

Scaling Tall Building Decarbonization in the Biggest US Market

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ABSTRACT

New York has some of the country's most ambitious climate policies at both the state and city levels, with New York City's (NYC's) Climate Mobilization Act setting carbon limits for buildings starting in 2024 and significantly tightening in 2030 and beyond. NY's high rise building stock and density, combined with the very high cost of construction in NYC, requires innovative solutions and presents challenges and opportunities for significant emissions reduction. NYC's existing office stock of more than 530 million square feet is by far the largest office market in the US, representing more than 13 percent of US existing office stock despite NYC having less than 3 percent of the nation's population. With the country's largest concentration of high-rise buildings located in NYC, this provides a massive opportunity for demonstrating successful tall building decarbonization solutions from all over the world.

The Empire Building Challenge (EBC) is a partnership between NY State and private sector leaders to develop highly replicable low carbon retrofit strategies for high rise buildings in NY. The program is a collaboration with ten of the largest real estate portfolio owners in NY who collectively control approximately 130 million sf and have made public commitments to carbon neutrality by 2035. In early 2022, \$20 million in funding was announced for four real estate partners' initial low carbon retrofit demonstration projects. This paper presents the theory of change for the initiative, documents the process of selecting Challenge partners, and reports on initial retrofit activity being stimulated through the Challenge.

Introduction

New York Policy Context

New York (NY) has some of the country's most ambitious climate policies at both the state and city levels. In 2019, landmark legislation significantly ratcheted up climate policy ambition first with the New York City (NYC) Climate Mobilization Act (CMA), passed by the NYC City Council in April 2019, and then the New York State (NYS) Climate Leadership and Community Protection Act (Climate Act) passed by the NYS Legislature in July 2019.

The NYC CMA, particularly through Local Law 97 of 2019, was first of its kind legislation that places limits on GHG emissions from existing large buildings starting in 2024 and introduces significant fines for every year a building exceeds its allotted GHG emissions limits. GHG emissions limits for the first compliance period under Local Law 97, running from 2024-29, will impact the lowest performing 25 percent of covered buildings. Limits in the law's second compliance period, running from 2030-34, will be much more stringent, impacting approximately 75 percent of covered buildings based on their current emissions levels (NYC MOS 2019). It is significant to note that many buildings that may be under the emissions limits

during the first compliance period (2024-2029) will nonetheless require significant reductions in their GHG emissions, or risk facing penalties starting in 2030.

The NYS Climate Act sets the state on a path to achieving its mandated goal of a zero-emissions electricity sector by 2040, including 70 percent renewable energy generation by 2030, and to reduce emissions 85 percent by 2050 from 1990 levels (New York State 2022). It builds on New York's unprecedented ramp-up of clean energy, including a \$35 billion investment in 120 large-scale renewable energy and transmission projects across the state, the creation of more than 150,000 jobs in New York's clean energy sector, a commitment to develop 9,000 megawatts of offshore wind by 2035, and 2,100 percent growth in the distributed solar sector since 2011.

The NYS Tier 4 program, part of the NYS Clean Energy Standard, was established to bring clean renewable energy directly to NYC, and in April 2022 the NYS Public Service Commission approved two new transmission projects (the largest in NY in the last 50 years) that will deliver more than one third of NYC's annual electricity consumption while providing significant economic and public health benefits statewide.

Tall Building Challenge

NY's existing high-rise building stock, density and very high cost of construction requires innovative solutions and presents challenges and opportunities with achieving deep decarbonization.

While there are proven solutions to achieve very low or zero carbon buildings, these solutions are mostly applicable for smaller buildings. Few proven solutions for tall buildings exist, and this lack of options is particularly evident in regions with significant heating and cooling loads like in the Northeast and Northern Midwest United States (US). To attempt to understand the current state of the art of high-rise deep carbon retrofits, in early 2020 the New York State Energy Research and Development Authority (NYSERDA) commissioned a global scan of deep energy reduction/decarbonization retrofits of high-rise buildings (Building Energy Exchange 2020). To be included in the inventory of projects, a retrofit needed to have measured and publicly published post-retrofit, whole building energy performance, which limited the number of potential case studies – many projects included **projected** energy performance after the retrofit, but not measured performance. The results of the survey were somewhat discouraging given the number of buildings that had measured, whole building post-retrofit performance available, particularly beyond US cities with mandatory building energy disclosure requirements.

