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November 8, 2024

New York State Energy Research & Development Authority
17 Columbia Circle
Albany, New York 12203-6399

RE: Comments on Draft Blueprint for Consideration of Advanced Nuclear Technologies

Dear NYSERDA staff,

Please accept the following comments on behalf of Nuclear New York, New York Energy and Climate Advocates, and Mothers for Nuclear regarding the Draft *Blueprint for Consideration of Advanced Nuclear Technology* ("draft Blueprint").[1]

At the outset, we wish to commend the New York State Energy Research and Development Authority (NYSERDA) for its initiative in commissioning the draft Blueprint. We also applaud Governor Hochul for recognizing the tremendous potential of advanced nuclear power to help New York achieve its ambitious climate goals while supporting the growing energy needs of a vibrant economy. The *Future Energy Economy Summit* hosted by the Governor and NYSERDA on September 5, 2024 in Syracuse was a game-changer, one that with cooperation from stakeholders can set New York on a successful path forward. Our organizations pledge our full support in that effort.

We recognize that the Blueprint is a starting point for action, with more work to follow. As discussed during the Syracuse summit, half the states in the country are already studying or actively planning for the deployment of advanced nuclear technology in the coming decade.[2] Other nations are as well, including neighboring Canada with projects underway on Lake Ontario, just north of New York. In fact, recognizing the essential role nuclear power must play in global decarbonization and with leadership of the Biden administration, twenty-two countries signed a declaration to triple nuclear capacity by 2050.[3] As discussed

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[1] NYSERDA (September 2024), Draft Blueprint for Consideration of Advanced Nuclear Technologies. https://www.nyserda.ny.gov/-/media/Project/Nyserda/Files/ny/Draft-Blueprint-for-Consideration-of-Advanced-Nuclear-Technologies.pdf

[2] C. Csizmadia (February 2023), From Alaska to Maine: State Nuclear Energy Policy Action is Booming, Nuclear Energy Institute. https://www.nei.org/news/2023/alaska-to-maine-state-nuclear-energy-policy-action

[3] Department of Energy (December 2023). At COP28, Countries Launch Declaration to Triple Nuclear Energy Capacity by 2050, Recognizing the Key Role of Nuclear Energy in Reaching Net Zero. https://www.energy.gov/articles/cop28-countries-launch-declaration-triple-nuclear-energy-capacity-2050-recognizing-key

in the draft Blueprint, nuclear power also enjoys broad bipartisan support in Congress, which offers valuable incentives in the form of loans and tax credits for advanced nuclear technology. All this is to say that New York is not alone. As New York embarks upon this important initiative, we expect that the Governor, NYSERDA, and other agencies will coordinate with other states, the federal government, and international leaders so that New York can best benefit from, and effectively contribute to, the exciting work already underway.

A sign of growing support for advanced nuclear power is the large number of positive nuclear events held during NYC Climate Week and the UN General Assembly Science Summit this year. Among these was ***Nuclear Symposium 2024: Uplifting Humanity*** hosted by Nuclear New York, which brought together industry, government agencies (including NYSERDA), investors, and other stakeholders to discuss the challenges and opportunities of nuclear energy and deep decarbonization.[4] Available online, much of the information presented during the sessions is relevant to the draft Blueprint. Significantly, 14 international financial institutions pledged support for a global tripling of nuclear capacity during a Nuclear Finance Summit in New York City the same week.[5]

Our comments on the draft Blueprint focus of several key points:

- Advanced nuclear power is not only essential to achieving New York's climate goals, but also to providing abundant reliable energy critical to economic growth and prosperity, supporting energy-intensive manufacturing and data centers, and expanding a skilled workforce.

- Creating a reliable, carbon-free grid that is feasible and affordable requires a system-level architecture optimized to make the most efficient use of installed capacity and infrastructure. By serving as part of the *backbone* of an efficient electric system rather than simply *backup* to intermittent sources, advanced nuclear will ensure that New York meets its climate and economic objectives with minimum impact to land and natural resources.

- New York must act expeditiously to reap the benefits of advanced nuclear technology and not be left behind as other jurisdictions move forward. The Governor should immediately appoint an Advanced Nuclear Technical Working Group composed of nuclear industry representatives, utility engineers, regulatory specialists, and financial experts to issue a report within one year on opportunities and strategies.

- Comparable to support offered to other carbon-free resources, the state should develop programs and incentives that encourage the deployment of firm clean generation, including but not limited to NYSERDA procurements, power purchase agreements, and public-private partnerships through entities like the New York Power Authority.

- New York should establish a consortium with other states in the region to plan for the deployment of advanced nuclear technology, develop multi-unit order-books for specific reactor types, resolve supply chain and workforce issues, share financial resources to reduce cost, and schedule projects.

