STATE OF NEW YORK
PUBLIC SERVICE COMMISSION

Proceeding on Motion of the Commission	)	
to Implement a Large-Scale Renewable Program	)	Case 15-E-0302
and a Clean Energy Standard	)	

Comments of Nuclear New York, Inc.

August 16, 2023

INTRODUCTION

New York has a proud history of pioneering nuclear technology for energy, medicine, and propulsion. It was the first state in the nation to recognize and reward low-carbon electricity generated by nuclear power plants (Zero Emission Credits), preceding the federal government granting equal tax treatment for nuclear power (both existing and new) in the Inflation Reduction Act of 2022. Today, consistent with a *global reckoning* of nuclear power's crucial role in tackling climate change while meeting the needs of a productive industrialized society, states like Texas, Wyoming, and Tennessee are racing to assert themselves as leaders in this emerging high-tech industry. New York should be at the forefront of nuclear innovation, not on the sidelines.[1]

Our electric system is the cornerstone of modern society. It protects the health and safety of all New Yorkers and has enabled the state to be the world's tenth largest economy. Maintaining the reliability, affordability, and resiliency of that system will be essential as New York endeavors to achieve its climate goals.

The following testimony answers questions posed by the Commission in the order, issued and effective on May 18, 2023, seeking public input in the development of a zero-emission

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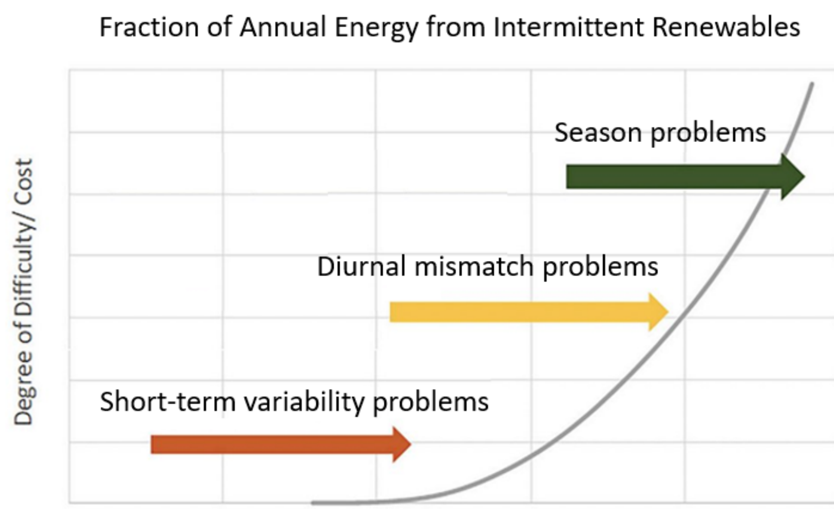
[1] Nuclear New York, Clean Energy Jobs Coalition-NY, Campaign for a Green Nuclear Deal. Bright Future: A More Reliable and Responsible Climate Plan for New York, July 2022 https://www.nuclearny.org/bright-future/

program. However, before doing so, we find it important to establish the system-level context in which those questions should be considered.

PRELIMINARY REMARKS: FIRM CLEAN POWER AS BACKBONE, NOT BACKUP

Understanding the relative value of different zero-emission sources requires system-level thinking. As seen below, in high-emission grids, adding solar PV and wind capacity can provide significant value in curbing emissions: summer peak demand can be shaved with solar; and both wind and solar, when available, can curb fossil generation. At fairly low penetration, intermittent renewables need no “firming.” Electricity from intermittent generation is simply used to the extent possible when it is produced. At other times, dispatchable high-emission sources (fossil fuels) meet demand.



Integration difficulty with rising fraction of annual generation from intermittent sources (Denholm, et al.)[2]

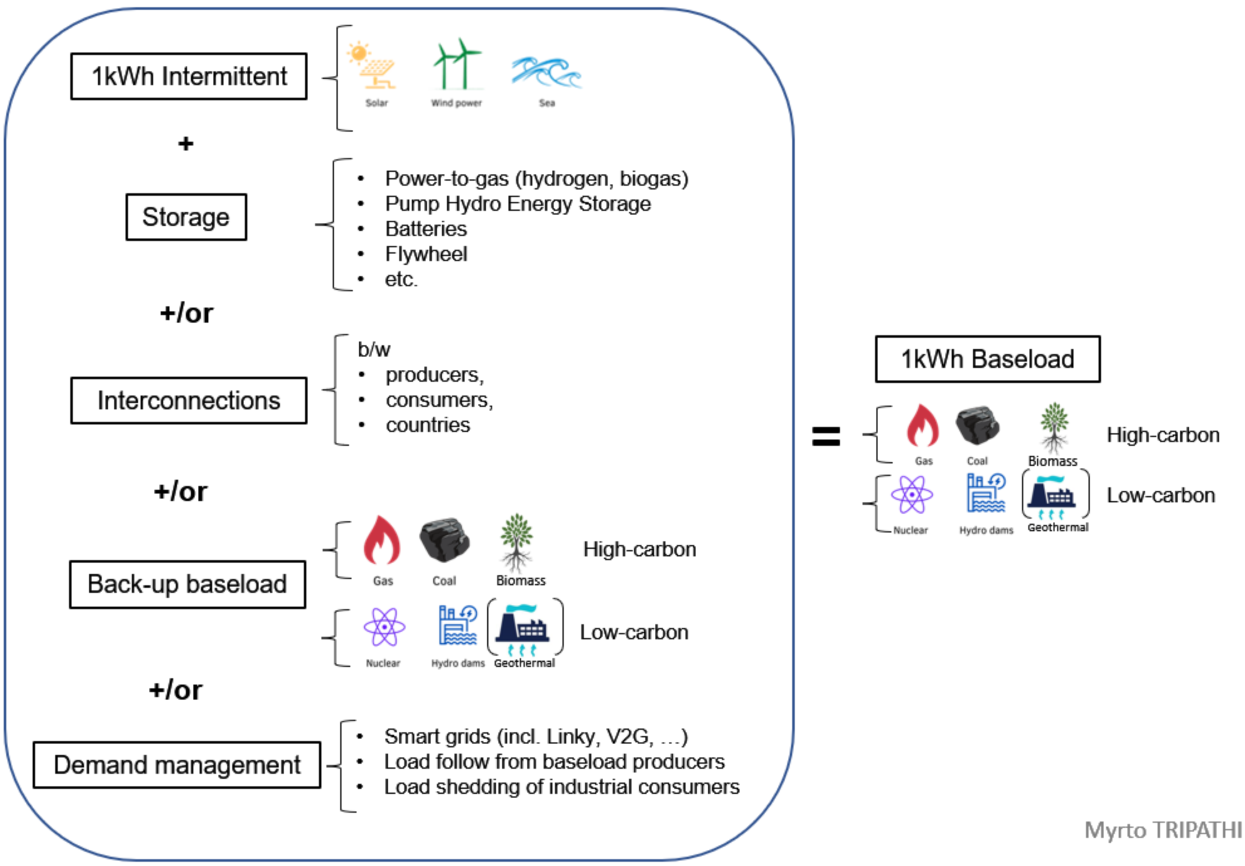
However, the electric system requires a moment-to-moment match of supply and demand. Therefore, as the penetration of intermittent generation rises, increasing amounts of storage becomes necessary to temporally match energy from *when* it is produced to *when* it needs to be consumed, as well as transmission to move electricity from *where* it is

[2] Denholm, P. et al. The challenges of achieving a 100% renewable electricity system in the United States. Joule, June 2021. https://doi.org/10.1016/j.joule.2021.03.028

generated to *where* it is consumed. Further, since storage can be depleted quickly, backup generation from dispatchable firm sources becomes necessary for reliability.

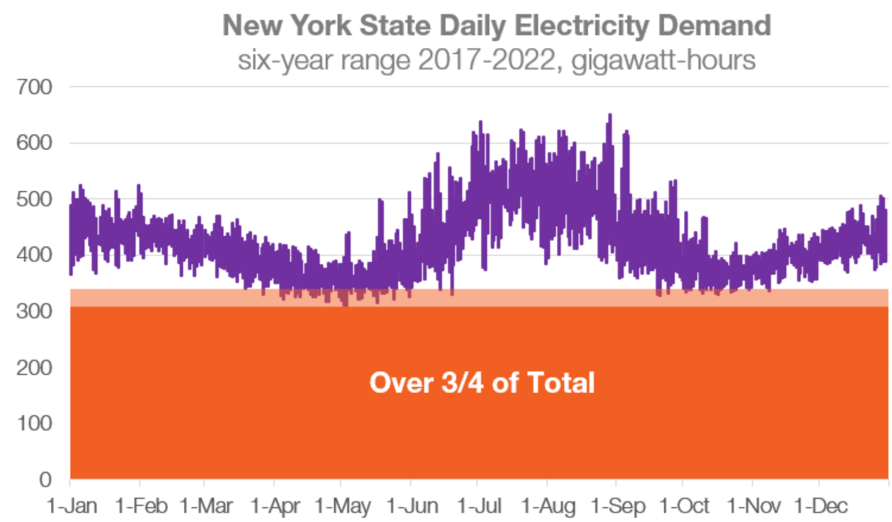
The complexity and cost of this additional support infrastructure can grow exponentially with higher levels of solar and wind penetration. As the grid is increasingly decarbonized, intermittent resources also become incrementally less valuable because they generate electricity at times when carbon-free generation is already in abundance.[3]

The distinct advantage of firm clean generation like nuclear and large-scale hydropower is that they can operate as little or as much as needed–regardless of the time of day or weather. However, nuclear energy is the only zero-emissions source of electricity that is inherently firm and also readily expandable in New York.

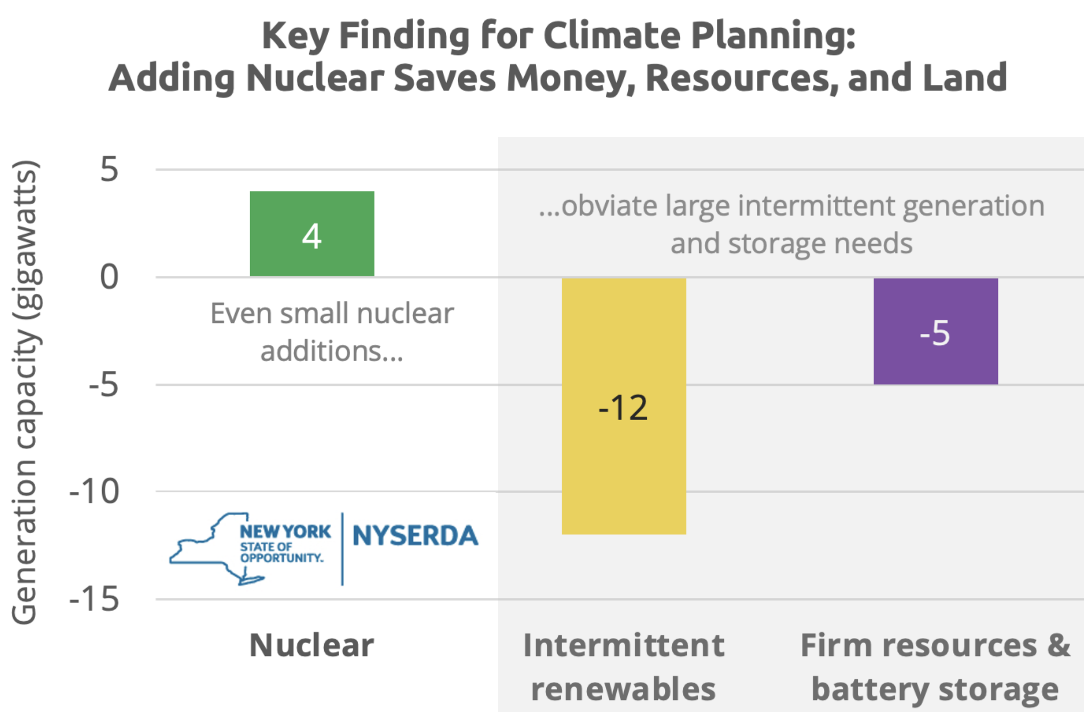


[3] Hirth, L. The market value of variable renewables: The effect of solar wind power variability on their relative price. Energy Economics 38 (2013) 218–236, February 2013. http://dx.doi.org/10.1016/j.eneco.2013.02.004

Over ¾ of New York's daily electric demand is steady over 365 days of the year. Nuclear power is ideally suited to meet this demand, optimizing installed capacity, providing system-level efficiency, and limiting the total cost to consumers. On the other hand, widely distributed low-capacity-factor intermittent resources like solar and wind require extensive storage, transmission, and backup generation to provide the same service.



Data Source: New York Independent System Operator OASIS



Source: **N**ew **Y**ork **S**tate **E**nergy **R**esearch and **D**evelopment **A**uthority Climate Action Council Meeting Presentation. November 2022

In its November 2022 presentation to the state Climate Action Council (CAC), the New York State Energy Research and Development Authority (NYSERDA) showed that adding new nuclear power could substantially reduce the *total* amount of installed generation capacity, transmission infrastructure, and storage, generating a large and sustained economic benefit.[4] Specifically, NYSERDA found that adding 4 gigawatts (GW) of nuclear generation would obviate the need for 12 GW of intermittent renewables plus 5 GW of dispatchable emissions free (DEFR) and battery storage.

This finding marks the beginning of necessary awareness essential to New York's Climate Leadership and Community Protection Act (CLCPA)'s success. It demonstrates the value of firm clean power not just as "backup" to intermittent generation, but as part of the "backbone" of a reliable, sustainable, and affordable grid. Moreover, by planning early for the inclusion of nuclear energy in the state's energy portfolio, instead of after ineffective investments have been made, New York can reduce the total costs of decarbonization.[5]

Firm clean nuclear power should be part of the backbone –not backup– of New York's future emissions-free energy system.

KEY POINTS

The specific answers to the Public Service Commission (PSC)'s questions follow. The most efficient and feasible route for New York to fully decarbonize its electric grid without compromising reliability will include:

- relicensing and maintaining existing nuclear power plants
- adding new reactors to existing nuclear plant sites
- transitioning old fossil fuel plant sites to nuclear
- improving transmission to receive electricity from new out-of-state nuclear plants that serve New York.

