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Cleaning the Peak with Energy Storage

vermont electric power company

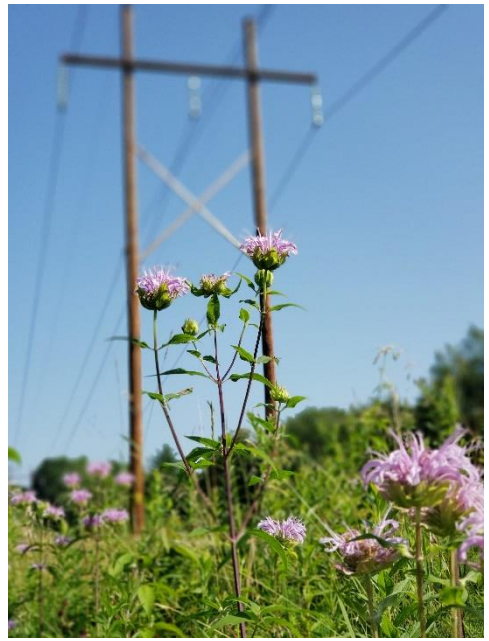
VELCO

REV2024 Conference

October 17, 2024

Outline

- Who is VELCO
- Vermont generation portfolio
- Vermont generation mix at the New England peak
- New England generation mix on a peak day
- Storage as a means to clean the peak



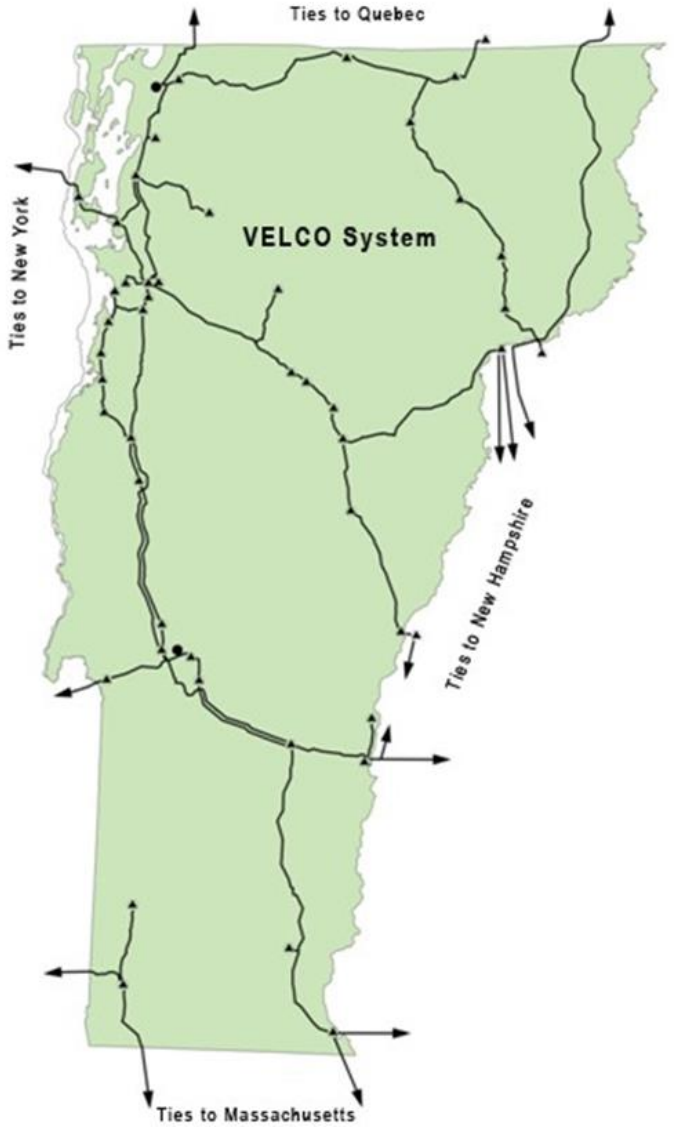
Background

- VELCO: 1956, Vermont's utilities united to form the first U.S. transmission-only company, delivering clean New York hydropower to Vermont
- Owned by Vermont's 17 distribution utilities and a public benefits corporation
- For-profit financial structure to deliver cooperative-like value to every grid connected customer, VELCO profits lower Vermont electric customers' rates

Managed assets

- 740 miles of transmission lines
- 1,600+ miles fiber optic communication networks that monitor/control electric system and aid Vermonters' high-speed data internet access
- Adding 800+ more miles of fiber to connect 80% of Vermont's distributed energy resources
- 56-site Statewide Radio System to support daily operations and emergency response
- 14,000 acres of rights-of-way managed for a variety of habitats
- 55 substations, switching stations, and terminal facilities
- HVDC equipment that enables interconnected operations with Hydro-Québec

