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Demand Flexibility in New York City Buildings

Benefits beyond Carbon

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About RMI

RMI is an independent nonprofit founded in 1982 that transforms global energy systems through market-driven solutions to align with a 1.5°C future and secure a clean, prosperous, zero-carbon future for all. We work in the world's most critical geographies and engage businesses, policymakers, communities, and NGOs to identify and scale energy system interventions that will cut greenhouse gas emissions at least 50 percent by 2030. RMI has offices in Basalt and Boulder, Colorado; New York City; Oakland, California; Washington, D.C.; and Beijing.

About Urban Green Council

Urban Green Council's mission is to transform buildings for a sustainable future in New York City and around the world. We focus on buildings because they account for two-thirds of the city's carbon emissions. We convene stakeholders to seek consensus; we research solutions that drive change locally and globally; we advocate for cutting-edge policy; and we educate a broad range of industry professionals.

Carbon Benefits of Demand Flexibility

Demand flexibility shows significant potential to reduce carbon emissions throughout all stages of the grid transition. With the right signal structure, laws such as New York City's Local Law 97 (LL97) could enable demand flexibility, which has the potential to cut NYC building emissions by 40% or so as the grid approaches full decarbonization. RMI's *The Carbon Emissions Impact of Demand Flexibility* report addresses the specifics.

1. Demand flexibility reduces peak demand, providing health and environmental benefits

Demand flexibility could reduce a building's peak electricity consumption by 30%–50% during specific hours, minimizing peaker plant reliance by limiting the system peak in the electricity grid. This, in turn, could reduce grid operational costs, avoid additional infrastructure costs, and provide health and environmental benefits to society.

2. Demand flexibility supports electrification that is beneficial for buildings and the grid

Electrified buildings have more load that can be flexed, maximizing the potential benefits of demand flexibility. Combining electrification with demand flexibility also minimizes winter peaks.

3. Demand flexibility could unlock an additional cost-effective path to LL97 compliance via a time-of-use carbon metric

Demand flexibility is an underutilized but vital decarbonization strategy. LL97's use of a carbon metric that values the time at which electricity is consumed presents NYC building owners with an additional cost-effective pathway to compliance and decarbonization.

1 Introduction

With some of the most aggressive carbon reduction goals in the country, New York City is primed to reap the rewards of a promising decarbonization solution—demand flexibility.

Demand flexibility is the ability of a building to shed or shift electricity use from one time to another without disturbing core building functions. Demand flexibility strategies are deployed continuously throughout the day, week, season, or year in response to cost or carbon signals. This is distinct from demand *response*, which is triggered in response to time-bounded isolated events, and which New York City currently employs to help balance energy needs with generation during times of high grid stress.

Demand flexibility would help New York City double down on efforts to reduce building peak loads and optimize the use of renewables. Over the coming decade, the state and region plan to nearly triple the amount of variable renewable energy generation (wind and solar power) to meet renewable targets.[1] Demand flexibility enables buildings to shift load out of times without renewables and into times when the sun is shining and the wind is blowing. By enabling buildings to shift their load into times when renewable generation is abundant, demand flexibility opens up a huge opportunity to rightsize expenditures in new renewable generation.

Demand flexibility is relatively untapped as a grid asset today, especially when it comes to optimizing based on carbon, because there are few ways for building owners to profit from it. In NYC, Local Law 97 (LL97) has introduced a value stream in the penalties associated with noncompliance by expanding building carbon tracking to include a time-of-use metric.[2]

This insight brief functions as an addendum to the findings presented in RMI's February 2021 report, ***The Carbon Emissions Impact of Demand Flexibility***. The initial report demonstrated that demand flexibility could reduce building emissions, whereas the purpose of this insight brief is to show how demand flexibility:

- provides benefits to NYC at a community level,
- supports electrification, and
- enables cost-effective compliance with LL97.

2 Proven Value of Demand Flexibility

Previous research demonstrated that demand flexibility in buildings could:

Carbon Emissions Impact of Demand Flexibility (RMI report, 2021)

1. Reduce emissions in New York City buildings by up to ~40% as the grid approaches full decarbonization
2. Benefit New York City's electricity grid **throughout the various grid conditions and phases of renewable generation integration** that it may see during its transition to decarbonization
3. Achieve the highest emissions savings by applying a **marginal emissions signal with a short timestep (15 minutes)** provided in real time

In summary, the research proved that demand flexibility shows significant potential to reduce carbon emissions and could be enabled under laws such as NYC's LL97 with the right signal structure. The details can be found in the original report.

