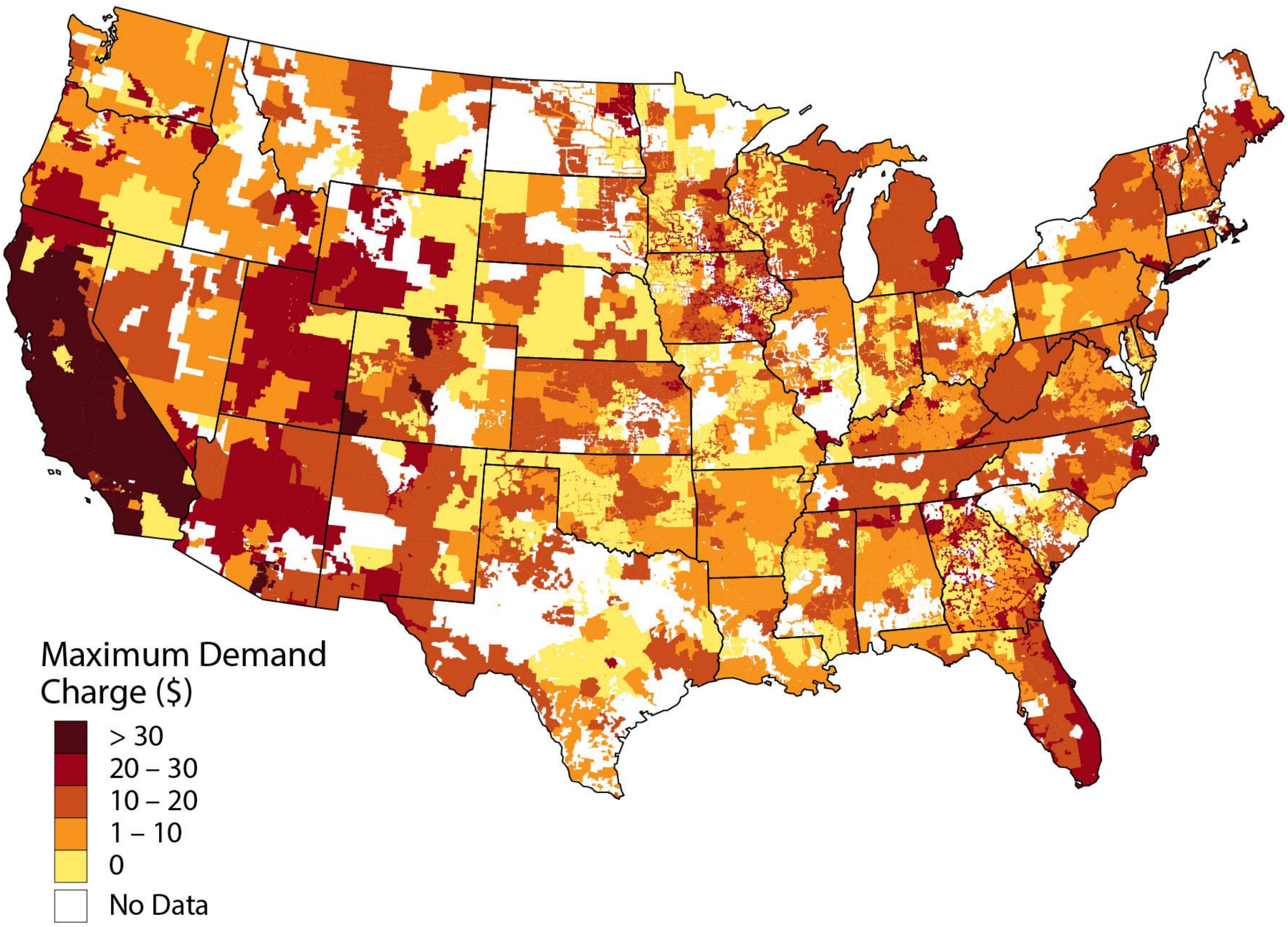
Assumptions & Limitations of the Data

- This study is intended to provide a high level overview current demand charges. Stakeholders interested in identifying potential markets for battery storage should use these data only to guide to further investigation into individual tariffs.
- These data were **interpreted and transcribed manually** from utility tariff sheets, which are often complex. They undoubtedly contain errors, and therefore should only be used as a reference.
- Since not all tariffs have a format that can be entered into the URDB, this list is incomplete.
- Tariffs may have changed since the maps were developed in 2017.
- Tariffs may have additional restrictions that are not represented here (e.g. only available to the agricultural sector or closed to new customers).
