QCoefficient
Turning Buildings into Batteries™

Summary

Large commercial buildings in New York City can easily, quickly, and substantially reduce local Queens baseload power plant emissions (both $CO2_e$ and co-pollutants) as a byproduct of reducing electric energy and energy expense, that is, at no cost.

QCoefficient ("QCo") proved such a substantial emissions reduction opportunity in 2019 by successfully deploying its EMeister model-predictive control (MPC) technology in one of Manhattan's most prominent, best designed and operated, and highly-rated (LEED Gold) commercial office buildings.

QCoefficient and its building RD&D partners at the University of Colorado Boulder, Penn State University and the Illinois Institute of Technology continue to improve EMeister MPC through a NYC-focused development project largely and significantly funded by the Solar Energy Technology Office of the U.S. Department of Energy.
https://www.buildingsasbatteries.com/our-team
https://www.buildingsasbatteries.com/nyc-demos

We have:

- Confirmed broad applicability to a wide range of large NYC commercial office buildings;
- Completed development of a portfolio version of EMeister MPC that can coordinate a portfolio of large commercial buildings to achieve grid-scale emissions reductions;
- Expanded EMeister MPC features to achieve and complement the objectives of the Climate Leadership and Community Protection Act and Local Law 97, with an emphasis on reducing Queens baseload emissions and leveraging photovoltaics physically installed in NYC; and
- Developed measurement & verification methods that meet the greater requirements of the CLCPA and LL97; and necessarily exceed current ASHRAE and IPMVP industry standards.

QCo and its technology partners believe we have identified one of the best, if not the best, CLCPA and LL97 opportunities, especially for the benefit of Disadvantaged Communities. EMeister MPC is an example of what the US DOE defines broadly as grid-interactive efficient building technology ("GEB"). (https://www.energy.gov/eere/buildings/grid-interactive-efficient-buildings). GEB emphasizes building flexibility – most importantly, when a building uses electricity is just as important as how much electricity a building uses. QCo would add to that definition the need for a building-interactive efficient grid, operated to take best advantage of building flexibility. The main impediment to broad GEB market innovation and deployment is the lack of building/grid market signals, for example, hourly day-ahead or week-ahead $CO2_e$ emission rates for NYC.

Proven – Large Commercial Building Deployed EMeister MPC to Substantially Reduce Local NYC Baseload Power Plant Emissions

In close coordination with the building's operating engineers, QCo's EMeister executed building air conditioning ("HVAC") operating strategies during the 2019 cooling season that reduced HVAC electric expense by $300,000 and corresponding on-peak energy use by 19% (weather-adjusted).

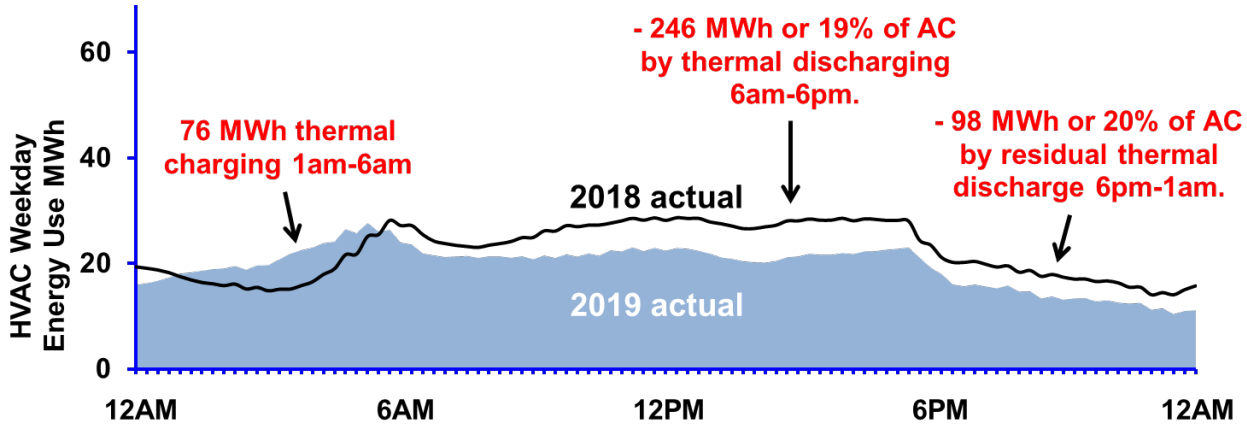


Figure Energy – 1

How to interpret this Figure – Energy reduction 8am to 6pm is when EMeister strategically released thermal energy into the building. Energy reduction 6am to 8am simply means that EMeister pre/subcooling strategies advanced the building HVAC start to before 6am.