Vermont Generation is mostly renewable and in



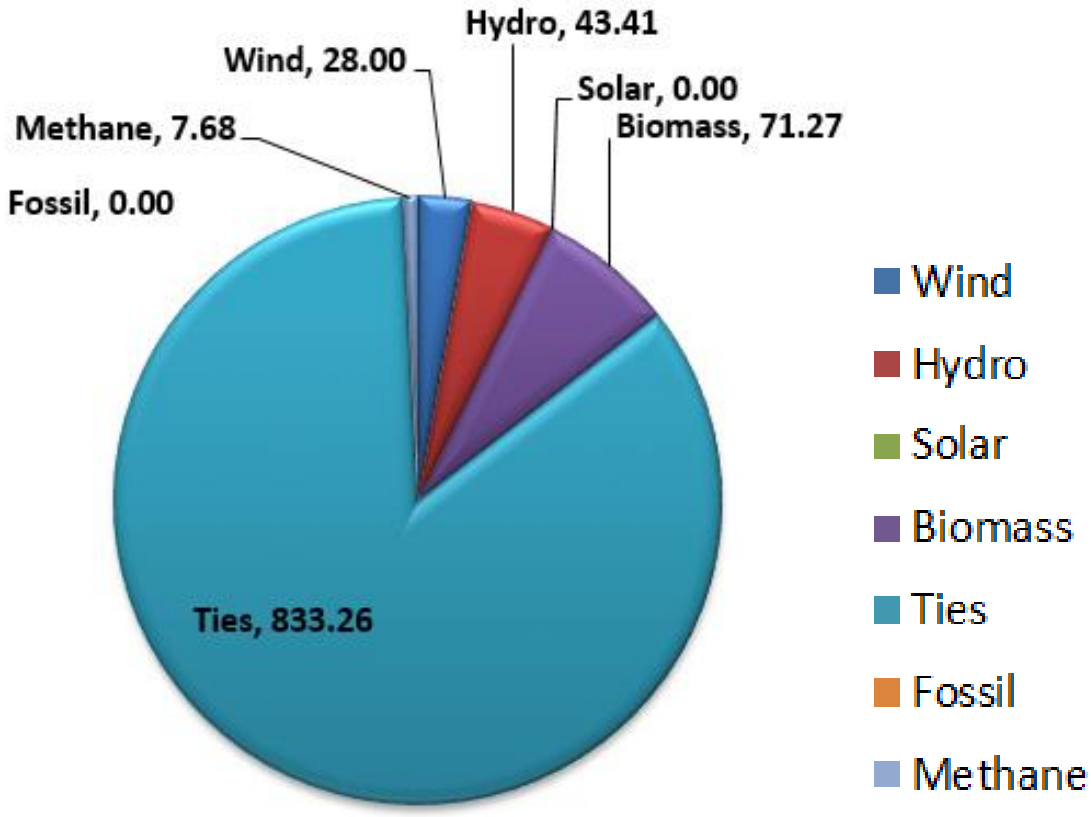
Type		MW
Fossil (fast start units)	Winter	173
	Summer	124
Hydro		152
Wind		151
Landfill gas		9
Biomass (wood)		72
Solar PV		20
Small-scale solar PV		520 and growing
Small-scale farm methane, wind, hydro		60 and growing
TOTAL IN-STATE GENERATION SUMMER NAMEPLATE		**About 1100**

- Small-scale battery about 70 MW and growing
- Highgate HVDC converter 225 MW (almost entirely hydro)

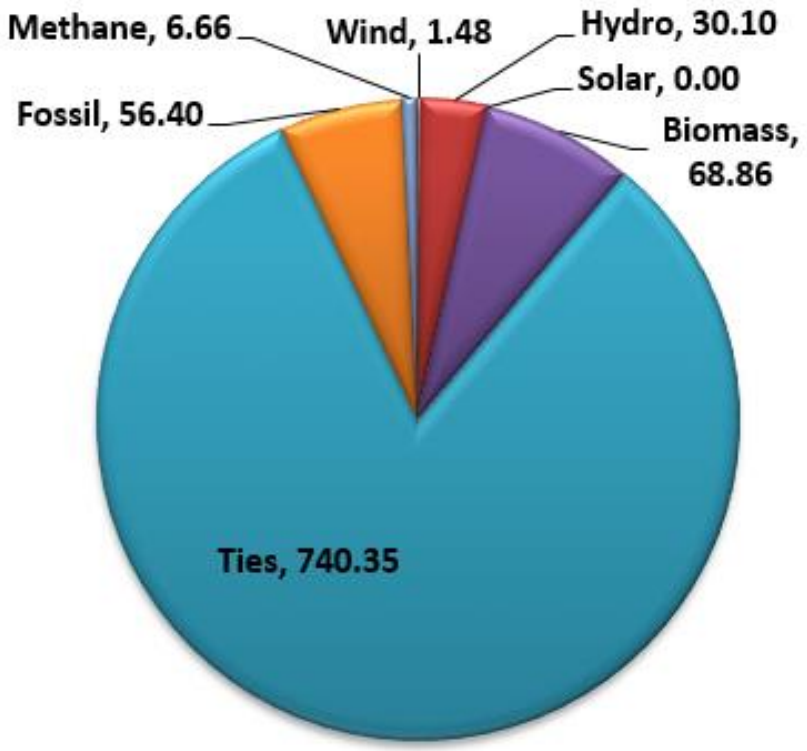
Vermont Peak load 1000 MW (winter and summer)