- The maximum demand charge may be significantly different from demand charges at other times in the year, day, or for lower tiers.

Questions NOT addressed in this analysis

- How many customers actually pay demand charges?
  - This study only estimates the number of customers that are eligible for at least one utility rate that has a demand charge above the $15 or $20 threshold. It doesn't determine if they actually subscribe to that rate.
- Is storage economical in a location/building type?
  - This study does not determine whether a battery will actually **save a customer money by reducing their demand charges**.
- How many customers in an area could benefit from storage in the future?
  - This study uses existing rates. Rates change frequently. Therefore, the study should not be used to forecast future markets for batteries.

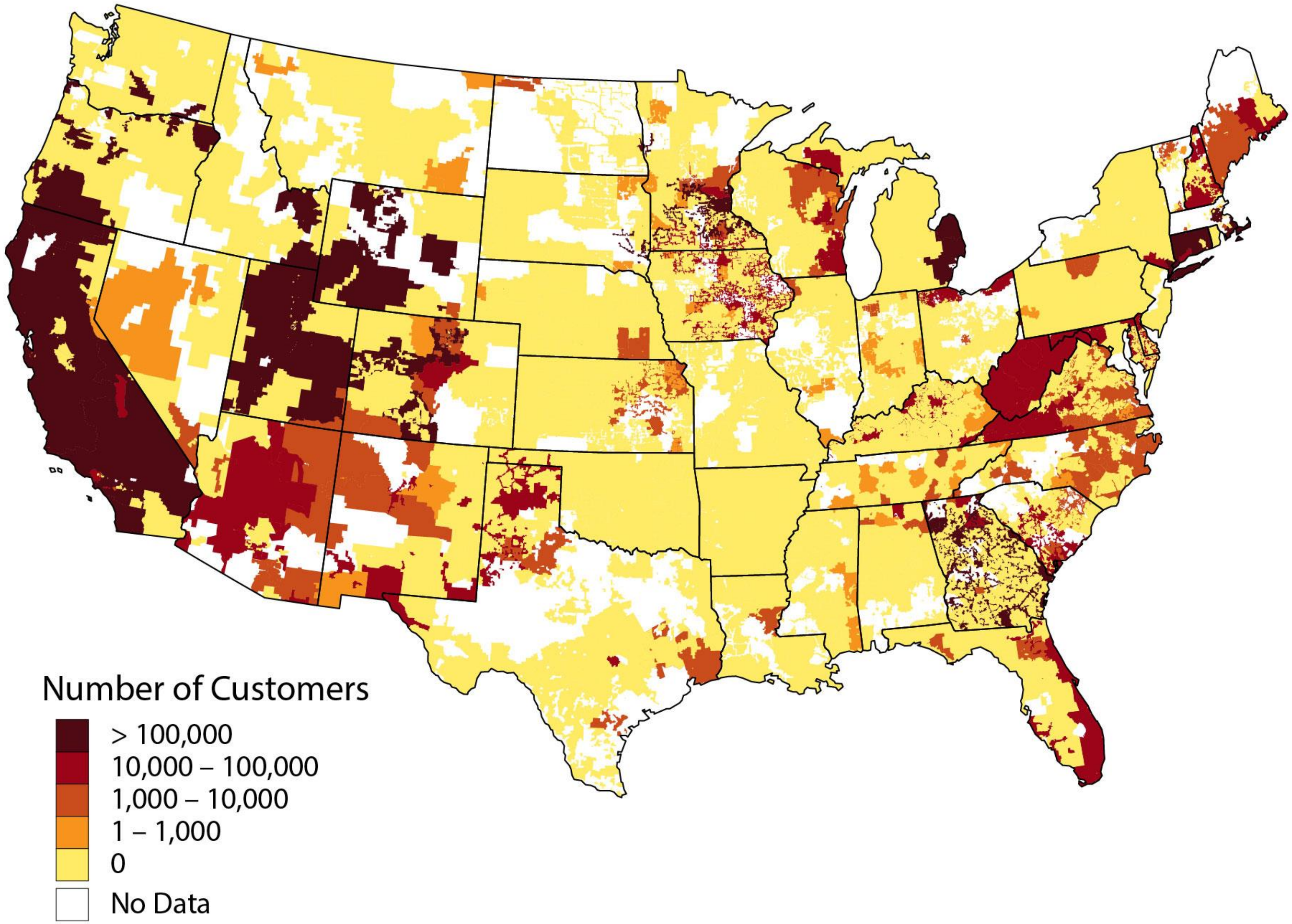
Maximum demand charges by utility territory