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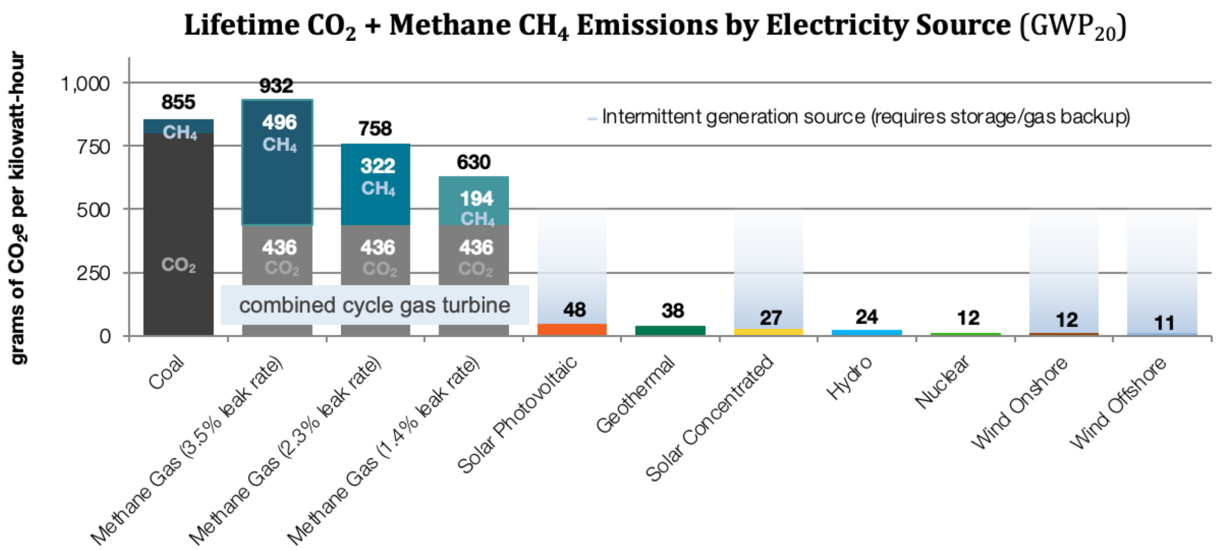
[4] New York State Climate Action Council. Meeting Presentation. Nov 2022 https://climate.ny.gov/-/media/project/climate/files/2022-11-07-CAC-Meeting-Presentation.pdf

[5] The Breakthrough Institute, "Advancing Nuclear Energy" July 2022. https://thebreakthrough.org/articles/advancing-nuclear-energy-report

1. How should the term "zero emissions," as used under PSL §66-p(2)(b), be defined?

No energy source has absolutely zero emissions when considering lifecycle emissions. It is therefore appropriate to interpret "zero emission" sources to mean near-zero emission sources. The figure below depicts lifecycle emissions for several forms of electricity. It is derived from modifying Intergovernmental Panel on Climate Change (IPCC) data to include the methane leaks associated with "natural" methane gas combustion for electricity. It uses New York's 20-year Global Warming Potential (GWP_{20}) standard.



Sources: UN IPCC, EDF, de Gouw et al., Howarth[6]

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[6] Intergovernmental Panel on Climate Change. Technology-specific Cost and Performance Parameters Annex III. Table A.III.2. 2014. https://www.ipcc.ch/site/assets/uploads/2018/02/ipcc_wg3_ar5_annex-iii.pdf#page=5
EDF Methane Science Brochure. 2018 https://www.edf.org/sites/default/files/EDF-Methane-Science-Brochure.pdf
de Gouw, Parrish, Frost & Trainer. Reduced emissions of CO2, NOx, and SO2 from U.S. power plants owing to switch from coal to natural gas with combined cycle technology. 2014. https://agupubs.onlinelibrary.wiley.com/doi/full/10.1002/2013EF000196
Howarth. Ideas and perspectives: is shale gas a major driver of recent increase in global atmospheric methane? 2019. https://www.biogeosciences.net/16/3033/2019

As visualized above, solar, wind, hydro, geothermal, and nuclear qualify as “zero-emission” sources pursuant to a “near-zero” metric. Significantly, the PSC already recognizes nuclear power as a “zero-emission” source with its Tier 3 Zero Emission Credit (ZEC) program. Likewise, all four scenarios identified by NYSERDA within the Climate Action Council’s adopted Scoping Plan include nuclear power as a contributor to the state’s 2040 goal of zero-emission electricity.

Due to the uncertainty of wood fuel-stock replacement, the length of time required for that fuel-stock to regrow and absorb carbon, and significant carbon emissions associated with its harvesting, biomass combustion should not be considered a zero or near-zero emission resource.

Beyond carbon dioxide, there are other emissions that should be avoided as well, either because they, too, contribute to global warming and/or because they are harmful to humans. Among these emissions are nitrogen oxides, hydrogen, particulate matter, and methane. For these reasons, electricity generation sources relying on biomass, renewable natural gas, hydrogen, and fossil fuels employing carbon capture and sequestration (CCS) need to be critically evaluated. Notably, co-pollutants associated with biomass combustion are about as harmful as those associated with coal, and fossil fuel combustion using CCS is not a perfect process. Methane leakage occurs at every lifecycle stage from the well-head to the power plant exhaust stack. CCS at the power plant exhaust stack is not 100% effective either. Typically, no more than 90% of combustion emissions can be captured using CCS.[7]

[7] MIT Climate Portal. How efficient is carbon capture and storage? February 2021. https://climate.mit.edu/ask-mit/how-efficient-carbon-capture-and-storage

2. Should the term "zero emissions" be construed to include some or all of the following types of resources, such as advanced nuclear (Gen III+ or Gen IV), long-duration storage, green hydrogen, renewable natural gas, carbon capture and sequestration, virtual power plants, distributed energy resources, or demand response resources? What other resource types should be included?

The appropriateness and applicability of various energy sources or technology types must be considered on their merits. Whether an energy source qualifies as "zero-emission" relates to its emissions, not the iteration of technology employed.

Since nuclear power plants have no fuel-based combustion emissions and have extremely low lifecycle emissions (less than or comparable to renewables), nuclear energy should be considered "zero-emission". This is true whether the technology is Generation II, III, III+, or IV. For example, New York's existing upstate reactors, which are already included in the Commission's Clean Energy Standard and NYSERDA scenarios within the Climate Action Council's Scoping Plan, represent Generation II technology.

Nuclear energy can be deployed quickly and at scale to meet the decarbonization targets of the CLCPA, as already shown by large-scale grid decarbonizations in France, Sweden, and Ontario. Key to this is a deployment program that builds on growing skills and experiences of the construction workforce.

Renewables including hydropower, wind, and solar may be characterized as zero-emission technology. Similarly, energy storage technologies including batteries, pumped hydro, low-carbon hydrogen (green or pink), and ammonia may be considered components of a "zero-emission" system if coupled with zero-emission generation. Synthetic methane gas and synthetic petroleum produced using zero-emission energy may be considered components of a "zero-emission" system as well, provided that carbon is removed from and returned to the atmosphere through a short-cycle process. Importantly, however, if systems involving renewables plus storage are incomplete because they still require firm carbon-intensive backup generation, or if significant amounts of support infrastructure with high lifecycle emissions are required, then the blanket characterization of renewables as "zero-emission" must be questioned.

As of now, no energy storage option, including hydrogen, has the necessary technological maturity, affordability, or scalability to back up a grid for extended periods of time.[8]

Demand response is not a technology, but instead a process by which demand profiles are modified to better correlate with electricity supply. Nor are the benefits of demand response limited to the zero-emission sources. For example, demand response can reduce the need for less-efficient generation from peaker plants that might otherwise operate during periods of peak demand. However, shifting demand does not eliminate the need for generation serving that demand. Thus "demand response" cannot *in-and-of-itself* be construed as zero-emission. It would certainly be beneficial for the Commission to develop programs that foster demand response. But it would not be appropriate for "demand response" to be allocated a zero-emission energy attribute as if it were an actual source of energy itself. Simply put, the metric for measuring the successful attainment of a zero-emission grid is the development of a system in which non-qualifying zero-emission sources are no longer used.

In its question, the Commission does not define "Virtual Power Plant". However, it may be assumed that this loosely refers to a collection of distributed generation and storage technologies that work together to emulate what might be considered the function of a power plant. As such, the zero-emission characteristics of such a collective system might be considered "zero-emission" if its component parts qualify as "zero-emission".

As previously discussed, CCS with fossil combustion can provide reliable electricity with low emissions at the power plant depending on the efficacy of the CCS technology employed. However, lifecycle emissions of imported methane are part of the CLCPA's accounting of statewide greenhouse gas emission. Thus, the Commission needs to evaluate the contribution of emissions due to methane leakage from fossil fuel extraction. If significant, this could preclude fossil fuel combustion with CCS from being considered "zero-emission."

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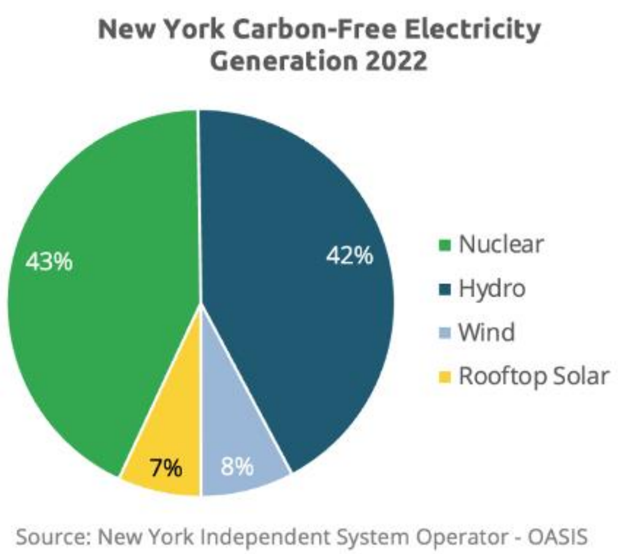
[8] Temple. The $2.5 trillion reason we can't rely on batteries to clean up the grid. *MIT Technology Review.* July 27, 2018. https://www.technologyreview.com/2018/07/27/141282/the-25-trillion-reason-we-cant-rely-on-batteries-to-clean-up-the-grid/

3. How should a program to achieve the Zero-Emission by 2040 Target address existing and newly constructed nuclear energy resources? Should the program be limited to specific types of nuclear energy technologies and exclude others?

A 2040 Zero-Emission program should include both existing and new nuclear, and should not be technology-limited. It should recognize the ongoing value of New York's existing reactors. Although existing nuclear plants are the cheapest form of carbon-free generation, they struggle in markets where less reliable forms of energy receive greater governmental support.[9] Therefore, it will be important that a future zero-emission program adequately value the important contributions that nuclear energy makes to grid reliability and resiliency, and towards reducing total system costs.



Today, New York's nuclear plants on Lake Ontario, with 3.3 GW capacity, are responsible for the largest share of the state's carbon-free electricity generation (43%). According to NYSERDA's Integration Analysis for the Climate Action Council's Scoping Plan, extending the licenses of these reactors will lower total system costs by $9 billion by 2050, and more in following decades.[10]

As extending the lifetime of existing functional reactors is shown to be the most economical method of continuing to limit greenhouse emissions, it will be essential to achieving the state's climate goals.[11]

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[9] Angwin. Shorting the Grid. 2020. https://www.meredithangwin.com/books/

[10] Appendix G of the draft scoping plan, Section I, page 75.

[11] OECE-NEA. The Economics of Long-term Operation of Nuclear Power Plants. 2022. https://www.oecd-nea.org/jcms/pl_14752/the-economics-of-long-term-operation-of-nuclear-power-plants?details=true

New nuclear generation, while making important contributions to grid reliability and resiliency, would save the state from land-intensive and material-intensive solar and wind, and reduce the need for storage, backup generation, and transmission. In NYSERDA's model, with conservative nuclear capital cost estimates[12], the addition of 4 GW advanced nuclear would save the state $1.1 billion by 2050, with additional savings accruing decades into the future.

By prematurely shutting down Indian Point and preventing the operation of the built Shoreham nuclear plant, New York created a regrettable history of succumbing to unwarranted fears about nuclear energy only to damage the health of downstate residents with emissions from less reliable and more expensive fossil generation.[13] This pattern must be broken. Nuclear energy is the only carbon-free, energy-dense technology that can be deployed at scale and in proximity to areas of high demand, reducing the need to expand long-distance transmission lines.[14] Further, nuclear's high capacity factor avoids the need for duplicative transmission and storage otherwise required to interconnect and support widely distributed, intermittent generation. In addition, nuclear energy can provide high-quality heat for industry and thermal networks, which will be important for CLCPA's 2050 economy-wide greenhouse gas reduction goals.

We urge the Commission to explore and incentivize investments in new nuclear energy and not discriminate against particular technologies:

- Large nuclear reactors (typically gigawatt-scale light water) can be added to new or existing sites upstate and downstate to provide firm clean electricity and valuable community benefits (jobs, taxes) for the hosting communities. Westinghouse's AP1000, GE-Hitachi's ESBWR, and KEPCO's APR1400 can be ordered today and deployed at scale.

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[12] MIT estimates the overnight capital cost for Vogtle 3 and 4 at $7,956/kW. It says the 'should cost' of the next AP1000 overnight capital cost in the USA to be $4,300/kW and $2,900/kW for the following 10th unit (online by around 2045), deployed in series, based on 2018 dollars. NYSERDA assumes "Low Cost Nuclear" to range between $6,000 to $5,000/kW. https://world-nuclear-news.org/Articles/AP1000-remains-attractive-option-for-US-market-say

[13] Nuclear New York. Indian Point. https://www.nuclearny.org/indian-point/

[14] Bryce. 47,300 Gigawatt-Miles From Nowhere. May 2023. https://robertbryce.substack.com/p/47300-gigawatt-miles-from-nowhere

- Small modular reactors (SMRs) are emerging as an option to provide grid service as individual units or banks of units with all of the benefits of existing larger reactors, as well as enhanced performance features such as fast-ramping response and thermal storage. SMRs are also ideally suited to provide grid-delivered electricity near demand centers or in behind-the-meter applications.
- Advanced nuclear reactors (including many SMR designs) can deliver process heat for industrial applications, which is of utmost importance to achieving New York's 2050 goal of deep decarbonization across all sectors.
- Nuclear energy, whether existing or advanced, is ideal for hydrogen production as heat and electricity from reactors can be used for around-the-clock hydrogen generation from water. This optimizes the use of available energy and maximizes the operational capacity of expensive electrolyzers.[15]

4. Should new measures adopted to pursue compliance with the Zero-Emission by 2040 Target focus exclusively on generation and resource adequacy, or should they also encompass a broader set of technologies that could be integrated into the transmission or distribution system segments, or installed and operated behind-the-meter?

The primary mission of the New York State Department of Public Service is to ensure affordable, safe, secure, and reliable access to electric, gas, steam, telecommunications, and water services for New York State's residential and business consumers, at just and reasonable rates, while protecting the natural environment.[16]

New York Independent System Operator (NYISO)'s latest Power Trends report, released in June (Power Trends 2023),[17] states "Electric supply from solar and wind resources is intermittent because those resources are dependent upon weather conditions and are unable to increase output to respond to changing system conditions." As intermittent

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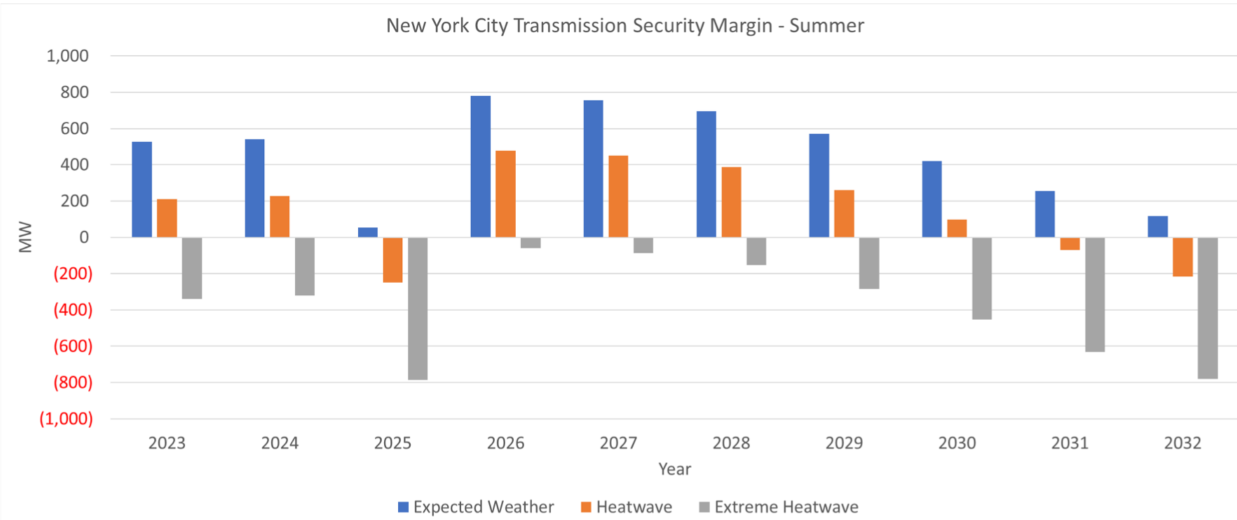
[15] Nuclear New York. Clean Hydrogen. https://www.nuclearny.org/clean-hydrogen/

[16] New York State Department of Public Service. About DPS and PSC. https://dps.ny.gov/about-us

[17] NYISO. Power Trends 2023: A Balanced Approach to a Clean and Reliable Grid. June 2023. https://www.nyiso.com/power-trends

resources increase electricity generation market share due to preferential treatment, government mandates, and/or market failures, more firm capacity needs to be installed as "backup." Further, these "backup" sources will rely more on capacity payments than on revenue from actual electricity generation.[9] This dynamic will increase costs to electricity customers, no matter how New York attempts to regulate resource adequacy.