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[4] Nuclear New York (September 25, 2024). Nuclear Symposium 2024: Uplifting Humanity at UNGA Science Summit during Climate Week NYC https://www.nuclearny.org/symposium-2024/

[5] World Nuclear News (September 23, 2024). International Banks Express Support for Nuclear Expansion. https://www.world-nuclear-news.org/articles/international-banks-express-support-for-nuclear-expansion

We also notice that the draft Blueprint frequently cites the *Pathway to Advanced Nuclear Commercial Liftoff* Report prepared by the Department of Energy (DOE) last year. However, that report was updated in September 2024 with more current information and additional information, including deployment and financial modeling relevant to New York.[6] We recommend that NYSERDA carefully review the updated DOE report and incorporate relevant material from it into the draft Blueprint.

The comments herein address the text of the draft Blueprint as well as questions in the document. Comments are provided by chapter and section or subsection number of the document. For chapter 4, comments on the text of an individual section or subsection are provided first, followed by answers to questions in that section or subsection. Some answers respond to multiple questions. We also recognize that some questions require further analysis. We ask that NYSERDA and the Governor pay special attention to our comments on Chapter 5 ("Next Steps") where we recommend an informed process for incorporating advanced nuclear power into state energy planning efforts moving forward.

Thank you for this opportunity to comment. Please do not hesitate to contact us if you have any questions or would like to discuss any aspect of the draft Blueprint, our comments, or advanced nuclear technology.

Respectfully,

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CC: The Honorable Governor Kathy Hochul

[6] U.S. Department of Energy (September 2024). Pathways to Commercial Liftoff: Advanced Nuclear (https://liftoff.energy.gov/advanced-nuclear/

1 Introduction: Potential Role of Advanced Nuclear Technologies in New York's Energy Future

As the updated Advanced Nuclear Liftoff study from the DOE shows, nuclear power provides a strong value proposition for a decarbonized grid.[7] Not only can advanced nuclear generate carbon-free electricity continuously or on-demand, it does so with minimal land and material requirements. Advanced nuclear power offers high-paying jobs and regional economic benefits that enable a just transition to a zero-emission grid and a prosperous modern society. The following table, from the updated Liftoff report, illustrates how well nuclear compares to other energy sources.

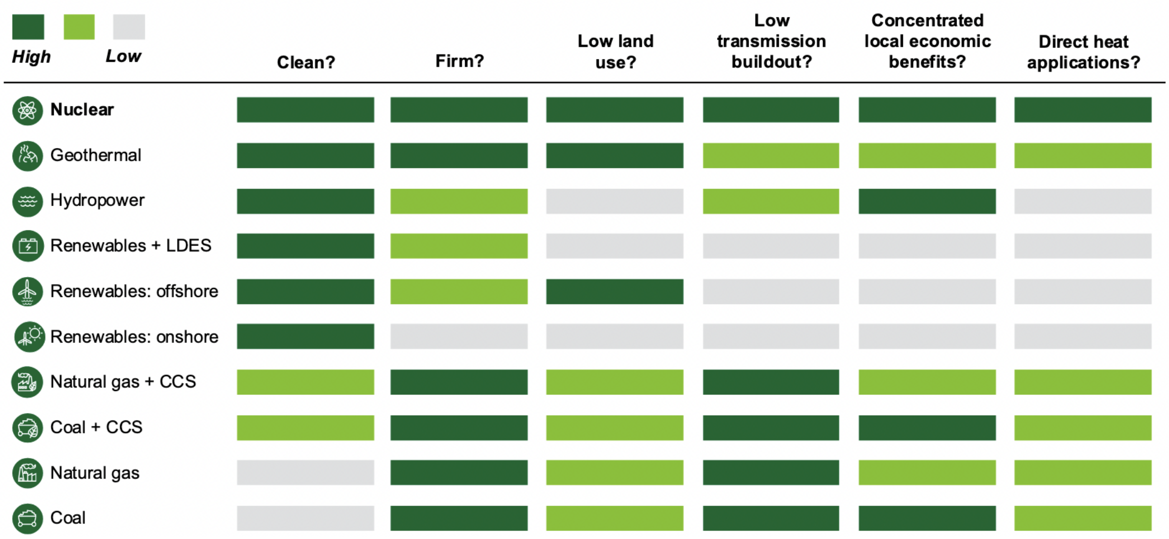

Figure 1. Source: DOE. Advanced Nuclear Liftoff

<u>System-Level Role of Advanced Nuclear Power</u>

The first chapter of the draft Blueprint (Introduction) appears to describe the approach assumed by NYSERDA in the Climate Action Council's Scoping Plan from 2022. That approach, presented as four very similar scenarios, contemplated a maximum deployment of intermittent generation (solar and wind) along with large amounts of storage and transmission to meet most of the energy needs of the state, and it relegated additional "firm" Dispatchable Emission-Free Resources (DEFRs) to serve merely as "backup" for those intermittent sources. However, this paradigm represents the least efficient use of installed capacity and infrastructure, and is therefore likely to be the least feasible and most expensive.[8] It also does not fully consider the more inclusive set of possibilities embraced by Governor Hochul in her words at the Future Energy Economy Summit.