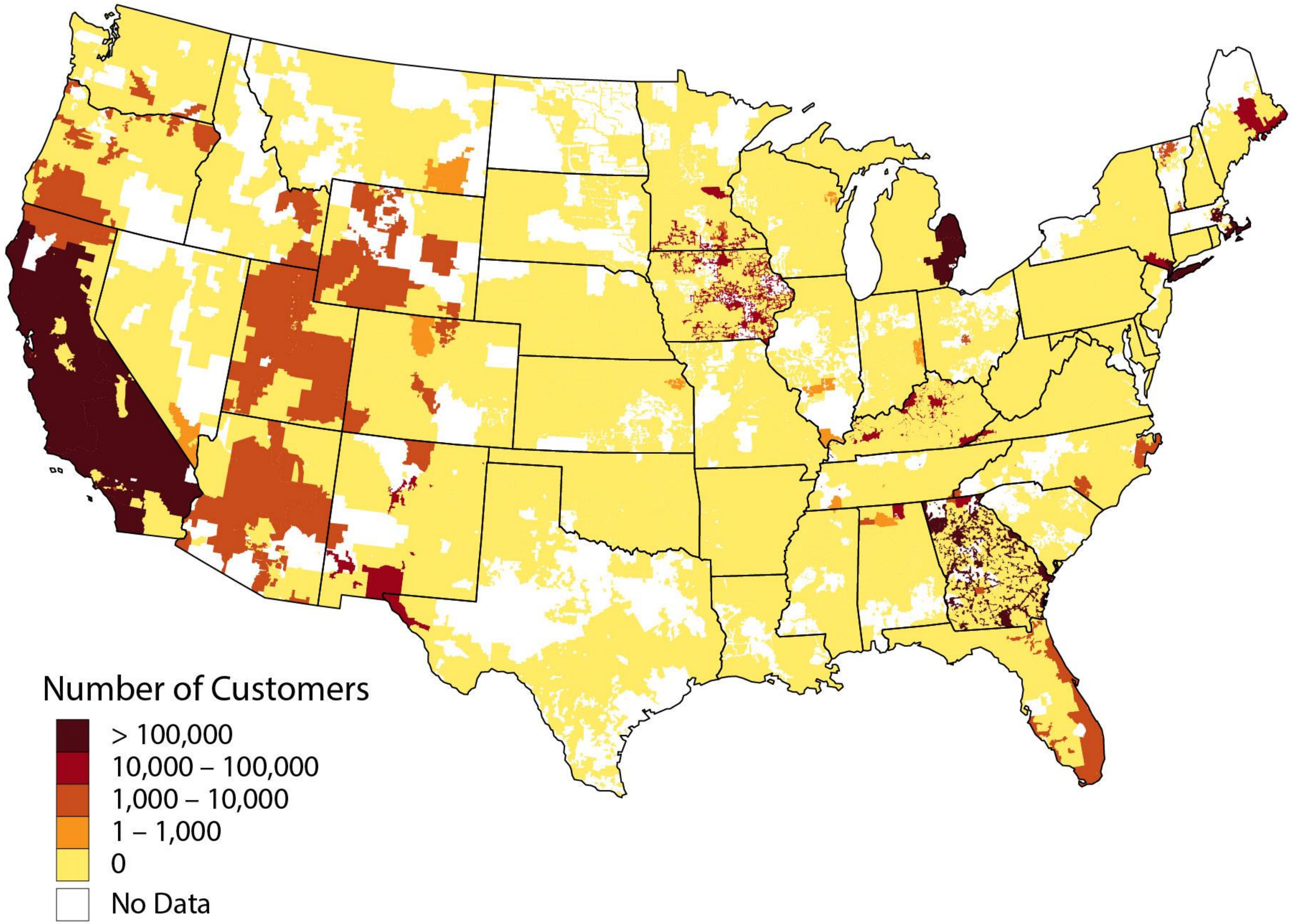
States with the Highest Demand Charges

Demand Charges Across All Utilities Operating in the State	Maximum charge across all utilities	Average of all utility maximum charges	Median of all utility maximum charges
New York	$51.25	$9.30	$4.30
California	$47.08	$11.45	$10.60
Colorado	$46.43	$21.68	$16.65
Massachusetts	$41.25	$19.14	$15.50
Arizona	$35.45	$18.82	$18.50
Nebraska	$30.00	$14.82	$15.70
Illinois	$30.00	$16.58	$16.63
Georgia	$28.70	$5.83	$3.60
North Carolina	$25.65	$15.61	$15.63
Vermont	$25.39	$17.43	$16.05

Number of Customers eligible for Demand Charge > $15



Number of Customers eligible for Demand Charge > $20



Top States by Number of Customers Eligible for Demand Charge

	Number of Customers Eligible for Demand Charge >$15/kW
California	1,420,000
New York	648,000
Georgia	237,000
Colorado	221,000
Michigan	209,000
Massachusetts	189,000
Texas	155,000
Connecticut	135,000
Minnesota	134,000
Ohio	124,000

	Number of Customers Eligible for Demand Charge >$20/kW
California	1,081,000
New York	648,000
Georgia	216,000
Michigan	205,000
Massachusetts	180,000
Kentucky	41,000
New Mexico	24,000
Alabama	23,000
Texas	23,000
Iowa	23,000

Relevancy to Distributed Storage Market

- Demand charges are dispersed and varied.
- Small number of customers with high demand charge ≠ small storage market.
  - Largest commercial customers often have the highest demand charges.
  - Small fraction of customers may represent a relatively large quantity of cost-effective behind-the-meter storage.
- As storage costs decline, additional markets for storage may open.
- Utilities are considering residential demand charges.
- Utility tariffs can & will change.

Where can I get the raw data?

NREL Data Catalog https://data.nrel.gov

"Maximum demand charge rates for commercial and industrial electricity tariffs in the United States" ID: #74

Note: The list uploaded to the NREL Data Catalog is unfiltered (it includes all demand charge rates, including special/agricultural rates). It was extracted from the URDB on September 13, 2017.

NREL (National Renewable Energy Laboratory). 2017. Maximum Demand Charge Rates for Commercial and Industrial Electricity Tariffs in the United States. Golden, CO: National Renewable Energy Laboratory.

- Utility Rate Database https://openei.org/wiki/Utility_Rate_Database
- EIA Commercial Buildings Energy Consumption Survey https://www.eia.gov/consumption/commercial/data/2012/
- DOE Commercial Reference Buildings https://energy.gov/eere/buildings/commercial-reference-buildings

Questions?