3 Additional Value of Demand Flexibility

1 Demand flexibility reduces peak demand, providing health and environmental benefits.

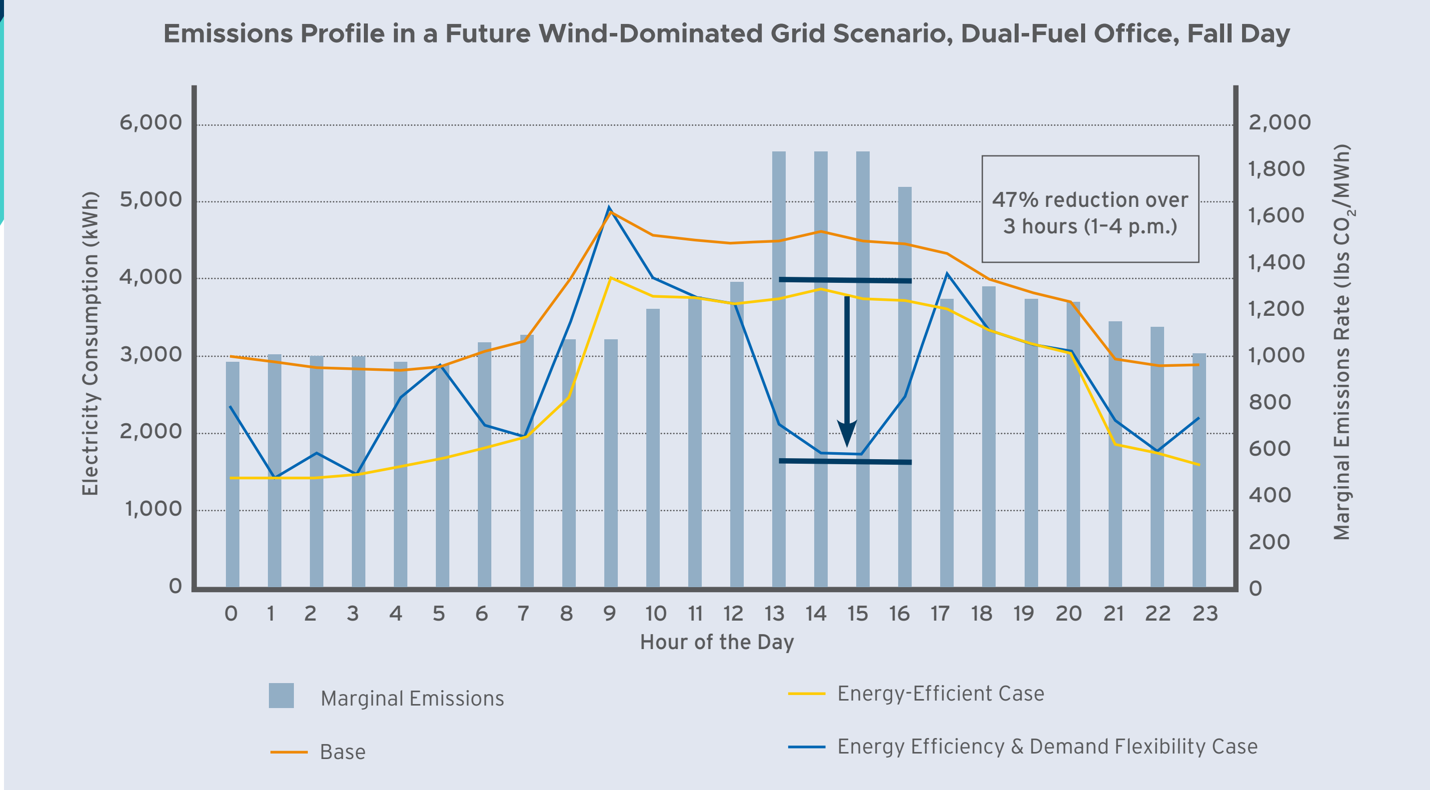
Demand flexibility could reduce a building's peak electricity consumption by 30%–50% during specific hours, minimizing peaker plant reliance by limiting the system peak in the electricity grid. This, in turn, could reduce grid operational costs, avoid additional infrastructure costs, and provide health and environmental justice benefits to society.

