

REIMAGINING NEW YORK CITY'S POWER SECTOR

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A policy forum series on NYC'S 2050 goal to reduce greenhouse gas emissions by 80% from 2005 levels

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EXECUTIVE SUMMARY

This paper examines the future of New York City's electricity grid, as the City's local government works to implement a wide range of policies and initiatives which will effectuate its commitment of an 80% reduction in greenhouse gas emissions by the year 2050 (80x50). While, beyond the grid, there are other critical components to reaching 80x50-i.e. buildings, transportation, and wastethis paper focuses on the energy system. The paper begins with discussion of the overall policy context, then addresses opportunities, challenges, and progress associated with the decarbonization of distribution grid, transmission system, and utility scale generation. The advancement of distributed generation, microgrids, community energy, and energy efficiency, and their contribution to "Cleaning NYC's Grid" are also discussed in this paper.

Policv

City policy and local action to advance clean energy has been growing in recent years, but decisions made at the Federal and State level have a powerful effect on the City's 80x50 efforts-both positively and negatively-and require examination. The Trump administration's withdrawal from the Paris climate accord, combined with the unwinding of the EPA Clean Power Plan proceeding, are in no way helpful to attaining 80x50. Trends in the utility sector and renewable energy markets, however, both indicate that federal policies' impact on decarbonization efforts will be limited. States have far more influence on regulation of the power grid, and New York State's strong clean

energy path certainly supports 80x50. The State's "Reforming the Energy Vision" (REV) initiative aims to transform how New York State's utilities will maintain and operate the grid, earn returns on investment, and profit through service to customers. Renewable and distributed energy resources, and deployment of technologies which will help customers increasingly be able manage their own consumption and demand, will be far more central to utility businesses like Con Edison. In addition to REV, the state's Clean Energy Standard (CES), which requires that 50% of power generation in New York be from renewable sources by 2030, is well aligned with the 80x50 effort.

Electrification

While the net impact of Federal and State policy on the City's decarbonization goals seems to be favorable, there are technical issues which need further clarity before the path to 80x50 is truly clear; specifically, surrounding the electrification of fossil fuel burning heating systems. Electricallypowered air source heat pumps have become more efficient in recent years, but there are major challenges to the kind of large-scale adoption needed to curtail emissions. Alternatives to fuel burning heating technology are not economically viable for most NYC buildings, and the trajectory for accelerated development in this area is unclear. If a large portion of the City's heating systems are electrified, and the clear trend towards electric motor vehicles continues, the impacts on the City's overall electricity load profile, and the intensified year-round demands

of the distribution grid, will need to be further modeled and analyzed. Furthermore, the economic impact of electrification on the City's natural gas utility delivery infrastructure needs further study as this system will be needed by consumers for decades to come, and will presumably be jettisoned for electric heating by a preponderance of residential and commercial consumers. A major investigative effort around building electrification technologies, and their grid impacts, needs to be launched as a collaboration involving city government, state policymakers, utility regulators, Con Edison, and National Grid.

The Distribution Grid and Con Edison

The distribution grid is required to evolve and manage the two-way flow of electricity and move energy from conventional distributed energy sources to meet customer needs on a minute-by-minute basis during the day. Con Edison, NYC's primary distribution system utility, has shown indications that it is responding well to REV regulations and new customer expectations, such as greater convenience and control over their energy use. Con Edison has established and staffed a new "Distributed Resource Integration" business unit and has expanded its Energy Efficiency and Demand Management Department significantly, which demonstrates the organization is invested in changing to meet new needs and challenges. The utility has a pipeline of "Non-Wires Alternative" projects underway, such as the Brooklyn Queens Neighborhood Program, which will defer major distribution network upgrades and result in investment in clean distributed energy, battery storage, energy efficiency, and demand response to meet new load requirements instead. Con Edison is also investing \$1.3 billion in 5 million smart meters by 2022. With emerging "big data" software solutions using high-resolution

smart meter data, it will be far easier to engage customers, provide insight into energy use, and prompt participation in clean energy management activities. However, more needs to be done and the state regulator needs to continue to push the utility establishment toward a smarter and cleaner distribution grid. And, as stated, coordinated policy and action between Con Edison and the City needs to be deepened to equip New York City's distribution system for 80x50.

New York City and New York State government are showing that they are doing their part to foster distributed energy solutions in the City. The City is leading by example with 53 solar installations totaling 9 megawatts in public buildings, with plans to reach 25 MW by 2019. Overall, with help from the State's "NY Sun" program, the City will have 140 MW of distributed solar connected by the end of 2017–almost all of which has been brought online in just the last few years. Meanwhile, the State's "NY Prize" initiative is leading to the development of several microgrids supporting New York City neighborhoods with critical hospitals and university facilities and at risk, disadvantaged communities. These projects feature several advanced energy technologies such as combined heat and power systems, solar, fuel cells, energy storage, and smart grid control technologies. These projects demonstrate that deploying the clean distribution grid of the future is very possible, but these need to be completed as scheduled, and policies to stimulate many more such projects must continue to be implemented.

Transmission

New York State's more than 11.000 circuit miles of transmission high voltage transmission lines are critical for delivering reliable, affordable, and increasingly clean energy to New York City. Upstate New York's utility-scale solar and

wind production is on the rise, and New York City needs the bulk power system to deliver increasing quantities of clean energy to its doorstep. Today's transmission system, however, is old and overburdened. Congestion in the transmission grid feeding the City is already a tremendous problem, preventing clean energy from reaching the City especially at peak periods. A number of projects are underway to relieve the strain on the system. For example, federal regulators recently permitted the \$2 billion Champlain-Hudson Power Express, which will transmit 1,000 MW of hydropower from Canada, passing underwater beneath Lake Champlain and all the way down the Hudson River into New York City. However, an off taker (or off takers) has yet to commit to the clean energy the transmission line will deliver, which is needed for this project to advance and would be a tremendous step in support of 80x50. The New York Power Authority (NYPA), which maintains about one-third of New York's transmission grid is also amid a 12-year, \$726 million set of upgrades to transmission lines in Northern, Western and Central New York, and related facilities such as switchyards and substations. NYPA is also deploying advanced control and communication technologies which will lead to a smart transmission grid, which can respond to the influx of solar and wind energy production and optimize their potential. In addition, the NY Independent System Operator (NYISO) is currently reviewing proposals to address new needs on three major stretches of the transmission grid. Winning proposals will be identified later this year and should begin development. Much is underway to modernize the transmission system and prepare it for the inevitable increase of renewable energy development, which will be needed for New York City consumers to reach the City's aggressive climate goals.