[7] U.S. Department of Energy (September 2024). Pathways to Commercial Liftoff: Advanced Nuclear https://liftoff.energy.gov/advanced-nuclear/

[8] Real-time dynamics of grid behavior for New York have been modeled in the following 2023 report: L. Rodberg, R. Kuhr, A. Nofal (December 2023), Filling the Gap in New York's Decarbonization Plan: A New View of the Electric Grid. https://www.nuclearny.org/wp-content/uploads/2024/06/Filling_the_Gap_in_New_Yorks_Decarbonization_Plan-LRodberg.pdf

A more effective system-level architecture will make use of high-capacity-factor "firm" generation like nuclear power not simply as ***backup***, but as part of the ***backbone*** of a reliable system serving a sizable portion of total energy demand in a baseload or load-following configuration.[9] Such an arrangement reduces the total amount of generation capacity and support infrastructure needed, thereby reducing land impacts and system-level costs that are ultimately borne by ratepayers and taxpayers. Indeed, this is how upstate New York, which relies largely on baseload hydropower and nuclear, has already achieved a 90% decarbonized grid while maintaining reliable and affordable electricity.[10]

NYSERDA also found this to be true in recent analyses that actually appears in Appendix G of the aforementioned Scoping Plan. NYSERDA determined that by adding just 4GW of additional nuclear power, New York could avoid 12 GW of intermittent generation, as well as 5 GW of storage or backup generation, thereby conserving land and saving money.[11] We would add that further system-level optimization may be achieved by using nuclear power (and heat) during times of low grid demand to produce hydrogen, which could be used later to supply peak power or DEFR services.

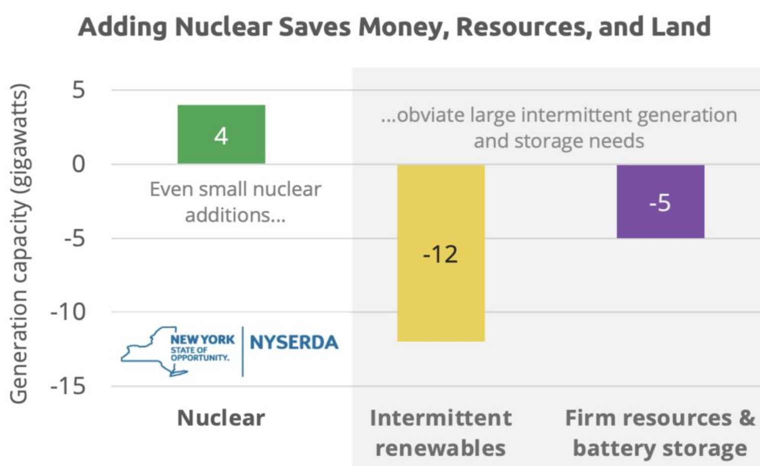

Figure 2: NYSERDA Scoping Plan Appendix G (December 2022)

These findings are further confirmed by national research on grid decarbonization pathways cited by DOE in its Liftoff report.[12] Despite the low capital and operating costs of solar and wind, pathways focused predominantly on intermittent generation result in higher system-level costs due to the volume of

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[9] Seneviratne (September 2024). "On demand" energy is essential: Matching New York's electricity demand with supply. https://isurusen.substack.com/p/new-yorks-electricity-demand-profile

[10] NYISO 2024 Power Trends 2024, The New York ISO Annual Grid and Markets Report https://www.nyiso.com/documents/20142/2223020/2024-Power-Trends.pdf/

[11] Energy and Environmental Economics (E3) Abt Associates (December 2022). Appendix G: Integration Analysis Technical Supplement New York State Climate Action Council Scoping Plan, Section I Page (labeled) 92. https://climate.ny.gov/Resources/-/media/project/climate/files/Appendix-G.pdf

[12] U.S. Department of Energy (September 2024). Pathways to Commercial Liftoff: Advanced Nuclear https://liftoff.energy.gov/advanced-nuclear/ ; see also:
Sepulveda, N. A., Jenkins, J. D., de Sisternes, F. J., & Lester, R. K. (2018). The role of firm low-carbon electricity resources in deep decarbonization of power generation. Joule, 2(11), 2403–2420. https://doi.org/10.1016/j.joule.2018.08.006 ;
Baik, E., Chawla, K. P., Jenkins, J. D., Kolster, C., Patankar, N. S., Olson, A., Benson, S. M., & Long, J. C. S. (2021). What is different about different net-zero carbon electricity systems? Energy and Climate Change, 2, 100046. https://doi.org/10.1016/j.egycc.2021.100046

generation capacity and support facilities (transmission, storage, and backup) required for a functional and reliable system. Furthermore, this leads to a decrease in the marginal value and utilization rates of intermittent generation as more is deployed. As already seen in New York, the sheer magnitude of low-energy-density, low-capacity-factor build-out can also exacerbate supply chain and logistical challenges. DOE demonstrates in its Nuclear Liftoff report that, even when priced at a premium, clean firm resources reduce overall system costs.[13]

System-level Modeling Shows Clean Firm Capacity Reduces the Need for Additional Variable generation

