Clean Energy Group

Can Virtual Power Plants Replace Peaker Plants?

A Conversation with CEG and Brattle Group

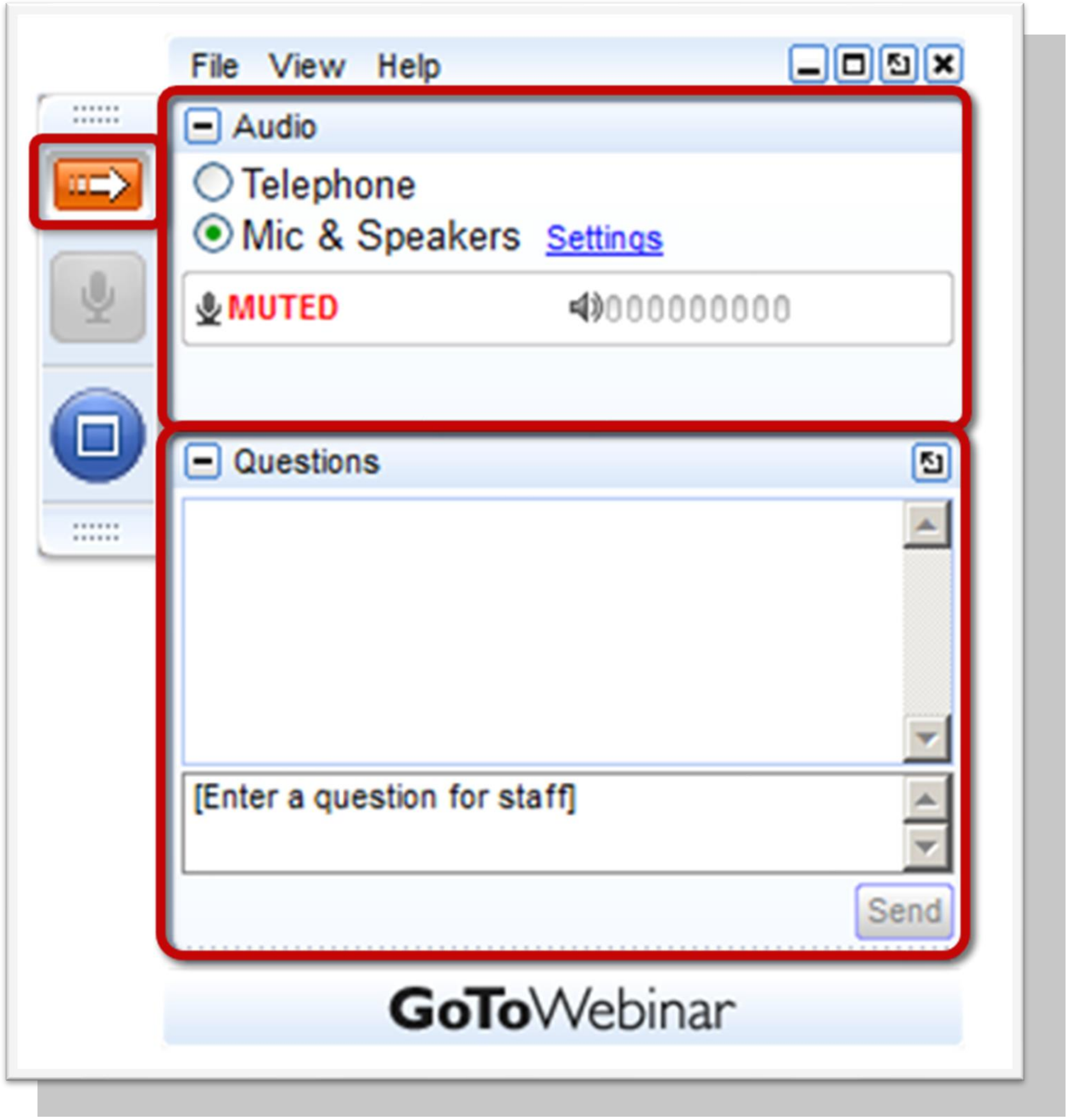
August 3, 2023

Webinar Logistics

Use the orange arrow to open and close your control panel

Submit questions and comments via the Questions panel

This webinar is being recorded. We will email you a webinar recording within 48 hours. This webinar will be posted on CEG's website at **www.cleanegroup.org/webinars**



CleanEnergyGroup

Affordable, reliable, clean energy for all.

Climate Resilience and Community Health

Distributed Energy Access and Equity

Energy Storage and Flexible Demand

Fossil Fuel Replacement

www.cleanegroup.org

CleanEnergyGroup

Phase Out Peakers

Replacing peaker power plants with clean alternatives in environmental justice communities.

New York City Environmental Justice Alliance · Strategen · MCAN Mass Climate Action Network · Slingshot · UPROSE · BEAT Berkshire Environmental Action Team · NYLPI Justice Through Community Power · The Point

Ravenswood Generating Station in Queens, NY. Credit: Bigstock

www.cleanegroup.org/initiatives/phase-out-peakers

Webinar Speakers

Can Virtual Power Plants Replace Peaker Plants? A Conversation with CEG and Brattle Group

Ryan Hledik

Principal, Brattle Group

Shelley Robbins

Project Director,
Clean Energy Group

Seth Mullendore

President and Executive
Director, Clean Energy Group

Todd Olinsky-Paul

Senior Project Director,
Clean Energy Group

Brattle

CleanEnergyGroup

Upcoming Webinars

Leveraging Federal Funding for Transmission Technologies and Renewable Energy Integration (Tuesday, August 22)

Read more and register at www.cleanegroup.org/webinars

CleanEnergyGroup

www.cleanegroup.org | info@cleanegroup.org

Real Reliability
The Value of Virtual Power

PREPARED BY
Ryan Hledik
Kate Peters

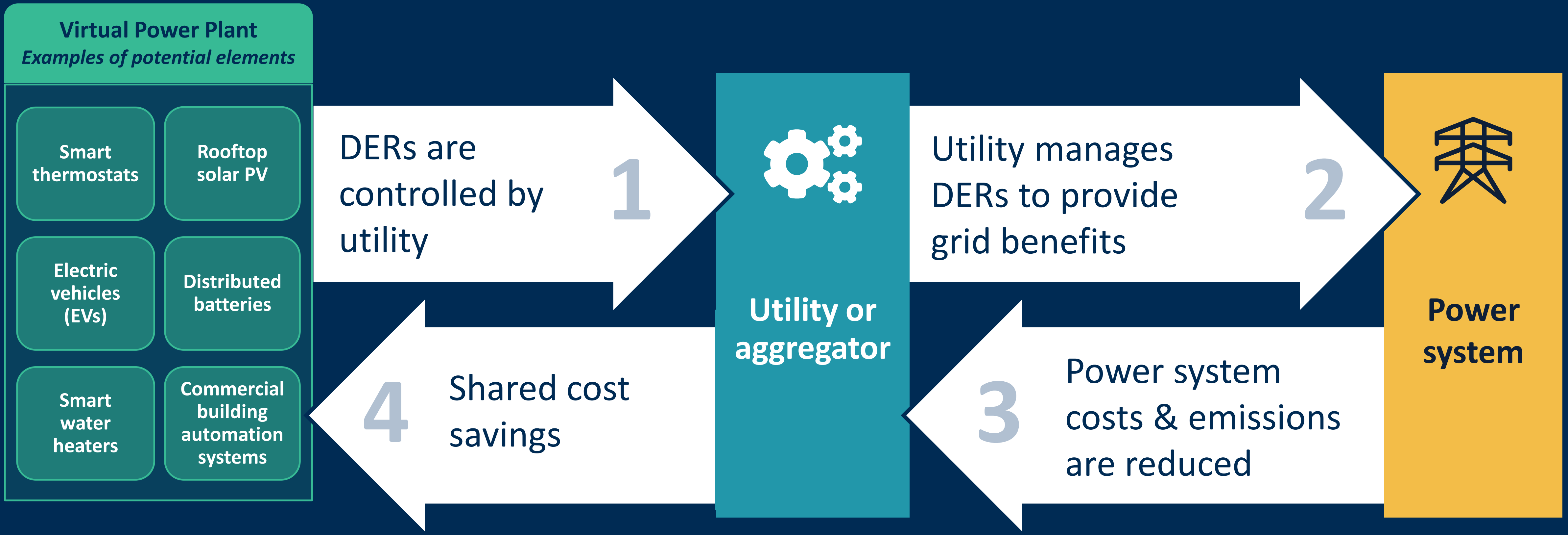
CLEAN ENERGY GROUP WEBINAR:
CAN VIRTUAL POWER PLANTS REPLACE PEAKER PLANTS?

AUGUST 3, 2023

Brattle

What Is a VPP?

A VPP is portfolio of distributed energy resources (DERs) that are actively controlled to provide benefits to the power system, consumers, and the environment.



VPPs are at a deployment inflection point

Drivers

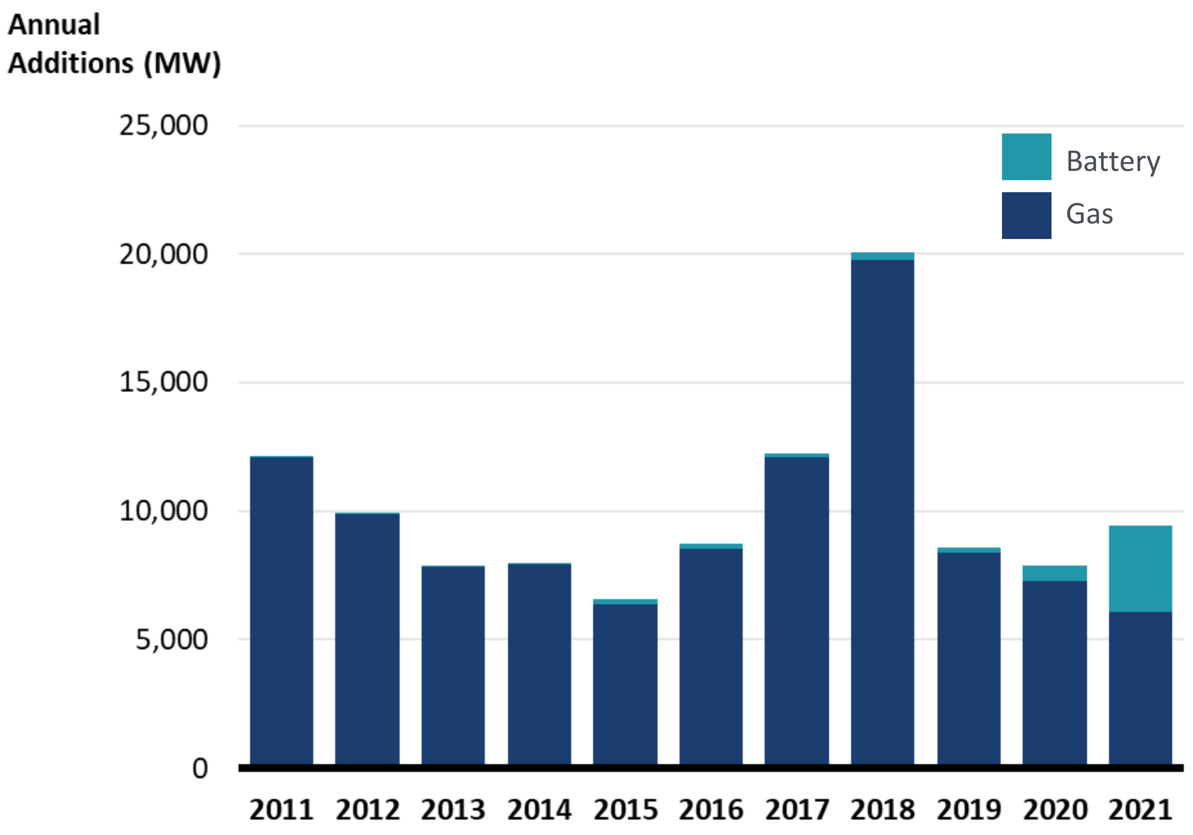
- Declining DER costs
- Technological advancement
- Inflation Reduction Act
- FERC Order 2222
- Growing model availability
- The decarbonization imperative

	PRESENT	2030
Homes with Smart Thermostats	10%	34%
Homes with Electric Water Heating	49%	50%
Residential Rooftop Solar	27 GW	83 GW
Behind-the-Meter (BTM) Batteries	2 GW	27 GW
Light-Duty Electric Vehicles	3 mil.	26 mil.