Generation

In a few years, 75 percent of in-city generation assets will be 50 years old or more, jeopardizing reliability and exacerbating air pollution and greenhouse gas emissions. Current reliability requirements dictate that many of the power plants in the City need to remain in service and/or be upgraded and repowered with more modern, efficient technology. Regardless, these generation facilities burn fossil fuels and their use needs to be minimized for NYC to reach 80x50. At the same time, the Indian Point nuclear power plant in Westchester, which covers one-quarter of today's New York City energy needs, is slated for closure between 2020 and 2021.

These are serious challenges, but there are efforts underway, in part because of the Clean Energy Standard, to meet the utility-scale renewable needs of the City. NY State currently has two Requests for Proposals (RFPs) soliciting new renewable generation, which could add as much as 1,600 MW in capacity into the market. City officials have indicated that they are in negotiations with the NYISO to relieve market restrictions and make it easier for owners of existing power plants in the City to embrace clean, efficient modern technology and upgrade the oldest, highest emitting generation facilities. The City government has committed that its own buildings and energy-consuming infrastructure will be 100% powered by clean energy by 2050. The Champlain-Hudson Power Express transmission line currently under development can contribute to New York City's increasing renewable energy requirements, particularly if all of its off takers are all located in the City and, thus, it could be treated as in-City generation. In addition, renewable energy costs are dropping rapidly and will continue to do so. Bloomberg New Energy Finance's New Energy Outlook 2017

anticipates that by 2040 the levelized cost of solar will fall 66%, wind will drop by 47%, and offshore wind will plummet by 71%. The future economics of renewable energy will be helpful to 80x50 efforts. In any case, it is vital for New York's policy makers and utility planners to prepare for the surging in-City capacity needs over time of what we must assume will be a customer base with increasingly-electrified homes, commercial building systems, and motor vehicles across the city.

Conclusion

The following recommendations are presented for consideration.

- A joint distribution grid planning process between the City and Con Edison needs to be established. The City and Con Edison need to come to a working understanding and jointly develop a forecasting model for how the 80% reduction is going to be reached in a way that is technically and economically feasible.
- The City needs to extend its "lead by example" efforts to electrification retrofits of heating systems in City government buildings. If fossil fuel fired boilers and steam heating systems are going to be replaced with electric air source heat pumps, for example, the City can be the first to do it at some level of scale in its own buildings.
- Policy coordination between the City and State needs to be strengthened. The current Governor and the leadership of the PSC, NYSERDA, and NYPA share a progressive, coordinated, and sophisticated clean energy policy vision and a strong team carrying it out. The Mayor's roadmap for 80x50 and the various initiatives described in it. and above, demonstrates the City's commitment

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to decarbonization, but the City lacks jurisdictional control of the energy system which limits what it can do.

• Continued focus on resolving the current 80% in-city generation reliability requirement. Even if all of New York City's local power plants are modernized, fossil fuel combustion will still be significant in the City, so this requirement must be addressed. The City and the State's utility industry need to find a way to meet the City's utility-scale energy needs primarily with carbon-free sources.

Cover Photo: http://www.npr.org/sections/thetwo-way/2014/03/13/289779344/report-small-scaleattacks-could-cause-national-blackout (George Widman / AP)

INTRODUCTION

Purpose of Paper

The aim of Cleaning NYC's Grid is to help NYLCVEF frame policy discussions as they seek to ensure and accelerate New York City's advancement toward its commitment of reducing carbon emissions by 80% (from 2005 levels) by the year 2050. The City of New York's planning documents appropriately group the actions toward 80x50 into four sectors: (i) Energy; (ii) Buildings; (iii) Transportation; and (iv) Waste. While each of these categorical areas intersect, this paper focuses exclusively on the energy sector and the grid. The focus is on the key aspects of the distribution, transmission, and generation systems the City relies upon for its electricity, and examines how the grid will need to evolve as the City reaches toward its ambitious decarbonization goal.

This paper seeks to serve as a launching off point for NYLCVEF to convene state and local government, the regulated utility industry, environmental advocates, and commercial actors. Of the four sectors listed above, energy has the most interdependencies, from the standpoints of technology solutions, market development and stakeholder involvement. In other words, much of the control of the grid's path to 80x50 is beyond the City's jurisdiction. and the cooperation of and with others is tremendously important. The way to 80x50 presents a tremendous technical challenge, and it is only possible if there is consensus between the City and State over climate goals, and if communication between policymakers, regulators, utilities, and private actors is consistently driving bold decisions and joint implementation of solutions.

Federal Policy

Recent actions by the Trump Administration impact the entire country including New York. These include: a) the withdrawal from the Paris Agreement (i.e. "Paris climate accord"); b) renunciation of the EPA's Clean Power Plan (new regulations of CO₂ emissions-the chief vehicle for meeting Paris commitments); c) plans to defund ENERGY STAR® and US Department of Energy clean energy research and development; and d), various policies supporting the oil, gas, and coal industries. These activities will by no means help the 80x50 effort, but there is considerable consensus around the notion that impacts on decarbonization efforts such as 80x50 efforts will be nominal. After the Paris accord withdrawal, utility executives across the country made statements criticizing the Administration's action and many agreed that the clean energy path will not slow down. Con Edison issued the following statement after Trump announced the Paris pullout: "Energy industry economics and investments have been moving for many years toward more renewables, smart technology, energy efficiency, and we expect that direction to continue."1 And there is consensus far beyond New York. Tom Fanning, CEO of the Alabama-based Southern Company, the nation's largest utility conglomerate, recently asserted decarbonization will continue in the nine southern states his company serves. Fanning remarked, "We don't chase fads. Our business approach, our strategies, our models, have a much longer life than any political party or any particular administration."2

One potential threat on the federal level comes from the Federal Energy Regulatory Commission (FERC) and the backlog of more than \$50 billion in energy projects that have been pending review and approval as the new White House fills the body's seats.³ Most of these projects are to transport natural gas, some of which has the potential to end up being used to power New York City's grid because of short-term assessments of cost effectiveness.