Identifying Potential Markets for Behind-the-Meter Battery Energy Storage: A Survey of U.S. Demand Charges

https://www.nrel.gov/docs/fy17osti/68963.pdf

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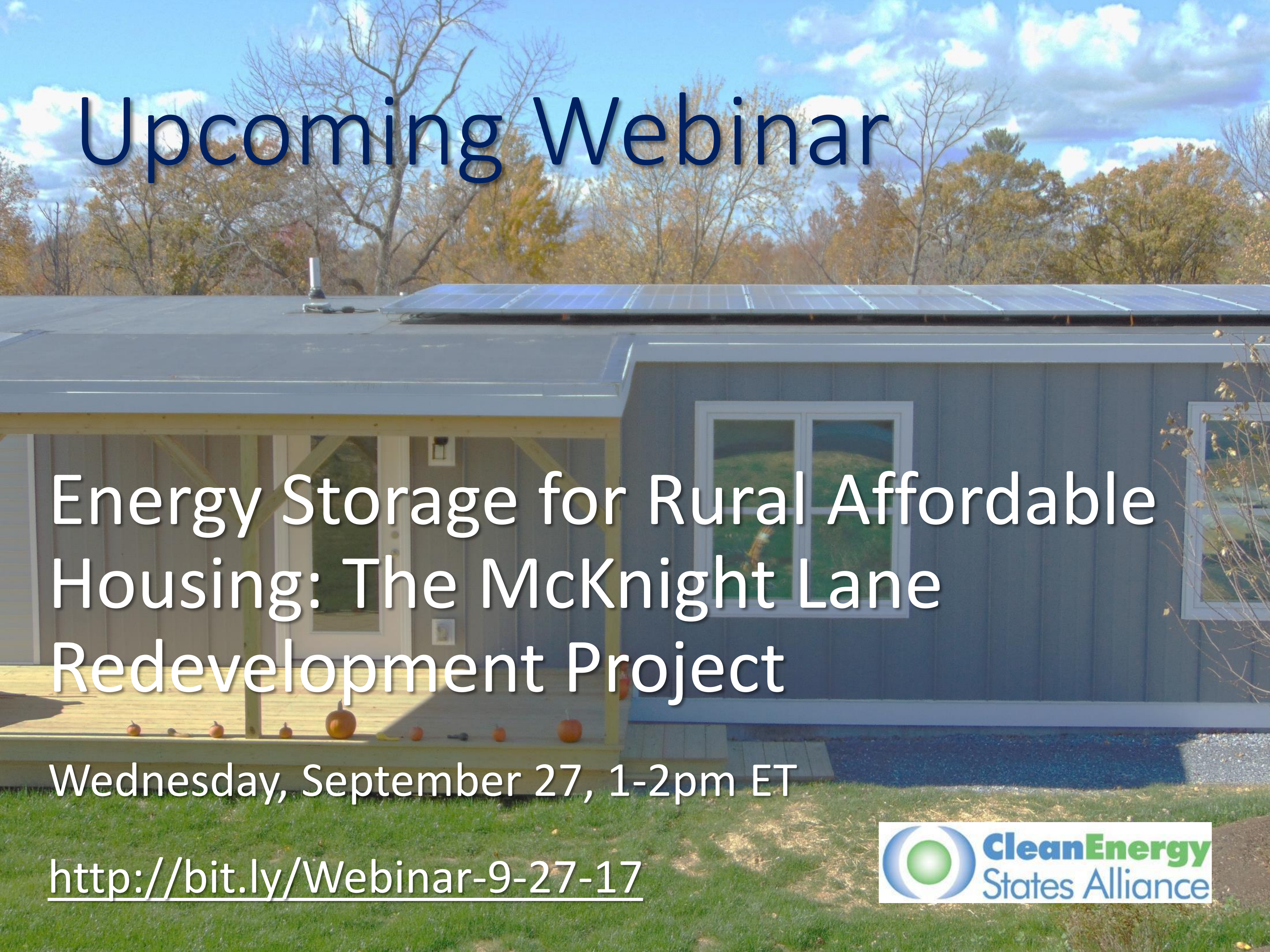
Upcoming Webinar
Energy Storage for Rural Affordable Housing: The McKnight Lane Redevelopment Project
Wednesday, September 27, 1-2pm ET
http://bit.ly/Webinar-9-27-17
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