Resource adequacy needs persist in the US

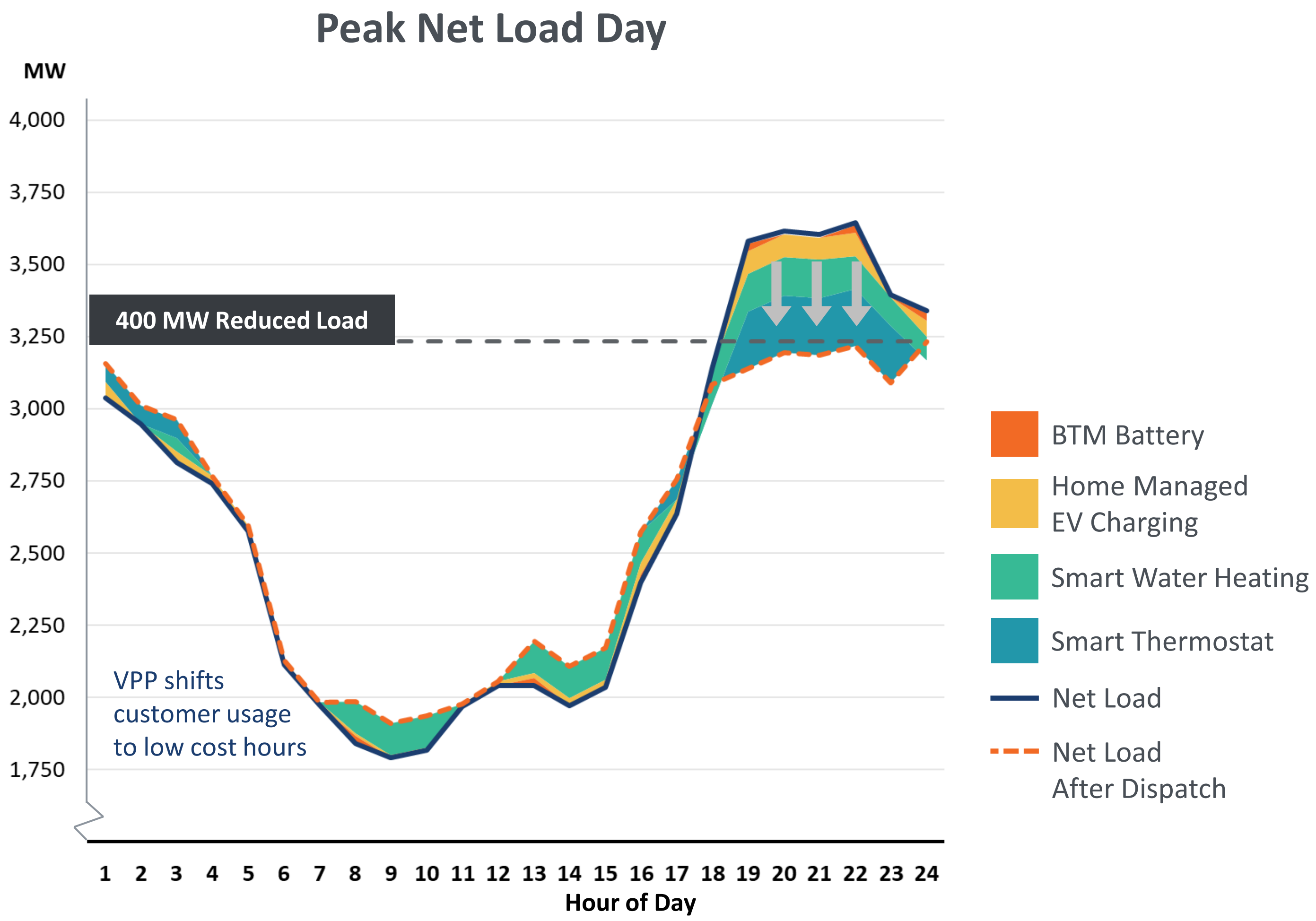
- $120 billion of investment in past decade
- Driven by electrification, coal retirements, and growing renewables dependence
- Our study:
  - Can VPPs reliably serve this resource adequacy need?
  - And can they compete economically with gas peakers and batteries?

Historical U.S. Capacity Additions for Resource Adequacy
~110 GW, 2012-2021



The modeled VPP can fully provide 400 MW of resource adequacy for a moderately-sized utility

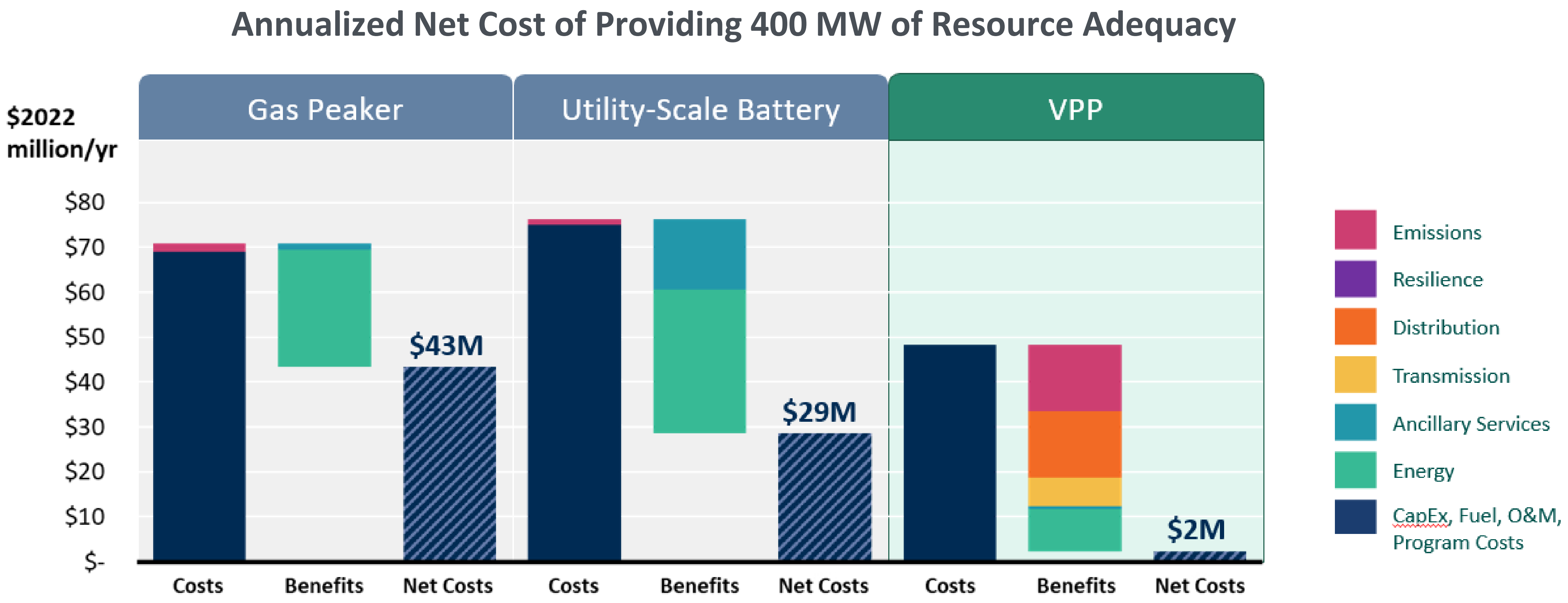
We modeled four commercially available residential demand flexibility technologies for an illustrative utility composed of 1.7 million customers



The VPP reduces load in:

- Summer and winter
- 7 months
- 63 hours of the year
- 7 consecutive hours

Resource Adequacy… For Cheap



RMI estimated that 60 GW of VPPs could be deployed nationally by 2030. At that scale, VPPs would save $15 to $35 billion in resource costs relative to the alternatives over 10 years … plus $20 billion in societal benefits

VPPs can provide several additional major benefits not modeled in this study

Increased renewables deployment

Flexible scaling

Better power system integration of electrification

Enhanced customer satisfaction

Faster grid connection

Improved behind-the-meter grid intelligence

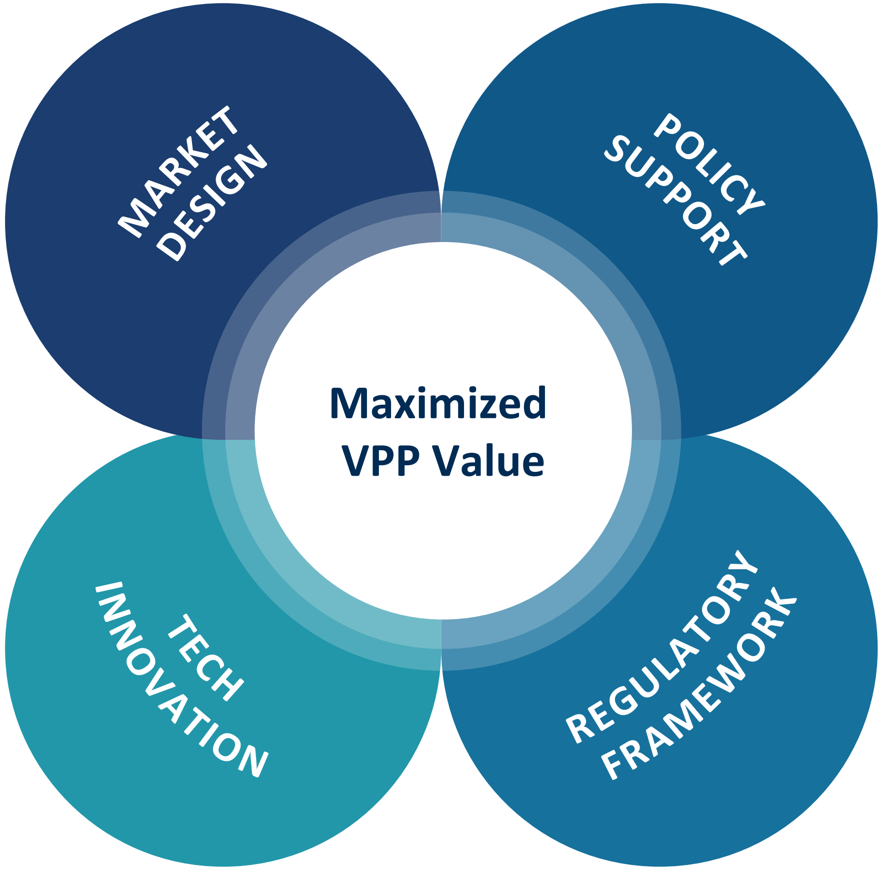
The ideal conditions for VPP deployment

MARKET DESIGN

- Wholesale markets provide a level playing field for demand-side resources.
- Retail rates and programs incentivize participation in innovative, customer-centric ways.

TECHNOLOGY INNOVATION

- DERs are widely available and affordable. DERs can communicate with each other and the system operator.
- Algorithms effectively optimize DER use while maintaining customer comfort and convenience.



POLICY SUPPORT

- Codes and standards promote deployment of flexible end-uses.
- R&D funding supports removal of key technical barriers.

REGULATORY FRAMEWORK

- Utility business model incentivizes deployment of VPPs wherever cost-effective.
- Utility resource planning and evaluation accounts for the full value of VPPs.