State Policy

The changes at FERC has the potential to impede efforts to clean New York's grid, but State policymakers and utility commissioners have far more direct authority to support 80x50. The State's sweeping bundle of policies and regulations, which has been named "Reforming the Energy Vision," if effectively implemented, will serve the City well in its climate efforts. If REV is successful, the benefits will arrive in time to synch with the City's advancement toward 2050. Regulated industries take time to evolve, as do bureaucracies like Con Edison. Con Edison has a lot of work to do to become what the Public Service Commission of New York (PSC) calls a "Distribution Platform Provider." This future version of Con Edison's success as a business will be tied to the efficient operation of a grid bursting with cleaner distributed energy, energy efficiency, and demand management activities.

The Clean Energy Standard (CES) requires that 50% of New York's electricity be sourced from renewables by 2030. This will certainly jumpstart the development of large scale renewables and create incentives for transmission projects so New York City can access this clean power. One continuing challenge for the City, however, may limit the benefit of the CES. Reliability requirements, overseen by the New York State Reliability Council and implemented by the

NYISO, currently prescribe that generation facilities within New York City own borders be capable of meeting 80% of peak demand (defined as the highest level of electricity demand required on the most power-intensive days each year). This keeps the City somewhat more reliant on existing and conventional power plants, particularly because of physical space constraints and limited potential for locally-based utility-scale renewable energy development.

Electrification

New York City's greenhouse gas emissions come from the combustion of gasoline, diesel fuel (used in motor vehicles and a decreasing number of buildings) and natural gas, which is the City's primary source for electricity production and building heating. Public data shows that the use of coal and fuel oil as inputs for power plants has fallen off, and cleaner natural gas fired electricity generation is now central for New Yorkers. Natural gas power production, by way of relatively-efficient combined cycle power plants, has been a considerable contributor to the first steps toward cleaning the grid. And natural gas' presence in power production will remain prominent for some time - even with the rapid integration of distributed and utility scale renewables into the City's electricity mix.

Natural gas is, by far, the primary energy source for heating and hot water systems in buildings throughout New York City - largely for heating multifamily apartments and single family homes. As with power plants, the rise in natural gas use to provide heat and hot water in buildings has been heralded as "clean heat" with the City's successful efforts to phase out the dirtiest forms of fuel oil used in NYC buildings.

¹ https://www.bloomberg.com/news/articles/2017-05-31/exxon-conoco-back-paris-climate-deal-astrump-weighs-pact-exit

^{2 &}quot;Inside the Minds of Top Utility Executives", The Interchange (Podcast - Interviews with utility leaders at the Edison Electric Institute Annual Convention). Greentech Media, June 2017

³ https://www.bloomberg.com/news/articles/2017-05-09/trump-names-picks-for-u-s-energy-age cv-crippled-without-auorum



These side-by-side images depict the 2 most common forms of fossil fuel combustion used to power, heat and cool NYC buildings: Left - a turbine used in natural gas fired, combined-cycle power plants; and Right - one of the many kinds of gas boilers used to heat multifamily buildings. Both will be relied upon for many years, regardless of the path to 80x50.4

Paradoxically, finding alternatives to natural gas for building heating and power generation are integral to current plans to reach 80x50. It is easy to see the many ways in which curbing the use of natural gas is a monumental challenge for the City of New York, Con Edison, National Grid, and State utility regulators and policy makers. In terms of building heating-while some solar and geothermal opportunities exist and will expand somewhat in the coming decades-the main option would be to electrify heat and hot water systems. The primary efficiency electric heating technology which will work in the City -air source heat pumps-are now used in new construction projects, but they are not currently a particularly affordable retrofit solution.

Energy Efficiency

While building electrification and the "customer-side of the meter" is addressed in a separate paper written for NYLCVEF focused on reducing energy use and emissions in New York City's buildings, it is important to note that energy efficiency is crucial to supporting decarbonization of the grid. Energy efficiency retrofits of existing buildings and highly efficient new buildings lowers the City's overall grid load. Some advanced energy efficiency measures such as controls with information

and communication technology effectively turn buildings into battery storage, and manage demand over the course of the day and the seasons, balancing the grid and reducing peak periods. Without substantial energy efficiency, 80x50 is not attainable.

When it comes to energy efficiency, the City of New York is active in areas it can directly control. Local laws which require building performance benchmarking, energy audits, retrocommissioning, submetering of commercial tenant spaces, among others, are robust and being improved. More stringent building codes are being enforced. Mayor De Blasio's administration has also set up the "New York City Retrofit Accelerator" which takes a grassroots approach towards educating, engaging, and providing critically needed technical assistance to harder-to-reach building owners who have been unable to develop and implement energy efficiency retrofit projects and need help finding resources to do so.

w.waterheatersnyc.com/our-fees/maintenance-services/; and https://www.sie com/press/photo/soaxx201412-02e (restricted)

The City's sphere of influence is limited, however, and authorities in Albany are needed to incentivize Con Edison to specifically invest in behind the meter just as it does with grid infrastructure. REV is intended to advance energy efficiency but its current implementation trajectory is not sufficient to achieve the levels of efficiency needed to reach 80x50 in New York City. State policy in Massachusetts, Rhode Island and California, for example, call for utilities to achieve 3% year-over-year load reductions through energy efficiency, and this is enforceable by way of specific targets in utility regulations. New York has no such targets or mandates. The Clean Energy Standard assumes