Vermont generation at the Vermont peak hour

- 2022/23 winter peak day (2/3/23, 6:00 PM)
- Net Load was 983.62 MW

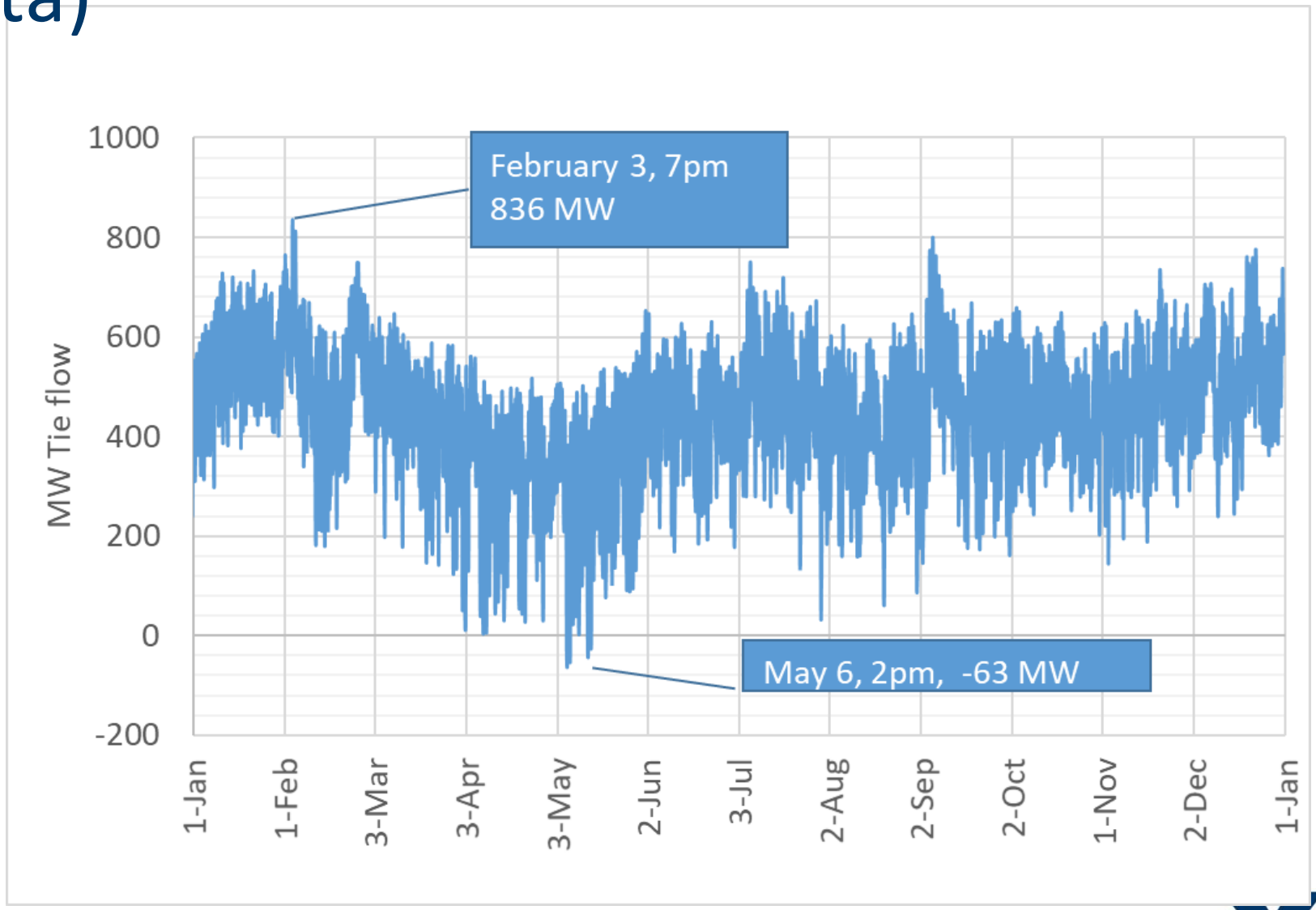


- 2023 summer peak day (9/6/23, 8:00 PM)
- Net Load was 903.85 MW

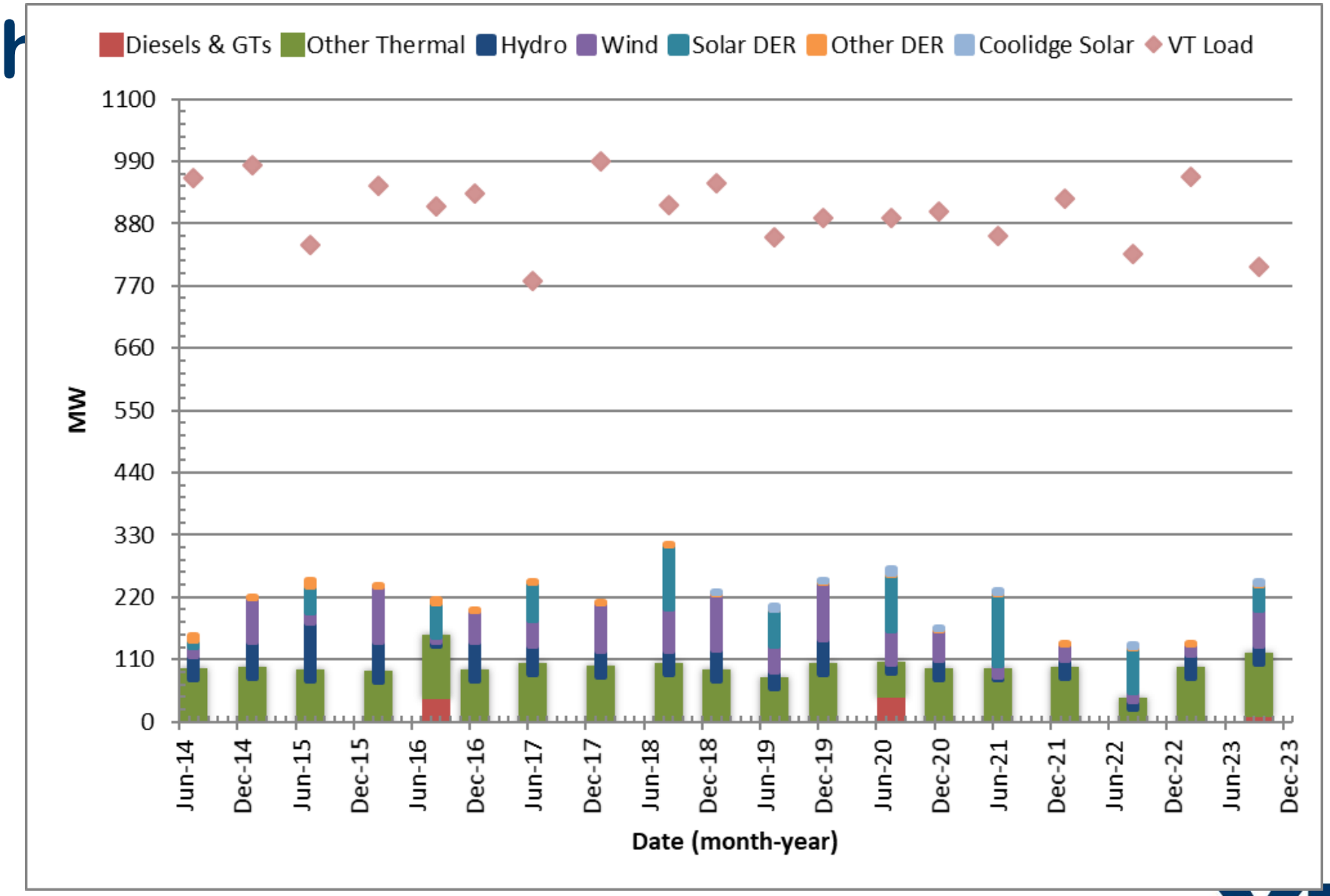


Ties are imports on transmission lines from neighboring states

Vermont imports electricity nearly 100% of the time (2023 data)