Three low-risk actions utilities and regulators can take now

1. Conduct a jurisdiction-specific VPP market potential study. Then establish VPP procurement targets.

2. Establish a VPP pilot. Test innovative utility financial incentive mechanisms.

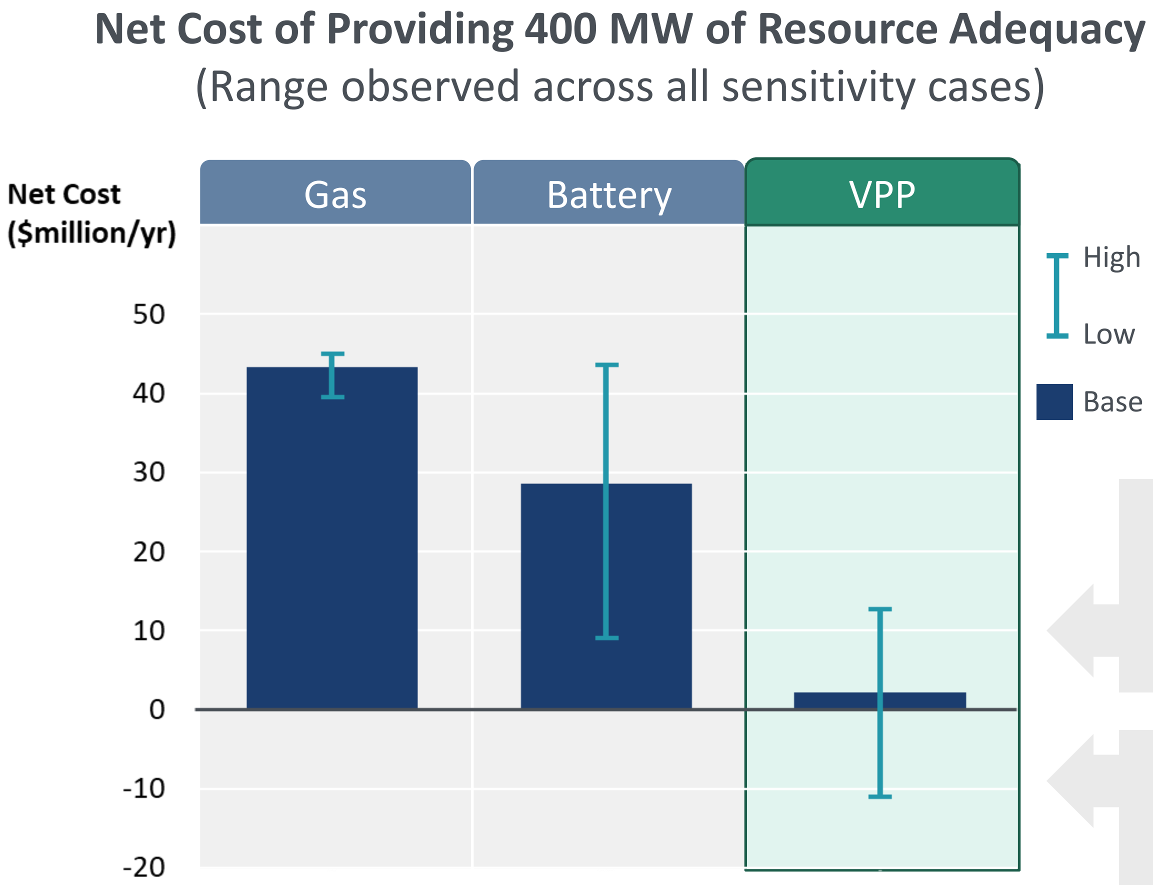
3. Review and update existing policies to comprehensively account for VPP value.

For more information:

https://www.brattle.com/real-reliability/

Appendix

The VPP could provide resource adequacy at a *negative* net cost to society

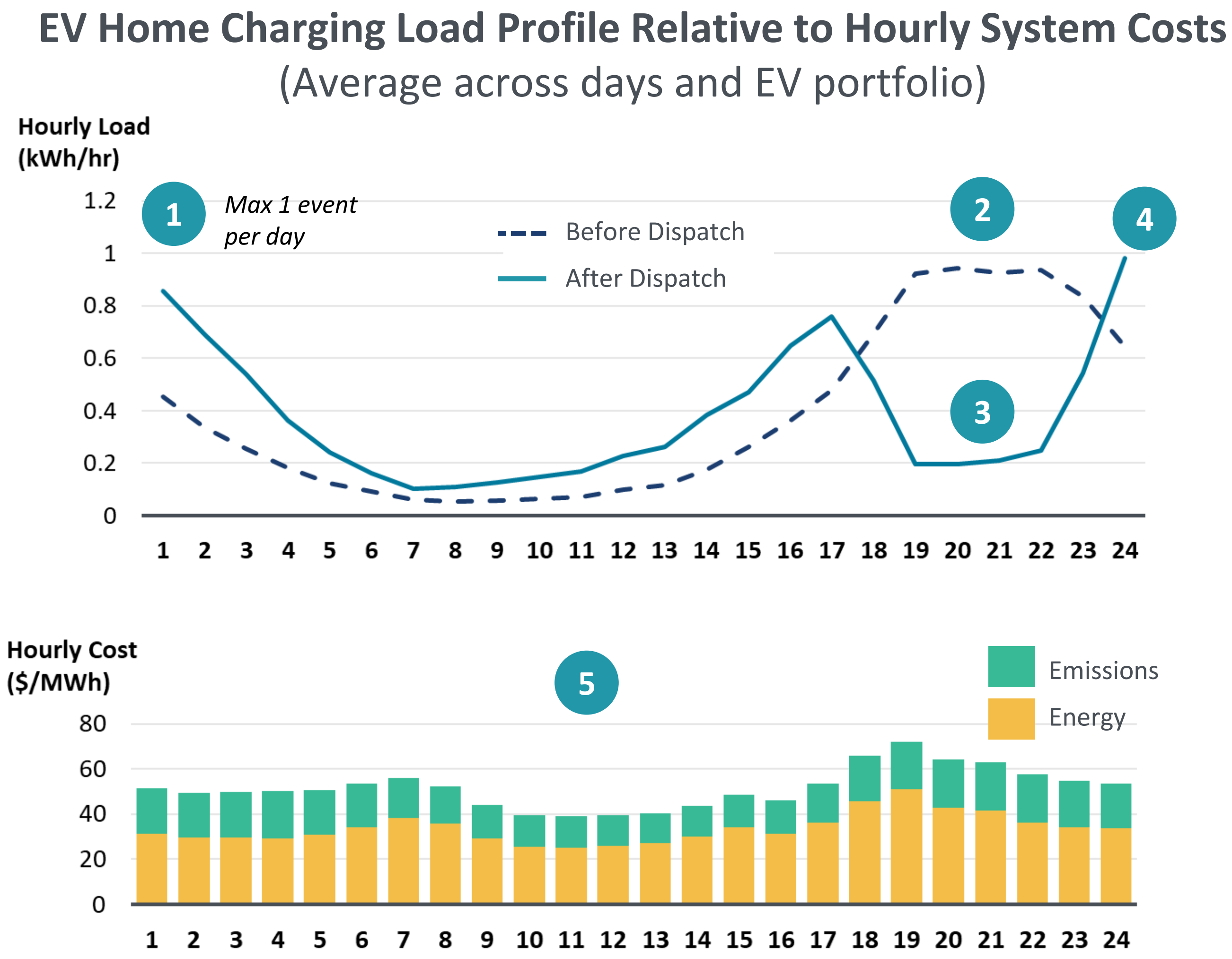


Economic competitiveness of battery storage and VPPs varies across markets, depends trajectory of future cost declines.

In markets with higher T&D costs or higher GHG emissions costs, the additional (i.e., non-resource adequacy) value of a VPP can outweigh its costs

Simulated VPP dispatch is based on observed performance in actual deployments

1. Limits on customer tolerance for number of interruptions
2. Load impacts limited to actual available load during system peak hours
3. Load impacts account for event opt-outs, remain within customer tolerance range
4. Pre- and post-event load building to ensure customer usage ability
5. Dispatch is simulated to maximize avoided power system costs, in addition to providing resource adequacy



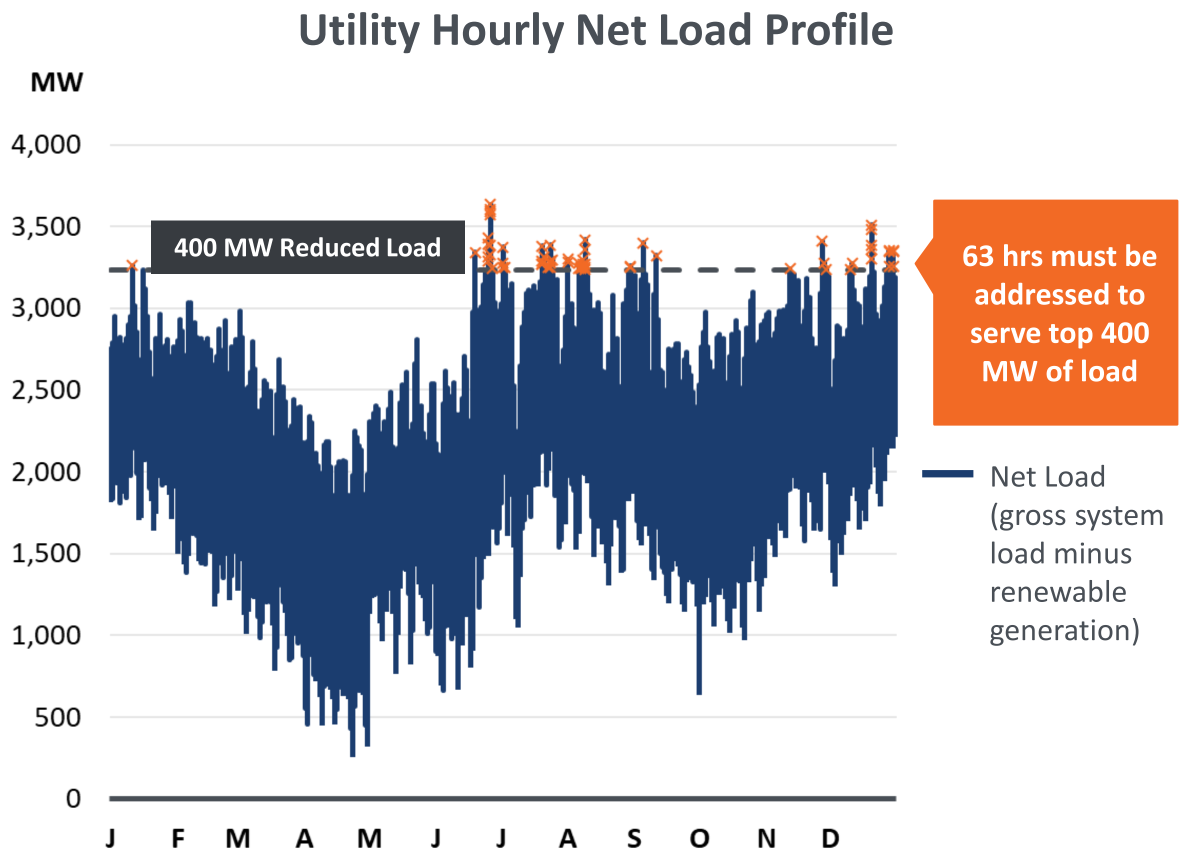
We conducted hourly reliability analysis for a VPP, a gas peaker, and a utility-scale battery

The illustrative utility

- Mid-sized (1.7 million customers)
- 50% renewables by 2030
- Winter and summer resource adequacy needs

Defining resource adequacy

- Serve all load contributing to top 400 MW of net peak demand
- Requires performance during 63 hours of the year
- 7 consecutive hours in one day



We modeled a VPP composed of four commercially available residential load flexibility technologies

	Smart Thermostat DR	Smart Water Heating	Home Managed EV Charging	BTM Battery DR
Eligibility (% of residential customer base)	67% summer; 35% winter	50%	15%	1%
Participation (% of eligible customers)	30%	30%	40%	20%
Total Controllable Demand at Peak (MW)	204 MW	114 MW	79 MW	26 MW
VPP Operational Constraints	15 five-hour events per season, plus 100 hrs of minor setpoint adjustments per year and energy savings	Daily load shifting of water heating load, ancillary services	Daily load shifting of vehicle charging load	15 demand response events per year

We model all utility-incurred costs (incentives, implementation including marketing and per-unit DERMS costs)

Clarity in the face of complexity

Brattle

CleanEnergyGroup

What Is A Peaker Plant?