Furthermore, in its Short-Term Assessment of Reliability: 2023 Quarter 1[18], NYISO found that New York City reliability margins may not be sufficient even for expected weather if:

I. the Champlain Hudson Power Express project experiences delays beyond 2026 completion,
II. forecast demand in NYC increases by as little as 60 MW in 2025, or
III. more generator deactivations beyond planned.

In 2025, the electric grid serving New York City will not have enough capacity to face a heatwave, when statewide average maximum temperature reaches 95 °F (1-in-10-year event). The NYC grid will fail during an extreme 98 °F sustained heatwave (1-in-100-year event) beginning in 2023. Under heatwaves or extreme heatwaves, the reliability margins from 2025 to 2032 are deficient for nearly half of the day.

[18] NYISO. Short-Term Assessment of Reliability: 2023 Quarter 1. April 14, 2023 https://www.nyiso.com/documents/20142/16004172/2023-Q1-STAR-Report-Final.pdf/

In response to the Climate Action Council's Draft Scoping Plan, the New York State Reliability Council stated "Operating a system largely based on renewable resources is not the same as operating the system of today. The performance and responsiveness of existing generation must be emulated to keep the lights on."[19]

Besides procurement of sufficient reliable generation capacity, utilities can improve resource adequacy via demand management and the deployment of behind-the-meter generation. Advances in remote monitoring and control technologies, such as smart meters and utility-controlled disconnection of high-energy uses can assist in demand management. However, these types of utility-administered programs ought to be structured on a voluntary basis, instead of infringing on customer choice.

We also urge the Commission to clarify that "statewide electrical demand system" includes behind-the-meter generation.[20] If this remains subject to interpretation, electricity customers concerned about rising prices and decreasing reliability might invest in their own behind-the-meter generators using high-emissions technologies, undermining the CLCPA's intent.

NYSERDA and New York Power Authority (NYPA) are already incentivizing and assisting electricity customers to deploy solar electricity generation behind-the-meter. We therefore urge the state to expand these types of programs by including behind-the-meter nuclear. Particularly for industrial applications, nuclear energy is ideal for cogeneration of reliable on-site zero-emissions electricity and process heat, while reducing strain on the outside grid and enhancing reliability within a microgrid configuration.[21] The Commission, in

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[19] New York State Reliability Council. NYSRC Comments on CAC's Draft Scoping Plan. June 22, 2022.
https://www.nysrc.org/PDF/NYSRC%20Comments%20on%20CAC%20Draft%20Scope%20Final%206-22-22.pdf

[20] "...by the year two thousand forty (collectively, the 'targets') the statewide electrical demand system will be zero emissions."
Casetext. N.Y. Pub. Serv. Law § 66-P https://casetext.com/statute/consolidated-laws-of-new-york/chapter-public-service/article-4-provisions-relating-to-gas-and-electric-corporations-regulation-of-price-of-gas-and-electricity/section-66-p-establishment-of-a-renewable-energy-program

[21] CNBC. Dow CEO Jim Fitterling on advanced nuclear reactor project in Texas. May 12, 2023.
https://www.cnbc.com/video/2023/05/12/dow-ceo-jim-fitterling-on-advanced-nuclear-reactor-project-in-texas.html

cooperation with other agencies, should evaluate this outstanding potential for behind-the-meter nuclear to serve industry while optimizing grid performance, reliability, and resilience.

5. Should any program to achieve the Zero-Emission by 2040 Target specify subcategories of energy resources based on particular characteristics, such as ramp rates, the duration of their operational availability, or their emissions profile with respect to local pollutants?

Reliability

Yes, the Commission's program should prioritize firm clean resources that provide greatest system-level value and the duration of operational availability. Power Trends 2023 warns:

[N]ew supply in total must provide reliability services comparable to departing supply so that, in aggregate, the grid remains reliable and resilient through this transition and beyond… As we move towards a zero-emissions grid, it is critical to understand how the growth of intermittent resources and extreme weather will impact the ability to maintain reliability of the New York electric system… The effect is that reliability margins have thinned to concerning levels, highlighting the need for a carefully coordinated and orderly transition to maintain grid reliability and resilience… A balanced and carefully planned transition from the power system of today to the clean-energy grid is essential to avoid the risks to reliability experienced recently in other areas of the United States.

Decarbonization modeling by the U.S. Department of Energy ("DOE Liftoff") shows that regardless of renewables deployment, a significant expansion of firm clean capacity will be needed to reach zero.[22] As we demonstrate below, optimizing the usage of that firm capacity is key to cost-effective decarbonization.

Likewise, NYISO's System & Outlook report[23] states:

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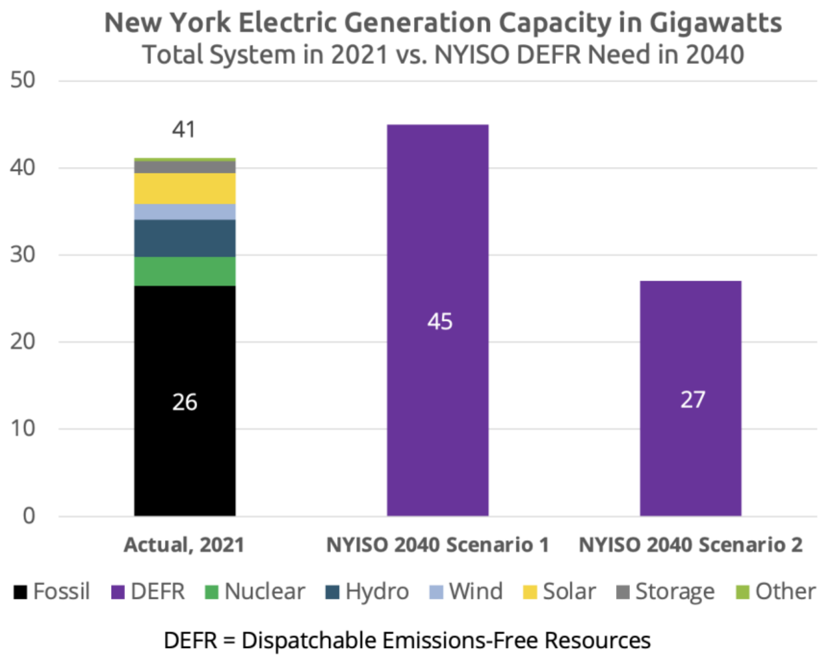
[22] US Department of Energy. Pathways to Commercial Liftoff: Advanced Nuclear. Washington, DC. 2023. https://liftoff.energy.gov/wp-content/uploads/2023/03/20230320-Liftoff-Advanced-Nuclear-vPUB.pdf

[23] NYISO. 2021-2040 System & Resource Outlook. September 2022.

To achieve an emission-free grid, dispatchable emission-free resources (DEFRs) must be developed and deployed throughout New York. DEFRs that provide sustained on-demand power and system stability will be essential to meeting policy objectives while maintaining a reliable electric grid... DEFRs will require committed public and private investment in research and development efforts to identify the most efficient and cost-effective technologies [for] eventual adoption of commercially viable resources.



Source: New York Independent System Operator 2021-2040 System & Reliability Outlook

According to NYISO, the amount of DEFRs that need deployment in a little over 16 years exceeds the sum of all New York's generation capacity (45 GW in NYISO Scenario 1) or all of fossil generation capacity (27 GW in NYISO Scenario 2). In selecting firm carbon-free resources, New York should seek the greatest benefit from this very large investment.

Tellingly, when NYISO's model allows for a "high capital low operating cost" DEFR (of unknown technology) with higher costs than what NYISO assumes for new nuclear energy, cost optimization still selects almost 4 GW of new capacity from such a "HcLo" resource to

https://www.nyiso.com/documents/20142/33384099/2021-2040-Outlook-Report.pdf run by 2040.[24,25] In contrast, NYISO's modeling shows little value in offshore wind, which dominates NYSERDA's Integration Analysis with a buildout target of 19 GW by 2050:

Offshore wind capacity buildout remains near the 9 GW policy objective through 2040 for both scenarios. This outcome results primarily from the assumed high capital cost of offshore wind technology in the model, which was the highest cost renewable technology available. Additionally, considering the declining marginal capacity reliability value curves assumed, offshore wind at the levels modeled is an inefficient resource to meet peak capacity needs and Locational Capacity Requirements because the capacity contribution of intermittent renewable resources declines as more are added to the system.

Regarding energy storage as a solution to intermittence of weather-dependent resources, Power Trends 2023 warns:

Energy Storage Resources offer great promise, but the amount of energy they can contribute to the grid, and the length of time they can perform, is limited today. By 2040, to achieve the mandates of the CLCPA, new emission-free generating technologies with the necessary reliability service attributes will be needed to replace the flexible, dispatchable capabilities of fossil fuel generation, and sustain production for extended periods of time. **Such emission-free technologies, either individually or in aggregate, are not yet available on a commercial scale.**

Power Trends 2023 further warns:

NYISO is obligated under its federally regulated tariffs to pursue solutions to resolve the reliability issue… Increasing levels of intermittent generation combined with increasing demand… are expected to result in **at least 17,000 MW of existing fossil-fueled**

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[24] NYISO. 2021-2040 System & Resource Outlook Data Document https://www.nyiso.com/documents/20142/32810936/2021-2040_System_Resource_Outlook_Data.xlsx/ Tab "Appendix F- 44&45"

[25] NYISO Economic Planning Department, Electric System Planning Working Group (ESPWG). System & Resource Outlook Update https://www.nyiso.com/documents/20142/27019028/ESPWG_System_Resource_Outlook_Update2.pdf/ Page 14

generating capacity which must be retained to continue to reliably serve forecasted "peak" demand days in 2030.

These sober observations by NYISO highlight a fundamental conflict between decarbonization scenarios identified within the state's Scoping Plan and measures that can and should be taken to make grid decarbonization a reality. As NYISO states, scalable DEFR technologies (hydrogen or other) capable of providing the 27 GW to 45 GW of high-capacity/low-capacity-factor service are not available. However, firm carbon-free generators capable of delivering reliable electricity with high-capacity/high-capacity-factor service are. In fact, they have existed for decades in the form of nuclear energy. New York's reliable and responsible climate plan should prioritize firm clean generation sources that maximize the effective use of installed capacity, not DEFRs.

The potential of certain firm resources is inherently constrained by their technology. For example, zero-emission generation using "green" hydrogen derived from solar and wind is intimately tied to the complexity and dynamics of the host grid. Generation using green hydrogen is "fuel-limited", meaning that its ability to deliver electricity when needed and for as long as needed relies on the amount hydrogen produced by the same intermittent resources that it seeks to back up.

Scenarios modeled by NYSERDA as part of its Integration Analysis for the state Scoping Plan suggest that DEFRs relying on green hydrogen might only be called upon about 3% of the time. However, those models are the product of a myriad sundry assumptions regarding the eventual buildout of renewables both in-state and out-of-state, the multi-state and real-time dynamics of electricity flow (imports and exports), and development of an entirely new infrastructure for hydrogen gas delivery and distribution.[26] NYSERDA's scenarios also contemplate a future in which 80% of electricity is eventually generated by solar and wind, even as demand doubles. Yet no large-scale grid on Earth has achieved anywhere close to this. Today, in all grids employing large amounts of solar and wind, firm generation (namely fossil gas) plays a much larger role in backing up those intermittent resources. Thus, in the

[26] New York Energy and Climate Advocates Comments on the CLCPA. January 2023. https://www.nuclearny.org/wp-content/uploads/2023/02/NYECA_testimony_on_CLCPA-2023.01.19.pdf

likely case that dispatchable firm resources in New York are needed more than 3% of the time for reliability, green hydrogen will fall short—perhaps far short. If New York were to rely mostly on hydrogen for DEFR generation, it is likely that fossil gas will remain a significant part of our electricity system.

Similarly, Renewable Natural Gas (RNG) is a constrained form of firm generation. Due to the limited supply of agricultural waste from which to produce it, RNG will not be able to meet more than a limited share of statewide electricity demand.[27] Because of this limited availability and all of the additional infrastructure necessary to accommodate it, firming up the state-wide grid with RNG is not advisable. Consuming biomethane where it is produced for on-site electricity generation or other applications is more practical.

New York will be in a much better position to achieve the CLCPA's goal of zero-emission electricity by prioritizing firm carbon-free resources capable of meeting demand whether they are needed a little or a lot. By focusing firm capacity on resources capable of serving not just as "backup" to intermittent generation, but as part of the "backbone" of an efficient grid, the state can substantially reduce the total amount of installed generation capacity required.

Nuclear energy is a reliable source of baseload power, and therefore ideally suited for this purpose. Incorporating new nuclear into New York's climate plan would also significantly reduce the amount of transmission and other infrastructure otherwise required to support solar and wind. **To achieve CLCPA goals while containing cost and ensuring system-level efficiency, the Commission should recognize and value reliable firm generation that can deliver electricity at a high capacity factor.** Indeed, this is the very effective role that nuclear power has played historically within New York and throughout the country. It is also largely why upstate New York already has a predominantly carbon-free grid.

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[27]New York State Energy Research and Development Authority (NYSERDA). 2021. "Potential of Renewable Natural Gas in New York State," NYSERDA Report Number 21-34. Prepared by ICF Resources, L.L.C., Fairfax, VA 22031. https://www.nyserda.ny.gov/-/media/Project/Nyserda/files/EDPPP/Energy-Prices/Energy-Statistics/RNGPotentialStudyforCAC10421.pdf

However, nuclear energy is not limited to baseload generation. Like other thermal plants, nuclear power plants are capable of gradual load following. In fact, in France where nuclear makes up 65% of generation, load-following is commonplace. Due to their enhanced flexibility, advanced small modular reactors will be even more suited for this.