Vermont generation at the New England peak h



New England 2023 monthly energy (GWh) by source

'23 GWh Supply	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
COAL	26	81	5	2	1	0	13	0	0	18	7	27
OIL	2	224	1	2	1	7	27	10	17	5	21	7
NATURAL GAS	4,041	3,548	4,089	4,272	3,882	5,291	6,628	5,400	5,126	4,469	4,430	4,409
HYDRO	998	782	819	895	801	680	967	822	680	687	653	859
NUCLEAR	2,455	2,199	2,484	999	1,498	924	2,331	2,321	2,209	2,089	1,518	2,178
LANDFILL GAS	41	37	41	35	40	35	39	39	37	32	39	40
METHANE	4	3	4	3	4	4	3	4	3	3	3	3
REFUSE	235	209	229	194	213	226	235	229	213	233	229	235
SOLAR	116	214	339	381	538	393	431	397	341	299	254	150
STEAM	0	0	0	0	0	0	0	0	0	0	0	0
WIND	301	297	385	327	369	168	132	231	178	257	350	309
WOOD	177	155	169	120	113	157	201	168	122	93	153	161
OTHER	5	8	13	14	29	27	30	30	25	23	20	14
PRD	0	3	1	0	0	1	1	2	1	0	0	1
Total Imports	2,274	1,900	1,450	1,378	1,179	1,646	1,427	1,249	992	844	1,686	1,869

Marginal unit flags on Feb 3, 2023 (hour beginning)

Time	Coal	Hydro	Gas	Oil	Other	Wind	Wood	Total
5 AM		2	9			10		21
6 AM			9			9		18
7 AM	1		8			9		18
8 AM		3	5			7	1	16
9 AM		2	6	1		9	1	19
10 AM				8		8		16
11 AM	1			6		7		14
12 PM	3			5		8		16
1 PM				7		8	1	16
2 PM			2	8		10		20
3 PM			1	10		11		22
4 PM			3	5		8		16
5 PM			3	6		8		17
6 PM			**4**	**4**		**8**		**16**
7 PM			8	3	1	10		22
8 PM			10	4		14		28

Time	Coal	Hydro	Gas	Oil	Wind	Wood	Total
6 PM							
:01				1	1		2
:02				1	1		2
:13				1	1		2
:25			1		1		2
:35				1	1		2
:44			1		1		2
:52			1		1		2
:57			1		1		2

Marginal unit flags on July 6, 2023 (hour beginning)

Time	Hydro	Gas	Other	Wind	Total
5 AM		13			13
6 AM		8			8
7 AM		6			6
8 AM		10			10
9 AM		8			8
10 AM		8			8
11 AM		6			6
12 PM		7			7
1 PM		6			6
2 PM		6			6
3 PM		7			7
4 PM		8	1		9
5 PM	4	4			8
6 PM		8			8
7 PM		8			8
8 PM	2	7			9

Time	Hydro	Gas	Total
5 PM			
:10		1	1
:17		1	1
:23		1	1
:27	1		1
:33	1		1
:41	1		1
:51	1		1
:59		1	1

Minimum conditions for storage to clean the peak

- Storage is charged with clean energy
  - Batteries paired with on-site solar PV, wind, hydro, …
    - Or contracts with remote emission-free resources
  - Pumped hydro storage
  - Seasonal storage with Hydro-Québec hydro reservoirs
    - New HVDC lines to export/import excess VT solar PV and New England wind
- Storage is priced lower than the marginal resource
- The marginal resource is carbon-based
  - May not be the case, e.g. ponding or pumped hydro, and in congested areas with excess renewables


Thank you

Energy Storage for Peaker Plant Replacement

A Maine Case Study

October 17, 2024

Renewable Energy Vermont 2024

Clean Energy Group

Affordable, reliable, clean energy for all.

Climate Resilience and Community Health

Distributed Energy Access and Equity

Energy Storage and Flexible Demand

Fossil Fuel Replacement

Celebrating 20 Years of State Leadership

Clean Energy States Alliance

The Clean Energy States Alliance (CESA) is a national, nonprofit coalition of public agencies and organizations working together to advance clean energy.

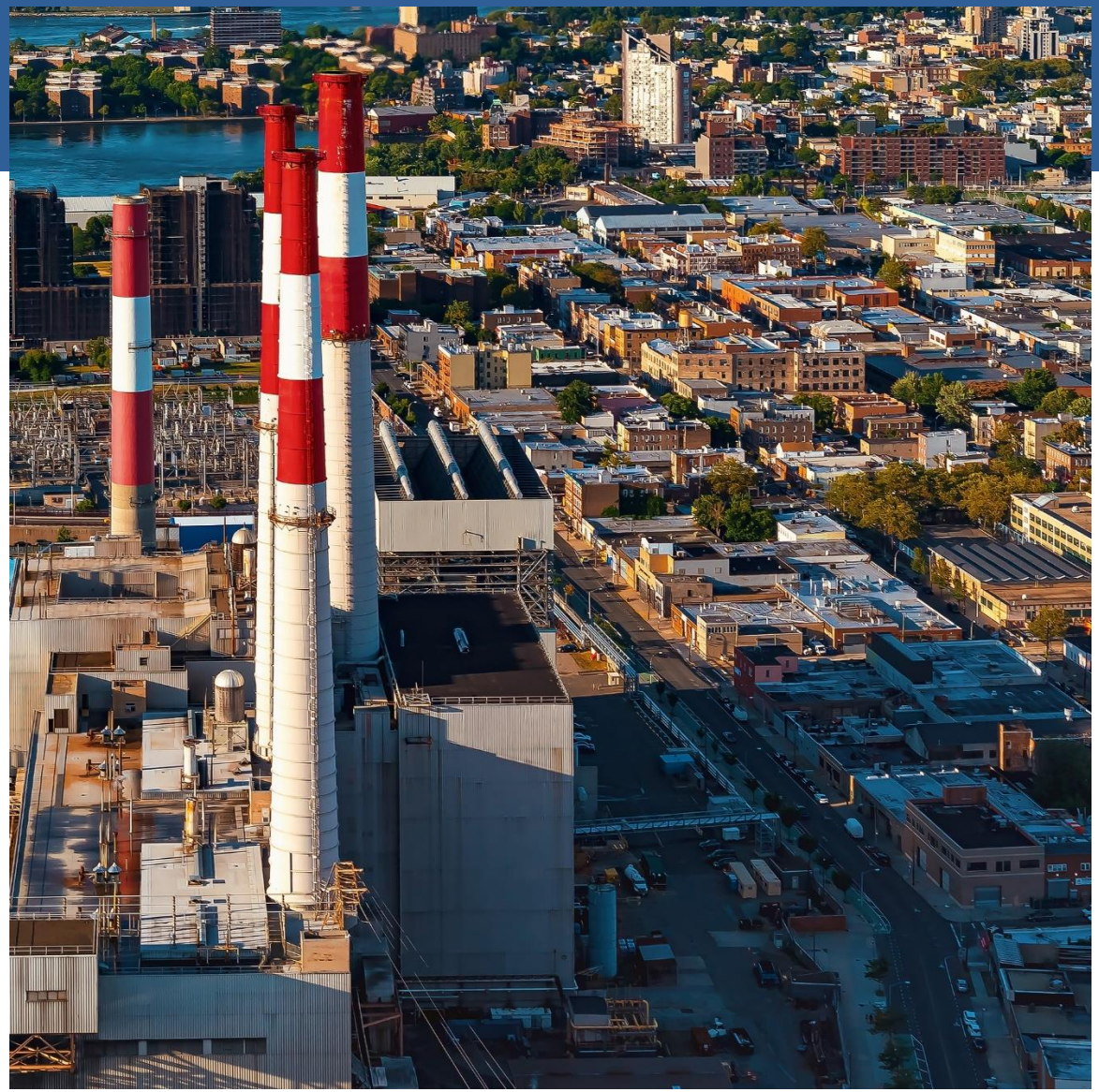
CESA members—mostly state agencies—include many of the most innovative, successful, and influential public funders of clean energy initiatives in the country.