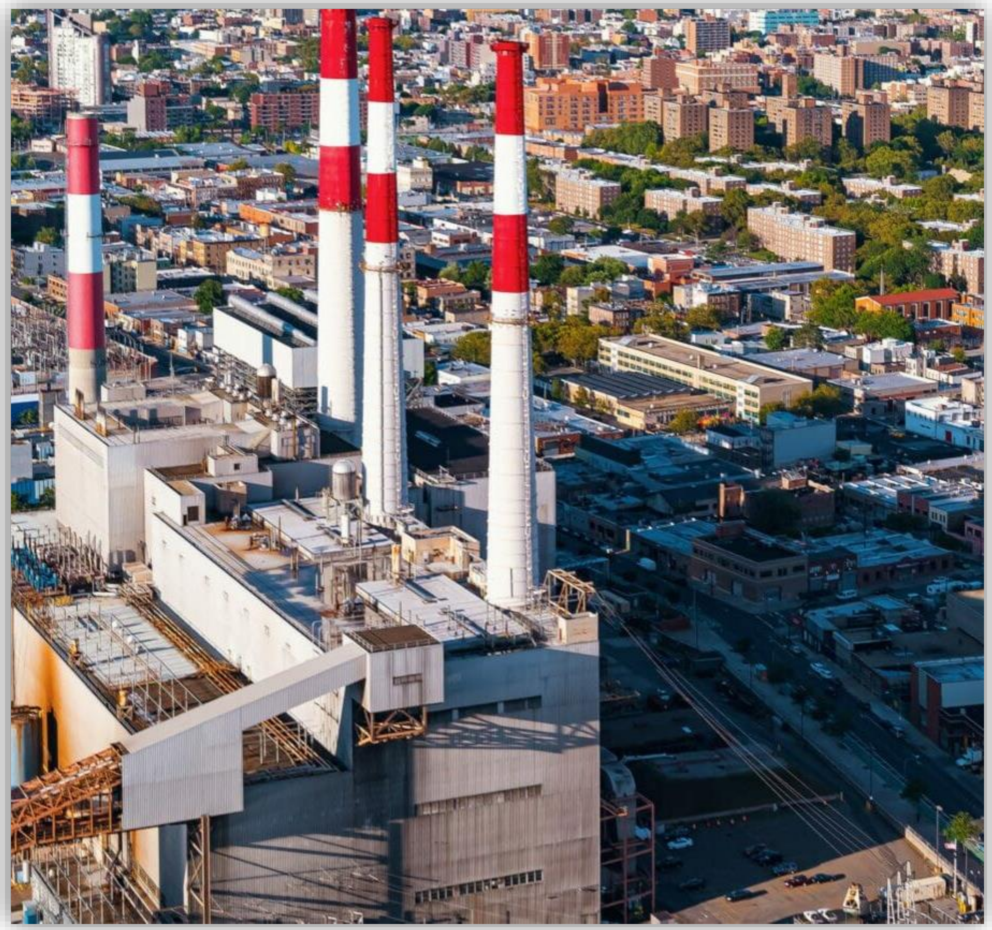
Run during periods of **high electricity demand**

Less efficient (higher emission rates)

Located **closer to population centers**

Low capacity factor (< 20%)

Typically **operate only a few hours** at a time



What Do Peaker Plants Look Like?

Photo Credits: Google Earth

Photo Credits: Google Earth

Peakers in the United States

Over 217 Gigawatts of fossil peaker capacity in the US

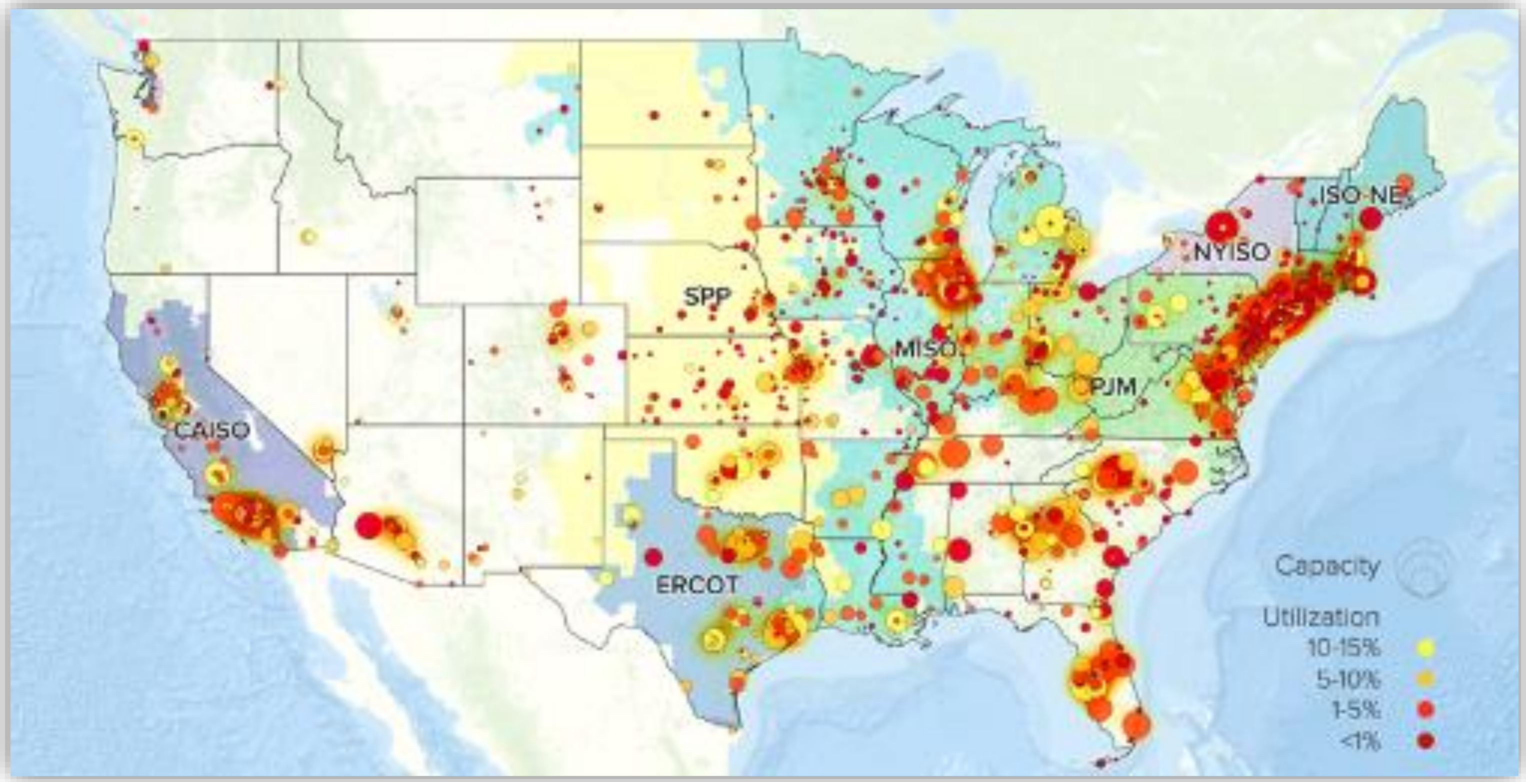
28% of the total fossil-fueled power plant capacity

Average capacity factor of 5%

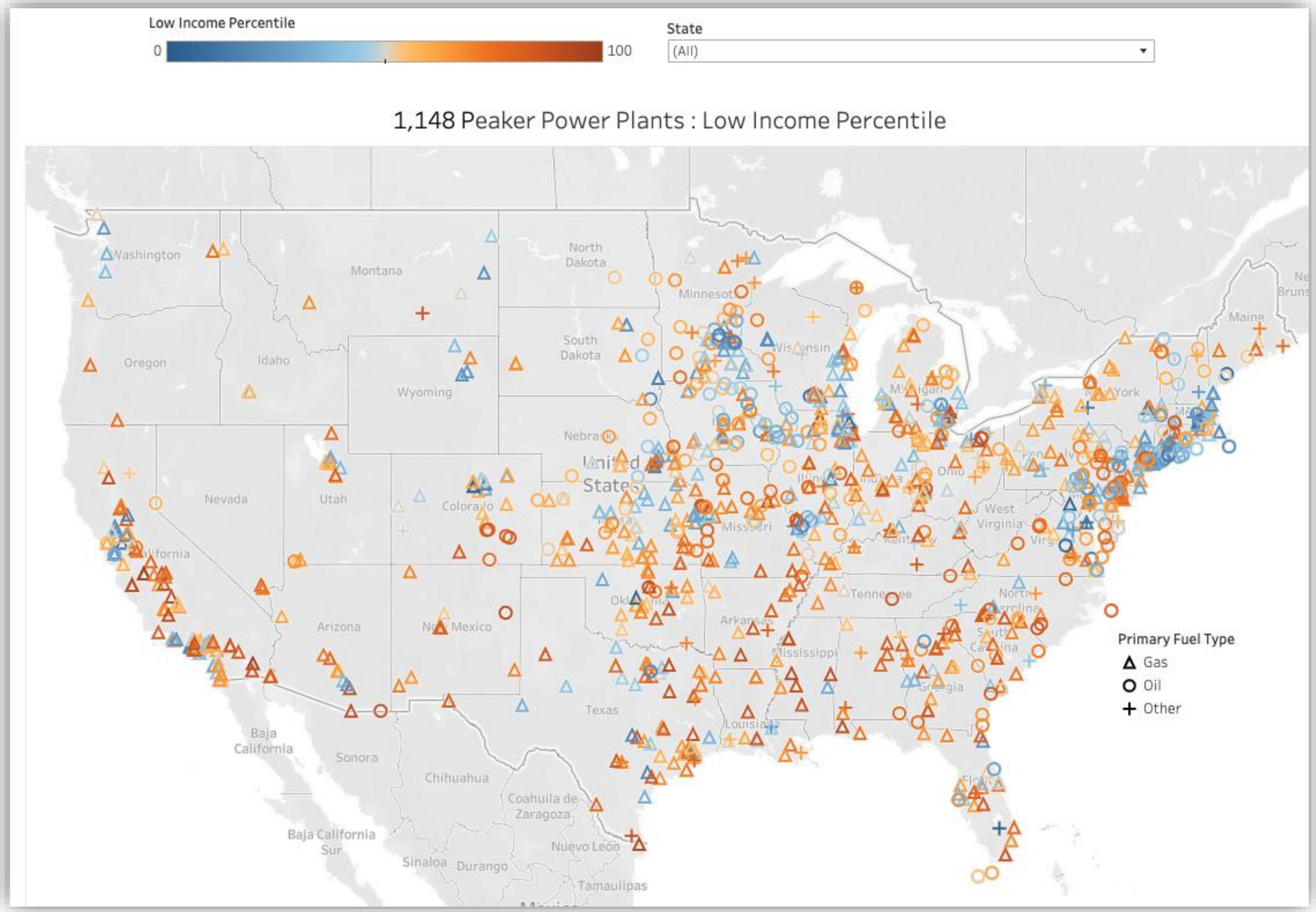
154 Gigawatts are located in or close to an urban area