NYC's existing office stock of more than 530 million square feet (sf) is by far the largest office market in the US, representing more than 13 percent of U.S. existing office stock despite NYC having less than 3 percent of the nation's population. NYC has two major Central Business Districts (midtown and downtown Manhattan), together more than triple the next largest city, and while midtown Manhattan is by far the largest in the US, downtown Manhattan by itself would rank as the third largest business district in the US. NYC has more skyscrapers than the next six US cities combined and has more than any city in the world except Hong Kong (Emporis 2022).

With the country's largest concentration of high-rise buildings located in NYC, this provides a massive opportunity for demonstrating successful tall building decarbonization solutions from all over the world.

Launching the Empire Building Challenge

The Empire Building Challenge (EBC) was conceived as a public-private partnership between NYSERDA and leading real estate developers, engineering firms, and solution providers to pioneer climate-friendly retrofits that can be replicated throughout the 3 billion+ square feet of existing, tall multifamily, commercial, and institutional buildings in NY. The Challenge was formally announced in January 2020 in the NY State Governor's State of the State message (New York State 2020).

NYSERDA's EBC is a \$50 million investment by New York State to demonstrate different pathways for achieving carbon neutrality in tall buildings. Through the establishment of private-public partnerships with leading real estate owners and their engineering experts, exciting approaches to cold climate decarbonization are being tested in the New York market. With the potential to replicate these solutions across the 130 million square feet of real estate controlled by the first cohort of Empire Building Challenge partners and beyond, the impact of each project will accelerate New York's progress toward the State's Climate Leadership and Community Protection Act's goal of reducing greenhouse gas emissions 85 percent by 2050. A second cohort of EBC partners will be on-boarded in 2022.

EBC Partner Selection

The EBC was publicly launched during Climate Week in New York in September 2020 with a solicitation seeking applications from real estate firms in New York willing to make public commitments to carbon neutrality in at least one of their tall buildings by 2035 (NYSERDA 2020). Nearly 40 major real estate owners responded, including the largest owners in New York and several multinational owners with high-rise properties around the U.S. and the globe. The solicitation specified the following:

- Building owners and large commercial office tenants had to formally apply to partner with NYSERDA on the Empire Building Challenge to be designated as an Empire Building Challenge Partner.
- Owners of affordable multi-family buildings were encouraged to apply, and the number of affordable housing units was a factor in the evaluation of the proposals.
- Only owners and tenants who committed to making one or more buildings carbon neutral were eligible.
- Partners selected through the process above were given technical assistance funds to work with chosen solution providers to develop a specific proposal that included a highly replicable low-carbon retrofit solution for addressing the one or more major challenges of decarbonizing high-rise buildings.
- These proposals were submitted for consideration as part of a competitive review process and would be evaluated based on a proposed project's scalability and feasibility in addressing the major challenges of decarbonizing high-rise buildings.
- Proposals were also evaluated based on the building owner's willingness and ability to implement solutions across their portfolio of buildings.

- Winning proposals would receive immediate technical assistance funding and would be eligible for up to \$5 million each to support project development and implementation through future competitive solicitations.

Selected Partners

In April 2021, NYSERDA announced its initial cohort of ten real estate portfolio owners who collectively control over 130 million square feet of real estate in New York State, including more than 250 buildings that contain affordable housing. The partners have each pledged to achieve carbon neutrality in one or more of their buildings and in more than 700 units of affordable housing collectively with the potential to scale across their portfolios to more than 25,000 units of affordable housing. Exceeding program requirements, Vornado, Empire State Realty Trust and Rudin Management Company all committed to achieving carbon neutrality in their entire real estate portfolios.

A full list of the EBC Partners can be found below, and more information about the buildings they have committed to carbon neutrality can be found on the EBC website.¹

- **Beam Living** -110 multifamily buildings totaling 12 million square feet.
- **Empire State Realty Trust** - Its entire real estate portfolio of 10.1 million square feet, leading with the Empire State Building's 2.89 million square feet.
- **Hudson Square Properties, a joint venture comprised of Trinity Church Wall Street, Norges Bank Investment Management, and Hines** - One commercial office building, totaling 928,366 square feet.
- **Jonathan Rose Companies** - Two mixed-use multifamily buildings including 274 units of affordable housing.
- **L+M Development Partners and Invesco Ltd.** - Three mixed use, high-rise multifamily buildings with 600 total units, including 402 affordable housing units of which 134 units are set aside for formerly homeless households.
- **Omni New York** -Two mixed use multifamily buildings with 195 affordable housing units.
- **Rudin Management Company** -Three commercial office buildings, totaling 1.7 million square feet.
- **Silverstein Properties** - Two commercial buildings totaling 2,825,000 square feet.
- **The Durst Organization** - Up to three high-rise commercial office buildings, totaling up to 3.2 million square feet.
- **Vornado Realty Trust** - Its entire office and retail real estate portfolio, leading with four high-rise commercial office buildings totaling 6.4 million square feet.