Demand flexibility's targeted electricity reductions could help reduce peak demand in NYISO Zone J (NYC) and strategically avoid loads traditionally met by expensive and dirty peaker plants. Efficiency reduces demand across all hours, whereas demand flexibility provides continuous response capabilities based on carbon emissions or grid needs. By shifting loads away from peak hours, demand flexibility can shed a building's daily peak demand by 30%–50% over specific hours compared with a building that does not shift. Assuming a substantial portion of the City's building stock implemented demand flexibility optimized to a marginal time-of-use carbon signal, Zone J could more directly focus demand reductions on the times that peaker plants operate.

Reduced peaker plant operation has a myriad of health, fiscal, and environmental justice paybacks.

Exhibit 1

A Building's Ability to Shift Demand away from Peak Carbon Times on the Grid Reduces the Need for Peaker Plants



Health Benefits

Zone J's peaker plants are old and inefficient. Because of this, they disproportionately contribute to the amount of air pollution in the city, compared with the amount of electricity they provide. As a result, communities adjacent to peaker plants suffer 55% of ozone-attributable asthma hospitalizations and 56% of emergency room visits among children. These plants contribute to particulate matter ($PM_{2.5}$) pollution that causes 3,000 deaths, 2,000 hospital admissions for lung/heart conditions, and approximately 6,000 emergency visits for asthma in children and adults in NYC annually.[3] Studies have shown that long-term exposure to $PM_{2.5}$ even dramatically increases the COVID-19 mortality rate.[4]

These health issues could be mitigated in the future. The Gowanus Gas Turbine Facility emits nearly six times as much carbon per kWh of electricity compared with the average electricity carbon factor of NYC.[i] If demand flexibility replaced even a single peaker plant, like the Gowanus Gas Turbine Facility, New York City could avoid the average 19,519 tons of CO_2 that the plant emits on an annual basis.[5]

[i] Based on eGrid 2019 data, the Gowanus Generating Station (ORIS facility code 2494) produced 7,468 MWh and emitted 12,792 metric tons of CO_2e. That's a rate of 1.7129 kg CO_2e/kWh as compared with the LL97 coefficient, which is 0.288962 kg CO_2e/kWh. Source: **https://www.epa.gov/egrid/download-data**.

Fiscal Benefits

Despite their limited run times, the operational expenses of peaker plants in New York have exceeded $4.5 billion over the past decade.[6] They are expensive resources that can cost up to 1,300 percent more than other generation resources.[7] Shifting demand away from peak hours will reduce the need to operate existing peaker plants and may support decommissioning them. The avoided costs of a nationwide implementation of demand flexibility could total $16.4 billion a year by 2030 through avoided generation capacity, avoided transmission and distribution capacity, ancillary services, and avoided energy costs.[8]

Environmental Justice Benefits

Disadvantaged communities throughout New York City often bear the brunt of peaker plant pollution. Many of the city's plants are sited where communities are historically overburdened by environmental pollution and underserved by clean energy solutions. The Gowanus Gas Turbine Facility burns fuel oil as its primary fuel in the Sunset Park neighborhood, subjecting members of the disadvantaged community to dangerous emissions like nitrogen oxides (NO_x) and sulphur oxides (SO_x). Reduction of peaker plant run times would improve the air quality in surrounding neighborhoods and begin to reverse health inequities in locales like New York City's South Bronx and Sunset Park, dubbed "Asthma Alley" due to its proximity to peaker plants.[9]

Demand flexibility could reduce reliance on dirty NYC peaker plants like the Gowanus Gas Turbine Facility pictured above.

2

Demand flexibility supports electrification that is beneficial for buildings and the grid.

Electrified buildings have more load that can be flexed, maximizing the potential benefits of demand flexibility. Combining electrification with demand flexibility also minimizes winter peaks.

Many NYC buildings still rely on fossil fuel (natural gas and fuel oil) boilers for heating and domestic hot water,[10] but electrification of the building stock with heat pumps is becoming more cost effective, especially in the residential context.[11] Because on-site combustion from natural gas boilers and equipment will always produce carbon emissions, electrification of the building stock is a necessary component of decarbonization.

The carbon metric that defines building performance benchmarks in LL97 will incentivize electrification of the NYC building stock as the grid gets cleaner (i.e., when carbon emissions associated with electricity use are clearly lower than on-site combustion of natural gas). Combining this electrification with demand flexibility will be beneficial for both buildings and the grid.