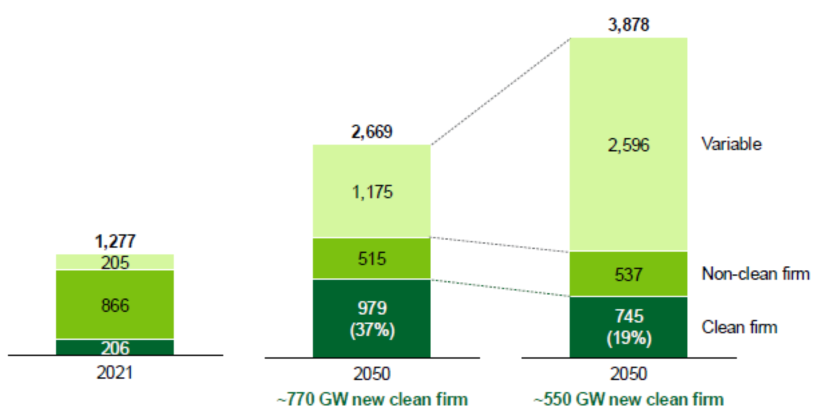

Figure 3. Source: DOE Advanced Nuclear Liftoff

Modeled decarbonization scenarios for California
show including nuclear with variable renewables and storage reduces system costs
(generation and transmission system costs with and without nuclear, $/MWh)

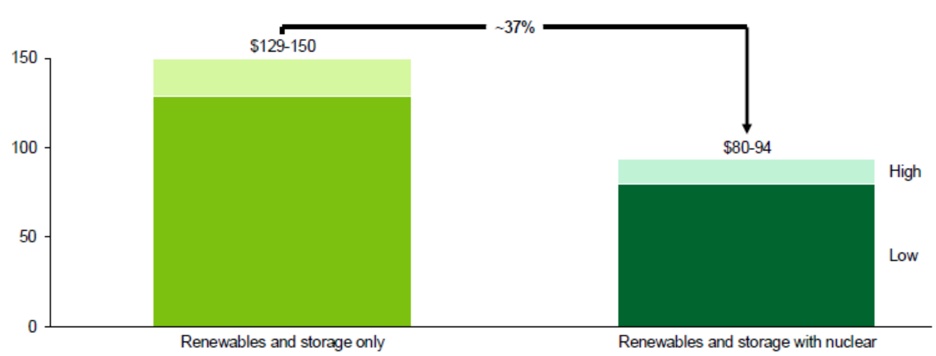

Figure 4. Source: DOE Advanced Nuclear Liftoff

Importantly, the Climate Leadership and Community Protection Act (CLCPA) provides flexibility with respect to system-level architecture. Although the Act sets forth a 70% “renewable” goal that does not include nuclear power for the year 2030, it does not mandate a technology-specific goal exceeding this amount;

[13] Ibid.

nor does it mandate a technology-specific goal for statewide generation of any amount after 2030.[14] Rather, the CLCPA simply states that by 2040, the state's electricity demand system must be zero-emission. 2030 will soon be here and it is unlikely that the 70% renewable target will be met (for many of the reasons discussed above). More importantly, however, even if the 70% renewable target is eventually achieved, the non-linear system-level challenges of intermittent generation will prevent New York from reaching its goal of carbon-free electricity unless nuclear power plays a meaningful role. The State must understand that all of these challenges will be compounded by the electrification of buildings and transportation, major new industrial loads including semiconductor manufacturing (Micron), and data centers that together promise to double or possibly even triple demand. In its draft biennial report, NYSERDA admits to having underestimated these impacts.[15]

To meet its climate goals, New York will need a practical, system-level strategy that can succeed. We recommend revising Chapter 1 of the draft Blueprint to describe the value of an optimized architecture in which advanced nuclear power can participate as a provider of firm generation serving a meaningful portion of demand.

<u>Readiness</u>

At the end of Chapter 1 (sixth and seventh paragraphs), the draft Blueprint introduces the subject of "technological readiness," asserting generally that advanced reactors raise a number of issues. We agree that there are technological issues of readiness with fusion. However, for fission, it would be more accurate to characterize the issue as one of "commercial" readiness. The science and technology of advanced fission reactors have been understood and demonstrated for decades. However, issues of commercial readiness with approved NRC designs remain. (Notably, this is not a factor for the AP1000, which is already technologically and commercially ready for deployment.)

This confusion between technological and commercial readiness is apparent elsewhere in the draft Blueprint as well, including Section 4.1. Except in the Blueprint's discussion of fusion, we recommend replacing the phrases "technical readiness" or "technological readiness" with "commercial readiness."