To the extent that additional nuclear power is built in excess of that required for baseload or load-following generation, fast-ramping is also a desirable feature as a complement to intermittent solar and wind. Several types of advanced nuclear designs support fast ramping. For example, TerraPower's Natrium reactor with molten salt thermal storage will be capable of providing 345 MWe of continuous power, with fast-ramping peaking capability of up to 5.5 hours of 500 MWe.

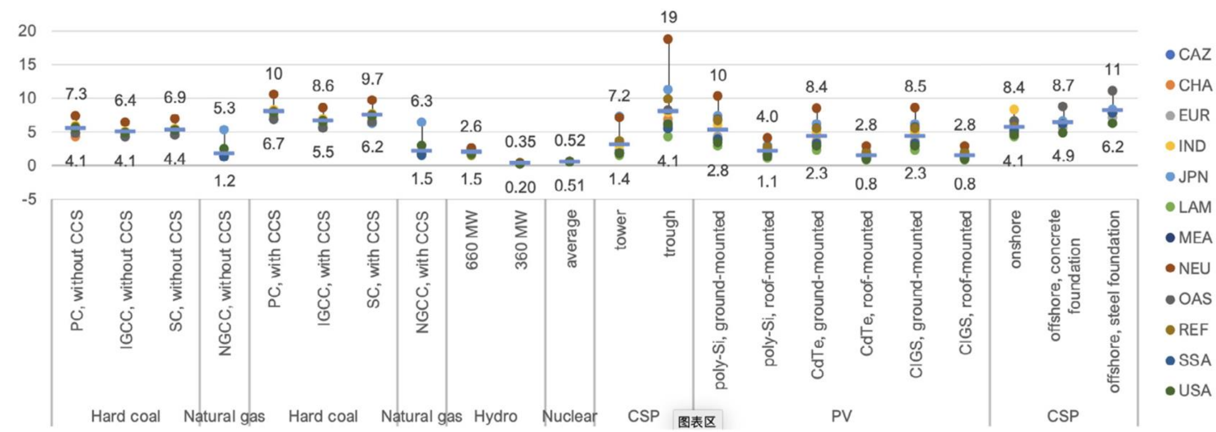
Health Impacts

In addition to prioritizing firm zero-emission sources based on performance, it is apt for the Commission to consider the impact of other harmful impacts, both local and remote. In this regard, nuclear energy has among the lowest human toxicity potentials of any energy source.[28] This can be attributed to the small amount of fuel and materials required, which results in less potential for exposure to toxic materials and processes, as well as the strict regulatory standards to which the nuclear industry adheres.

[28] United Nations Economic Commission for Europe. *Carbon Neutrality in the UNECE Region: Integrated Lifecycle Assessment of Electricity Sources*. March 2022. https://unece.org/sites/default/files/2022-04/LCA_3_FINAL%20March%202022.pdf

Lifecycle human toxicity potential, carcinogenic

in comparative toxic units per terawatt-hour, 2020



Source: United Nations Economic Commission for Europe

The low toxicity potential of nuclear energy is also consistent with the fact that nuclear power plants do not expose the public to significant amounts of radiation. In fact, according to data from the EPA, a person living near a nuclear plant experiences less than 1 mREM (0.01 mSev) of additional radiation annually.[29] This is far below differences in the normal level of background radiation experienced by just living in various parts of the country.[30] As the Joint Research Center of the European Commission, EU's highest scientific body, found in its taxonomy assessment of energy sources[31]:

[29] Radiation Sources and Doses https://www.epa.gov/radiation/radiation-sources-and-doses

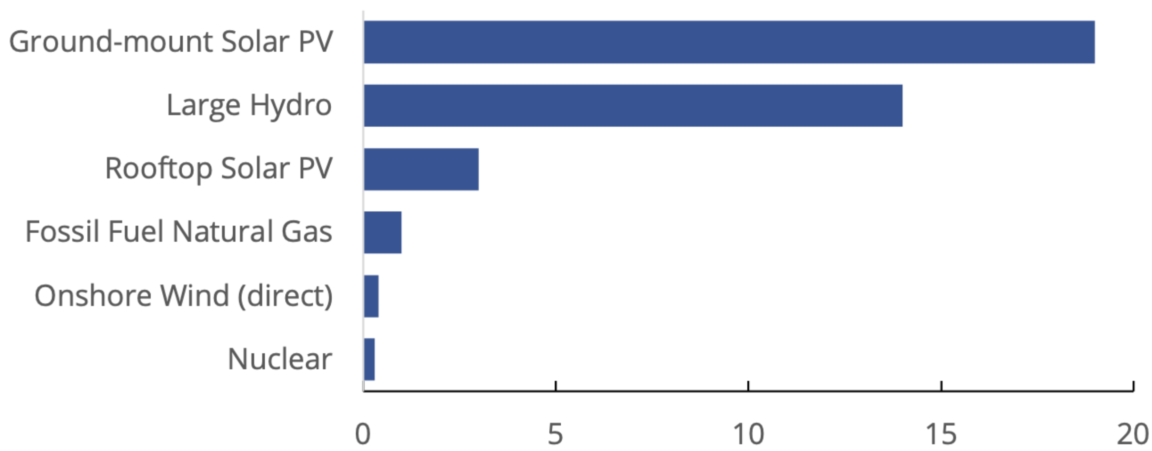
[30] For example, the average amount of naturally-occurring background radiation (cosmic, terrestrial, and indoor radon) received annually by a person is 278.3 mREM in New York, 523.1 mREM in Maryland, and 700.1 mREM in Colorado. The average annual dose of radiation received by a person in the U.S. from all sources is about 400 mREM, including but not limited to cosmic, terrestrial, indoor radon, and medical procedures.

Mauro, Briggs. Assessment of Variations in Radiation Exposure in the United States, US EPA, July 2005. https://www.nrc.gov/docs/ML1224/ML12240A227.pdf

[31] EU Joint Research Centre. March2021 https://snetp.eu/2021/04/07/jrc-concludes-nuclear-does-not-cause-significant-harm/

There is no science-based evidence that nuclear energy does more harm to human health or the environment than other electricity production technologies already included in the EU Taxonomy as activities supporting climate change mitigation.

Land Use

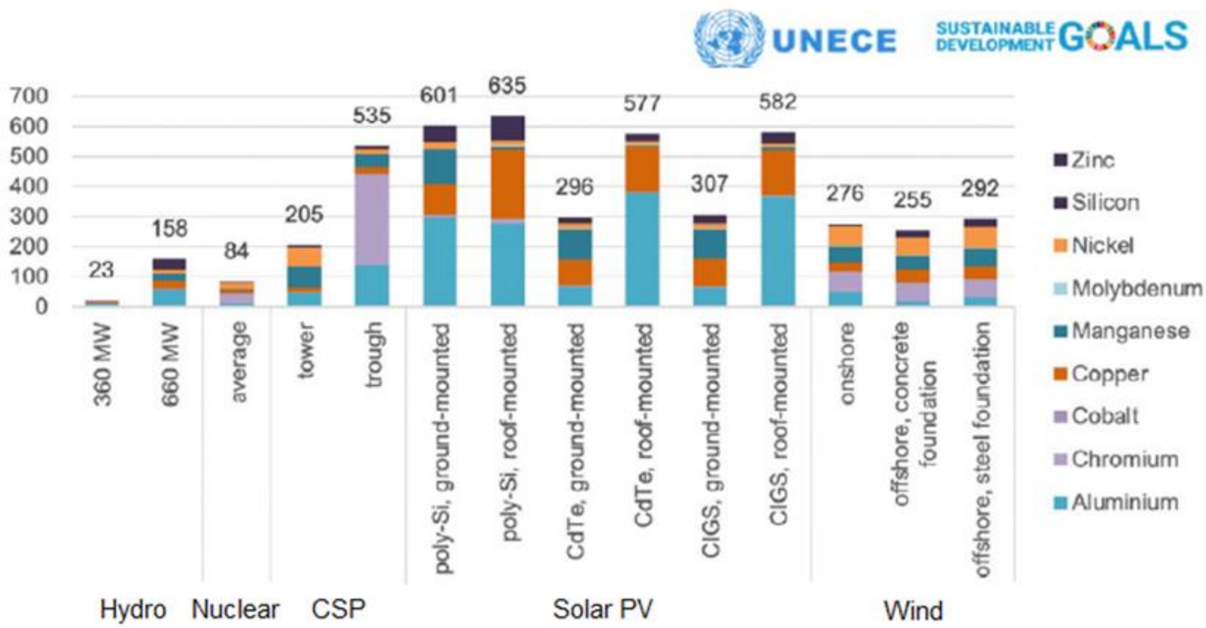


Average lifecycle land use in square meter-annum per megawatt-hour
UN ECE Integrated Life-cycle Assessment of Electricity Sources (2021), OurWorldinData.org

In addition, nuclear energy possesses several other advantages that justify the technology receiving priority over other carbon-free resources. Due to its very compact physical footprint, nuclear power helps New York conserve nature and farmland. For example, Indian Point occupied 240 acres of land and in 2019 generated 16.7 terawatt-hours of electricity (12% of statewide generation). Producing this much electricity with solar in a year would require industrial-scale projects totaling 9,675 MW, assuming an AC capacity factor of 20%. At six acres per megawatt, this would consume over 58,000 acres of land. This estimate does not consider the land for storage, nor account for losses associated with said storage. On the other hand, building 4 GW of additional nuclear power as contemplated by NYSERDA could save over 100,000 acres of farmland, forests, and wildlife habitat. Because of its very high energy density, nuclear energy also has a very small *lifecycle* land and material footprint.

Material Intensity

Select Material Use per Unit of Electricity by Source (kg/gigawatt-hours)

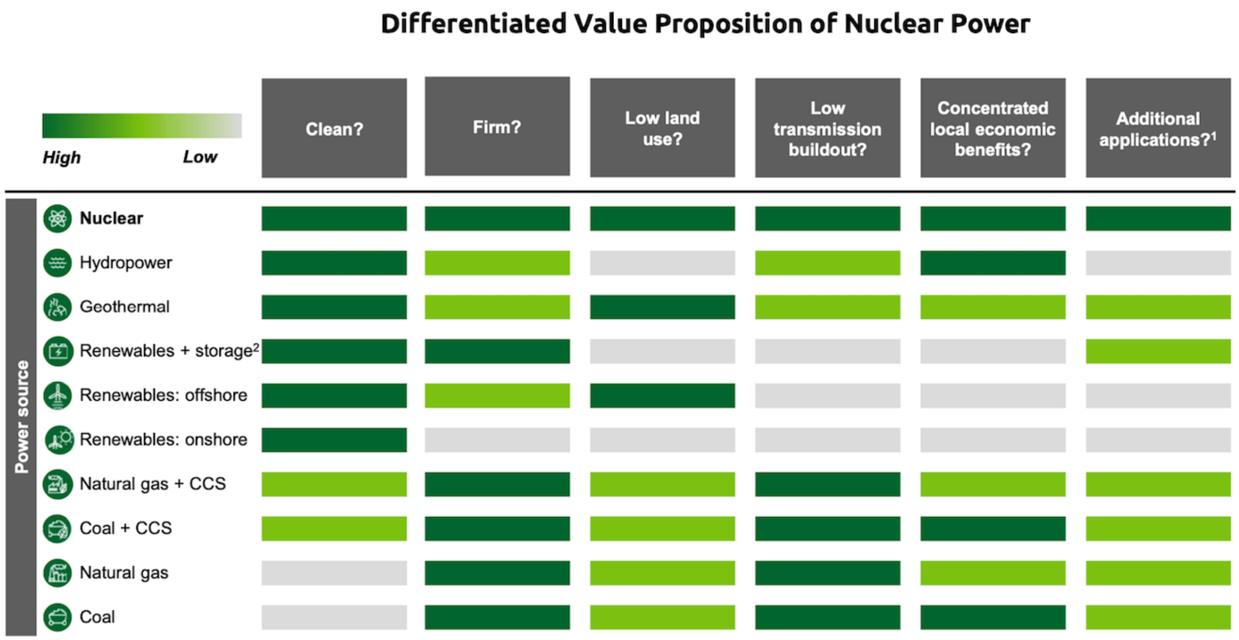


Source: UN Economic Commission for Europe (2022)

The amount of wire that must be installed to transmit electricity from a power source of given capacity is the same regardless of whether that power source operates a lot (high capacity factor) or a little (low capacity factor). Therefore, by optimizing the use of high-capacity-factor nuclear power plants that can be located in proximity to demand centers, nuclear energy can also dramatically reduce the amount of transmission required to create a functional, reliable, carbon-free grid.

Jobs

Nuclear power plants provide steady, high-wage jobs and economic benefits concentrated within communities fortunate enough to host them. In addition to electricity generation, other applications of zero-emission nuclear energy include the production of high-temperature heat for industrial applications, as well as the production of hydrogen or other synthetic fuels. The following is a summary by the Department of Energy of these benefits compared to other forms of energy.



Source: DOE Liftoff

6. What role does technology innovation need to play to meet the CLCPA's Zero-Emission by 2040 Target?

Technology innovation is important, but it is no substitute for credible system-level planning.

New York's grid today is composed primarily of infrastructure designed for energy-dense plants that can produce electricity as needed in a baseload or dispatchable configuration. These are powered by natural gas, nuclear, and hydro. It is not designed to rely on predominantly intermittent, energy-diffuse, low-capacity-factor sources that require extensive storage, transmission, and backup generation. Thus, the most feasible and least impactful method of decarbonization will involve solutions that require the least amount of modification to today's grid. This makes the expansion of firm nuclear energy, which is both scalable and carbon-free, the logical choice.

It is also important to recognize that the nuclear industry has dramatically innovated since the inception of nuclear power in the 1950s. This has led to modern reactor designs which have the ability to ramp up and down faster, use less fuel and create less waste or even recycle waste, and be built in small modular form.[32] Advanced nuclear designs build on half a century of engineering progress and incorporate different fuel forms, coolants, and barriers limiting the potential release of radioactive material beyond the site boundary. These inherent safety features, largely based on physics not systems, alter the siting constraints on advanced nuclear deployments. The Nuclear Regulatory Commission (NRC), the U.S. regulator, aims to incorporate "technology-inclusive, risk-informed, and performance-based criteria to assess population-related issues in siting advanced reactors." In August 2023, the Nuclear Regulatory Commission approved rules changes to allow advanced nuclear plants to make alternate emergency preparations.[33]

With its energy density being a fundamental advantage over other types of electricity generation, nuclear technology also has the highest potential to innovate beyond current applications.