THE DISTRIBUTION GRID

Collection Components

New York City's electric distribution grid serves nearly 3 million residential, commercial, and industrial customers. The City's main distribution system, operated by Con Edison of New York, reached its all-time highest peak demand, of more than 13,300 MW, in 2013. In 2015, the 20,200,000 MWh sold to customers by Con Edison represented nearly 1% of the total MWh delivered to customers in the United States.^{5,6}

Con Edison's Distributed System Implementation Plan (DSIP), dated June 30, 2016 effectively describes the colossal scale of the utility's infrastructure:

Con Edison's electric underground distribution system is the largest underground, low-voltage network system in the world. The Con Edison distribution system includes approximately 251.500 manholes and service boxes. 25.000 conduit miles of duct, 95,800 miles of underground cable, and 41,200 underground

energy efficiency will contribute to the 50% by 2030 target—at about a rate of 1.5 percent in incremental reductions each year. Utilities, however, do not have distinct energy efficiency goals beyond short-term "Energy Efficiency Transition Implementation Plan[®] requirements established by the PSC for the changeover to REV.

Energy efficiency is critically important to cleaning the grid, particularly because of the demands it will face with the anticipated, dramatic growth of electricity demand from building heating and cooling systems and transportation over the coming decades.

transformers that further step the voltage down from 33kV, 27kV, 13kV, or 4kV to 120/208 volts to supply the low-voltage secondary distribution system . . . The Company's (nonnetwork) electric overhead distribution system includes 168 autoloops; 219 unit substations; 13 multibank substations; approximately 198,400 poles; 50,800 overhead transformers; and approximately 34,200 miles of overhead wire including primary, secondary and service wire.

Maintaining Con Edison's vast, complex, and aging grid, and maintaining safe and reliable service is a demanding ongoing exercise. The system is also expensive for rate payers, which is one of the main reasons New Yorkers consistently pay the highest electric rates in the continental United States. Looking forward, the prospects for the operations and

⁵ US Department of Energy, Energy Information Administration, Form EIA-861, 2015 Data.

⁶ Con Edison data provided includes Westchester County. PSEG-Long Island (LIPA) distribution service in NYC, which serves fewer than 35,000 customers in Rockaway peninsula in Queens, is considered negligible for this paper's purposes, thus data and direct discussion of it are excluded.

development of Con Edison's grid will become ever more complicated, but the opportunities for customers and the utility's business will also evolve and emerge in exciting ways.

Con Edison and REV

NY REV is becoming a major trigger for the evolution of New York City's grid. REV's regulations aim to shift Con Edison and all of New York's distribution utilities into Distribution System Platform providers which will function like "traffic police"; commanding, controlling, and optimizing the flow of electricity-from conventional and distributed sources to meet customer needs on a minute-by-minute basis during the day. REV is gradually going to recalibrate price signals and prioritize the use of utility-scale renewables into the system, establishing clean, distributed energy resources (DER) and increasing energy efficiency (EE). All this bodes well for the 80x50 effort.

Large utility bureaucracies are typically challenged by change, but it appears Con Edison is "leaning into REV." New technological developments, such as advanced metering infrastructure (AMI) and greater possibilities for the "internet of things" on both sides of the meter are changing Con Edison's plans for capital upgrades and future modes of operating the system. In addition, its expanding new generation of customers with evolved expectations and preferences, such as greater convenience choice and control of their energy use, will impact Con Edison's future operations.

Some major Con Edison initiatives which indicate the utility's progressive posture and support for 80x50. are:

Organizational investment on new direction. Con Edison has established and staffed a new Distributed Resource Integration business unit. Also, the utility's Energy Efficiency and Demand Management Department team has expanded

considerably and has been placed in the company's ratemaking division, which indicates its business function and less of its regulatory compliance function.

 Proactive pursuit of Non-Wires Alternative (NWA) projects: In 2014. Con Edison obtained regulatory approval for the Brooklyn Queens Neighborhood Program, which proposed to offset 52 MW in anticipated new demand from 2017 to 2019 in a discrete set of distribution networks. A new substation and other conventional capital upgrades, estimated at \$1.2 billion at the time, has been deferred with \$200 million in energy efficiency, distributed energy resources such as combined heat and power, renewables, storage, and other "non-traditional" upgrades to the grid infrastructure. This project set a precedent for a statewide pipeline of similar efforts, and the Con Edison website lists RFPs and/or plans to procure 8 new such projects in the near future.

Targeted Brooklyn-Queens Networks



Advanced Metering Infrastructure (AMI) Rollout. In 2015 Con Edison, announced a \$1.3 billion investment in an installation of 5 million smart meters across its customer portfolio by 2022. The new meters, combined with the explosion of software interfaces using the higher resolution customer data, brings tremendous opportunities. AMI will facilitate better demand response, new forms of energy efficiency, and

has the power to integrate battery storage and distributed solar-optimizing the grid.

The propagation of smart meters and their data will also improve customer experience, and create more value for residents and businesses considering clean, distributed energy solutions. A

Impacts

new generation of New Yorkers will be engaged to Direct conversations with Con Edison officials control what kind of energy they consume-and indicated that the utility expects a steeplyhow and when they use it-helping them save rising summer peak and a new high winter money and make carbon-based service choices. peak.⁸ Maintaining the grid and responding to population growth estimates right now Future Demands on the Grid and Cost makes for extremely high costs for the utility and higher distribution rates for the consumer. Despite these "80x50-friendly" developments, New York City's utility prices are the highest uncertainty envelops the future distribution in the continental United States now, and a system in the goal to reach 80x50 targets. The major contributor is the costs associated with technical feasibility of upgrading and maintaining maintaining the distribution system. If the the system to meet newly electrified space heat energy efficiency needed falls short (quite and hot water heating demand needs to be possible), and even some of the building studied. And the cost implications for ratepayers electrification anticipated takes place, the associated with expanding the bandwidth of the added costs for modernizing Con Edison's distribution grid are very unclear. infrastructure would hit consumers hard. This does not even include the high cost of using electricity for heating. The electricity costs associated with heating the average home or commercial building, with today's most advanced technologies, is still significantly higher than using fuel or gas.