2 Profile of Advanced Nuclear Technologies

2.1 Performance Profile

The text in this section refers to a "deeply renewable" grid. However, rather than implying a technology preference not in the CLCPA, we recommend that New York focus on its actual climate objectives, which are ***deep decarbonization*** and **carbon-free electricity**. We notice that the text does acknowledge the benefits of continuous power for co-located applications, but as discussed in our comments on Chapter 1, the benefits of using firm carbon-free generation to serve a meaningful proportion of demand extend to the larger grid as well. Relating to this, the draft text refers to stability benefits of synchronous steam

[14] The CLCPA calls for 9 GW of offshore wind by 2035. The statewide 70% renewable mandate applies "in" the year 2030.
[15] NYSERDA (July 1, 2024), Draft Clean Energy Standard Biennial Review, Case 15-E-0302 - Proceeding on Motion of the Commission to Implement a Large-Scale Renewable Program and a Clean Energy Standard. https://www.nyserda.ny.gov/-/media/Project/Nyserda/Files/Programs/Clean-Energy-Standard/A00194900000C313A126877CFFAA2B0C.pdf

turbine generators. However, these benefits only exist if those generators actually run, which corroborates the value of high-capacity-factor operation. We recommend revising this section of the Blueprint consistent with our comments on Chapter 1 above.

2.2 Low Land Use and Modularity

This section appropriately discusses the substantial benefit of land conservation with nuclear power. However, the comparison to a "similarly sized" solar panel system may even be more dramatic than stated. This is because a comparison of annual energy production does not convey all infrastructure and thus land-use impacts. Additional "firming" facilities such as storage (and additional generation to overcome round-trip storage losses), transmission, frequency regulations, and other components needed to convert intermittent electricity into reliable electricity serving real-time load amplifies the difference in land impact. This is further compounded by land impacts associated with extraction of mined materials, which are extensive for low-energy-density solar and wind.[16]

Land Use Efficiency for Different Energy Sources
(MWh/year per acre, direct and indirect)

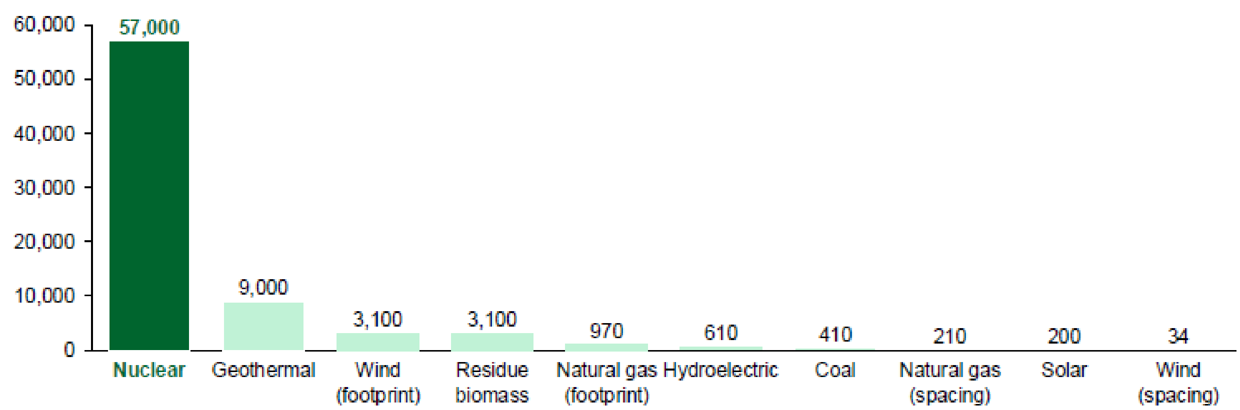

Figure 5. Source: DOE Advanced Nuclear Liftoff

2.3 Workforce and Economic Development

In addition to the potential benefits to New York discussed in the last paragraph of this section, we recommend adding that the nuclear industry is predominantly "Made in America". Nuclear power creates the most on-site permanent jobs, has the highest median wages, and has the highest union representation. Communities with nuclear power plants benefit greatly from hosting them.[17]

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[16] Nuclear New York (n.d.). Why Nuclear Power? https://www.nuclearny.org/why-nuclear/

[17] U.S. Department of Energy (September 2024). Pathways to Commercial Liftoff: Advanced Nuclear https://liftoff.energy.gov/advanced-nuclear/ ; U.S. Energy & Employment Jobs Report (2023). National Report https://www.energy.gov/media/299601

Jobs, Unionization, and Benefits

Generation type	Permanent jobs on site, jobs/GW	Industry wage median, $/hour	Union representation or collective bargaining coverage	Benefits concentrated in local community?
Nuclear	237 / ~500	$56	19%	✓
Coal	107	$49	17%	✓
Natural gas	~30	$49	17%	✓
Wind	80	$37	12%	✗
Solar	~36	$34	11%	✗

Small Modular Reactor | Conventional

Figure 6. Sources: DOE, U.S. Energy & Employment Jobs Report

By contrast, the supply-chain associated with intermittent generation is largely sourced overseas. Investing in a vibrant domestic nuclear industry provides both economic and national security by reducing dependence on foreign suppliers, creating domestic jobs, and retaining wealth domestically instead of sending profit overseas.