Energy reduction 6pm to 1am means that, occupied or not, pre/subcooled floors continue to release thermal energy and remain comfortable after 6pm.

A 19% energy reduction during the hours most important to grid efficiency, grid economy, and carbon emissions is a remarkable achievement in this LEED Gold building. The energy reduction was mostly targeted and achieved on hot days corresponding to higher NYISO electric energy prices and peak demands; and to higher ConEd system and billing peak demands.

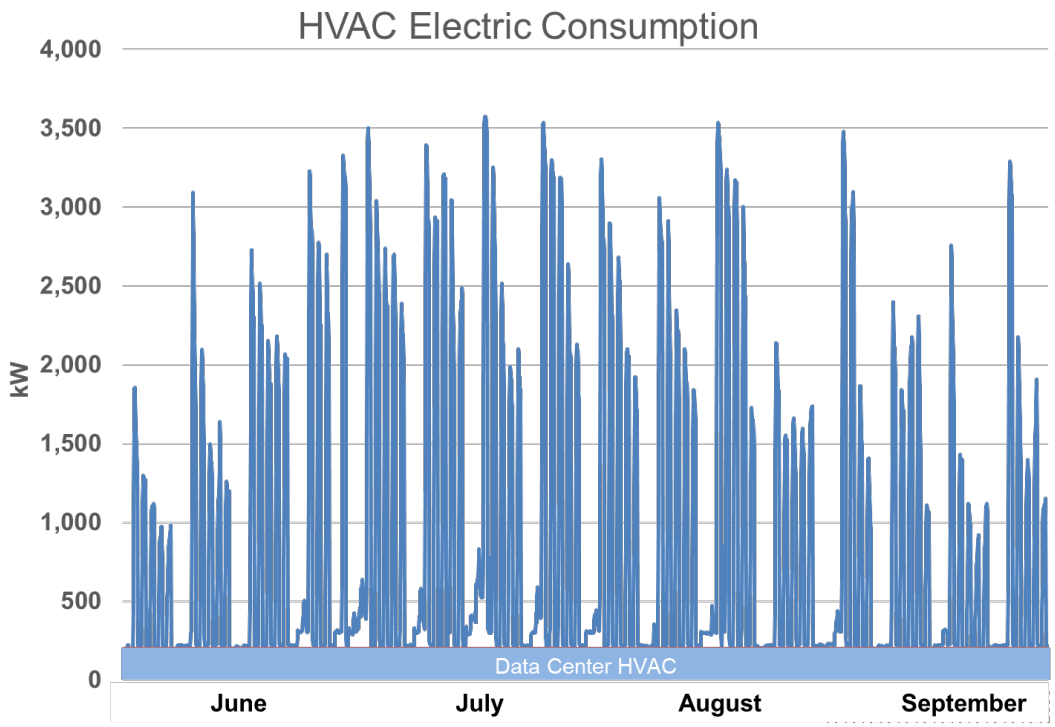
(For non-engineers who do not understand how very early morning cooling can displace 3x cooling during occupancy hours – remember that even your home air conditioner is more efficient when you operate it in the middle of the night. As a middle-of-the-night bonus, your home air conditioner would be supplied by lower cost, more efficient and less polluting generating plants.)

In 2019 QCo engineers learned the building; and the building operating engineers learned EMeister MPC. 2020 cooling season savings expectations were $400,000 (and then Covid shut everything down).

https://smartgrid.ieee.org/bulletins/march-2022/important-post-covid-opportunity-for-smart-grid-photovoltaic-and-building-grid-integration-to-jump-start-decarbonization-in-new-york-city-and-other-urban-centers

https://smartgrid.ieee.org/bulletins/april-2020/demonstration-of-effective-building-grid-integration

https://www.energy.gov/eere/buildings/articles/qcoefficient-uses-energyplus-reduce-willis-tower-energy-bills



The 2019 cooling season "baseline" electric energy consumption for this EMeister MPC building's heating, ventilating and air conditioning ("HVAC") was 1,700,000 kWh or 1,700 MWh.

The eGrid output emission rate (CO2e) for New York City is 634.6 lbs per MWh or 0.3173 tons per MWh. (Source: https://www.epa.gov/egrid/power-profiler#/NYCW)

The resulting cooling HVAC carbon footprint for this building was 539 tons (=1,700 MWh x 0.3173 tons per MWh).

Huetteman, Justine, Travis Johnson, and Jeremy Schreifels. "Using eGRID for Environmental Footprinting of Electricity Purchases." U.S. Environmental Protection Agency. 2020. Available at https://www.epa.gov/egrid/egrid-technical-documents.