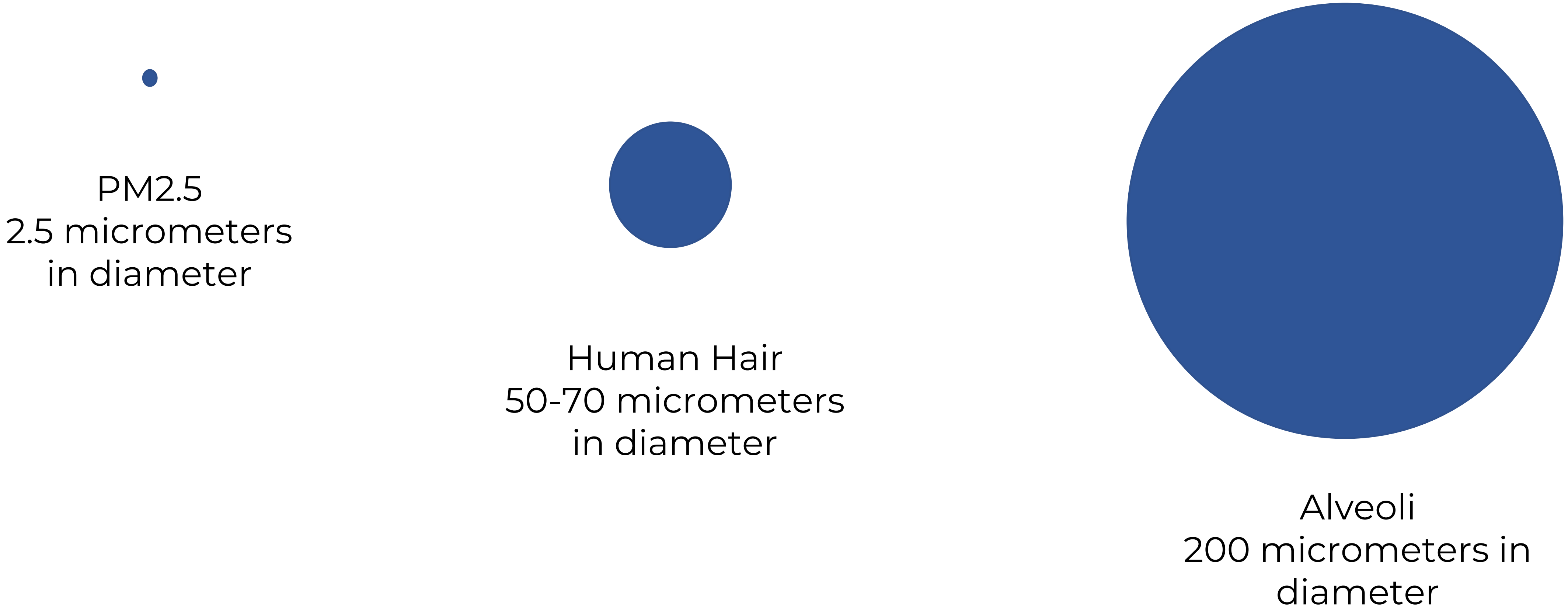
32 million people live within 3 miles of a peaker

The US peaker fleet emits more than **46,000 tons of NOx** energy year



Source: Strategen


Low Income Percentile
0
100
State
(All)
1,148 Peaker Power Plants : Low Income Percentile
Primary Fuel Type
Gas
Oil
Other
Washington
Oregon
Idaho
Montana
North Dakota
South Dakota
Wyoming
Nevada
Utah
Arizona
Texas
Arkansas
Mississippi
Minnesota
Maine
West Virginia
Baja California
Sonora
Chihuahua
Coahuila de Zaragoza
Baja California Sur
Sinaloa
Durango
Nuevo Leon
Tamaulipas


PM2.5
2.5 micrometers
in diameter
Human Hair
50-70 micrometers
in diameter
Alveoli
200 micrometers in
diameter

Detroit – Dearborn Industrial Generation Gas

Photo Credits: Google Earth

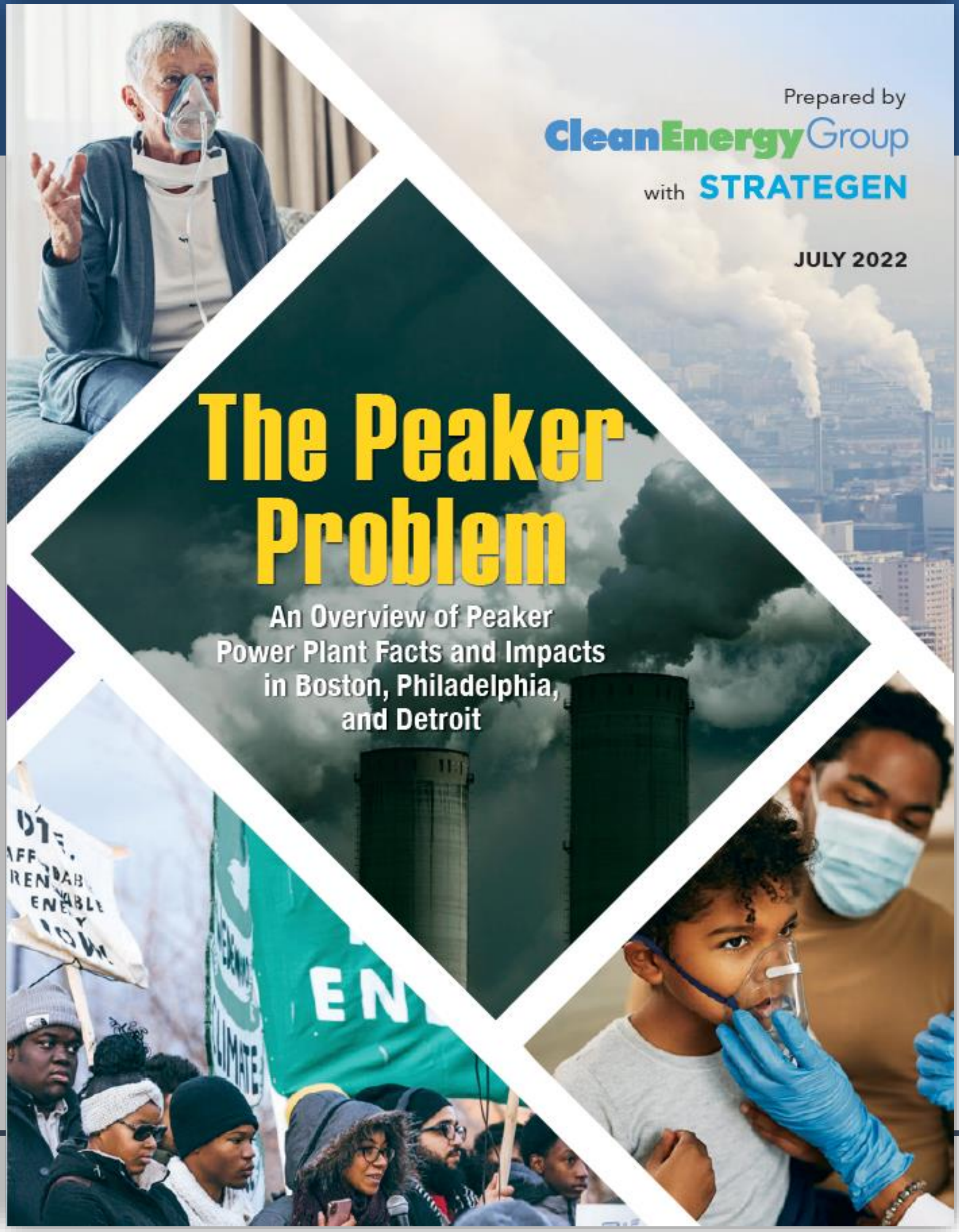
Clean Energy Group

Philadelphia – Schuylkill Combustion Turbine

Photo Credits: Google Earth

For more detailed information, download *The Peaker Problem*

www.cleanegroup.org/publication/peaker-problem

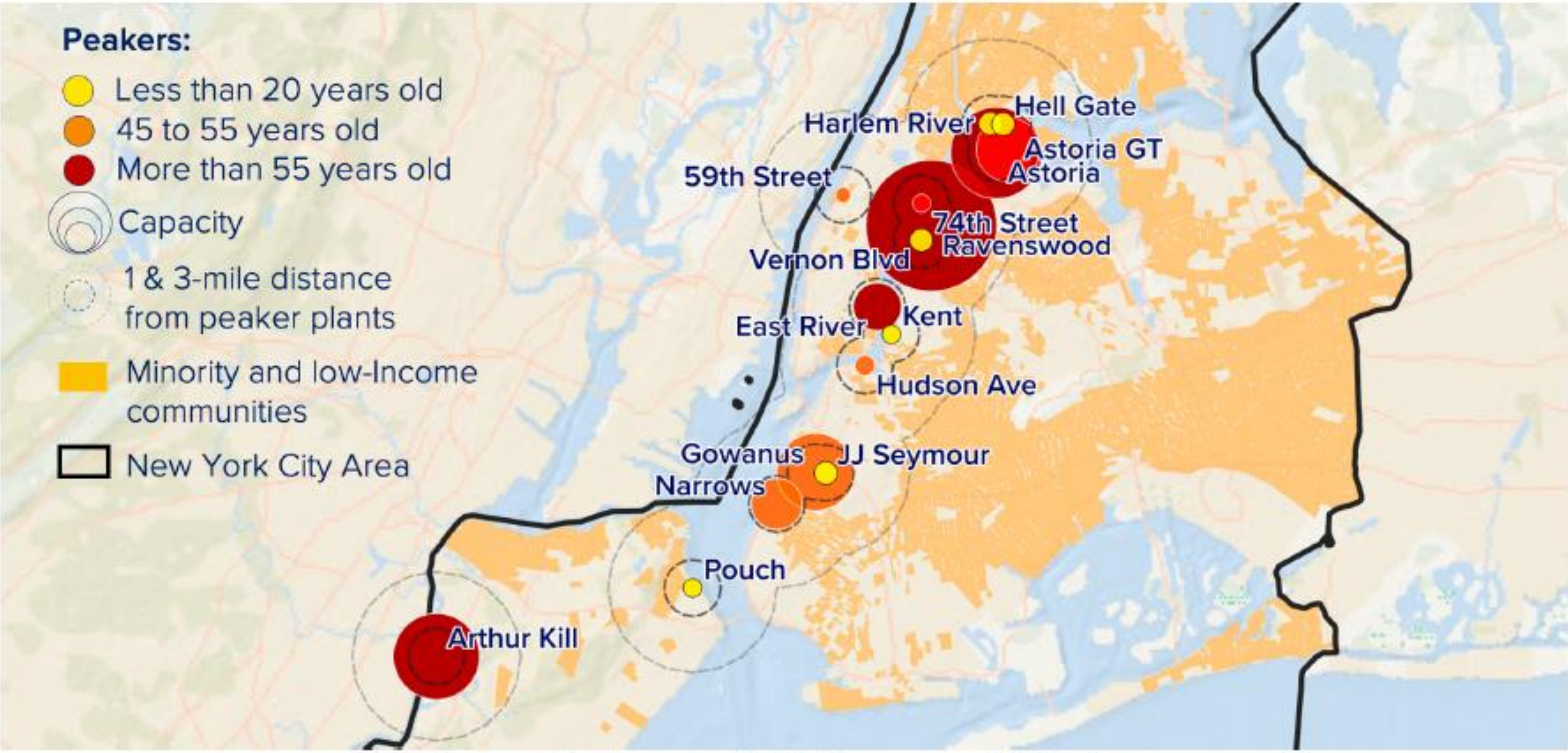


PEAK Coalition

The PEAK coalition—UPROSE, THE POINT CDC, New York City Environmental Justice Alliance, New York Lawyers for the Public Interest, and Clean Energy Group — came together to end the long-standing pollution burden from power plants on the city's most climate-vulnerable people.

Together with communities, we are advocating for a system of localized renewable energy generation and battery storage to replace peaker plants, reduced GHG and local emissions, lower energy bills, and a more reliable and resilient electric system.