EBC Partner Retrofit Project Development

Following announcement of the selected EBC Partners in early 2021, the chosen partners and their engineering consultants began detailed development of potential deep decarbonization projects. Each selected partner received \$250,000 in technical assistance funding to develop

¹ www.nysenda.ny.gov/ebc

carbon neutrality roadmaps for their targeted buildings, as well as engineering analysis and design for projects to achieve the carbon neutrality targets.

EBC Framework

As the EBC evolved, a framework to decarbonize tall buildings has developed. In partnership with real estate and best-in-class engineering and technology providers, the EBC team confronted the most challenging aspects of decarbonizing buildings containing complex systems by taking the following actions:

- Developed design engineering approaches and a heuristic for designers to develop retrofits that reduce reliance on fossil fuels and transition high rise buildings to low carbon heating sources,
- Created a common decarbonization language across sectors and industry actors to advance Resource Efficient Decarbonization (RED),
- Integrated short-, medium- and long-term decarbonization strategies into the building owner's capital planning and asset management process, and
- Solicited low carbon technology innovation and product development from international equipment manufacturers and solution providers that meet the technical and economic requirements of real estate.

The Resource Efficient Decarbonization (RED) process of building decarbonization incorporates strategic capital planning, an integrated design process, and an incremental, network-oriented approach to deliver building heating, cooling and ventilation which:

- requires limited or no combustion,
- enables carbon neutrality,
- is highly efficient at low design temperatures and during extreme weather,
- is highly resilient, demand conscious, and energy grid interactive,
- reduces thermal waste by capturing as many on-site or nearby thermal flows as possible, and
- incorporates realistic and flexible implementation strategies by optimizing and scheduling low carbon retrofits phase-in.

The RED framework is shown in Figure 1.

As EBC partners and their engineering design teams were finalizing their study work, the EBC project team held “design charettes” to review and critique retrofit approaches. The design charettes were crucial to achieving the caliber of projects and the level of innovation sought by the EBC team. A solicitation for decarbonization capital projects to be funded through EBC was released during Climate Week in September 2021, with applications due in November 2021.

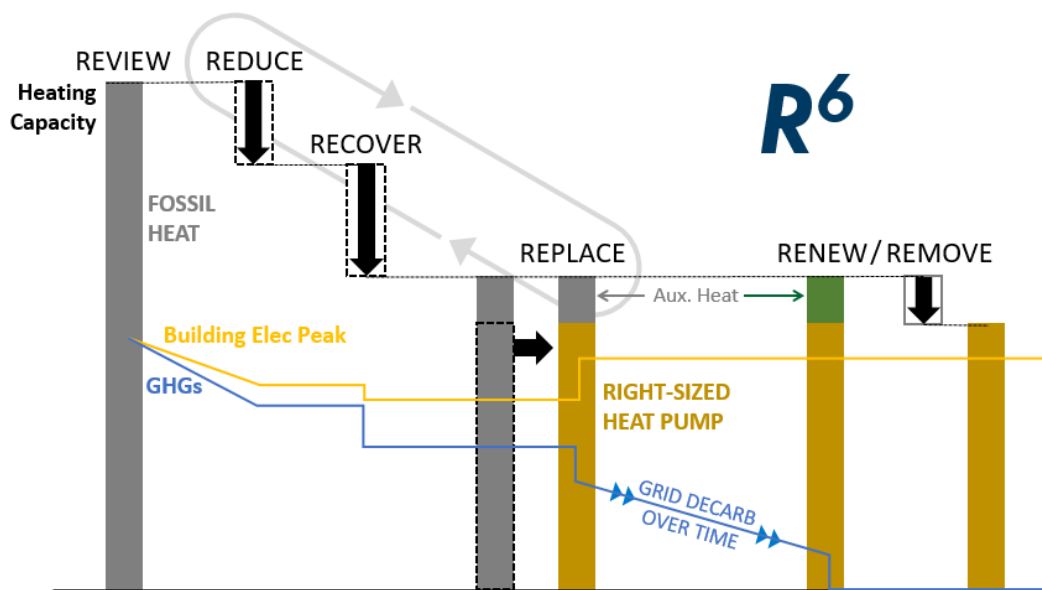


Figure 1. The “Resource Efficient Decarbonization” model, with the x-axis showing progression over time, and the y-axis magnitude of energy reduction. *Source: NYSERDA 2022b.*