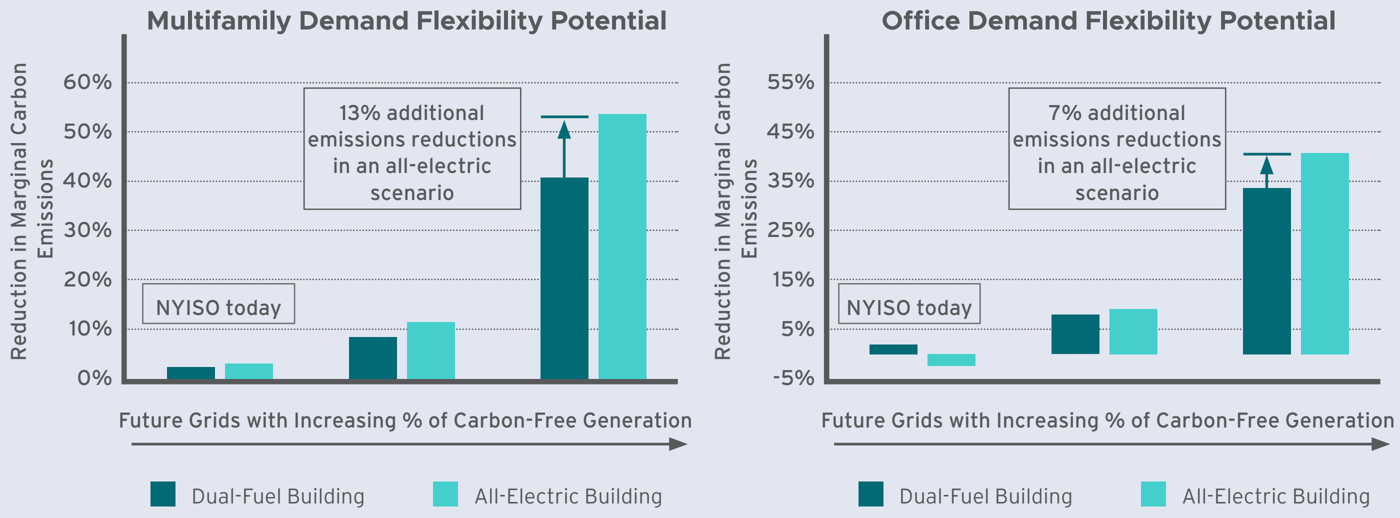
Buildings with a larger electrical load have more load available to flex, which means increased potential for carbon reduction. This analysis focused primarily on electrifying thermal loads like domestic hot water and space heating, because they are responsible for three-quarters of NYC multifamily carbon emissions and are especially flexible end uses.[12] We did not consider the electrification of kitchen equipment or other gas-consuming end uses in buildings.

Thermal loads make up a larger portion of total energy consumption in multifamily buildings than in office buildings. Therefore, electrifying a multifamily building results in a higher percentage difference in flexible load as compared with the electrification of an office building (for more detail, see energy modeling assumptions in the appendix of the larger report).[13] In multifamily buildings, electrification can provide up to 13% more load compared with a dual-fuel building in a nearly decarbonized grid. For an office building, this difference is about 7%.

Adding more electric systems to the grid (e.g., heat pumps and electric vehicles) will increase the system load. This will be especially apparent during the winter because many of the added building loads are associated with heating. Buildings must be incentivized to combine the electrification of heating with controls that allow their demand to be flexible. Sending clear signals to building owners about how to upgrade their systems will ensure that they have the tools necessary to support the grid's decarbonization, particularly by easing the strain of peak demand in the heating season.

Exhibit 2

Comparison of the Annual Demand Flexibility Potential for Multifamily and Office Buildings between All-Electric and Dual-Fuel Buildings



Note: The negative percentage for the all-electric office building on NYISO today represents an increase in emissions from electrification that was not outweighed by demand flexibility measures. A larger battery or higher-capacity flexibility measures could potentially make that value zero or positive, but the measures selected for this analysis limited those capacities.

3 Demand flexibility could unlock an additional cost-effective path to LL97 compliance via a time-of-use carbon metric.

Demand flexibility is an underutilized but vital decarbonization strategy. LL97's use of a carbon metric that values the time at which electricity is consumed presents NYC building owners with an additional cost-effective pathway to compliance and decarbonization.

Least-cost, systemwide decarbonization will likely require a combination of efficiency, demand flexibility, and electrification. These strategies are inherently intertwined:

- Without flexibility, complete electrification overwhelms grid capacity.
- Without electrification, decarbonization is not possible.
- Without efficiency, both flexibility and electrification are much less cost effective for buildings and the grid.