Figure 5. Peaker Sites by Capacity and Average Unit Age



Source: Strategen with US Census and EPA data

CleanEnergyGroup

In 2019, 79 out of NYC's 89 peaking units operated for **less than 5 percent of the time** (fewer than 500 hours) and 60 of them ran for **less than 1 percent** (fewer than 100 hours)

750,000 people in NYC live within one mile of a peaker plant; **78 percent** are either low-income or people of color

All of NYC's peakers could be **reliably and cost effectively replaced** by offshore wind, rooftop solar, energy efficiency, and battery storage by 2030

Replacement will save customers **$1 billion in energy market costs** by 2035 and avoid another **$1 billion in environmental and health costs**

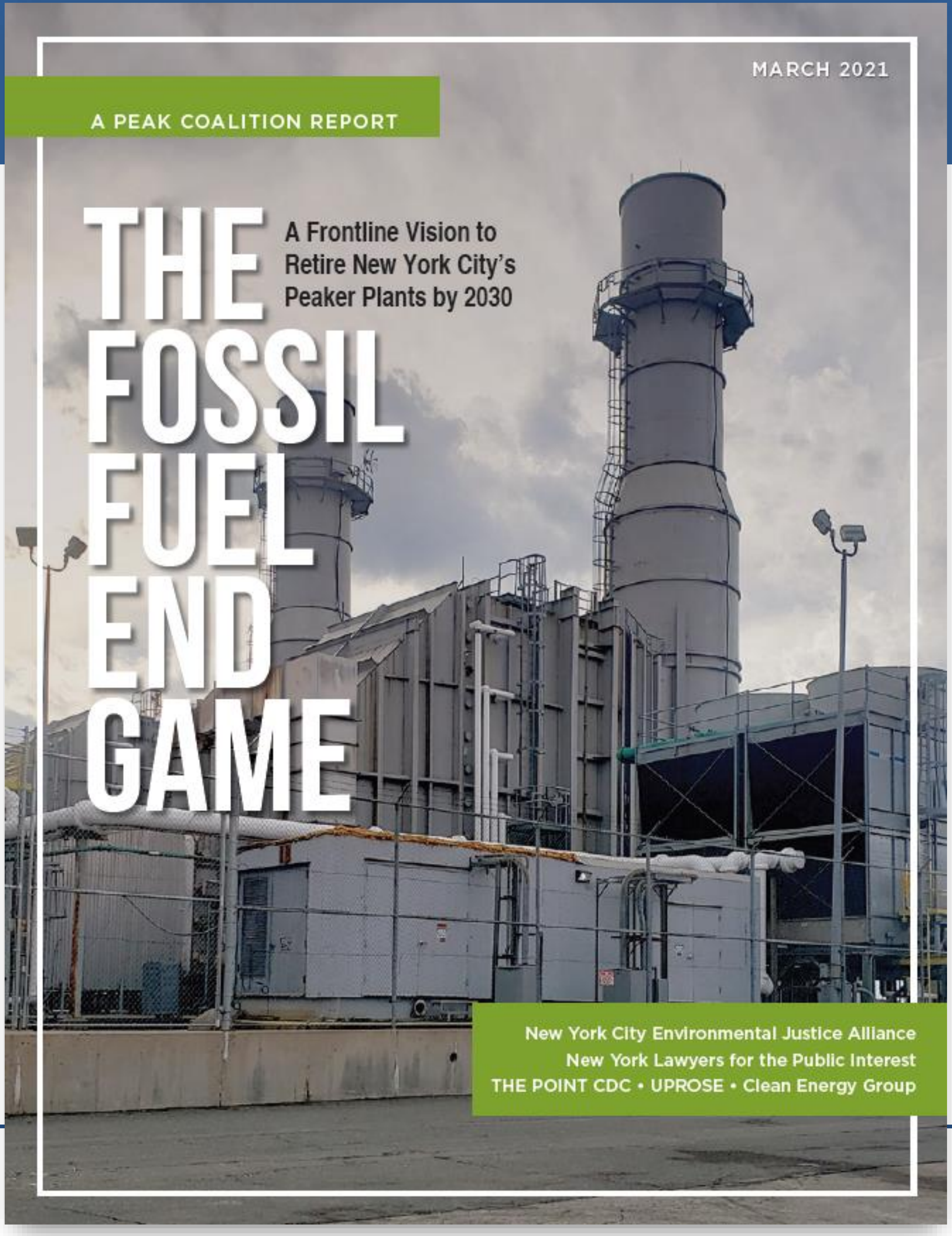
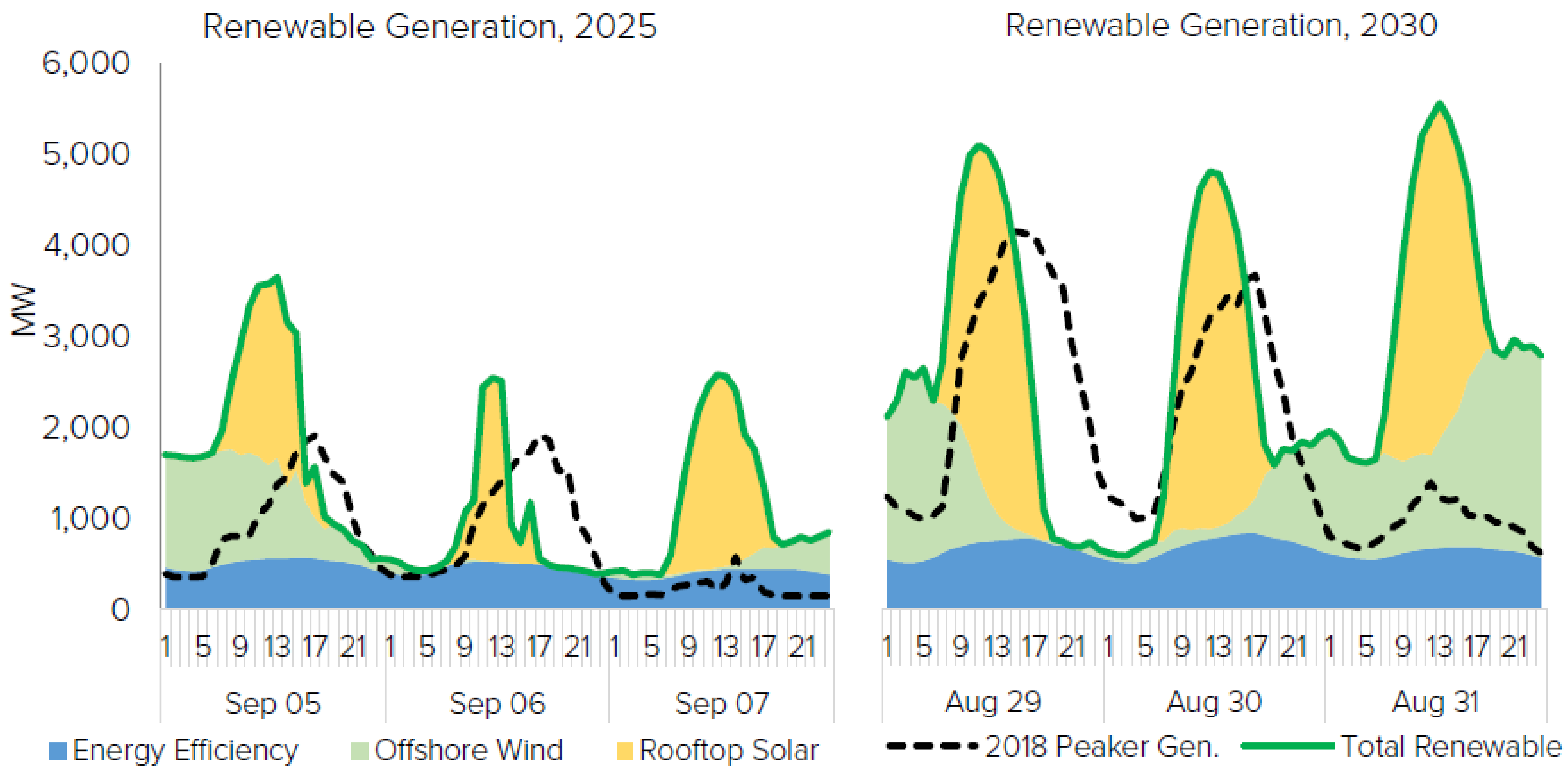


Table 6. Summary of Replacement Resources

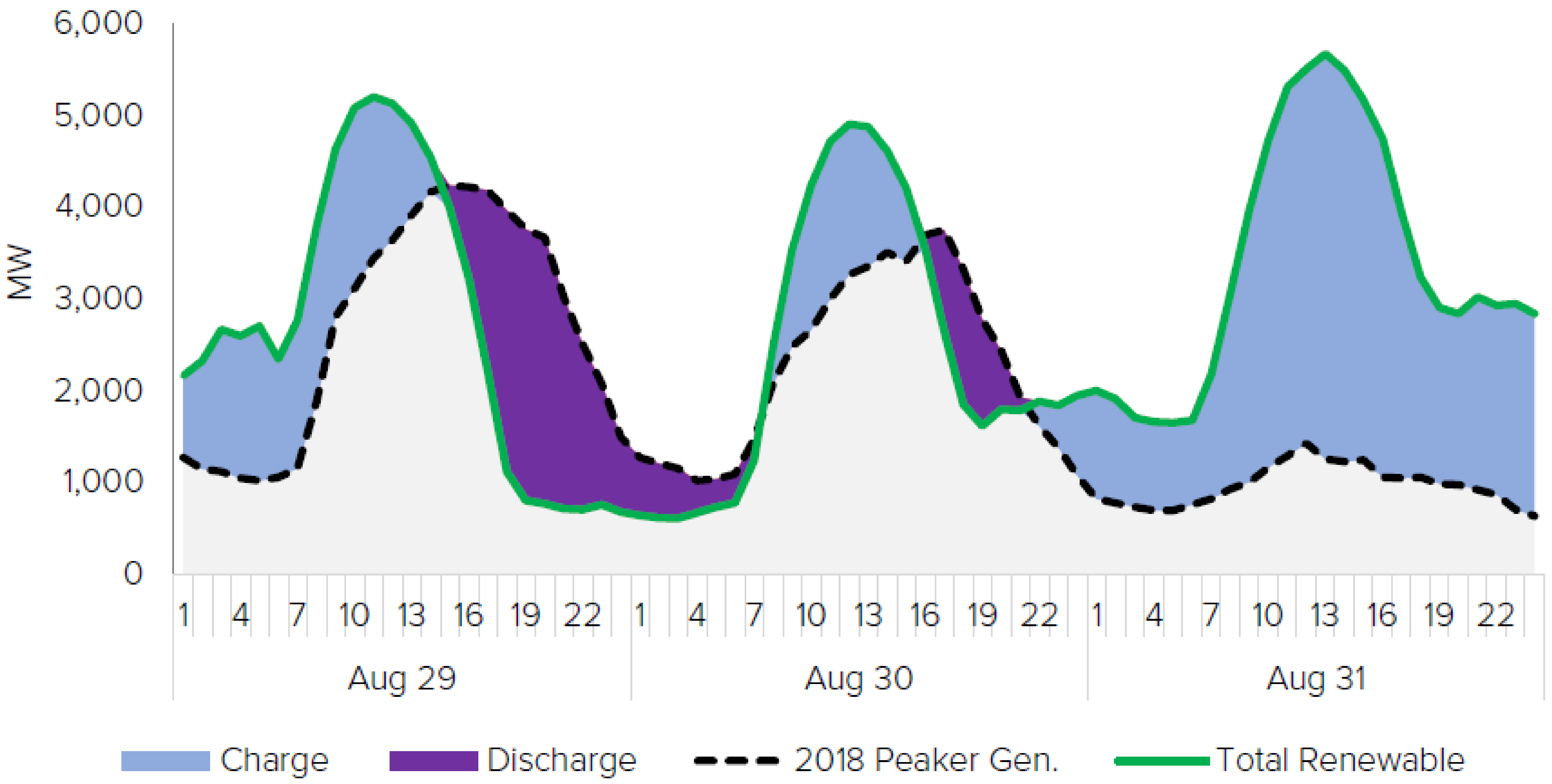
Replacement Resource	Requirements by 2025	Requirements by 2030 (cumulative)	Comments
Rooftop Solar	2.8 GW	5.6 GW	About 520 MW per year. Significant increase over historic additions. Incremental to CLCPA targets, but potentially cost-effective.
Offshore Wind	1.5 GW	3 GW	About 300 MW per year must interconnect into NYC, where about 800 MW has already been contracted. Consistent with CLCPA targets.
Energy Efficiency	4,100 GWh	5,400 GWh	Consistent with NYISO's "low" EE growth forecast.
Energy Storage	2.42 GW of 4-hour storage (equivalent)	4.2 GW of 8-hour storage (equivalent)	Incremental relative to CLCPA given existing storage targets of 3 GW