Innovation is often not just technical in nature but also in financing, engineering, and deployment, leading to reduced costs. Such hopes for cost reductions through innovation can lead to disappointments, as recently shown with the filings by Sunrise Wind LLC[34], Beacon Wind LLC/Empire Offshore Wind LLC, and the Alliance for Clean Energy New York[35], Inc. on this docket (Case Number 15-E-0302) on June 7, 2023. All three petitions, asking for more money from New York ratepayers in response to perceived higher costs of building

[32] Cornell Law School. 42 U.S. Code § 16271 - Nuclear energy https://www.law.cornell.edu/uscode/text/42/16271

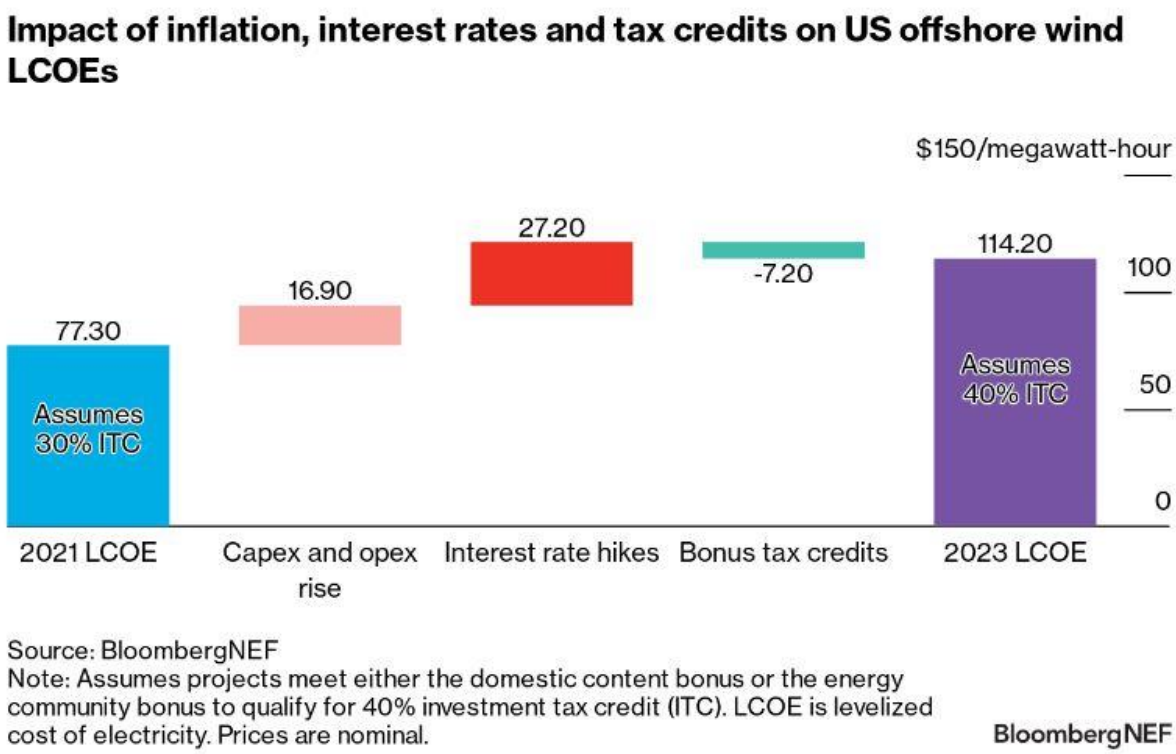
[33] Howland. August 2023. NRC approves emergency preparedness rule for small modular reactors

https://www.utilitydive.com/news/nrc-smr-emergency-preparedness-rule-small-modular-reactors/690871/

[34] Verified Petition of Sunrise Wind LLC for an Order Authorizing the New York State Energy Research and Development Authority to Amend the Offshore Wind Renewable Energy Certificate Purchase and Sale Agreement https://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId=%7b90E79688-0000-CC36-A816-67B1C2522CE8%7d

[35] Petition of the Alliance for Clean Energy New York to Address Post COVID-19 Impacts on Renewable Development Economics and Contract Considerations https://urldefense.com/v3/__https:/documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId=*7B909B9788-0000-C53F-9145-808CE763D4A1*7D__;JSU!!DUT_TFPxUQ!Baf8opLxdSOn__pfGuHymPisgipjpE6Ndvxa4IEGGTHyN6K251_z9zDPp87BYOjHiTvn7MWufFtQOIkxPV2dvg$

and operating renewable energy facilities, stand in contrast to predictions of cost decreases anticipated by NYSERDA in its Integration Analysis for the Scoping Plan, approved by the Climate Action Council last year.



Even after the federal government picking up 30% of the investment cost of offshore wind, Bloomberg expects offshore wind levelized cost of electricity (LCOE) to be $114 per megawatt-hour.[36]

While NYSERDA first solicited offshore wind energy in 2018, the developers have yet to secure as much as a single jack ship needed for offshore construction, and the PSC has only recently begun looking into the technical and financial challenges of accepting and integrating the electricity from these projects into the downstate grid.

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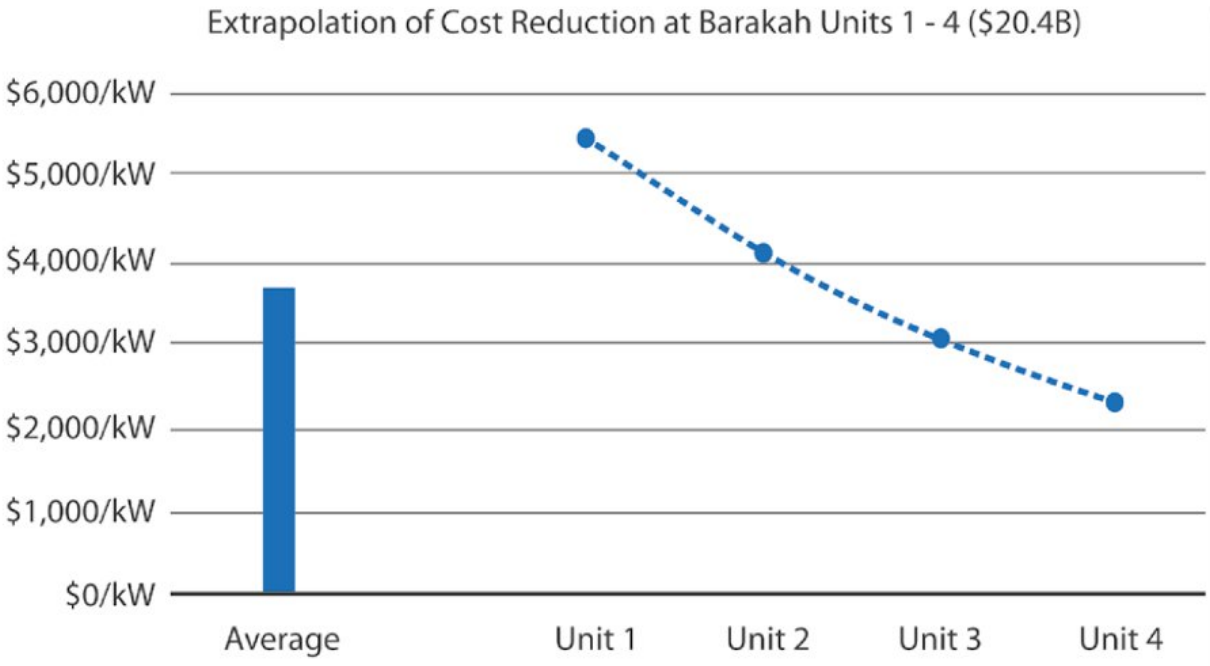
[36] Jain. Soaring Costs Stress US Offshore Wind Companies, Ruin Margins. BloombergNEF. August 2023 https://about.bnef.com/blog/soaring-costs-stress-us-offshore-wind-companies-ruin-margins/

Figure 9: The cost reductions from one reactor to the next were significant at the UAE's Barakah nuclear power plant project.



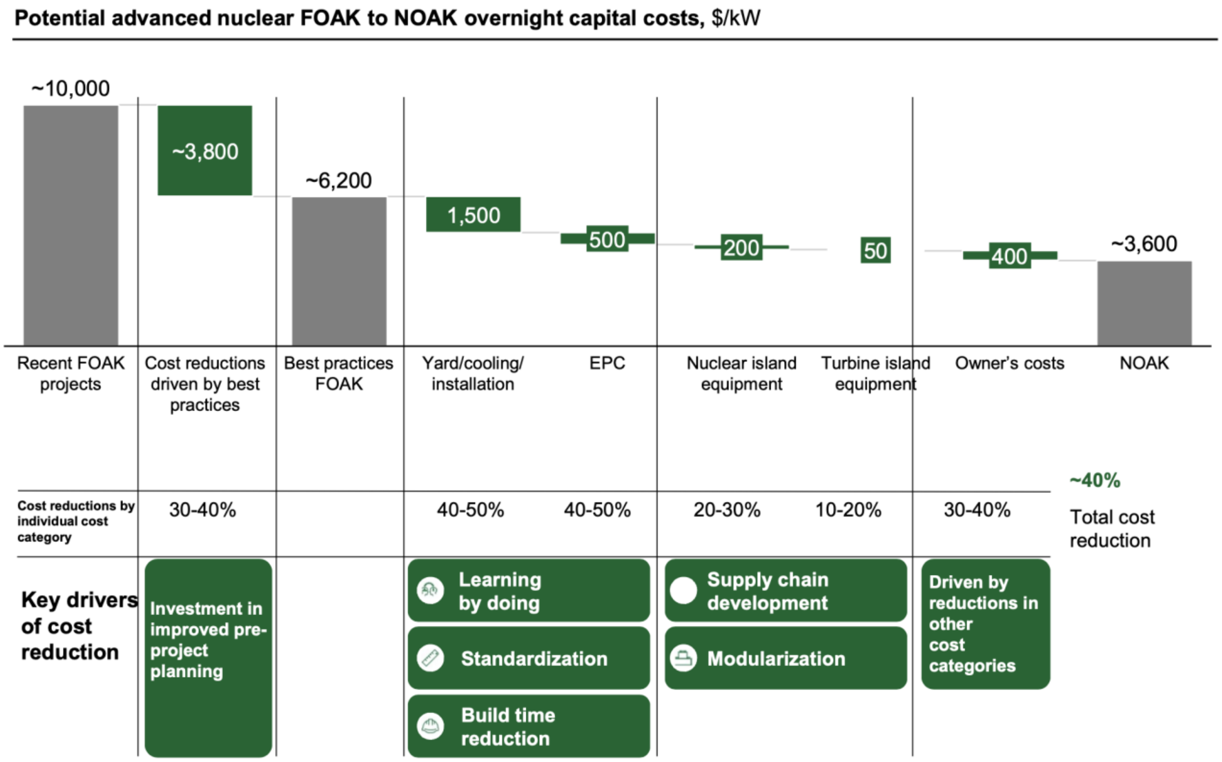
Source: One Billion Tons[37]

The new AP1000 reactors at Vogtle 3 and 4 as examples of cost overruns with nuclear energy. In fact, however, these reactors are the exception to the rule, as successful deployments of the same reactor in China and the deployment of four South-Korean-made APR1400 reactors in the United Arab Emirates clearly demonstrate that nuclear energy can be built on time and on budget. “Innovation” materialized in the growing experience and skills of a local workforce, leading to significant cost declines from reactor to reactor:[38]

Similarly, New York could take advantage of skills and experiences gained by the American workforce that recently completed construction of Vogtle 3 and 4. This way, New York can tap right into a learning curve that allows the state to build new nuclear reactors rapidly and on budget.

[37] Think Atom. One Billion Tons. 2021 https://www.onebilliontons.org

[38] Think Atom Ltd. One Billion Tons. 2022. https://www.onebilliontons.org/



Source: DOE Liftoff

7. Should life cycle emissions impacts be considered when characterizing energy resources? If so, how?

Yes. Life-cycle emissions of individual sources should be considered, as detailed in answers to questions 1 and 2. This includes embedded lifecycle emissions associated with manufacturing, materials and material transport, lifetime operation, and disposal. As previously discussed, according to the IPCC, nuclear energy has among the lowest emissions profiles of any energy source when total life-cycle impacts are taken into account.

However, we also wish to emphasize that the Commission should address the aggregate life-cycle emissions profile of technology combinations required to create a functional system. For example, if fossil methane gas is necessary to complement intermittent solar, the combined emissions from both should be taken into account.

Likewise, the emissions profile of the input energy (in batteries, as manufactured hydrogen, or other) is equal to the profile of the energy that was stored plus the emissions during its operation. This is in addition to the prorated allocation of emissions associated with construction of the storage device. For instance, if electrical energy is stored using hydrogen electrolysis and later released through a fuel cell, the energy loss during those power-to-gas (P2G) and gas-to-power (G2P) conversions need to be factored in. The maximum theoretical full-cycle power-to-gas-to-power (P2G2P) efficiency is about 50%.[39] So for input electricity with an emission profile of 250 grams CO_2e per kilowatt-hour (g/kWh), the output electricity would have an emissions profile of over 500 g/kWh, as the embodied emissions of the machinery and operational emissions need to be factored in.

A final factor affecting a true accounting of lifecycle emissions is the need for excess capacity that is only rarely if ever used but required to guarantee system reliability. Most, if not all emissions associated with "near-zero emissions" energy sources result from the raw materials, manufacturing, and the deployment of the facilities, irrespective of how often the provided capacity is actually needed. For example, any system relying solely on solar and wind energy will balance the need for (expensive) storage with overbuilding solar and wind capacity. Therefore, any evaluation of technologies that requires an "overbuilding" of capacity should incorporate those emissions instead of relying solely on textbook specific emissions per unit of energy generated.

8. Given that the feedstocks and other resources required to produce renewable natural gas are limited and will be in demand in other sectors of New York's economy, how should this fuel be considered in the context of this proceeding?

This is a valid concern. As discussed in our answer to question 5, renewable natural gas (RNG) derived from agricultural waste (biomethane) may be a source of "firm" energy. However, it is a highly "fuel-constrained" firm resource. Thus, relying on RNG for grid-delivered electricity generation is imprudent. A more effective application for biomethane

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[39] Forsberg. Addressing the low carbon million-gigawatt energy storage challenge. The Electricity Journal. October 10, 2021 https://www.sciencedirect.com/science/article/pii/S1040619021001330

will be for the on-site powering of machinery or the local generation of electricity for on-site consumption.

Notably, as with fossil natural gas, producing electricity from biomethane or RNG using combustion also produces nitrogen oxides (NO_x). Therefore, fuel-cell technology may be required to qualify it as a zero-emission source for electricity generation.

Furthermore, only biological waste streams should be considered as feedstock for the production of renewable natural gas. New York should not repeat the mistake of Germany, where misguided policies and government subsidies led to the cultivation of feedstock crops, mostly corn, for biomethane fermentation. The result has been a displacement of food production crops and the wasteful consumption of land, further exacerbated by the use of diesel fuel to cultivate, harvest, and transport crops for energy production, along with fossil-based fertilizers and chemical pesticides. In total, Germany dedicates about 13.5% of its total arable land[40] to the production of biomethane feedstocks, yet biomethane contributes just 2.7% to the nation's use of primary energy.[41]

9. In what ways might a program to meet the Zero-Emission by 2040 Target require reexamination and possibly revision of different tiers of the Clean Energy Standard? Should one or more of the policy approaches that have been used to implement the CES be considered to meet the Zero-Emission by 2040 Target?

New York currently supports zero-emissions energy sources through the Commission's Clean Energy Standard (CES): Renewable Energy Credit (REC) and Zero-Emissions Credit (ZEC) tiers of the CES, and dedicated programs such as for offshore wind. However, anyone interested in adding new nuclear capacity, indispensable for New York reaching its 2040

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[40] Anbaufläche von Energiepflanzen in Deutschland nach Art in den Jahren 2007 bis 2021 https://de.statista.com/statistik/daten/studie/153072/umfrage/anbauflaeche-von-energiepflanzen-in-deutschland-nach-sorten-seit-2007/ and Daten und Fakten 2000 https://www.bmel.de/SharedDocs/Downloads/DE/Broschueren/daten-fakten-2022.pdf?__blob=publicationFile&v=8

[41] Erzeugung von Primärenergie aus Biogas in Deutschland in den Jahren 2008 bis 2020 https://de.statista.com/statistik/daten/studie/198617/umfrage/erzeugung-von-primaerenergie-aus-biogas-in-deutschland/

goal of 100% zero-emissions generation, currently finds no incentive to do so from the State. This is despite the fact that nuclear energy reduces system cost and offers multiple grid benefits not provided by solar and wind.