2.4 Potential Supplemental Applications

The title of this section "Potential *Supplemental* Applications" does not convey the broad scope of possible applications for advanced nuclear technology. For example, U.S. industrial leader Dow Inc. is partnering with Maryland-based X-energy to install an advanced high-temperature gas reactor at its Seadrift facility in Texas. A chief purpose of the reactor will be to produce carbon-free, high-quality process heat.[18] Nuclear heat and/or power can also be used to efficiently produce zero-carbon hydrogen (as demonstrated at the Nine Mile Point nuclear plant in Oswego, NY) and derivative synthetic fuels.[19] Furthermore, civilian nuclear technology is responsible for the production of life-saving medical isotopes.

In the last paragraph, it may be an overstatement to assert that any supplemental application would require "extensive coordination among stakeholders." This would certainly be true in a district heating application that extends well beyond the plant. However, for dedicated applications involving an industrial user in a co-located or behind-the-meter scenario, extensive coordination with outside stakeholders may not be necessary.

[18] Dow Inc. (May 2023). Dow's Seadrift, Texas location selected for X-energy advanced SMR nuclear project to deliver safe, reliable, zero carbon emissions power and steam production. https://corporate.dow.com/en-us/news/press-releases/dow-s-seadrift--texas-location-selected-for-x-energy-advanced-sm.html

[19] LucidCatalyst (Sept 2020). Missing Link to a Livable Climate: How Hydrogen-Enabled Synthetic Fuels Can Help Deliver the Paris Goals https://www.lucidcatalyst.com/hydrogen-report

3 Overview of Advanced Nuclear Technologies

In the second paragraph, it is inaccurate to claim that water-cooled reactors use "less uranium." Commercial water-cooled reactors are typically not fast reactors, which means they are less efficient at fuel consumption compared to fast reactors and, as a result, require *more* uranium per watt-hour of energy produced. Additionally, the sentence is confusing as it does not distinguish between U-238 and fissile U-235. While it's true that fast reactors must be loaded with fuel that has a higher U-235 to U-238 ratio than thermal (slow neutron) reactors, this does not imply they contain "more uranium." Over its lifetime, a fast reactor should use significantly *less* enriched fuel per unit of energy generated due to the process of breeding. The sentence which states that water-cooled reactors require less uranium should simply be deleted.

In the third paragraph, we recommend removing the sentence that states “some may use ‘SMR’ to refer only to light water reactors.” It is true that the terms "SMR" and "microreactor" lack fully uniform definitions. However, we are unaware of any companies or institutions defining "SMR" based on the cooling medium. In fact, many reactor designs marketed as SMRs are sodium-cooled, molten salt, or gas-cooled. A more accurate statement would be that the term "SMR" generally refers to reactors that are 300 MW or smaller and have modular features to support factory production. It should also be noted that several SMR designs such as the TerraPower Natrium and Molten Chloride Fast reactors, as well as the Moltex Stable Salt Reactor, are specified with both a nominal generation capacity, as well as operational capacities to reflect peaking capabilities that exceed 300 MW. We would add that while Natrium is a nominal 345 MW reactor, it is actively promoted by TerraPower as a SMR.

In the fourth paragraph, the text says that currently operating reactors are referred to as Gen III. However, New York’s existing reactors are generally considered Gen II.

In the fifth paragraph, the last sentence states that “Microreactors could be advantageous for their ease of transport, load-following capabilities, no requirement for water, and flexibility to operate either on or off the electric grid.” However, only the first of these is unique to microreactors. Large advanced nuclear reactors and SMRs also have load-following capability, several SMR designs do not require, water, and many are designed for either the grid or to be co-located with industry in a behind-the-meter setting.[20] A more accurate statement would be “Microreactors could be advantageous for their ease of transport, use in remote locations, and extended operation without refueling.”

Table 1 should be improved or replaced for accuracy and completeness. There are a variety of different characteristics by which various fission designs could be grouped, such as by neutron spectrum (thermal or fast), by moderator, by heat transfer mechanism, by outlet temperature, by fuel type (LEU or HALEU), or by fuel structure (solid fuel assemblies, liquid suspension, TRISO, etc). Furthermore, the characteristics of various reactor designs overlap with each other in ways that differ depending on grouping. Unfortunately, limiting the fission reactor categories in Table 1 to “water-cooled light water”, “sodium/molten salt”, and “high temperature gas” has led to overgeneralized and at times inaccurate descriptions of each in Chapters 3 and 4 of the draft Blueprint, as well as overgeneralization or often inaccurate descriptions of their pros and cons.

[20] However, as often the case with large-scale power plants, existing conventional nuclear plants typically do not have black start capability.