As we move toward 2050, the changing demands on the distribution system are unclear. The American Council for an Energy-Efficient Economy published a paper authored by former New York City policy advisor Laurie Kerr that contains variations on a model which predicts that peak demand levels by 2050 would be One final cost factor worth examining is the similar to that of today. The model assumes a impact on Con Edison and National Grid's local 14% growth in population, a 29% increase in natural gas distribution networks in New York commercial growth, and about 50% in efficiency City. Depending on the degree of building gains in existing buildings (a low scenario of 40% heating system electrification, the erosion of and high of 60%) with 65% in efficiency gains in the heating gas user base will negatively impact new buildings constructed. And, depending on remaining users. The fixed costs of maintaining the case, between 37% and 61% of all fuel-based two systems will remain, with far fewer heating building systems and motor vehicles will need to gas consumers. Cooking gas customers and the be electrified.7

While one can imagine that the electrification of the transportation sector will happen in the

coming decades, the full set of technology solutions needed to reach the overall levels of both building electrification and energy efficiency do not currently exist. When will these technologies exist, and become economically viable for consumers?

7 Kerr, Laurie. "The Lazy Man's Guide to 80x50 in NYC" ACEEE 2016: http://aceee.org/files/proceed ings/2016/data/papers/9 883.pdf

How will a smart meter help me?



https://www.coned.com/en/our-energy-future/technology-innovation/smart-meters/features-benefits

enduring heating users will face substantial cost increases. A similar pattern has been seen over the last few decades with Con Edison's steam system; rates have increased tremendously as large numbers of customers dropped off the network.

Rigorous Analysis Needed

Many questions remain about the future of the distribution grid, and a more precise analytical model is needed to plan for 80x50. The analysis will need to be regularly updated as the market evolves and technology penetrations are better understood. Only then, can there be real planning and implementation of the clean distribution grid of the future. And the only way this analysis will be accomplished is when

all constituencies are convened on an ongoing basis to collaborate on plans:

- · City and State policymakers and regulators (Governor, Mayor, NY PSC)
- City and State agency "line" agencies (e.g., EDC, DOITT, DEP, DCAS, NYCHA, MTA, NYSERDA)
- Utilities (e.g., Con Edison, National Grid, PSEG-LI, and NYPA)
- Building owners and property managers
- Building retrofit project developers
- Distributed energy developers
- Community based organizations

A codified governance structure which includes these parties and is centered around evolving the distribution system would go a long way towards securing the City's clean energy future.

DISTRIBUTED GENERATION

Much of the energy sector "buzz" in New York centers around distributed generation. While NY REV has proposed structural changes to overall regulation on all levels of the grid, much of the market focus is on two areas, and both are about the distribution system:

- 1. There is the transformation that the investor-owned utilities such as Con Edison are undertaking to become a platform for distributed generation, energy efficiency, and other forms of demand management.
- 2. There is the issue of defining the value of distributed energy resources and stimulating entrepreneurs and their customers to participate and engage in a more dynamic marketplace.

While both these topics are inextricably intertwined, let us say that the first one-with the focus on Con Edison-has been discussed. The NWA efforts described above demonstrate that Con Edison is finding its way toward being able to make physical integration of distributed resources part of their operation, and the utility is on the path to figuring out how to reshape its business out of efforts like these to continue to satisfy their shareholders.

The second area is about how rapidly and how effectively industries like rooftop solar and modular storage can find their way into New York City. As is always the case, construction is more difficult and physical space comes at a premium in New York City. Given the City's density, the limitations on roof space and shadows make siting solar PV and other technologies more difficult.

Solar

Yet, adoption of solar photovoltaics (PV) is ramping up quickly. New York State has done its part regarding evolving the regulations and providing incentives to consumers. The City is pushing hard as well. According to the City Department of Citywide Administrative Services (DCAS) website, the City completed 53 solar PV projects totaling 9 megawatts and plan to increase to 25 MW by 2019. In addition, installations of solar PV across all of New York City's homes and commercial buildings have more than quadrupled over last few years. In April 2017, the City announced that it had reached 100 MW of solar installed in the City and expects to attain 140 MW by the end of 2017.

Looking forward, there are multiple pieces of legislation under consideration which will foster clean, distributed energy action:

- Int. 1644-2017 will establish a "green project accelerator" which would operate in conjunction with the City's Buildings Department to remove barriers and speed up permitting of renewable energy projects.
- Int. 1630-2017, Int. 1639-2017 will require the City to create implementation plans for "Solarize" programs, which would create easy pathways for adopting use of solar energy through cost-effective bulk procurement of renewable energy or the systems that produce solar energy. Int. 1630 targets homeowners within the vast city government workforce of more than 300,000 employees, of which even a small subset of participants could lead to implementation of tens of thousands of systems.

 Int. 1639 targets the 74 Business Improvement Districts⁹ within the City to take advantage of their collective economies of scale to procure renewable energy systems in the 85,000 businesses and other facilities across the BIDs respective geographies.

Legislation like the bills above-if passed-can target consumers to facilitate streamlined clean energy action, and are effective in creating momentum among early adopters. The impact of voluntary participation efforts, however, is ultimately limited. Eventually-and probably sooner than later-some combination of mandates, codes, and tax mechanisms will need to be introduced to achieve the levels of clean distributed generation needed to reach 80x50.