The primary method of compliance for LL97, which uses annual average carbon emissions factors, clearly encourages efficiency. Reductions in annual consumption correlate to improvements beyond the benchmark. As the annual emissions factor for electricity decreases with higher portions of carbon-free generation on the New York City grid, LL97 will also encourage electrification as a path to compliance.

With the additional option of complying using time-of-use carbon emissions factors, LL97 brings demand flexibility into the fold. Valuing carbon emissions from the electric grid based on the time at which the electricity is consumed allows buildings to receive credit for shifting their loads with demand flexibility in a way that an annual metric does not.

Not only is demand flexibility an essential element of decarbonizing the electric grid, but it includes a host of cost-effective building-level measures. Demand flexibility measures implemented through energy management information systems are available today and can decrease building energy consumption, carbon, and demand charges. Building owners can save 25% of their total annual energy costs at a simple payback of two to six years, prior to incentives, through a combination of demand-charge management, efficiency, and demand response.[14] Demand flexibility measures also represent a set of improvements that could have less tenant disruption than traditional efficiency measures.

Demand flexibility requires well-planned orchestration between the grid and building operations. Achieving optimal demand flexibility requires that buildings' various mechanical and electrical systems can automatically respond to subhourly signals from the grid based on carbon or pricing. Until these control systems are automated and utility interoperability advances, building operations will require close tracking and good management.

Demand flexibility is quickly gaining traction, but it is not yet widely deployed. Exhibit 3 shows the cost-effective flexibility strategies currently feasible in NYC.

Exhibit 3 Summary of the Cost-Effectiveness of Demand Flexibility Measures in New York City

Cost-effective in most scenarios (priority measures for demand flexibility in NYC buildings)	Recommended but potentially challenging to implement (measures that will have high value in NYC buildings as technology costs decline and accessibility increases)
• Space preheating/precooling • Electric domestic hot water storage • HVAC equipment (e.g., fans, coils, compressors) staging • Space temperature setbacks • Advanced lighting controls • Managed EV charging • Office plug load staging • Multifamily appliance load staging	• Battery storage: challenging under current NYC fire code; however, could be implemented elsewhere in New York State • Thermal energy storage: challenging due to space constraints; however, smaller, distributed thermal storage and integrated phase-change material options are emerging[15] • Solar photovoltaic (PV) energy generation: difficult to implement due to limited roof space in NYC, but facade integration, even in windows, is available • Ground source heat pump: requires space and high infrastructure costs, but emerging business models enable cost sharing across buildings and subscription options, and new drilling enables smaller footprints[16]

Note: Solar PV was not analyzed as a demand flexibility measure in this analysis.

Source: Matt Jungclaus, Cara Carmichael, and Phil Keuhn, *Value Potential for Grid-Interactive Efficient Buildings in the GSA Portfolio: A Cost-Benefit Analysis*, RMI, 2019, **http://www.rmi.org/gebs_report**

4 Conclusion

Limiting the global average temperature increase to 1.5°C will require every tool in the electricity grid's arsenal. Demand flexibility provides significant potential in NYC to reduce carbon emissions, provide improved health and environmental benefits, and support cost-effective electrification and compliance to LL97.

Our focus on NYC was due in part to LL97, a lever on which demand flexibility can be incentivized, but the potential for demand flexibility needs to be recognized across the country and encouraged quickly to achieve the lowest-cost decarbonized future. Over half of Americans live in areas pursuing decarbonization targets by 2050, where demand flexibility could be a key contributor.[17] Extrapolating the results from this analysis demonstrates the significant value of demand flexibility today. For instance, in California and the states served by the Southwest Power Pool, demand flexibility offers a ~10% carbon reduction potential today. In the mostly clean grid of Ontario, Canada, the carbon reduction potential for demand flexibility today is ~40%.

Moving forward, there are some follow-on questions that remain unanswered. It will be critical to assess the system-wide implications as we extrapolate the findings from the level of individual buildings to the entire building stock of NYC. It also remains to be determined how investment will best be balanced between demand-side efficiency, electrification, and flexibility versus grid-side increases in capacity. We must determine how best to allocate public and private resources to ensure the benefits flow to all members of the community equitably. Answering these research questions will help define the value proposition of demand flexibility for both buildings and the grid and accelerate its integration as a decarbonization strategy.

5 Endnotes

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