Reduce Cooling Season HVAC $CO2_e$ Emissions by 11%

A reduction of 11% of the HVAC cooling season footprint is calculated in accordance with the above referenced EPA method. This method explicitly assumes that GEB and other energy efficiency measures displace non-baseload generation.

Importantly, this EMeister MPC reduction was achieved as a byproduct of minimizing electric bill expense and site energy use, that is, achieved at zero cost. Had the building assigned a price to the carbon or had there been a carbon emission rate to identify and explicitly target the more important hours, greater carbon reduction would have been easily and inexpensively achieved.

QCo recommends that the CLCPA Draft Scoping Plan place greater emphasis and expectations on GEB. The New York State Energy Research and Development Authority (NYSERDA) has the skillset to manage such higher expectations.

QCo recommends that the CLCPA Draft Scoping Plan include development of day-ahead hourly emission rates for each NYISO zone – that reflect unit commitment – to complement the day-ahead prices already published daily by the NYISO.

Or Reduce Cooling Season HVAC $CO2_e$ Emissions by 70%

If acting in coordination with other NYC buildings and in a reliable manner that provides confidence to NYISO operators to eliminate the marginal 300 MW Queens baseload plant from weekly commitment, portfolio buildings would have each reduced $CO2_e$ by an amount equal to 70% of their $CO2_e$ footprint.

Baseload generating plants in Queens produce much more energy and emissions than combustion turbines. The marginal baseload generating plant is a more valuable target, especially for Disadvantaged Communities proximate to the plant. (The EPA footprint reference, referenced above, does not include a method that anticipates coordination, at scale, to displace a baseload unit from unit commitment. Moreover, the EPA footprint reference does not distinguish "when" electric energy is reduced.)

QCo recommends that the CLCPA Draft Scoping Plan place much more emphasis on initiatives to drop the Queens marginal baseload generating plant from weekly operations.

Photovoltaics compliment large commercial buildings and can play a strategic role in reducing Queens baseload generating plant emissions … if physically located in New York City.

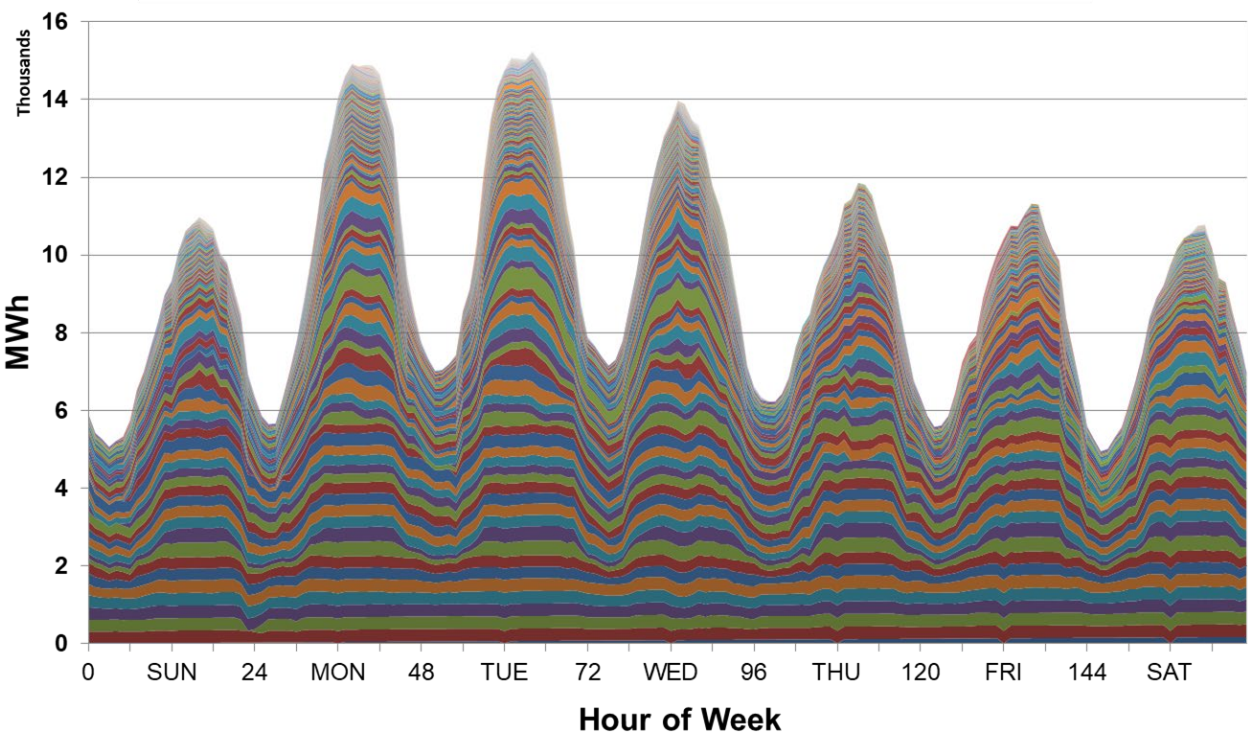
Photovoltaics has more value in NYC than out. Photovoltaic performance is highly correlated with New York City and ConEd peak demand. Therefore, photovoltaics, if physically located within NYC, can help displace the marginal Queens baseload generating plant in many weeks. For the same reason, such photovoltaics, if physically located downstream of ConEd distribution system capacity limits, can unload the ConEd distribution system and help defer expensive underground capital upgrades.