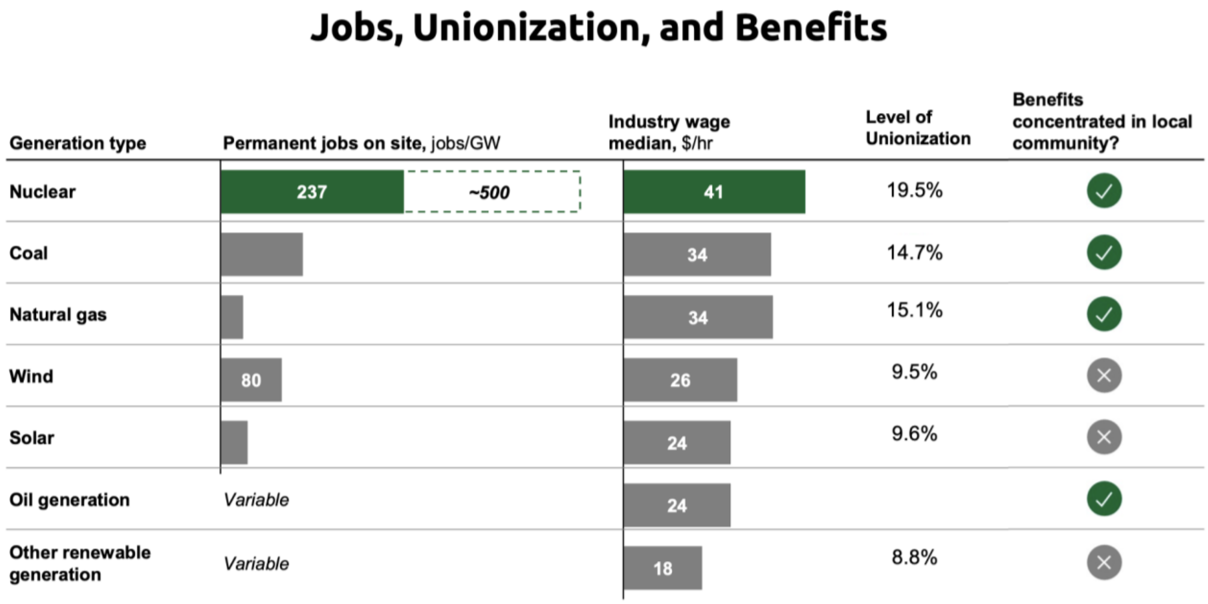
We urge the Commission to revise the existing Clean Energy Standard to create incentives for new nuclear energy facilities, which provide electricity that is as clean as renewables, and to properly value the additional reliability benefits of those facilities. Such incentives should include both grid-connected and behind-the-meter nuclear applications.

Notably, the CLCPA's goal of satisfying 70% of electricity demand with sources defined as "renewable" is an interim goal that applies specifically in the year 2030. After 2030, there is no numerical requirement within the law for how much of the state's electricity must come from renewables. Therefore, the Commission should consider broadening the applicability of the Tier 1, 2, and 4 programs to be inclusive of all zero-emission sources beyond 2030, instead of limiting those programs to sources branded as "renewable."

As previously discussed, firm carbon-free capacity is essential to achieving a zero-emission grid and ensuring reliability of a system involving intermittent generation. However, currently the CES provides no mechanism for recognizing the additional system-level value that firm carbon-free generation provides to a functional grid. We therefore recommend that the Commission establish a tier or tiers specifically designed to recognize this critical attribute of system reliability and procure the 27 to 45 GW of firm generation that NYISO deems necessary. In this value stack, firm carbon-free sources that are not limited by how long they can operate will be most useful, and therefore should receive highest priority.

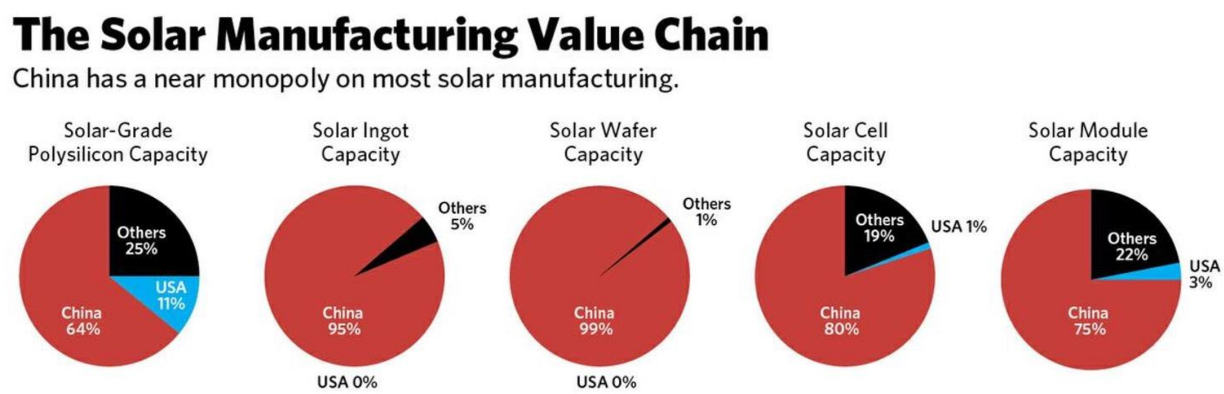
10. What is necessary to align a program to meet the Zero-Emission by 2040 Target with the priority of just transition embedded within the CLCPA?

For a clean energy transition to be successful, it must be advantageous for the workers responsible for delivering it. That means quality of work and wages of current fossil fuel workers must be maintained or improved upon. New jobs should be able to build and sustain communities, with equal opportunities for all New Yorkers in diverse and desirable careers. The electricians, welders, pipe fitters, millwrights, and boilermakers who keep our lights on and our homes comfortable have earned the right to a prosperous life.



Sources: DOE Liftoff, U.S. Energy Employment and Jobs Report[42]

Our ability to create a just transition is inseparable from technology choice, with each scalable power generation option having a better or worse potential to create high-quality, community-building, uplifting jobs that power domestic supply chains.



Source: REC Solar[43]

Industrial solar and wind facilities are not concentrated revenue sources for host communities as a whole, even if a few large landowners can collect rent for allowing such

[42] U.S. Department of Energy. U.S. Energy & Employment Jobs Report (USEER) https://www.energy.gov/policy/us-energy-employment-jobs-report-useer

[43] REC Solar https://recsilicon.com/

facilities to be constructed on their land. With commodified manufacturing largely offshored to China, more than half of the domestic jobs in solar are in installation and construction, transient and temporary jobs that provide only short-term economic benefits to local communities. After construction and installation, wind and solar installations are virtually workerless facilities with few hands-on operational requirements, generating limited value and capacity-building potential to local communities.

On the other hand, nuclear energy is a strategic sector with an almost entirely domestic material supply chain. Nuclear power plants provide well-paying jobs that enable vibrant, healthy, and prosperous host communities. New York's three operating nuclear plants support 25,000 jobs, contribute over $3 billion to New York's economy and generate $144 million state and local taxes annually.[44] Nuclear energy is produced with high-skilled labor, its largest expense aside from capital costs. Nuclear plants are bustling facilities with abundant year-round work for skilled tradespeople, STEM professionals, healthcare professionals, and more. Multi-generational employment at nuclear power plants ensures steady tax revenues enriching local communities.

In fact, nuclear energy offers the highest pay of all electricity generation sectors. Nationally, nuclear generation median wages are over 20% better than fossil generation, and 60-70% better than offered by solar and wind industries.[41] A few years ago, the average annual payroll of over 2,100 employees at New York's nuclear plants exceeded $113,000.[45] The U.S. nuclear sector is also heavily unionized, with over a dozen unions representing tens of thousands of workers.

We cannot wish our way to high wages, union membership, and other positive concessions for social and labor justice. These arise from the ability of highly skilled workers to organize and win concessions from management in bargaining. These opportunities abound at nuclear power plants, but are largely absent at solar and wind facilities erected by lower-skilled construction and installation workers.[46]

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[44] Upstate Energy Jobs https://upstateenergyjobs.com/nuclear-facts/

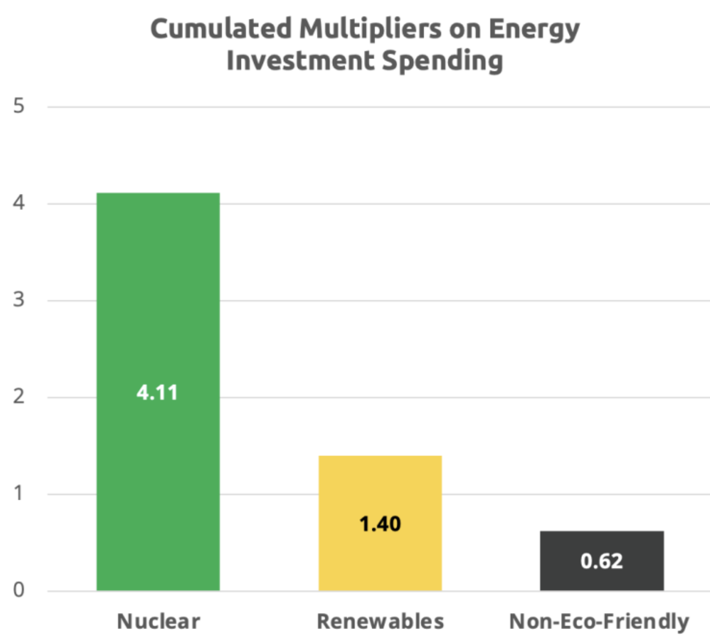
[45] The Nuclear Decommissioning Collaborative https://decommissioningcollaborative.org/

[46] Scheiber. Building Solar Farms May Not Build the Middle Class. *New York Times.* July 2021. https://www.nytimes.com/2021/07/16/business/economy/green-energy-jobs-economy.html

11. How might the benefits of a program to meet the Zero-Emission by 2040 Target be measured for the purpose of ensuring that, consistent with PSL §66-p(7), it delivers "substantial benefits" to Disadvantaged Communities?

Nuclear energy benefits disadvantaged communities by creating well paid, high-quality work and by ensuring reliable, clean, and affordable energy.

As previously discussed, nuclear is a rare strategic sector with an almost entirely domestic supply chain and workforce. According to research by the IMF, nuclear has the largest economic multiplier effect of any energy technology.[47] With this platform technology, New York can have the abundant, reliable energy necessary to attract and retain industry, create a clean energy revolution, and support sustaining middle-class jobs.[48]

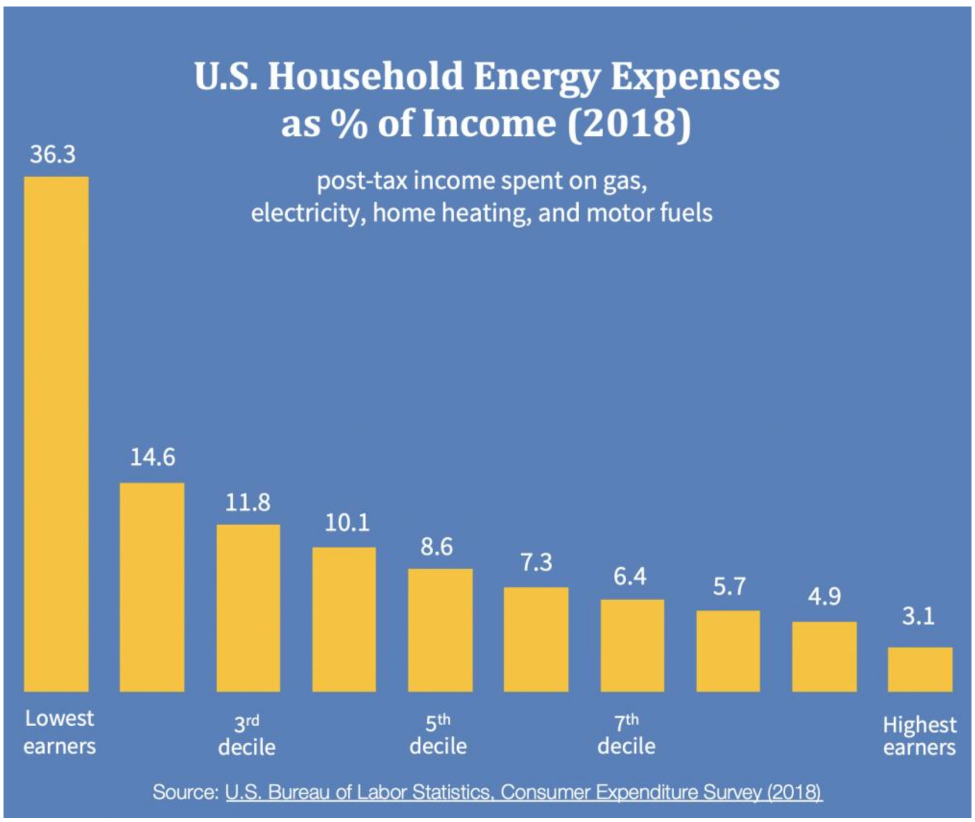


Furthermore, the low operational costs of existing nuclear power plants and system-level advantages of adding new nuclear plants help to ensure energy affordability, benefiting

[47] Batini, Di Serio, Fragetta, Melina, and Waldron, "Building Back Better: How Big Are Green Spending Multipliers?" *International Monetary Fund.* 2021. https://www.imf.org/-/media/Files/Publications/WP/2021/English/wpiea2021087-print-pdf.ashx

[48] Nuclear New York letter to NYS Joint Legislative Budget Committees Re: Testimony in Joint Legislative Budget Hearing on Environmental Conservation, February 14, 2023 https://www.nuclearny.org/wp-content/uploads/2023/02/NNY-Joint_Budget_Hearings-Feb_2023.pdf

disadvantaged communities the most. Surveys by the federal Bureau of Labor Management show that the burden of energy expenditures is highest for the lowest earners, reaching over 36% of post-tax personal income for the poorest decile.[49] On the other hand, the highest earners spend only a little over 3% of income on gas, electricity, home heating, and motor fuels. While the rich can afford to have their own backup power when the grid fails, this is not a luxury available to the poor.[50] Not only is incentivizing an electricity system that is reliable, affordable, and sustainable consistent with mandates of the Department of Public Services, it is also the best way to provide "substantial benefits" to all Disadvantaged Communities.



[49] Bureau of Labor Management. Consumer Expenditures in 2018. May 2020. https://www.bls.gov/opub/reports/consumer-expenditures/2018/home.htm

[50] Bryce. What's Good For Generac Is Bad For America. Forbes. February 2022. https://www.forbes.com/sites/robertbryce/2022/02/10/whats-good-for-generac-is-bad-for-america/

12. NYISO has adopted an effective load carrying capacity (ELCC) rubric and treatment of Zones J and K as load pockets with special resource adequacy requirements. How should these constructs and other NYISO market rules inform design of a program meant to support the development and deployment of resources capable of achieving a zero emissions grid?