First Funded Projects

In January 2022, NY Governor Hochul announced the first four showcase retrofit projects to receive funding support from Empire Building Challenge (NYSERDA 2022a). These first-of-a-kind projects will pioneer repeatable retrofit approaches, prove performance of advanced technologies and de-risk adoption for the broader marketplace. Each of the EBC Partners receiving funds embraced and are demonstrating the RED approach to building decarbonization. The four projects are:

- Empire State Realty Trust - Empire State Building: Pilots on several tenant floors focused on energy recovery, heating distribution upgrades, electrification of space heat and hot water through air and water source heat pumps and an effort to efficiently share heat across a thermal network, which will ultimately extend throughout the building. The building is already connected to the Con Edison district steam network, which has also committed to decarbonizing steam production.
- Hudson Square Partnership – 345 Hudson Street: Floor-by-floor and building level thermal network approach to achieving carbon neutrality by replacing fossil-fuel heating systems with water source heat pumps, heat recovery, highly efficient ventilation systems and thermal storage. When complete the building will be “district thermal ready” whereby plugging into a future low carbon thermal energy network will be more easily completed compared with most of the existing building stock.
- L+M Fund Management – The Heritage Buildings: High performance façade overclad of all three buildings, including two 34-story buildings, and near-term carbon neutrality at

the 11-story 1660 Madison site through packaged terminal heat pumps, domestic hot water electrification, ventilation upgrades, and dryer electrification.

- Omni New York – Whitney Young Manor: Comprehensive retrofit including major building envelope overclad that will dramatically improve the buildings' façade performance, reducing heating and cooling loads; two new centralized heat pump systems to serve all heating, cooling and domestic hot water needs taking advantage of energy recovery and a thermal network approach. When complete, the buildings will also be district thermal ready.

These projects are getting underway with designs being finalized in 2022 and construction beginning for some buildings in 2022, with most construction completed by 2025.

EBC Future Plans

Additional Partners and Funding Round

Beyond the first cohort of 10 Partners announced in 2021, NYSERDA has recruited a second EBC Partner cohort and is reviewing applications. The second cohort will focus on near-term deep thermal system retrofit projects, particularly targeting electrification of building heating and domestic hot water loads, shifting buildings away from using on-site fossil fuels.

The new selected EBC Partners (along with Partners from the first cohort who have not already received project funding) will also be eligible to submit proposals to receive up to \$3,000,000 for low carbon retrofit project implementation through a competitive funding opportunity expected to be released in October 2022.

Empire Technology Prize

As part of the Empire Building Challenge, NYSERDA is launching a \$10 million Empire Technology Prize focused on supporting entrepreneurs with breakthrough solutions that can disrupt the retrofit industry, overcome persistent technical and economic barriers, and accelerate broader market adoption of low carbon retrofits. By joining forces, the real estate industry and clean technology sectors will surface new solutions for low carbon high-rise buildings in New York, establishing repeatable pathways to decarbonization, and set the stage for broad-based market adoption of low carbon technologies.

In October 2021, NYSERDA issued a solicitation for the Prize Administrator to manage the Empire Technology Prize program, an ambitious new corporate challenge aimed at advancing building decarbonization across New York State. The Empire Technology Prize is designed to be both a business accelerator and a prize program by combining business support with monetary awards to advance low carbon retrofit approaches.

The program administrator will be awarded up to \$1.7 million through 2024 to engage industry partners in a competitive corporate challenge to facilitate the deployment of carbon emission reducing technologies. NYSERDA is dedicating an additional \$7.8 million for prizes under the program, with the program administrator expected to grow the prize pool by leveraging private sector partnerships and investments.

The prize program will connect industry professionals with innovators to ensure usable, sustainable solutions are developed and have a pathway to market. The Prize is focused on engaging private industry to lead market change, decarbonize commercial and multifamily buildings and create a greener, cleaner future that benefits all New Yorkers.

The prize administrator was chosen based on their past track record of creating successful corporate challenges with activities including global recruitment, industry-focused convening, business acceleration support, strategic partnerships and facilitation of manufacturer teaming arrangements, and leveraging private dollars. The prize program will publicly launch in the fall of 2022.