www.cesa.org

CleanEnergyGroup

Phase Out Peakers

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



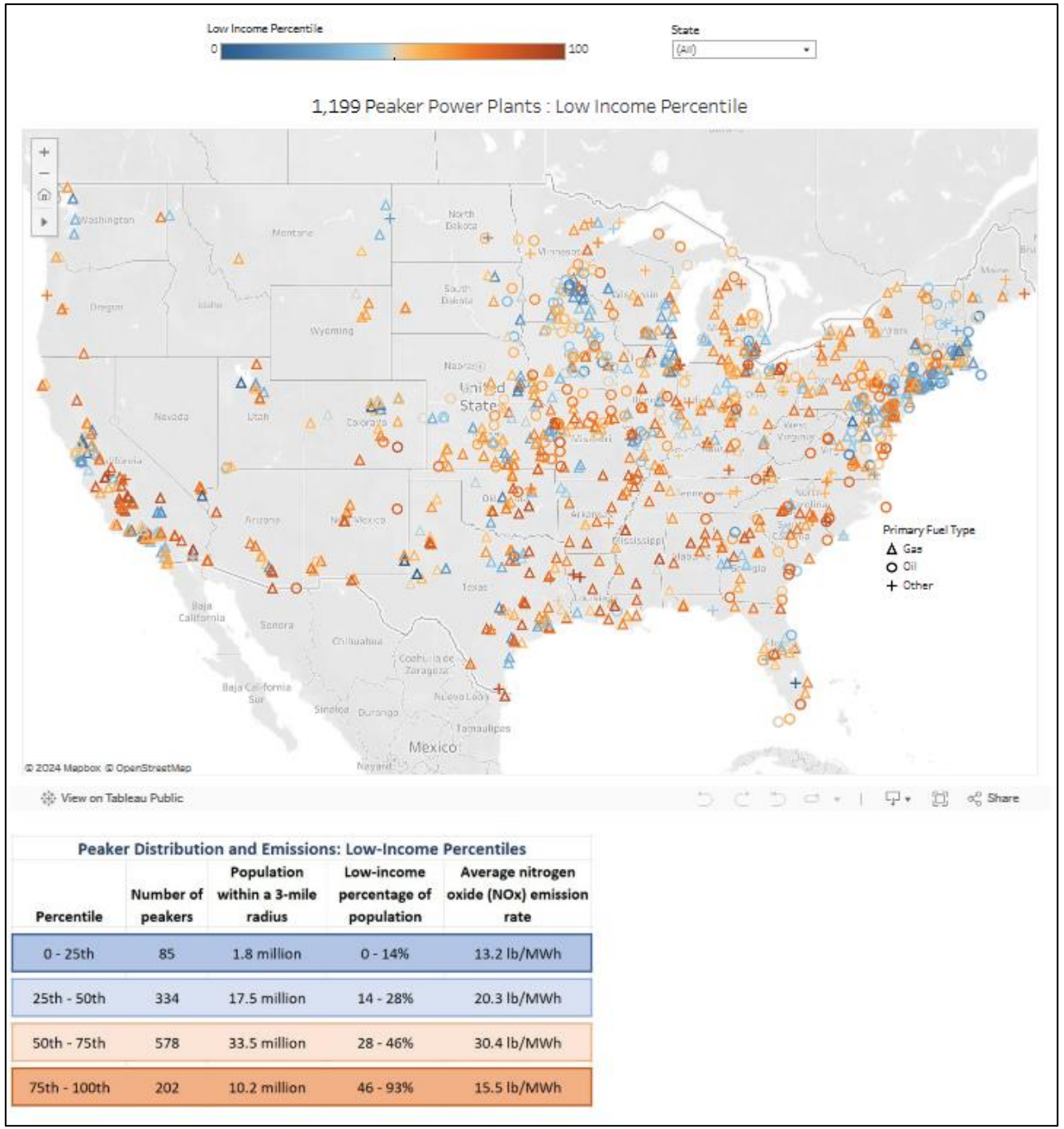
Ravenswood Generating Station in Queens, NY. Credit: Bigstock

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

Fossil-Fueled Peakers:

- May run on natural gas, oil, kerosene or even coal
- Run infrequently, but are very costly
- Highly polluting
  - Human health impacts
  - Environmental impacts
- Often sited in populated areas
- Disproportionately sited in poorer and underserved communities
- Cause equity concerns

Interactive maps are available at CEG's Phase Out Peakers project page: https://www.cleanegroup.org/initiatives/phase-out-peakers/



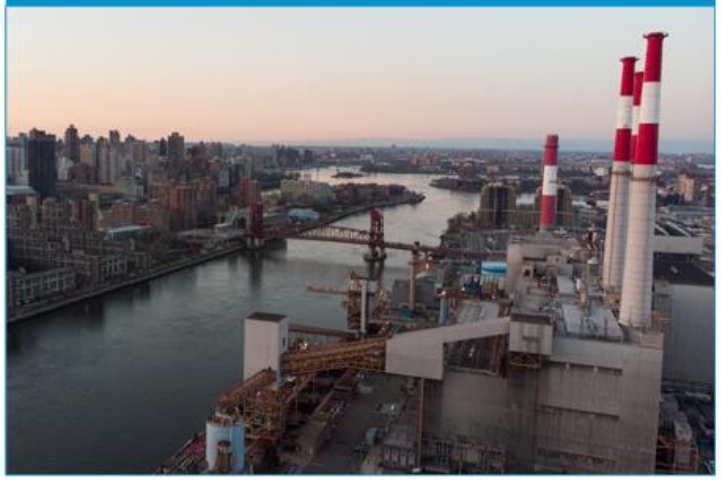
Peaker Distribution and Emissions: Low-Income Percentiles