Effective Load Carry Capacity (ELCC) is a statistical estimate of a generating resource's ability to produce energy when the grid is most likely to experience electricity shortfalls.[51] Expressed as a percentage of a resource's capacity, ELCC calculations depend on the type of technology being studied, patterns in electricity usage, and the type and quantity of other resources already on the grid.

As Robert Idel states in "Levelized Full System Costs of Electricity" (LFSCOE), which assumes that each source of generation has to meet the full electricity demand over a given year (with the help of storage):[52]

Once the share of intermittent generation increases to a certain level (and dispatchable capacity is shut down), efforts have to be taken to maintain system reliability. But who should be responsible for these costs? How can the cost of integrating renewables into the system (which increases significantly with their market share) be included in the evaluation of their cost?

In its latest iteration of its "Levelized Cost of Energy" study, Lazard identified the cost of firming intermittency as a necessary inclusion within the popular metric.[53] As seen below, in many instances, the "firming" cost exceeds the cost of the deployed wind and solar facilities. Firming costs in California (CAISO) is 3.5x the cost of solar and 1.7x the cost of wind.

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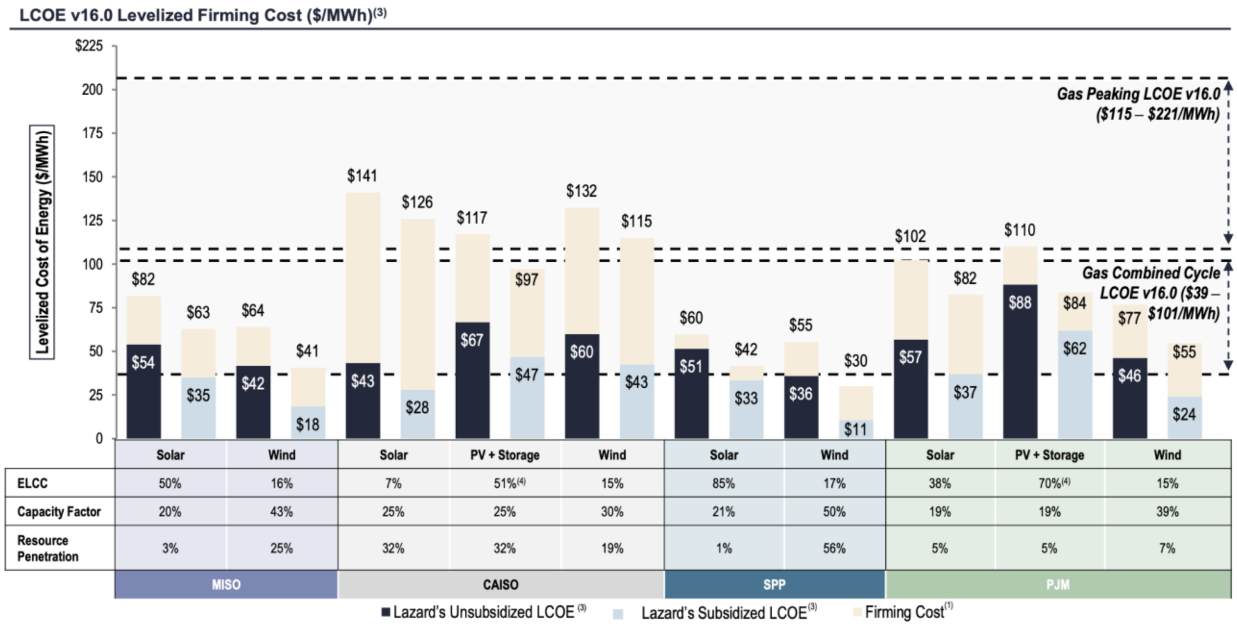
[51] Specht. ELCC Explained: The Critical Renewable Energy Concept You've Never Heard Of.

The Union of Concerned Scientists. October 12, 2020 https://blog.ucsusa.org/mark-specht/elcc-explained-the-critical-renewable-energy-concept-youve-never-heard-of/

[52] Idel, R. Levelized Full System Costs of Electricity. Energy 259 (2022) 124905. 2022. https://doi.org/10.1016/j.energy.2022.124905

[53] Lazard. 2023 Levelized Cost Of Energy+. April 2023. https://www.lazard.com/research-insights/2023-levelized-cost-of-energyplus/

Levelized Cost of Energy Comparison—Cost of Firming Intermittency (Lazard, 2023)



Idel finds that "LFSCOE of wind and solar in Germany and Texas are higher than the most expensive dispatchable technology. Even a storage cost reduction of 90% is insufficient to make wind/solar competitive on a LFSCOE basis."

The incremental cost to firm up intermittent resources varies regionally, depending on ELCC values in the particular region. ELCC varies with the relative penetration of intermittent generation, which means that ELCC can also change over time as the grid portfolio changes.

Importantly, there is an emissions cost to firming up intermittent resources on the grid. A National Bureau of Economic Research study of solar and wind deployment across 26 OECD countries between 1990 and 2013 found that, all other things equal, more renewable sources were installed in those countries with fast-reacting fossil fuel plants available to compensate for supply variability.[54] A one percentage point increase in the share of rapidly responding fossil generation capacity in a country is associated, on average, with a 0.88 percentage point increase in the long-run share of renewable energy. Not only does this

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[54] NBER, A Role for Fossil Fuels in Renewable Energy Diffusion. *The Digest: No. 10*, October 2016 https://www.nber.org/digest/oct16/role-fossil-fuels-renewable-energy-diffusion

ensure carbon lock-in by relying on fossil fuel plants, it incentivizes the least-efficient type of fossil gas plants: simple-cycle peakers with fast ramping capability.[9]

As part of its analysis, the Commission should include costs and emissions associated with the firming of intermittent resources based on current and projected ELCC levels within each of NYISO's New York Control Area Zone.

13. What additional studies, if any, should the Commission undertake with respect to the development and deployment of resources capable of achieving a zero emissions grid?

- **System-level feasibility and costs of an electric grid with zero-emission nuclear as part of the backbone of New York's electric system**

Although all four of the scenarios evaluated in NYSERDA's Integration Analysis supporting the state's Scoping Plan assume the relicensing of New York's upstate reactors, they neglect the potential for any additional nuclear power. Instead, those four decarbonization pathways (which are very similar to each other) rely overwhelmingly on solar and wind, requiring a large installed capacity, large amounts of battery storage, and DEFRs.

Many recent technology-neutral, cost-optimized studies demonstrate that deep decarbonization strategies which invest in nuclear energy can yield substantial benefits of reliability, reduced system-level costs, and conservation of natural resources over those that rely predominantly on intermittent generation.[5,22,55,56,57] Several such studies were also cited by clean energy and labor interests in comments on the state's draft Scoping Plan in 2022.

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[55] Princeton University. Net-Zero America. October 2021 https://netzeroamerica.princeton.edu/the-report

[56] Vibrant Clean Energy. Role of Electricity Produced by Advanced Nuclear Technologies. June 2022 https://www.vibrantcleanenergy.com/wp-content/uploads/2022/06/VCE-NEI-17June2022.pdf

[57] Pacific Northwest National Laboratory. Scenarios of Nuclear Energy Use in the United States in the 21st Century. April 2023. https://www.pnnl.gov/publications/scenarios-nuclear-energy-use-united-states-21st-century

Responding to this, in November 2022, NYSERDA briefly presented information to the Climate Action Council on the possibility of deploying advanced nuclear energy.[58] Advanced nuclear was also briefly mentioned in the text of the adopted Scoping Plan. However, state agencies have not conducted a thorough comparative analysis of how additional high-capacity-factor nuclear energy can contribute to New York's energy portfolio, giving fair, equal, and objective consideration to scenarios based on a comprehensive professional review of system-level performance, feasibility, and cost.

With growing awareness of the vital role nuclear energy must play to accomplish deep decarbonization, states throughout the country and nations around the world are revisiting the technology. New York should not be left behind. The Commission should expand upon NYSERDA's initial work by performing an in-depth evaluation of how advanced nuclear energy can contribute to the state's future energy portfolio. Rather than simply considering firm carbon-free generation as "backup" to intermittent solar and wind, the Commission should explore scenarios for expanding the existing and proven role of nuclear as a reliable source of baseload power—part of the "backbone" of a reliable and efficient grid that optimizes installed capacity.

We recommend that the Commission evaluate scenarios in which advanced nuclear power is deployed in the early 2030's, potentially satisfying 50% or more of total electricity demand by mid-century. In addition, the Commission should explore how nuclear energy can contribute to statewide greenhouse gas reduction goals by providing behind-the-meter electricity for dedicated applications, high temperature heat for industry, and facilitating the production of synthetic fuels and hydrogen or ammonia.

- **Evaluation of underlying assumptions and feasibility associated with NYSERDA and NYISO models**

In performing its Integration Analysis which modeled scenarios included in the CAC Scoping Plan, NYSERDA had to make numerous assumptions on future conditions, the deployment

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[58] Nuclear New York. Advocates for Sound Climate and Energy Policy Praise New York for Proposing Nuclear Power. November 14, 2022 https://www.nuclearny.org/press-release-advocates-for-sound-climate-and-energy-policy-praise-new-york-for-proposing-nuclear-power/

and distribution of resources, and the interaction of various affecting operations of the grid. Many of those assumptions and the results they produced have been questioned in comments on the draft plan[1,26], or cited as concerns by NYISO. Among these are:

- The questionable capacity factor of intermittent resources to be deployed in and out of state. For example, NYSERDA power and energy predictions for imported wind (over 6 GW), indicate an average capacity factor of 44%, only possible if imported wind is located almost entirely offshore.
- Impacts of degradation affecting capacity factor and the reliability of deployed resources, including renewable generation and storage, and the ongoing expense of maintaining non-resilient resources.
- Dependency on the widespread expansion and enhancement of interconnection transmission pathways between subregions of the state and between New York and out-of-state resources. Departing from real-world conditions in California and elsewhere that large-scale renewables have been deployed, NYSERDA’s models assume zero curtailment of intermittent sources.
- The questionable real-time availability of imported electricity from weather-dependent wind and solar sources in neighboring states which are likely to experience a surplus or dearth of electricity coinciding with conditions in New York.
- The questionable existence of a market to receive excess renewable electricity from New York when neighboring states are likely to experience supply and demand profiles which also coincide with conditions in New York.
- The feasibility and practicality of developing hydrogen-based generation capacity and accompanying infrastructure for DEFR resources that receive limited use. NYSERDA contemplates construction of 21 GW to 26 GW of capacity, using dedicated hydrogen-consuming generators which operate at a capacity factor of about 3%. This is in addition to hydrogen storage within large underground caverns, 400 miles of new hydrogen-grade pipeline, and an unspecified amount of electrolyzer equipment. NYSERDA also assumes that half of all hydrogen for electricity generation in New York will be produced out of state.

- The extent to which incremental increases in electricity generation from intermittent sources may not translate to corresponding reductions in fossil fuel consumption if building a system with higher penetration of intermittent generation results in more efficient combined-cycle gas plants being replaced with faster ramping, but less-efficient, simple-cycle peaker plants.

Compounding these concerns, substantial differences exist between NYERDA's Integration Analysis and modeling performed by NYISO. Within its "Climate Change Impact and Resilience Study–Phase II" report, NYISO estimated that a decarbonization strategy focused on intermittent generation would require more installed capacity (solar + wind + storage + DEFR) by 2040 than contemplated by NYSERDA's four scenarios in 2050.[59] Significantly, NYISO also projects the need for 27 GW to 45 GW of DEFR by 2040.

The Commission should conduct its own studies to analyze these significant issues and discrepancies, and to assess the feasibility of various decarbonization strategies. As part of this evaluation, sensitivity analyses should be performed to understand how vulnerable those strategies are to the variables and assumptions involved, as well as consequences of that sensitivity. In conjunction with our previous recommendation for a study of scenarios that embrace additional nuclear, this constitutes due diligence essential to meaningfully inform decisions regarding future programs and policy.

- **Evaluate the ability of neighboring grids to underwrite the reliability and sustainability of the electricity system of New York ("Battery on Paper")**

In all four scenarios modeled in its Integration analysis, NYSERDA estimates that about 14,000 GWh of electricity will be imported and exported across the New York state line in 2040—a flow of energy corresponding to about 5% of total demand. Significantly, 14,000 GWh is roughly three times the total amount of actual storage (batteries and pumped-hydro) that NYSERDA prescribes in its four scenarios. This operation functions as a "battery

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[59] Analysis Group, *Climate Change Impact and Resilience Study - Phase II*, NYISO, September 2020. https://www.nyiso.com/documents/20142/10773574/NYISO-Climate-Impact-Study-Phase-2-Report.pdf

on paper" to store excess generation from New York, and allows New York to draw down when needed. New York will not be able to benefit from such a **"battery on paper"** if neighboring states do not have electricity to spare when New York is short, or absorb excess generation when New York is long.

Further, 14,000 GWh represents a three-fold increase in electricity flow between New York and its neighbors compared to today. This is in *addition* to the importation of electricity from out-of-state wind and hydropower identified by NYSERDA in its Integration Analysis.

The Commission should evaluate how much actual storage would be needed without this "battery on paper" that relies on imported electricity, and how this would affect the amount of additional carbon-free generation required in New York.

What generation sources need to be deployed by New York's neighbors to ensure this grid balancing function? Could this scheme call on polluting fossil fuel power plants to serve New York demand? Would it lock in the ongoing operation of fossil fuel power plants on either side of New York's border long into the future?

The Commission should clarify whether such an exchange of dirty electricity is legally consistent with the CLCPA mandates that 100% of New York electricity demand be served by load serving entities that produce zero-emissions. In Power Trends 2023, NYISO cites research by the North America Reliable Energy Corporation (NERC):

NERC's 2023 Summer Reliability Assessment identifies reduced supply reserve margins in regions neighboring the NYISO in its risk analysis. These reduced margins potentially limit the ability to import electricity from neighboring regions, putting greater importance on available supply and transmission within New York.

- **Conflict between the CLCPA's 2030 goal and zero-emission goal**

The CLCPA's mandate of a zero-emission grid by 2040 is preceded by the legislation's 2030 interim goal that 70% of electricity generation come from renewables. However, the best paths toward achieving these two goals do not necessarily overlap. A real danger exists that unless steps necessary to meet the state's goal of zero-emission electricity receive adequate attention now, then actions taken in the near-term to meet the 2030 goal—

absent forethought regarding system-level needs of a future zero-emission grid—could render the state's 2040 goal infeasible or prohibitively expensive.

Cost-optimization models have shown that while the addition of solar and wind resources can achieve *moderate* decarbonization, deep decarbonization requires the deployment of significant nuclear energy resources, depending on various factors:

[S]olar photovoltaics and wind power can provide less costly bulk electricity, substituting for natural gas or other dispatchable generation, in moderate electricity decarbonization scenarios. However, in deeply decarbonized scenarios, in which emissions from fossil fuel-based generation sources are substantially limited, solar and wind alone cannot cost effectively provide reliable power due to weather variability and high electricity storage costs.[60]

For New York, this could mean that "70% renewable" electricity by 2030 comprises wind and solar capacities that are too large for a cost-optimized path towards the 2040 goal. This could lead to higher costs for the deployment of firm generation, including nuclear, on an unrealistically short timeline. Moreover, undue emphasis on intermittent generation to the detriment of carbon-free baseload could lead to development of a grid architecture that locks in fossil fuels for reliability.