EMeister MPC provides significant flexibility and energy storage for large commercial buildings to complement intermittent photovoltaics and wind-power around the clock. Regardless of EMeister or photovoltaic deployment location in NYC, it provides equal value to displacing Queens baseload generation.

In its DOE SETO-sponsored NYC demonstration, QCo learned that installing photovoltaics in NYC is more difficult than in the suburbs, in Manhattan not feasible. Even with the help of DOE's SETO and the NYC Mayor's Office, QCo was not able to find a photovoltaic company to whom to bring business and partner in Manhattan – because rooftops are a valuable and scarce resource.

Nonetheless, QCo recommends that the CLCPA Draft Scoping Plan figure out a way to incent in-City photovoltaics, especially in Manhattan.

For Reference – the QCo Emission Rate Method



The QCo analysis started with a view of the actual New York fossil generation, in the above example during a hot week in the Summer 2019. On Monday and Tuesday, New York City temperatures reached the mid-90's, on Wednesday through Friday the mid-80's. This graphic simply stacks the fossil generating units in order of their total weekly MWh. Obviously, to meet total New York demand, this generation was complemented by nuclear and renewable generation; by imports from neighboring markets; and by very small fossil DER not required to report to the U.S. EPA.

Reference: United States Environmental Protection Agency (EPA). 2022. "Emissions & Generation Resource Integrated Database (eGRID), 2020" Washington, DC: Office of Atmospheric Programs, Clean Air Markets Division. Available from EPA's eGRID web site: https://www.epa.gov/egrid.

QCo analysis revealed a marginal baseload plant "opportunity" in every week June to September 2019, regardless of weather and load conditions. That is, this is not just an occasional hot summer day opportunity. QCo did not evaluate the other eight months of the year, but expects to find a marginal baseload plant "opportunity" in those weeks also.

(For more information on the QCo analysis and analysis method used, see https://www.buildingsasbatteries.com/carbon-reduction. QCo expects often to expand and update the materials available at this link.)