Moving to Scale

The EBC is creating and documenting industry best practices, starting with “The Empire Building Playbook: An Owner’s Guide to Low Carbon Retrofits”² that was launched on Earth Day 2022 (NYSERDA 2022c). The Playbook provides examples of repeatable processes that all building owners can utilize to achieve substantial energy and carbon reductions at commercially acceptable returns. The Playbook provides extraordinary detail on the processes that four leading real estate owners utilized to develop long term strategies to decarbonize operations in over seven million square feet of existing high-rise buildings. The Playbook helps real estate owners and engineers keep track of evolving technology, refine design approaches, and understand their building in the context of current industry innovation. The Playbook and Knowledge Base are living resources and NYSERDA invites the industry at large to add to this body of knowledge as additional decarbonization means and methods are identified.

It is expected that selected EBC partners will replicate many of the projects identified through the EBC process more widely in their portfolios, and the NYC Local Law 97 GHG emissions limits will drive significant investment in on-site carbon reductions in the coming years.

Discussion

The EBC has targeted tall buildings, and major real estate portfolios, to demonstrate replicable solutions to decarbonize some of the most complex and difficult buildings to decarbonize, where there are currently quite limited demonstrated solutions. In its first two years since the launch of the EBC, the program has achieved the following:

- Partnerships with 10 real estate portfolio owners who collectively control approximately 130 million square feet in New York, and collaborative technical and financial planning to develop repeatable approaches for decarbonizing existing high-rise buildings through retrofits.
- The establishment of a “Resource Efficient Decarbonization” framework that phases-in decarbonization approaches over 10 to 15 years, allowing buildings to achieve significant carbon reductions at commercially acceptable returns. All building owners can apply this framework to decarbonize their buildings.

² <https://knowledge.nyserra.ny.gov/display/EBP>

- Four unique demonstration projects that will deploy heat pumps, façade improvements, energy recovery, and thermal storage in a variety of high-rise buildings, including the Empire State Building. These projects, and the overall interest from New York real estate in low carbon retrofits, has attracted the attention of the global marketplace of solution providers, bringing innovation, job creation and economic activity to New York State.

While the initial projects chosen for funding have strong potential for replication, there is still significant need for both market development and technology adoption to reach scale for the deep decarbonization required by state and city policy goals.

The Challenge launched as the COVID pandemic was hitting NY real estate markets very hard. Also, for large capital investments in these tall buildings, the capital planning process can take quite a long time, and often be a multi-year effort to fully implement large scale projects.

The Challenge has received significant press coverage since its launch, including a feature story with a related video in Time Magazine in 2021 (De La Garza 2021), a Northeast Sustainable Energy Association article on Resource Efficient Electrification/ Decarbonization (Rodriguez and Bridgeland 2021), a post in Canary Media highlighting the EBC approach to large building decarbonization (St. John 2022), and a feature article in The Real Deal, NY's leading Commercial Real Estate Weekly (Cavanaugh 2022).

Conclusions

New York is home to North America's highest concentration of tall buildings in a very dense urban environment. Some real estate practitioners have publicly questioned the technical viability of decarbonizing tall buildings, particularly to levels that are required by NYC policies that establish carbon intensity limits on large buildings. EBC is demonstrating the feasibility of large-scale, deep decarbonization retrofits with an exclusive focus on tall buildings in cold climates – one of the hardest to decarbonize sectors of the built environment. Such a focus is crucial to addressing the unique set of technical barriers to decarbonization these buildings face: their height and density make it significantly more challenging to find technical pathways to carbon neutrality.

Projects funded through the EBC aim to emphasize transformative decarbonization technologies, achieve meaningful energy use intensity and carbon reductions at the whole building and/or end-use levels, and open the path for replication and scale for other building owners to follow suit, for one building or for their entire portfolio. Successful projects will not only demonstrate viable pathways to carbon neutrality, they will also 1) support the recruitment of best-in-class equipment manufacturers, solution providers and others to invest in business development, innovation and product development in New York State, to overcome the barriers preventing tall buildings in New York from achieving carbon neutrality, and 2) establish New York State as a global hub for low carbon retrofits, through public-private partnerships that maximize private sector investments in building retrofits, create good jobs and promote local economic development, while reducing greenhouse gas emissions.

Selected real estate partners include the largest building owners in New York and were chosen from a very competitive applicant pool that included several of the world's largest and most respected building owners. Ten of the applicants focused exclusively on achieving carbon neutrality in low and moderate income multifamily residential buildings.