The solarize programs described above constitute a simple, straightforward form of "community" energy"—a way for a group of energy consumers to come together, aggregate the power of numbers and access clean energy in an affordable way. Each one of these initiatives are key building blocks to greening the grid. There are other vehicles for community energy-which can be enabled by public-private partnerships-to reimagine the grid and engage and incentivize customer to act. The potential of community energy needs to be unlocked, replicated and scaled-and can be. Each such project, however, has its own combination of technology solutions, field conditions, and stakeholders, so the barriers to implementation can be daunting.

Microgrids

Microgrids are emerging as a key form of community energy in New York City. A microgrid is a discrete subset of the electric grid which can balance, command, and control supply and demand points. Military bases, college campuses, and correctional facilities have operated microgrids for decades, for various reasons,



NYSERDA NY Prize Awardees in NYC

including resiliency, public safety and security, energy efficiency, demand management, and cost savings. Solar PV, storage, building energy management systems, and use of equipment can all be harmonized on a microgrid. They can be financed in a variety of ways, and REV regulations will bring utilities to the table to "pay a microgrid operator" to balance flow of electricity on "macro" distribution grids, including supporting Con Edison non-wires alternatives (NWA) projects.

There are several microgrid projects undergoing feasibility analyses and planning phases, a few are under development, and one has recently been brought online. Earlier this month, the 625-unit Marcus Garvey Apartments energized its new microgrid. This 10-city block affordable housing development in Brooklyn now has solar panels on 21 rooftops generating 480 kW, coupled with a 400-kW fuel cell and a 300-kW lithium battery. The project features a computerized "Network Optimization System" which integrates the onsite generation and storage, and creates savings for the Marcus Garvey operation and provides grid relief for Con Edison during peak period in summer.

Additional activity has been prompted by the Governor Cuomo's "NY Prize" initiative, implemented by NYSERDA. NY Prize is a multistage competition which provides financial and technical assistance for communities and institutions looking to create microgrids. NYSERDA solicited proposals from respondent teams comprised of hospitals, schools, community organizations, public agencies, utilities and engineering firms. "Stage I" awardees-there were 9 in New York Cityreceived grants to pursue feasibility studies. Three "Stage II" awardees have moved into the design phase.¹⁰

One of these microgrids, which will span an eleven-block area in Brooklyn, is being developed by Kingsboro Psychiatric Center (State OMH), Kings County Hospital (NYC HHC), and Downstate Medical Center (SUNY). The team includes NYPA, Con Edison, and a few consulting engineering firms as well. The scope includes combined heat and power, solar, fuel cells, storage, and advanced control technologies to supply power and heating to three lead hospitals, another local hospital, and a high school. The two other NY Prize supported projects involve Amtrak, LaGuardia Community College, Middle College High School, and other facilities in Queens.

Finally, much press and fanfare surrounds the community-based microgrid of smaller consumers being launched in Boerum Hill, Gowanus, and Park Slope, Brooklyn by start-up LO3 Energy. Based on "Block Chain" or "peerto-peer" technology, participants' meters allow for dynamic engagement, buying, and selling of distributed and other energy resources. This project is perhaps a glimpse into new ways to optimize the grid at a more granular level than ever before.

The potential for microgrids is appealing. They employ smart technology to balance on-site generation with conventional grid power, and manage supply and demand to prioritize lowestcarbon outcomes. These systems could be major assets on the path to 80x50, but much remains to be learned. Many stakeholders need to be coordinated to build project such as these, and the more community-based microgrids, like the LO3 Energy, one seem to require a lot of "sweat equity" on the ground, which can be challenging.

Smart Communities

When planning for the distribution grid of the future, the broader concept of "Smart Communities", or "Smart Cities", needs to be considered. "Smart" is defined here as using information communication technology (ICT) to connect the people and businesses of a jurisdiction with their residences, commercial buildings, infrastructure, and public services. David Owens, retiring executive for operations and regulatory affairs at Edison Electric Institute, describes smart communities as a "partnership of the energy industry with the transportation, communications, and water sector."11 The "internet of things" creates tremendous opportunities for upgrading the electric distribution system in concert with other systems in the City. Hidden in these synergies may be ways to finance smart infrastructure in a joint fashion, using public/private partnerships to create cost efficiency and new revenue streams. The City's ICT leaders and stakeholders must be sure to include its energy policy and utility colleagues when developing policies that support the smart city of the future.

⁹ Business Improvement District (BID) is a geographical area where local stakeholders over and fund the maintenance, improvement, and promotion of their commercial district.

¹⁰ NYSERDA website: https://www.nyserda.ny.gov/All-Programs/Programs/NY-Prize/Opportunitv-Zones-Map

^{11 &}quot;Inside the Minds of Top Utility Executives", The Interchange (Podcast - Interviews with utility leaders at the Edison Electric Institute Annual Convention). Greentech Media, June 2017

"Even if all of New York **City's local power plants** are modernized, fossil fuel combustion will still be significant in the City, so this requirement must be addressed. The City and the State's utility industry need to find a way to meet the City's utility-scale energy needs primarily with carbon-free sources."

TRANSMISSION

The prospects of greening New York City's buildings, expanding distributed solar, and integrating storage, smart meters, and microgrids and their impact on the distribution system—are exciting and vital elements to reaching 80x50. New York State's more than 11,000 circuit miles of transmission high voltage transmission lines, however, will always be central to delivering New York City reliable and affordable energy. And now, the bulk power system brings tremendous promise to deliver the City's residents and businesses large scale renewable energy contributing significantly to meeting the Mayor's decarbonization commitment.

New York City's neighbors in remote rural areas to the North and West have the physical space to host utility scale wind and solar, and the lack of population in these areas requires that the output of these renewables be exported. And coastal wind projects offer the same kind of potential for the City. New transmission system technologies improve prospects even more. With the availability of today's smart grid automated "command and control" functionality, the system can be optimized to deliver the least expensive, cleanest energy to NYC when the sun is shining brightest, wind is blowing steadily, and/or customer demand is greatest. Both of Governor's Cuomo's flagship energy policies described earlier, REV and the Clean Energy Standard, will help reset the rules of the market to facilitate delivery of utility scale renewables to the City.