Percentile	Number of peakers	Population within a 3-mile radius	Low-income percentage of population	Average nitrogen oxide (NOx) emission rate
0 - 25th	85	1.8 million	0 - 14%	13.2 lb/MWh
25th - 50th	334	17.5 million	14 - 28%	20.3 lb/MWh
50th - 75th	578	33.5 million	28 - 46%	30.4 lb/MWh
75th - 100th	202	10.2 million	46 - 93%	15.5 lb/MWh

Yes, Batteries Can Replace Peakers!

Successful Projects: a Few Examples

New York City



LS Power's 316 MW (8-hr) battery to replace Ravenswood oil and gas peaker plant

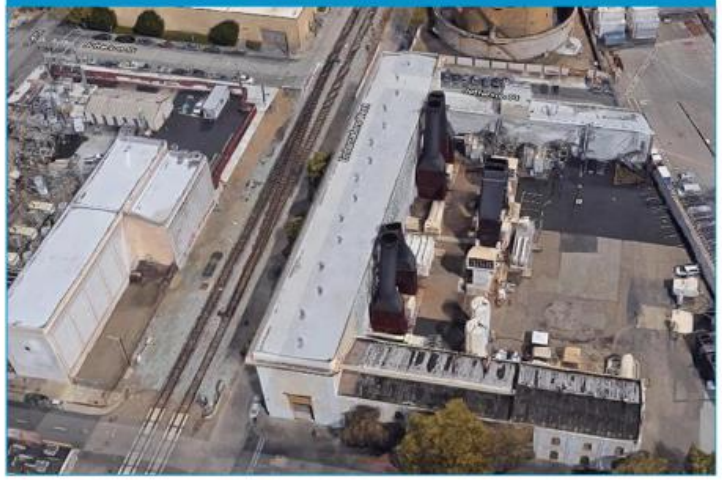
- Expected to be online 2022-2024
- Approved & waiting contractor

Los Angeles

SoCal Edison is using 195 MW of 4-hr batteries to replace Puente Gas Power Plant (262 MW)

- Decision followed the push-back of community & environment advocates

The Bay Area



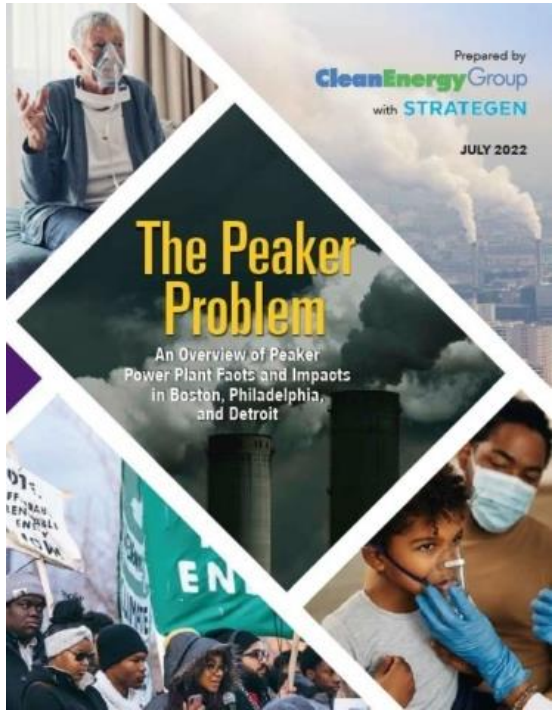
East Bay CCA replaces Oakland peaker with 20 MW (4-hr) battery and home solar+ storage

- 2 MWh of batteries on 500 low-income units in the area before 2022.

Peaker Replacement: A Community Issue

Clean Energy Group's *Phase Out Peakers* program works with community-based organizations to support peaker replacement initiatives

- New York City
- Philadelphia
- Boston
- Western Massachusetts
- Detroit



These reports and others are available at CEG's Phase Out Peakers project page: https://www.cleanegroup.org/initiatives/phase-out-peakers/

Peaker Replacement: A State Issue

Clean Energy States Alliance works to support state energy agencies in developing energy storage for peaker replacement

Several states have combined energy storage procurement with fossil-fueled peaker replacement initiatives:

- New York State – 1,500 megawatts (MW) of energy storage by 2025 and 3,000 MW by 2030; Regulations to phase out peakers with high nitrogen oxide emissions between 2023 and 2025.

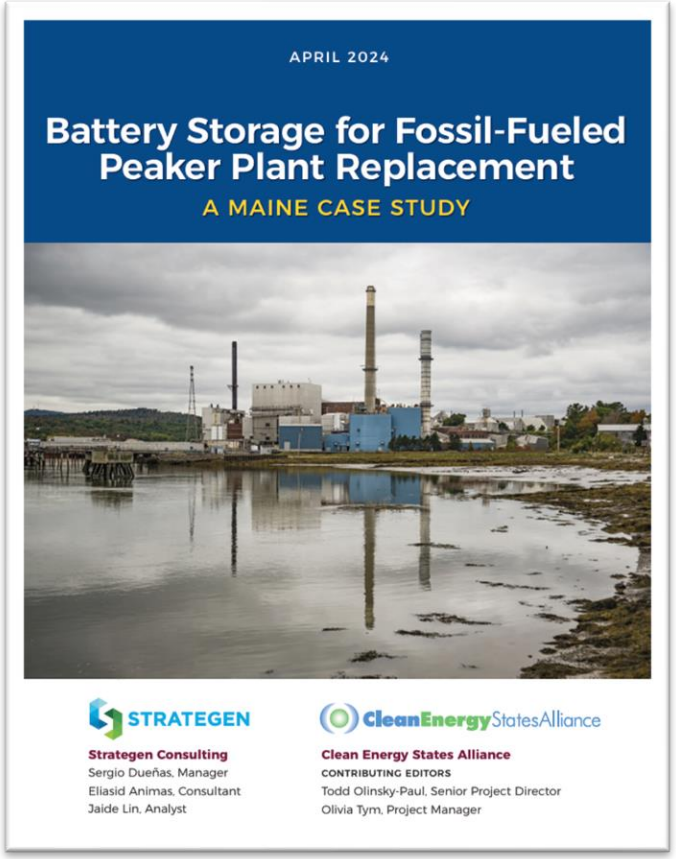
- Massachusetts – 1,000 MW of energy storage by 2025; Adopted the nation's first Clean Peak Energy Standard, which requires peak power to be increasingly sourced from renewables and storage.