Figure 16. Replacement Resources by 2025 and 2030



Source: Strategen, 2020

Figure 15. Energy Storage Dispatch During System Peak, 2030



Source: Strategen, 2020

ConnectedSolutions

A new distributed battery funding model

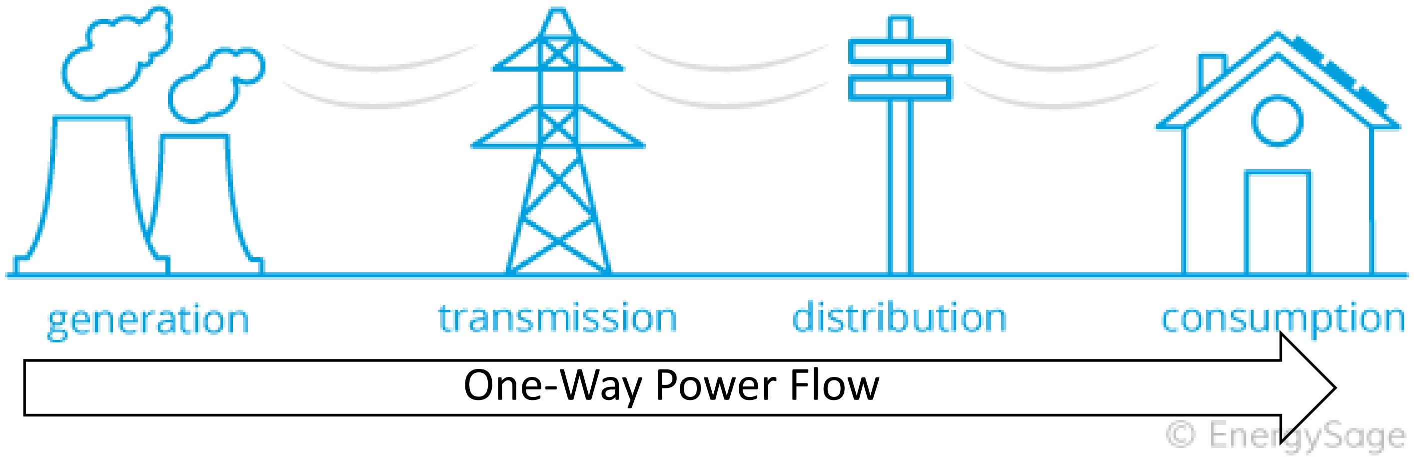
Todd Olinsky-Paul
Senior Project Director
Clean Energy Group
August 3, 2023

Clean Energy Group
Innovation in Finance, Technology & Policy

Virtual power plants don't spring up organically: Policy, programs and regulation are needed to help create them

Old Power Grid (world's biggest just-in-time delivery system)

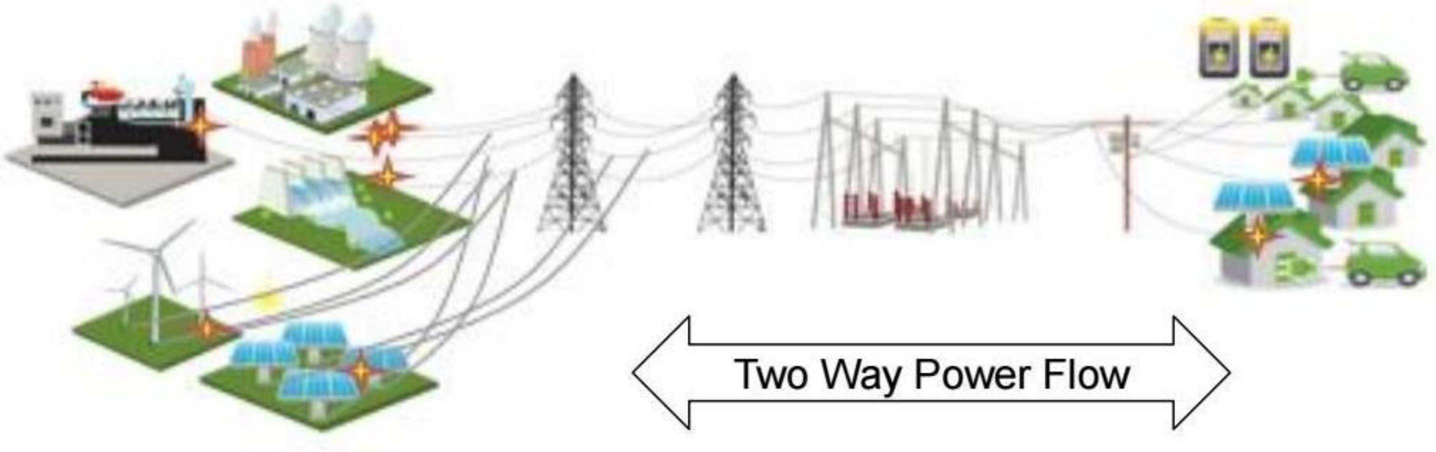
Dispatchable Generation



Variable Demand

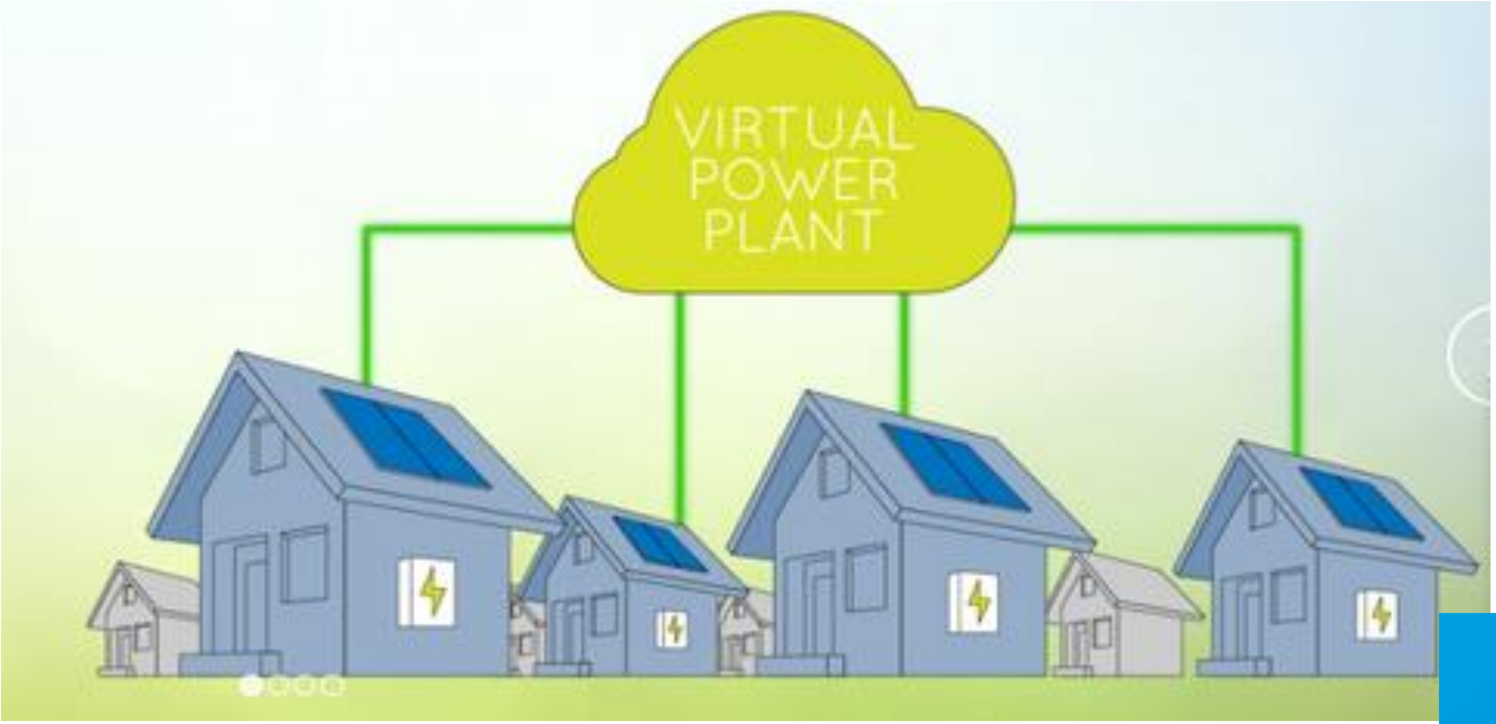
Modern Power Grid (decentralized, flexible, resilient, highly variable)

Dispatchable Generation -AND- Variable Generation with storage



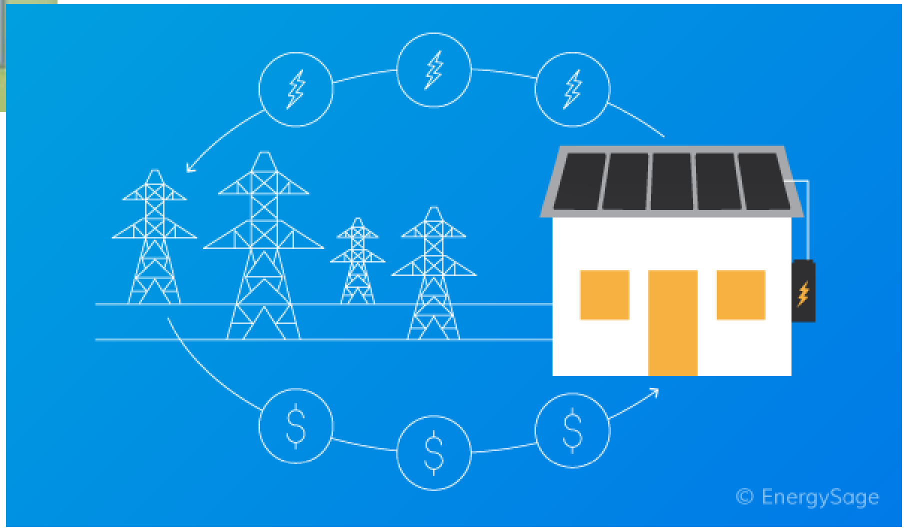
Variable Demand -AND- Variable Generation with storage

ConnectedSolutions forms Virtual Power Plants (VPPs)



Homes and businesses with battery storage supply energy (capacity) to the grid during peak demand times

- Utilities dispatch aggregated BTM batteries at peak hours
- Customers retain use of batteries for resilience and other needs



In return, utilities pay battery customers as they would a peaker plant or demand response resource

- Battery customers monetize their investment
- Utilities reduce load at peak hours
- Ratepayers save money

Key elements of the program model:

- Battery storage is incorporated into the state energy efficiency program
  - Some states, such as Massachusetts and Rhode Island, run ConnectedSolutions as an efficiency program offering
  - Some states, such as Vermont, offer a similar program as utility demand response
- Customers (residential or commercial) purchase or lease batteries and sign a multi-year, pay-for-performance contract with their utility
  - Utilities pay customers for load reduction and power export on a signal (pay for performance)
  - Developers and aggregators can market the program, offer financing and enroll customers
  - Equity provisions (rebates, adders and favorable financing) may be adopted
- Result: Customer batteries reduce system-wide electric demand peaks
  - Ratepayers benefit from reduced system-wide costs
  - Host facilities earn revenues and have battery back-up power during grid outages