However, the age and condition of the transmission infrastructure serving the City is limiting. Per a recent publication from New York Independent System Operator (NYISO), more than 80% of the 11,000-mile system is 35 years old or older, and nearly half of it will need replacement before 2050 at an estimated cost of \$25 billion."¹² And even today's transmission system does not provide adequate bandwidth. Congestion is a longstanding problem. Currently, when demand is at its greatest in the City lowercost and/or cleaner power available cannot be reached because of transmission bottlenecks.

These issues have been recognized by the State policymakers and regulators. The NY Public Service Commission (PSC) sets direction for the transmission grid by directing the NYISO to procure the development of project, and has been pushing toward an expansion of the system. The PSC has an Alternating Current (AC) Transmission proceeding ongoing. AC transmission lends itself to multiple interconnections, which is more flexible for integrating new sources of renewable power from multiple points. In addition, NYPA is leading the Governor's "Energy Highway" initiative. NYPA manages about one-third of the transmission grid in the state, and it has embarked on several major projects seeking to modernize and reduce congestion on the system across the state. Some of the projects recently completed or underway are described below.

NYPA's Life Extension and Modernization

 (LEM) Program is a 12-year, \$726 million
 project, which will upgrade transmission
 lines in Northern, Western and Central New
 York and related facilities such as switchyards
 and substations. Some of the upgrades will
 modernize transmission assets that date back
 to the 1950s and 1960s when NYPA built its
 major hydroelectric plants on the St. Lawrence
 and Niagara rivers. NYPA started this work in
 2013 and anticipated its completion by 2025.

12 "Power Trends 2017: New York's Evolving Electric Grid", NY Independent System Operator

 Transco projects energized. In 2016, New York Transco (a company owned by the parent companies of Con Edison, NYSEG/RG&E and Central Hudson, among others) commissioned 3 new projects which help relieve congestion to New York City.

Champlain-Hudson Power Express.

In December of 2016, the US State Department completed a review and approved a permit which will enable construction of a new pathway for receiving Canadian hydropower into range of a transmission line that could bring the capacity to New York City. This \$2 billion project, referred to as Champlain-Hudson Power Express, will transmit 1,000 MW of renewable energy from Quebec into southeast New York, passing underwater beneath Lake Champlain and all the way down the Hudson River. If the line were dedicated to only provide power within the City limits, it would be considered in-City generation, but off takers have yet to be identified in New York City or elsewhere.

 AC Transmission RFPs. The PSC designated three areas of transmission needed in January 2017: Western New York, AC Transmission Segment A (Central East), and AC Transmission Segment B (UPNY-SENY). The NYISO is evaluating the transmission proposals to select the more efficient or cost-effective solutions to those needs. Winning proposals should be identified later this year and begin development.

It seems that these and other projects in development, which seek to relieve congestion in the system, will improve the prospects of newly developed clean energy capacity reaching the City. Stakeholders for 80x50, however, need to remain vigilant. The City's overall load profile will shift with energy efficiency initiatives, electrification of heating systems, and the introduction of local distributed generation and microgrids. The question is—how far will we advance and at what pace? As future capacity needs become clearer, the City, the State, utilities, and other industry players will need to respond to meet New York City's clean energy transmission requirements.

"The City's overall load profile will shift with energy efficiency initiatives, electrification of heating systems, and the introduction of local distributed generation and microgrids.The question is—how far will we advance and at what pace?"

GENERATION (UTILITY-SCALE)

Like the distribution and transmission systems, June 2017 by NYPA and the New York State generation of clean energy for New York City Energy Research and Development Authority presents opportunities and challenges. On the (NYSERDA) will create a flurry of activity toward plus side, the wide range of potent state policy the development of new large-scale renewable activities including REV, Clean Energy Standard, projects. NYSERDA's RFP is soliciting 1.5 million the Energy Highway plan, Regional Greenhouse MWh through the purchase of renewable Gas Initiative (RGGI), and the PSC's transmission energy credits (RECs) under contracts for up expansion orders will aid the City in finding to 20 year terms. NYPA's RFP seeks to procure ways to source and import more clean energy another annual output of 1 million MWh. toward its decarbonization goals. There are NYPA's RFP also looks for respondents to many challenges to the generation component propose projects that leverage both federal tax of reaching 80x50 as well. In New York City's incentives for renewable energy and NYPA's Roadmap to 80 x 50, it is asserted that the unique access to low-cost financing. Taken CES will need to be exceeded to reach the together, the projects resulting from these solicitations could add as much as 1,600 MW in 2050 target. The New York Independent System Operator (by way of New York State Reliability capacity to the market. Council rules) requires that generation facilities within New York City's own borders be capable The City is leading other efforts which seek of meeting 80% of peak demand. This keeps to advance of cleaner and renewable utilitythe City somewhat more reliant on existing scale generation. City officials have indicated and conventional power plants (for economic that they are in negotiations with the NYISO to relieve market restrictions and make it easier reasons, if not technical ones), due to space constraints and limited potential for renewable for owners of existing power plants in the City energy development, beyond small distributed to embrace clean, efficient modern technology generation. Nearly 75% of the in-city generation and upgrade the oldest, highest emitting assets will be 50 years old or more, which generation facilities. jeopardizes reliability and exacerbates air pollution and greenhouse gas emissions. With The City government has committed that the potential for significant load increases due its own buildings and energy-consuming to electrification of building heating systems infrastructure will be 100% powered by clean energy by 2050. The City, as well as other public and motor vehicles, the in-city requirement has potential to fetter the city ratepayers agencies with large facilities within the City,¹³ into paying for dormant conventional fossil have tremendous purchasing power. These fuel powered generation even if demand is government facilities alone consume 4 million generally being met with clean energy sources. MWh per year. The previously-mentioned Champlain-Hudson Power Express would Despite these challenges, there are many benefit from the mix of renewable energy in the

Despite these challenges, there are many initiatives underway about which to be optimistic. Notably and most recently, two companion Requests for Proposals issued in

13 There is a consortium of government agencies with facilities in NYC which form a consortium which works with NYPA to identify and negotiate clean and affordable power. This group includes the City of New York, NYC Housing Authority, Metropolitan Transportation Authority, Port Authority to f NY & NJ, NY State Office of General Services, State University of NY, among others.