Numerous states have adopted emissions caps, clean energy goals and climate plans:

- Regional Greenhouse Gas Initiative (RGGI) – 11 states
- 100% clean energy targets – 23 states plus DC and Puerto Rico
- Climate action plans – 33 states

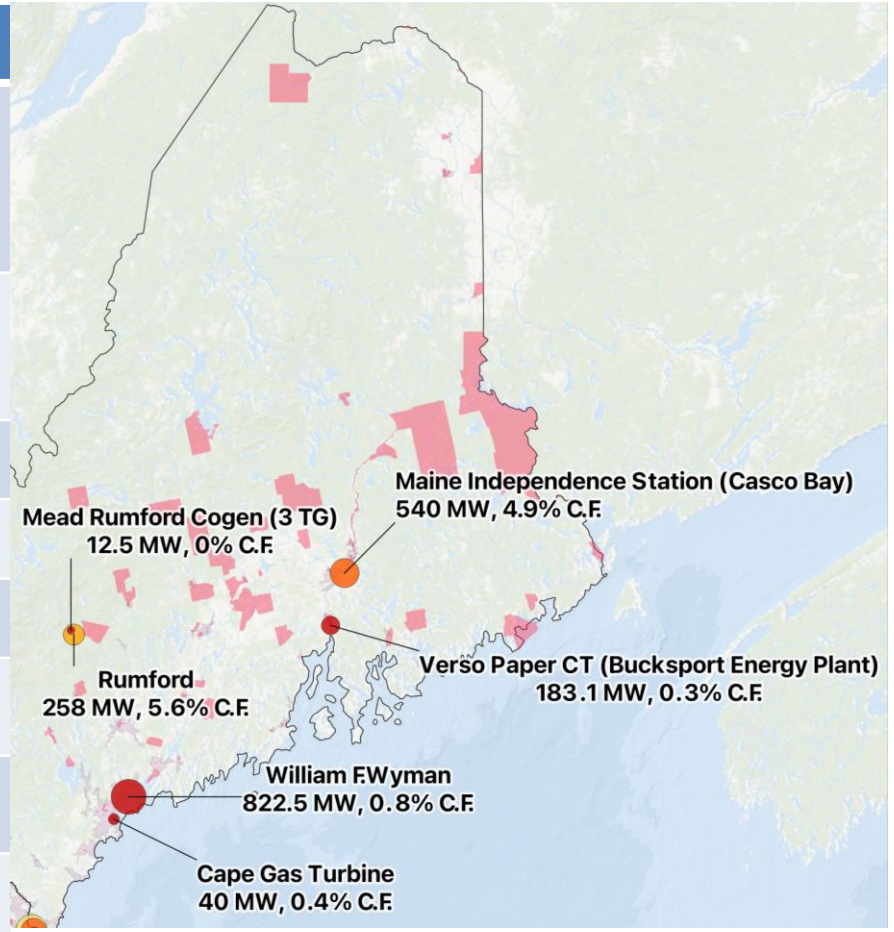
Report: Battery Storage is More Cost-Effective Than New Gas Peakers in Maine (and the rest of New England)

- Clean Energy Group and Clean Energy States Alliance contracted Strategen to conduct an economic analysis of battery storage for peaker plant replacement in Maine
- This report is intended to support Maine's upcoming 200 MW energy storage procurement
- Due to the nature of the regional energy capacity market, the results should be applicable across all six New England states
- **Takeaway: When the costs of air pollution are included in the analysis, new batteries are more cost-effective than new gas peakers.**