The Commission should undertake an analysis of actions needed within the next seven years to optimize a path toward the 2030 renewable goal while facilitating, not jeopardizing, the 2040 goal. It should also quantify the magnitude of the costs that achieving the interim 2030 goal entail and offer legislators information guiding a possible correction of the specific definition of the 2030 goal to better align with the 2040 goal of grid decarbonization leading the way to the 2050 goal of economy-wide decarbonization.

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[60] Lei Duan, Robert Petroski, Lowell Wood & Ken Caldeira. Stylized least-cost analysis of flexible nuclear power in deeply decarbonized electricity systems considering wind and solar resources worldwide. *Nature Energy*, February 2022 https://www.nature.com/articles/s41560-022-00979-x

- **Risk of expanding behind-the-meter generation undermining CLCPA goals**

With growing uncertainty about the reliability and cost of grid-based electricity, many consumers, particularly large industrial ones, are likely to invest in their own behind-the-meter generation. While this could have a beneficial effect of reducing burden on the existing grid and potentially enhance resiliency through the development of microgrids, the emissions from such behind-the-meter generation could undermine the spirit of New York's climate law.

The Commission should clarify that behind-the-meter electricity generation falls under 2030 and 2040 mandates of the CLCPA within its jurisdiction. (See response to Question 1.) The potential drivers and volume of this shift to behind-the-meter generation should be studied. Likewise, the Commission should evaluate steps needed to effectively regulate this component of electricity generation.

14. Given that New York is not the only jurisdiction investigating options and opportunities for the research, development, and deployment of new technologies capable of achieving a zero emissions grid, how should the State seek to coordinate with and otherwise draw upon efforts that are underway elsewhere?

NYSERDA is coordinating with seven northeastern states to build a Clean Hydrogen Hub[61]. Similarly, New York should help aggregate demand for nuclear energy with other states to ensure that learning is shared and unit costs are brought down with programmatic deployment.

The federal government is incentivizing nuclear, with ground-breaking occurring right now for some (like Natrium's Gen IV reactor this thermal storage). Likewise, the Westinghouse AP1000 is an advanced Gen III+ reactor operating in the U.S. and China. Most importantly, the completed project at Vogtle created an experienced, domestic construction workforce

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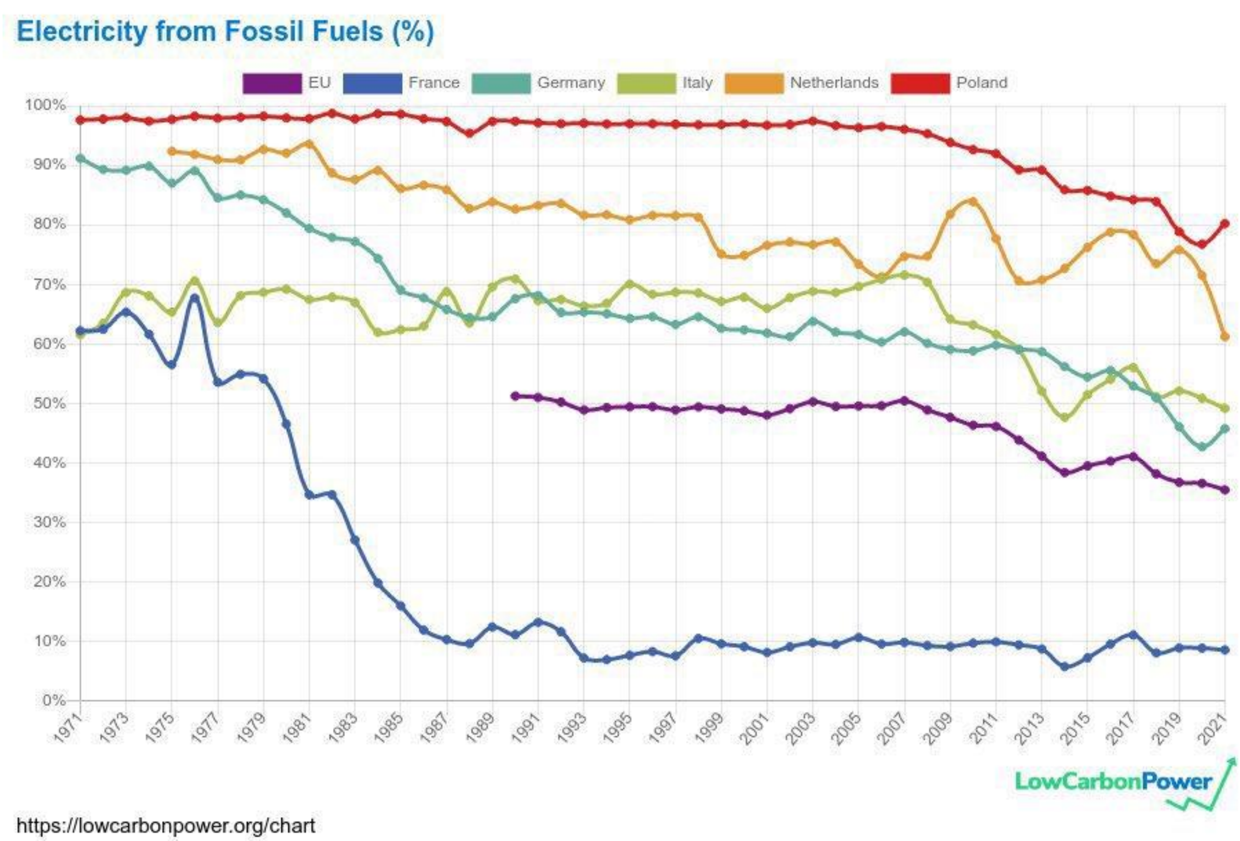
[61]NYSERDA. Seven States in NE Regional Clean Hydrogen Hub Announce DOE Proposal for Funding and Designation as a National Hub. April 7, 2023 https://www.nyserda.ny.gov/About/Newsroom/2023-Announcements/2023-4-7-Seven-States-in-Northeast-Regional-Clean-Hydrogen-Hub

and supply chain that is ready to build more. New York should seize this opportunity and reap the benefits of this regained nuclear reactor building capacity.

Other states are embarking on the next generation of nuclear energy:

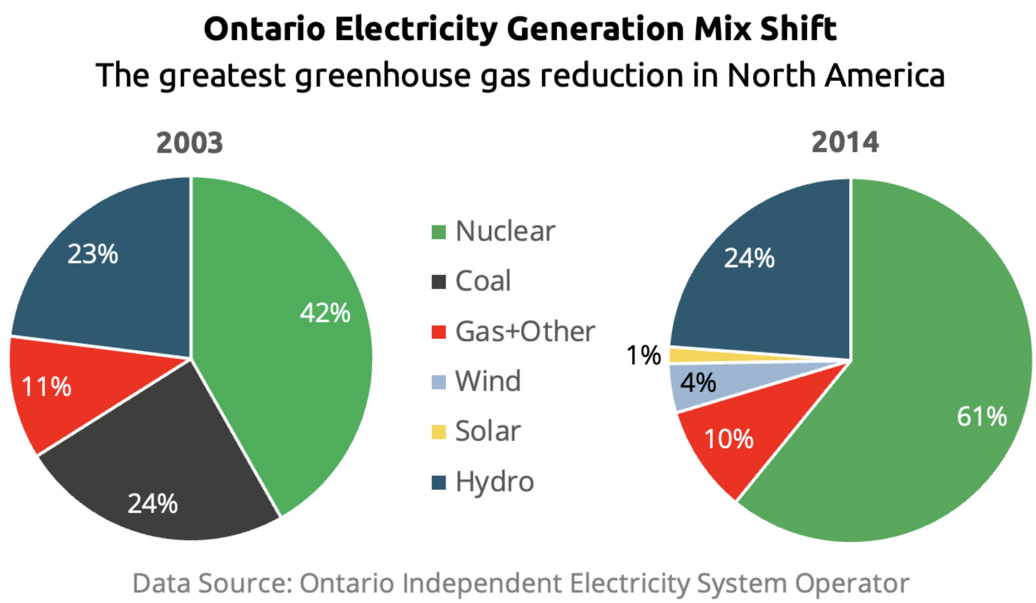
- Ohio has committed to host two Oklo microreactors.
- The Tennessee Valley Authority (TVA) is preparing a construction permit application for a GE-Hitachi BWRX-300 near Oak Ridge, Tennessee, and is considering other sites in its service area for SMRs.
- Texas will be home to X-Energy's first pebble-bed reactor, which will provide not just electricity but also high heat for a Dow industrial plant
- Wyoming is about to begin construction of TerraPower's sodium cooled Natrium reactor with revolutionary thermal storage
- Idaho is hosting NuScale's first small modular reactor construction.
- Washington State and Energy Northwest have agreed to deploy 12 X-Energy pebble bed reactors



New York should join in these efforts and contribute to the momentum that is building for a reliable and affordable decarbonized future enabled by nuclear energy.

Importantly, New York should also learn from successes and failures elsewhere. France largely decarbonized its grid with nuclear power in fifteen years, and now receives 70% of its electricity from this low-carbon source.[62]

The greatest greenhouse gas reduction in North America was Ontario's coal phaseout. Ninety percent of the power needed for this real-world energy transition was provided by nuclear power.



Jurisdictions that have invested heavily in wind and solar while ignoring or shutting down nuclear capacity have experienced significant increases in the cost of electricity. Electricity in Germany is twice as expensive as in France, even though French electricity is nearly eight times as clean. Despite half-a-trillion Euros investment in renewables, Germany received a third of its electricity from coal and lignite in 2022, and is opening new coal mines and

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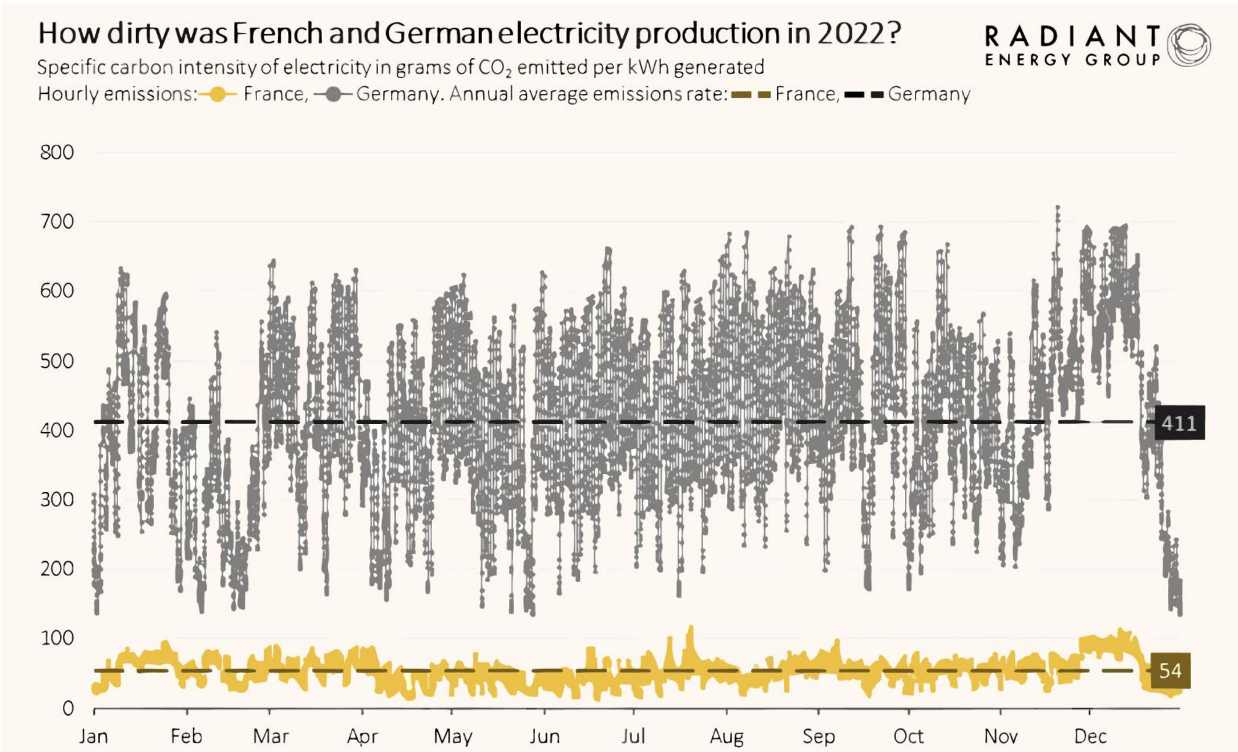
[62] World Nuclear Association. Nuclear Power in France. July 2023. https://www.world-nuclear.org/information-library/country-profiles/countries-a-f/france.aspx

power plants in 2023.[63] New York must avoid Germany's path of deindustrialization due to shutting down nuclear plants and making energy expensive.[64,65]

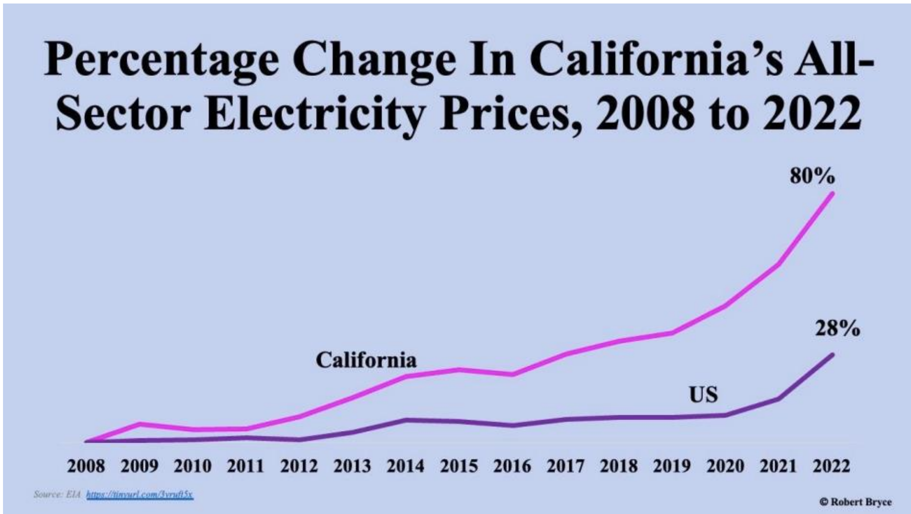


[63] Taylor. Despite Protests, a German Coal Mine Expands. *The Atlantic.* January 2023. https://www.theatlantic.com/photo/2023/01/luetzerath-protests-german-coal-mine-expands/672696/

[64] Lights. Will We Learn from the Deindustrialization of Germany? *Human Progress.* February 28, 2023. https://www.humanprogress.org/will-we-learn-from-the-deindustrialization-of-germany/

[65] Wilkes, W., & Randow, J.. Europe's Economic Engine Is Breaking Down. *Bloomberg.Com.*25 May 2023 https://www.bloomberg.com/news/articles/2023-05-25/germany-enters-recession-europe-s-largest-economy-is-breaking-down

Likewise, here in the U.S., renewables champion California has seen its retail electricity prices soar 80% since 2008.[66] By blindly pursuing a similar decarbonization strategy, New York threatens to make energy scarcer and more expensive, chasing away industry and ushering in energy poverty.



Source: Bryce[67]

[66] U.S. Energy Information Administration. State Electricity Profiles https://www.eia.gov/electricity/state/

[67] Bryce. California Screamin' March 2023. https://robertbryce.substack.com/p/california-screamin