City, and offshore wind developments proposed in the waters off Long Island and New Jersey are being examined as well. None of these projects, however, are clearly secured as sources of renewable energy for New York City at this time.

Another key ingredient to the advancement of renewable generation are the prospects for continued decreases in solar and wind prices. Costs have been plummeting. According to Bloomberg New Energy Finance's New Energy Outlook 2017, by 2040 the levelized cost of solar will fall 66%, wind will drop by 47%, and offshore wind will plummet by 71%. These steep declines will be aided by more efficient and cost-effective solar cells and wind turbines, implementation experience, competition, and economies of scale.

With generation, as with distribution and transmission, there are multiple moving parts which need to be monitored and coordinated. New York City, its government, and its energy users need to remain committed to balancing the advancement of decarbonization while ensuring that energy affordability is managed to protect consumers and keep the economy of the City strong.

Indian Point

Indian Point Energy Center (IPEC) is 2,000 megawatt power station located on the Hudson River in the Village of Buchanan, New York. The plant is fueled by two nuclear reactors, and it provides approximately 25 percent of the energy supplied to Con Edison's customers in Westchester County and New York City. In January 2017, NY state officials and IPEC's owner, Entergy, entered an agreement to close the plant. Under the arrangement, one of IPEC's reactors will be deactivated in April 2020 and the other will follow a year later. Safety and environmental concerns and political controversy have centered around IPEC for many years. On one hand, the plant is an aging facility, and the safety risks associated with nuclear fuel and waste, coupled with the potential of operational failure so close to a dense population centers, are very real. On the other hand, IPEC currently supplies a large portion New York City's energy, and provides it consistently, cheaply, and without any greenhouse gases. IPEC's eventual shutdown is an added challenge as the City seeks more emissions-free energy sources, not less. In addition, there are serious concerns over the cost impacts on consumers when Indian Point is decommissioned, as substituting sources of energy may be more expensive. Even with the NYS-Entergy agreement in place, the timing of IPEC's closure could be delayed, but it is far too risky for any planning assumptions to contain output from the plant after 2021.

In February of 2017, Synapse Energy Economics issued a study-commissioned by the Natural Resources Defense Council and Riverkeeper-which presents detailed scenarios in which it posits New York can reach its emission reduction and clean energy targets economically, even as IPEC closes as scheduled. The prescription Synapse offers for addressing Indian point is three-fold: a) compliance with the State's Clean Energy Standard (50 percent renewables by 2030); b) associated transmission system upgrades; and, most notably c) significant increases in the trajectory of energy efficiency gains which, as described earlier in this paper, need to be prompted by more aggressive policies and targets than exist right now.

"New York City, its government, and its energy users need to remain committed to balancing the advancement of decarbonization while ensuring that energy affordability is managed to protect consumers and keep the economy of the City strong."

CONCLUSION

As described above, creating New York City's clean grid of the future is a complex endeavor. To summarize, there are several areas which require ongoing attention. The following are some concluding recommendations for consideration.

- A joint distribution grid planning process between the City and Con Edison needs to be established. As described in the body of this paper, the demand requirements for the distribution system of the future is ambiguous at best. The City and Con Edison need to come to a working understanding and jointly develop a forecasting model for how the 80% reduction is going to be attained. How much energy efficiency will be done, by when? How much electrification of heating systems will happen by 2050? What is the adoption rate of solar PV, storage and microgrids going to look like? With these answers, we can then assess the needed investment in the distribution system and the time it will take to plan for ratepayer cost impacts.
- The City needs to extend its "lead by example" efforts to electrification retrofits of heating systems in City government buildings. If fossil fuel fired boilers and steam heating systems are going to be replaced with electric air source heat pumps, the City can be the first to do it at some level of scale in its own buildings. NYC Housing Authority's residential towers, and the City's firehouses, schools, and office buildings offer a large and diverse portfolio in which to: i) push manufacturers of the heat pump units to improve unit specifications for retrofit applications; ii) model the retrofit deployment process; and iii) assess the energy load, demand and costs impacts associated with operating an electrically heated building.
- Policy coordination between the City and State needs to be strengthened. The current Governor and the leadership of the PSC, NYSERDA, and NYPA share a progressive, coordinated, and sophisticated clean energy policy vision and a strong team carrying it out. The Mayor's roadmap for 80x50 and the various initiatives described in it, and above, demonstrates the City's commitment to decarbonization, but the City lacks jurisdictional control of the energy system which limits what it can do. Impressions obtained from discussions with various stakeholders indicate that there is not an ongoing policy dialogue or steady work relationships among members of the Mayor's office and the Governor's office, for example. The longstanding processes of setting the city governments own energy procurement path between DCAS and NYPA continue, and NYSERDA is engaged with the City's Retrofit Accelerator project; but there appears to be a need for higher level State-City policy task force that devises joint strategies and coordinates their implementation.
- Intense, continued focus on resolving the 80% in-city generation requirement is

needed. The in-city generation requirement is a challenge. Even if all the old plants are repowered, they will still burn fossil fuel which will be utilized at some significant level. Can the 80% requirement be reduced without compromising reliability? Is more dedicated transmission to the City a feasible solution? Regardless, the City and the NYISO need to perform a deep dive into this issue and identify solutions.





The New York League of Conservation Voters Education Fund (NYLCVEF) engages and educates New Yorkers on environmental issues and the environmental decision-making processes at the local, regional, state and federal government levels. NYLCVEF fosters open, nonpartisan discussion on environmental policy and empowers New Yorkers to be effective advocates on behalf of the environment. Learn more at **www.nylcvef.org.**

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