Equity provisions support equitable access to benefits

- Natural disasters and associated grid outages hit low-income and historically underserved communities hardest
  - Behind-the-meter solar+storage can provide resilience benefits
- Low-income customers are most in need of energy cost savings
  - Solar+storage can reduce energy costs through net metering and demand charge management (commercial customers)
  - ConnectedSolutions provides equitable opportunities for revenues/payback to all customers (residential and commercial)

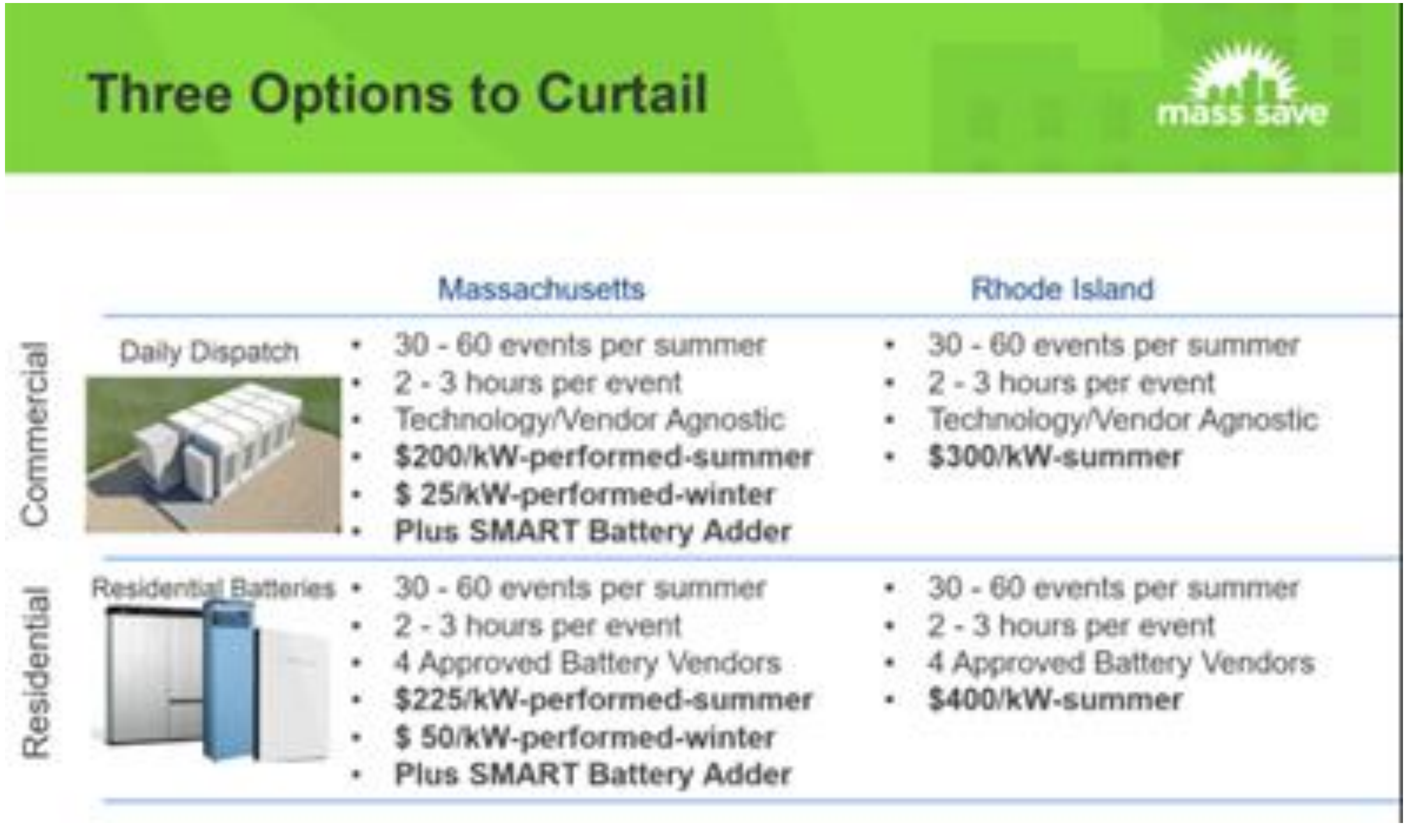
Equity provisions should include both carve-outs and additional incentives

- Justice40 commitment in incentive program (40% of awards go to projects benefiting underserved communities)
- Additional incentives for income-eligible participants and those serving historically underserved communities (community benefits requirement)
  - Incentive adders/multipliers
  - Front-loaded incentives
  - Low- or no-cost financing
  - Pre-development technical assistance
  - On-bill financing option
  - Incentives for owned and leased systems

ConnectedSolutions Project Economics Example

A commercial customer participating in the Massachusetts targeted dispatch program installs a 60 kWh battery and signs up for a $200/kW summer daily dispatch program. Assuming no opt-outs:

- **60 kWh battery = 20 kw/hr load reduction averaged over 3-hour calls**
- **20 kW average load reduction x $200/kW incentive rate = $4,000 maximum seasonal payout, or $40K over 10 years**
- **Customers can stack other revenue streams such as net metering, solar rebates, demand charge management (for commercial customers), and participation in energy market programs**



Where are ConnectedSolutions and similar model programs?

- **Massachusetts** – ConnectedSolutions effective in January, 2019
- **Rhode Island** – ConnectedSolutions effective in January, 2020
- **Connecticut** – ConnectedSolutions effective summer, 2020; Energy Storage Solutions customer battery program began January, 2022
- **New Hampshire** – Liberty Utilities customer battery pilot (to be expanded)
- **Maine** – Energy Storage System program
- **Vermont** - Green Mountain Power Tesla and BYOD programs – 3,000 customer batteries installed
- **New York** – ConEd and PSEG customer battery programs (Dynamic Load Management)
- **North Carolina** – PowerPair pilot (Duke)
- **Maryland** – Delmarva Power Elk Neck customer battery pilot program
- **Montana –** DR Resources Program
- **Idaho** – Idaho Power FlexPeak Management
- **Oregon** – Portland General Electric Energy Partner On Demand program
- **California** – Statewide Self Generation Incentive Program; Sacramento Municipal Utility District (SMUD), Southern California Edison (SCE) and Pacific Gas and Electric Company (PG&E) customer battery programs
- **Hawaii** – Battery Bonus program

CEG recommends funding BTM energy storage through state energy efficiency programs

Why?

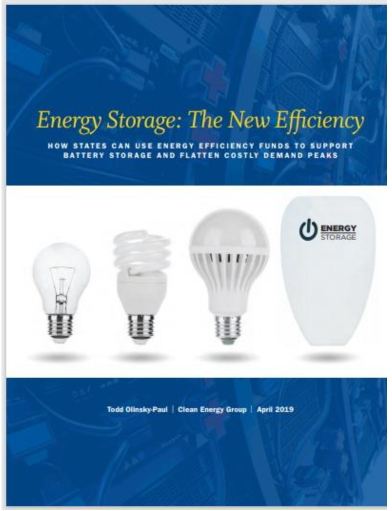
- Most states have an energy efficiency program
  - Easier to add a new measure to an existing program than to develop a new program
  - New measures are commonly added to efficiency programs as technology advances
- EE programs are generally well-established and well-funded
- EE programs are open to all customers (DR programs usually are not)
  - EE programs often include equity provisions
- The definition of efficiency needs to be expanded to accommodate new clean energy technologies and grid modernization

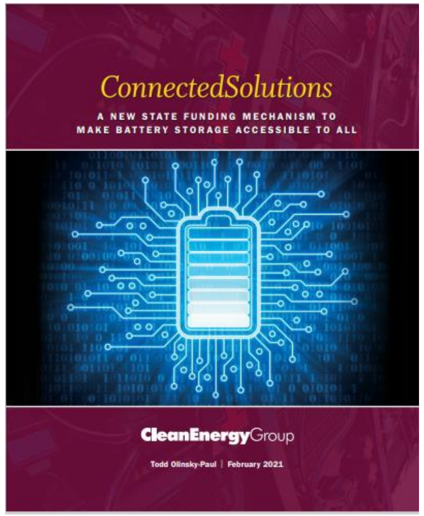
2019 Electric Efficiency Program Spending by State

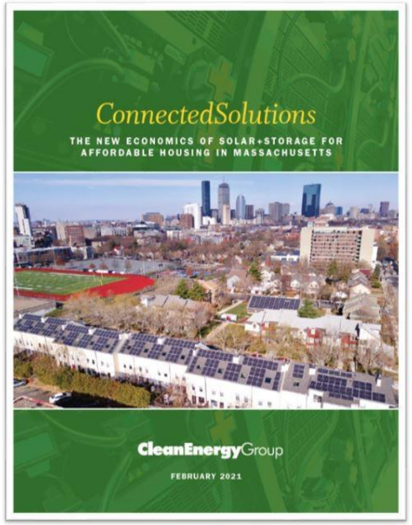
State	2019 Electric Efficiency Spending ($ million)	$ Per Capita	State	2019 Electric Efficiency Spending ($ million)	$ Per Capita
Rhode Island	104.1	98.24	Nevada	45.3	14.71
Massachusetts	620.4	90.02	Utah	47.1	14.69
Vermont	55.2	88.46	Missouri	85.8	13.98
Maryland	275.6	45.58	North Carolina	145.8	13.90
Connecticut	161.4	45.28	New Jersey	123.0	13.85
California	1516.4	38.38	Wisconsin	79.0	13.57
Oregon	161.5	38.28	Montana	14.4	13.44
New Hampshire	48.6	35.74	South Carolina	64.0	12.43
Idaho	61.4	34.37	Arizona	82.4	11.32
Illinois	433.8	34.23	Texas	196.2	6.77
Maine	45.9	34.12	Kentucky	27.2	6.09
New York	645.2	33.17	Mississippi	17.1	5.74
Hawaii	42.0	29.66	Georgia	57.0	5.37
Minnesota	157.0	27.84	South Dakota	4.7	5.31
Michigan	250.7	25.10	Louisiana	24.6	5.29
Washington	190.7	25.05	Florida	105.4	4.91
Iowa	75.6	23.95	West Virginia	7.6	4.24
Arkansas	68.0	22.52	Virginia	31.7	3.72
District of Columbia	15.4	21.79	Nebraska	7.1	3.65
Colorado	108.0	18.75	Tennessee	19.2	2.81
Delaware	17.9	18.41	Alabama	7.7	1.57
Wyoming	10.2	17.66	North Dakota	0.2	0.20
Oklahoma	68.6	17.34	Kansas	0.3	0.11
Pennsylvania	197.5	15.43	Alaska	0.0	0.03
Indiana	101.8	15.12			
New Mexico	31.7	15.12	**U.S. total**	**6,832.4**	
Ohio	175.0	14.97	**Median**	**64.0**	**15.12**

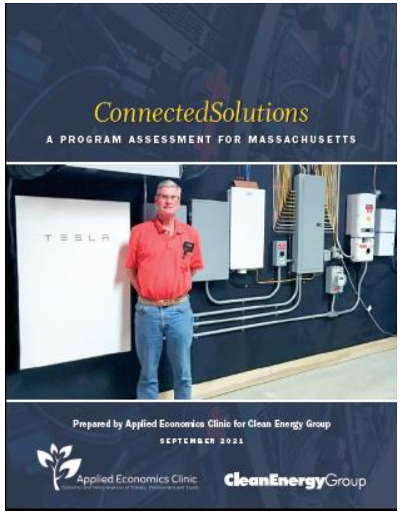
Source: ACEEE, "The 2020 State Energy Efficiency Scorecard." https://www.aceee.org/research-report/u2011

More Information is Available from Clean Energy Group









Reports and analysis are available from our online publications library at https://www.cleanegroup.org/publications-library/

We are also happy to meet with state energy officials to answer questions about the ConnectedSolutions program model