Rather than displaying a table with power output on one axis and a rather arbitrary set of reactor types on the other, we suggest that a more useful way of presenting information would be to identify various design examples on one axis and their characteristics on the other. The document, *Advanced Nuclear Reactor Technology: A Primer,* prepared by Nuclear Innovation Alliance (NIA) is a useful resource in understanding the variety of advanced nuclear technologies available. It contributed to our creation of the suggested table below:[21]

Several Advanced Fission Reactors and Their Characteristics

Reactor	Technology	Power Output	Spectrum	Moderator	Heat Transfer	Temp	Fuel	Fuel Form	Refueling period
Westinghouse AP1000	PWR	1,110 MWe	thermal	water	water	~ 300 C	LEU	U02 pellets	12-24 months
Westinghouse AP300	PWR	300 MWe	thermal	water	water	~ 300 C	LEU	U02 pellets	12-24 months
Holtech SMR-160	PWR	160 MWe	thermal	water	water	316 C	LEU	UO2 pellets	42 months
NuScale Power Module	PWR	77 MWe	thermal	water	water	314 C	LEU	UO2 pellets	18 months
GE-Hitachi BWRX-300	BWR	300 MWe	thermal	water	water	287 C	LEU	UO2 pellets	12-24 months
TerraPower Molten Chloride Fast Reactor	MSR	300 MWe (170-430)	fast	NA	molten chloride salt	735 C	HALEU	U-molten chloride	online
Terrestrial Energy Integrated MSR	MSR	195 MWe	thermal	graphite	molten fluoride salt	> 600 C	LEU	U-molten fluoride	online
Moltex Stable Salt Reactor	MSR	300-500 MWe	fast	NA	molten fluoride salt	700 C	HALEU	solid fuel	online
Kairos KP-FHR	MSR	140 MWe	thermal	graphite	molten fluoride salt	650 C	HALEU	TRISO	online
TerraPower Natrium	SFR	345 MWe (100-500)	fast	NA	liquid sodium	540 C	HALEU	Metallic U-Zr	24 months
ARC-100	SFR	100 MWe	fast	NA	liquid sodium	510 C	HALEU	Metallic U-Zr	up to 20 years
Oklo Aurora Powerhouse	SFR	15 MWe	fast	NA	liquid sodium	> 500 C	HALEU	Metallic U-Zr	up to 20 years
General Atomics Fast Module Reactor	GFR	44 MWe	fast	NA	helium gas	800 C	HALEU	UO2 in silicon carbide	15 years
X-Energy Xe-100	HTGR	80 MWe	thermal	graphite	helium gas	750 C	HALEU	TRISO	online
BWXT Advanced Nuclear Reactor	HTGR	17-25 MWe	thermal	graphite	helium gas	> 800 C	HALEU	TRISO	> 5 years
Westinghouse eVinci		1-5 MWe	thermal	graphite	heat pipes	> 750 C	HALEU	TRISO	4-5 years

PWR = Pressurized Water Reactor
BWR = Boiling Water Reactor
MSR = Molten Salt Reactor
SFR = Sodium-Cooled Fast Reactor
HTGR = High Temperature Gas-Cooled Reactor
GFR = Gas Cooled Fast Reactor

As seen above, several of the reactors have characteristics that depart from the descriptions included in Chapters 3 and 4 of the draft Blueprint. For example, both the Moltex Stable Salt Reactor and the Kairos KP-FR are molten salt reactors that actually use solid fuels rather than uranium dissolved in molten salt, and Terrestrial Energy's Integrated Molten Salt Reactor utilizes LEU, rather than HALEU. Several molten salt and high temperature gas reactors also utilize the thermal, rather than fast, neutron spectrum. Although not included in the above table, advanced large-scale and SMR variations of Canada's heavy-water CANDU reactor could also exist in the future.[22]

We recommend excluding fusion from the table since it is an entirely different technology and lacks the technical readiness of fission. The SPARC fusion reactor should not be included as an example because–like many other fusion projects–it will only be an experimental reactor without the ability to create electricity. (We also note that while most fusion concepts involve fusing isotopes of hydrogen to create helium, there are also aneutronic concepts that fuse other elements such as lithium or boron.)

Although we provide comments below on the sections of Chapter 3 that attempt to describe fission reactors, we suggest that a more accurate and effective way of providing information would instead be with sections that discuss various characteristics of the technology. This would recognize that the plethora

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[21] Nuclear Innovation Alliance. (updated July 2023), Advanced Nuclear Reactor Technology: A Primer. https://nuclearinnovationalliance.org/advanced-nuclear-reactor-technology-primer
[22] https://www.atkinsrealis.com/en/projects/monark ; https://smractionplan.ca/content/candu-smr

of actual designs share different combinations of those characteristics. As previously mentioned, those categories include:

- Power Output (large, small, micro)
- Neutron spectrum (thermal or fast)
- Moderator (if applicable)
- Heat Transfer Mechanism and Temperature
- Fuel Enrichment (LEU or HALEU)
- Fuel structure (solid, liquid suspension, TRISO, etc)

3.1 Light Water Reactors

The third paragraph should state that SMRs are typically described as generating less than *or equal to* 300 MW of electrical power. Many SMR designs define their upper output limit as 300 MW.

It is not valid to say that, because NuScale's US600 has received NRC design approval, it is the "closest to commercial operation." There are many different opinions on this. The US600 is actually an older 50 MW design and is not being proposed for deployment. NuScale's various VOYGR Power Module packages now propose using a 77 MW reactor. Although TerraPower's Natrium reactor has not yet received NRC design approval, it may be just as close to commercial operation as NuScale. Activity by OPG at its Darlington facility suggests that the BWRX-300 may also not be very far from commercial operation.