For Reference – EMeister MPC

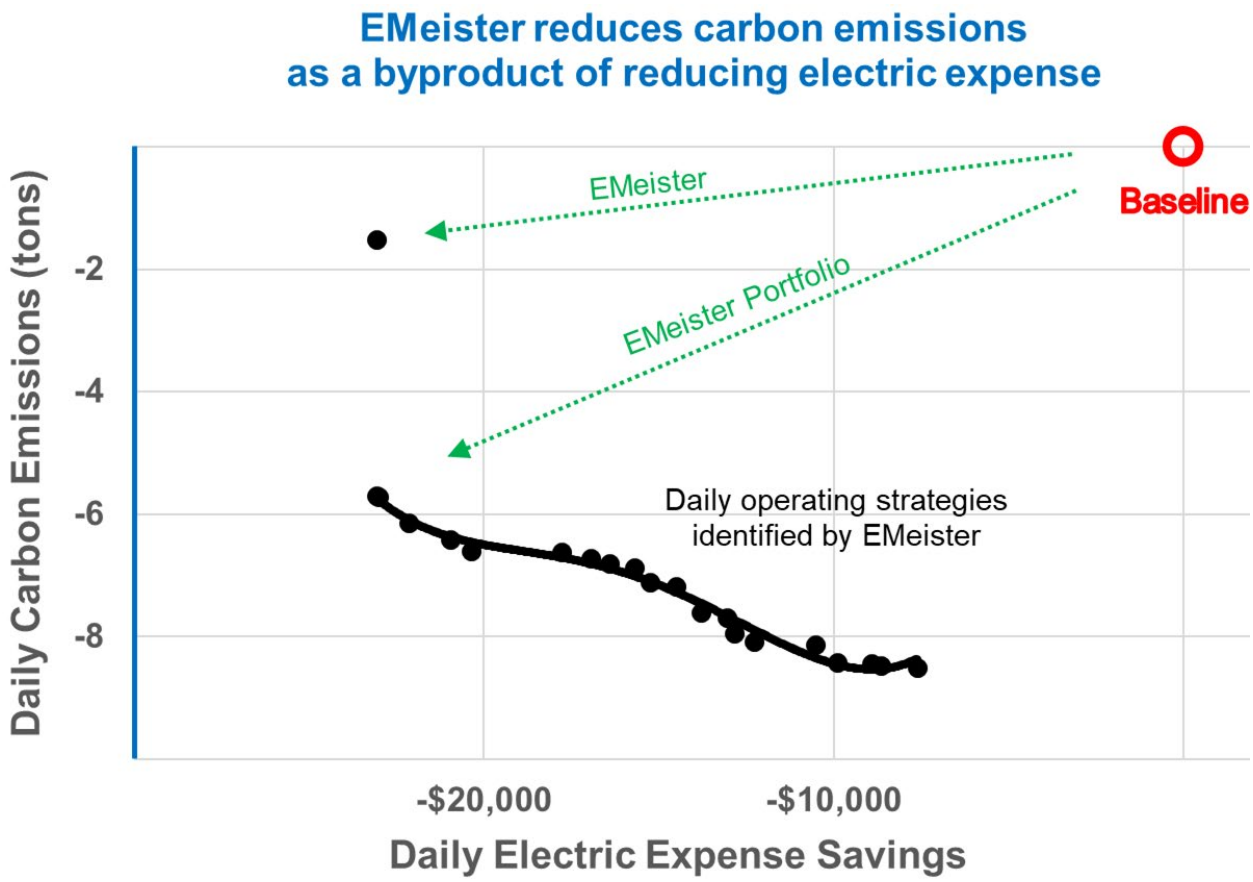
> *"So I saw a group this morning, [QCo], here, which is one of your innovators… They're using office buildings in blocks, in groups as batteries, as storage in essence doing the same thing, and it's going to happen all over the country, and it's going to be a new paradigm for the electric industry."*
>
> Jon Wellinghoff, Chairman, FERC

At the core, EMeister is a SaaS platform that combines breakthroughs in building energy modeling and model predictive control to harness the drywall and concrete in large commercial buildings as a grid-scale thermal energy storage medium. QCo storage outperforms all other forms of energy storage … better efficiency, no capital expense, no space requirement, no equipment, and no permitting.

EMeister is the first scalable building/grid integration technology that reduces energy use and expense … and shrinks the carbon footprint, enhances grid resilience and provides grid-scale flexibility to accommodate PV and wind.

The thermal energy storage harnessed by QCo MPC outperforms other forms of thermal or electric storage, in several dimensions:

- *Better efficiency at the site, more at the source* – at the site, by extending operation of the best chillers to the more efficient low lift conditions that prevail at night and by "economically dispatching" all chillers under the high lift conditions that prevail during the day; at the source, by both reducing and shifting electric production to more efficient and cleaner nighttime generation and, at scale, by reducing generating unit commitment.
- *Dramatically lower deployment and operating expense* – No capital expense because the thermal energy storage medium already exists. EMeister is cloud-based, automated, and secure – executing its temperature setpoint strategy through the energy management system.
- *Rapid deployment, strategically located, locally scalable* – 2 to 4 weeks to deploy, no space, no zoning or codes, in the heart of the grid-congested urban core where it can best serve local and regional grid purposes.
- *Infinite cycles with no degradation in performance* – building thermal mass does not wear out.
- *Accelerated payback on energy efficiency operating and capital investments* – and high fidelity simulation models proved in operations help identify and evaluate the best of such investments.
- *High fidelity building simulation models* – proactively evaluates, maintains, and improves tenant comfort throughout the building. And QCo models provide building engineers, managers, owners, and their service providers with actionable operating insight and investment foresight.



This demo creates a strategic role for EMeister and local NYC PV to substantially reduce Queens generating plant emissions – carbon, SO_2, NO_x, and particulate matter.

This example is for a vintage 800,000 ft2 LEED Gold building on a hot peak day – the economic choice on this day was dominated by ConEd demand charges. As a byproduct of reducing expense, the building reduces carbon emissions. EMeister MPC identified alternative operating strategies – with trade-offs between carbon emissions and electric expense. EMeister Portfolio MPC identifies the opportunity to displace a baseload generating plant in coordination with other NYC buildings.

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