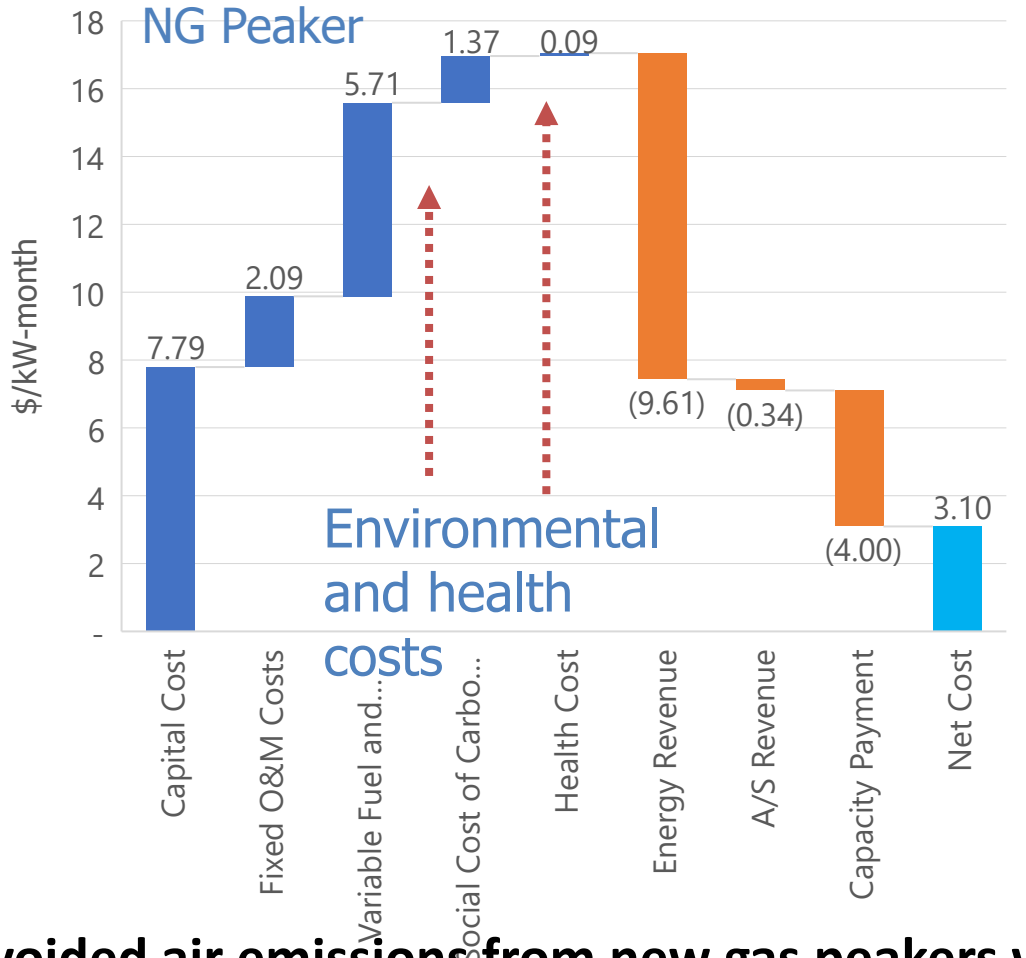
1. Selection of target peakers

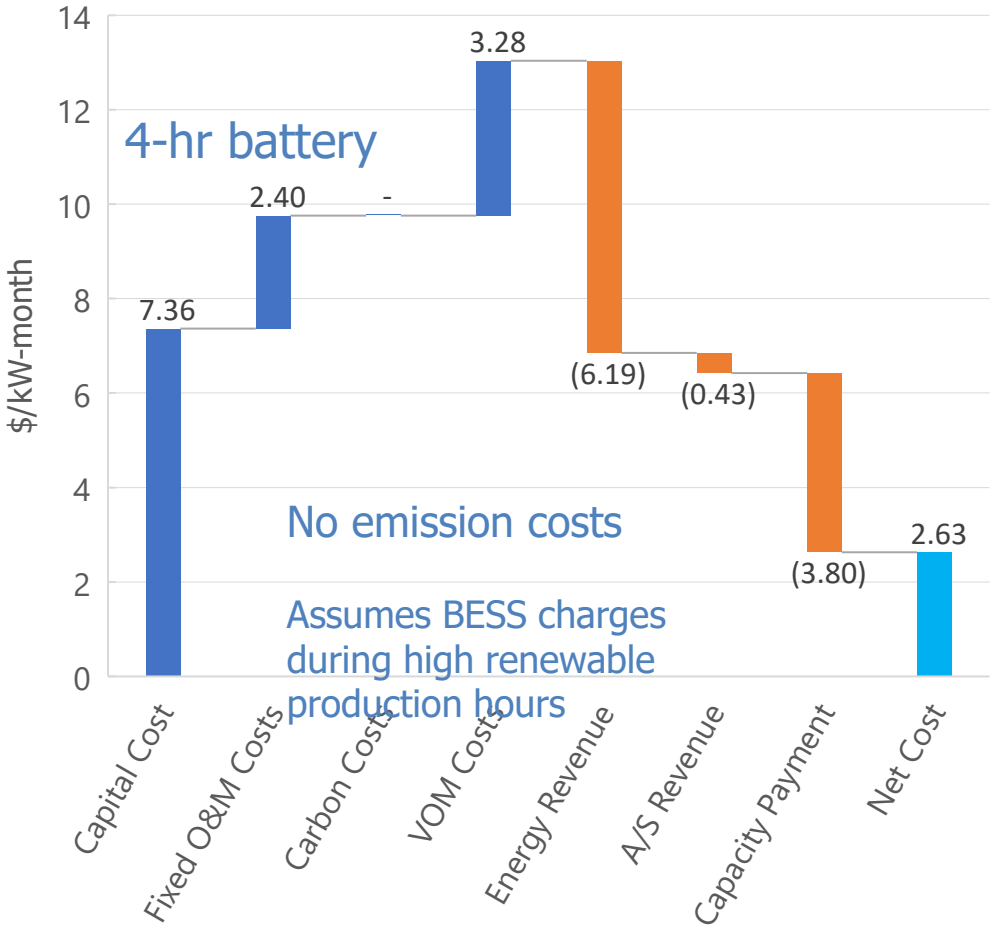
	Wyman	Cape Gas	Bucksport	Casco Bay	Rumford
Technology	Steam turbine, residual fuel oil	Gas turbines, distillate fuel oil	Gas turbine, ng and distillate fuel oil	**Combined cycle**, natural gas	**Combined cycle**, natural gas
Units (MW)	Two units (114 and 605 MW)	Two units (20 MW each)	1 unit (183 MW)	1 unit (540 MW)	1 unit (258 MW)
Age	59 and 46 yrs	54 years old	23 years old	24 years old	24 years old
Owner	NextEra	NextEra	JERA	Vistra	Carlyle Group
Utility	CMP	CMP	CMP	Versant Power	CMP
Heat Rate (Btu/kWh)	10,990	20,730	12,300	~7,500	~7,500
2022 Capacity Factor (%)	3.3	0.1	0.6	14	19
Variable O&M Costs ($/MWh)	83	300	-	-	-



Wyman, Cape and Bucksport are likely candidates for replacement; all plants are at least 3-miles away from a community

Maine cost-benefit comparison: New NG Peaker VS 4-hr Battery





Avoided air emissions from new gas peakers would save Maine an estimated $7.1 million annually based on the morbidity and mortality of NO_X and SO_2 and precursors of fine particulate matter (PM2.5). These are externalities that fossil fuel generators do not pay for.

Findings

When the societal costs of air emissions are counted, energy storage is cheaper than a new F-frame gas peaker in Maine (and New England)

Table 4

Comparison of New Peaking Alternatives' Net Costs Under QC and ELCC Cases, Inclusive of Health and Societal Costs ($kW-month)

QC		ELCC	
Asset	Net Cost	Asset	Net Cost
BESS, 2-hr	(0.54)	BESS, 4-hr	2.63
BESS, 4-hr	2.42	New F-Frame	3.10
New F-Frame	3.10	BESS, 2-hr	3.12

Source: Strategen Consulting

Takeaway: The state can create a more level playing field for storage by internalizing externalities, such as emissions costs, in benefit-cost analysis (and valuing non-monetizable services).

Thank You

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