The goal of the EBC is to change conversations about, and knowledge of building-centric carbon neutrality within the real estate industry, by supporting leading organizations' commitment to meeting the decarbonization challenge. Large building portfolio owners are naturally real estate industry leaders, and EBC partners include the top officers of both the Real Estate Board of New York, the leading New York real estate trade organization, but also the national Real Estate Roundtable. What these owners do invariably changes the outlook for other landlords, big and small – EBC partners are role models for other owners in New York, across the U.S. and around the world.

References

- Building Energy Exchange. 2020. High Rise/Low Carbon: Office Deep Retrofit Profiles. August 2020. be-exchange.org/report/hi-rise-low-carbon/
- Cavanaugh, S. 2022. “Four big landlords get paid to model green retrofits – L&M, Hines, ESRT, Omni take decarbonization challenge for \$5M.” The Real Deal, February 10, 2022. therealdeal.com/2022/02/10/four-big-landlords-get-state-money-to-model-green-retrofits/
- De La Garza, A. 2021. “The Empire State Building’s Green Retrofit Was a Success. Will Other Buildings Follow Suit?” Time Magazine, May 10, 2021. time.com/6026610/empire-state-building-green-retrofit/
- Emporis. 2022. Cities with the most skyscrapers. www.emporis.com/statistics/most-skyscraper-cities-worldwide (accessed March 15, 2022)
- New York State 2020. State of the State 2020. January 8, 2020. www.governor.ny.gov/sites/default/files/atoms/files/2020StateoftheStateBook.pdf
- New York State 2022. Our Climate Act: Climate Leadership and Community Protection Act. climate.ny.gov/Our-Climate-Act (accessed March 15, 2022)
- NYC MOS (New York City Mayor’s Office of Sustainability) 2019. Climate Mobilization Act Brief. be-exchange.org/wp-content/uploads/2019/05/BE-Ex_MOS_2pger.5.22.19.pdf. May 2019.
- NYSERDA (New York State Energy Research and Development Authority) 2020. During Climate Week Governor Cuomo Announces \$50 Million Empire Building Challenge to Combat Climate Change and Create Jobs. September 22, 2020. www.nyserdera.ny.gov/About/Newsroom/2020-Announcements/2020-09-22-during-climate-weegovernor-cuomo-announces-50-million-empire-building-challenge-to-combat-climate-change-and-create-jobs
- . 2021. Governor Cuomo Announces 10 “Empire Building Challenge” Partnerships to Decarbonize High-rise Buildings, Combat Climate Change and Support the State’s Green Economy. April 21, 2021. www.nyserdera.ny.gov/About/Newsroom/2021-

[Announcements/2021-04-21-Governor-Cuomo-Announces-10-Empire-Building-Challenge-Partnerships-to-Decarbonize-High-rise-Buildings-Combat-Climate-Change-and-Support-the-States-Green-Economy](#)

- . 2022a. Governor Hochul Announces \$20 Million Awarded to Advance Climate-friendly High-rise Building Retrofits in New York State. January 12, 2022. www.nyserda.ny.gov/About/Newsroom/2022-Announcements/2022-01-12-Governor-Hochul-Advance-Climate-Friendly-High-Rise
- . 2022b. The Empire Building Challenge Knowledge Base. knowledge.nyserda.ny.gov/display/PUBLIC/Empire+Building+Challenge (accessed March 15, 2022)
- . 2022c. Governor Hochul Announces Playbook for Advancing Carbon Neutrality in High-rise Buildings. April 21, 2022. <https://www.nyserda.ny.gov/About/Newsroom/2022-Announcements/2022-04-21-Governor-Hochul-Announce-Playbook-for-Advancing-Carbon-Neutrality-in-High-Rise-Buildings>
- Rodriguez, J., and B. Bridgeland, Michel Beguin, Mayra Lujan. 2021. “A Rational Approach to Large Building Decarbonization: Lessons from New York’s Empire Building Challenge.” *BuildingEnergy (NESEA)*, Volume 40, No. 1, 2021. pp. 20-23. https://emflipbooks.com/flipbooks/NESEA/BuildingEnergy/2021/Vol40_Number1/book/20/
- St. John, J. 2022. “How to get New York City’s biggest buildings to zero carbon”. *Canary Media*. <https://www.canarymedia.com/articles/carbon-free-buildings/how-to-get-new-york-citys-biggest-buildings-to-zero-carbon>. January 20, 2022.