As previously mentioned, large or small advanced heavy water reactors, which could be based on the Canadian CANDU technology, are also a possibility. Heavy water reactors do not require enriched fuel.

3.2 Sodium and Molten Salt Reactors

This section confuses sodium-cooled and molten salt technologies, which are very different. Sodium-cooled reactors use liquid elemental sodium (Na), not a chemical salt, as the heat transfer mechanism.

The second paragraph asserts that molten salt reactors dissolve fissile material in the coolant, but this is only true of some molten salt reactors. Others, like the Moltex and Kairos reactors, use solid fuel assemblies or TRISO. Furthermore, not all molten salt reactors are fast reactors. Again, this shows how the draft Blueprint's grouping of reactor types is confusing.

In the third paragraph, the text implies that TerraPower's Natrium reactor is far from being operational because certain NRC reviews are only 8% complete. However, it is as much "on track for commercial operation in the 2030s" as the reactors mentioned in the fourth paragraph, so this should be clarified. The third paragraph also incorrectly states that construction has begun at the site of an abandoned coal plant. The Natrium facility is actually being built near the Kemmerer coal plant, which is still operating but scheduled to close. In fact, TerraPower intends to employ workers currently there.

The fifth paragraph incorrectly states that light water reactors do not have a moderator. Water is the moderator in LWRs. Fast spectrum molten salt reactors do not require a moderator, and thermal spectrum molten salt or gas cooled reactors use graphite as a moderator. The paragraph is also confusing because HTGR reactors like X-Energy also use TRISO fuel. Furthermore, molten salt reactors that suspend uranium in liquid do not use fuel rods. Again, this makes the group of reactor types in the draft Blueprint difficult to understand. It also makes the last sentence overly broad and inaccurate.

The last sentence of this section implies that waste and safety are problems with HALEU fuel. However, HALEU actually reduces waste volume by more efficient fuel consumption and enhances safety by reducing long-lasting actinides.[23] Likewise, TRISO fuel is designed to make meltdown essentially impossible because of the individual encapsulated structure of fuel "pebbles," and proliferation is exceedingly difficult for the same reason.[24] TRISO also avoids the need for a hardened containment structure. These unique design, safety, and non-proliferation are benefits that should be discussed. Many advanced nuclear fuels have been specifically designed to reduce waste, enhance safety, and avoid proliferation, so the sentence should be removed.

3.3 High-Temperature Gas Reactors ("HTGRs")

In the first paragraph, it is misleading to state that HGTR reactors "operate similarly" to other reactors. In particular, reactors that use TRISO fuel are quite different, especially with respect to containment and emergency management. The sentence stating that HTGR reactors "use HALEU fuel in the same variety of forms as sodium-cooled or molten-salt reactors, with the same attendant fuel supply, waste, nonproliferation, and safety considerations" is not accurate. Most HTGR reactors use TRISO fuel which encapsulates HALEU grains into fuel pebbles, which is fundamentally different from sodium-cooled or molten salt reactors that use solid fuel assemblies or dissolve fuels into a liquid. Therefore the supply chain, waste, and safety issues are also different.

The second paragraph asserts that timelines for commercialization of such reactors are "uncertain." However, this is not any more so than for other reactor types discussed.

3.4 Fusion Reactors

The first paragraph states that fusion reactors can make steam for electrical turbines or heat for other purposes, but this has not yet been demonstrated in a prototype.

In the second paragraph, rather than saying that fusion occurs by compressing "gaseous" fuel, it would be more accurate to state that fusion involves compression and extreme heat to create a fusible plasma. Some experiments claim to have achieved energy gain, but they only measure reaction gain and do not account for required containment energy, input energy losses, and output energy-to-electricity losses. Even the International Thermonuclear Experimental Reactor (ITER) project which anticipates eventually achieving a local reaction gain factor of 10, is not expected to achieve a total net gain in useful energy. Given the extreme complexity of fusion, it is not known when a reactor capable of providing net electricity to the grid will be possible, or whether doing so will ever be economically viable. Notwithstanding some startup claims, this makes fusion a very unlikely candidate for New York in the foreseeable future.

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[23] https://www.iaea.org/bulletin/shrinking-nuclear-waste-and-increasing-efficiency-for-a-sustainable-energy-future# ; https://inl.gov/feature-story/u-s-researchers-fabricate-commercial-grade-uranium-dioxide-haleu-fuel/

[24] https://www.tandfonline.com/doi/full/10.1080/00295450.2023.2298157#abstract

The last paragraph asserts that fusion could unlock enormous amounts of power to "supplement" wind and solar energy. However, if commercial fusion were to ever become a reality, using such an energy source to merely "supplement" low-energy density intermittent general would be an irrational and immensely wasteful underutilization of generation capacity. (See our prior discussion of this in our comments on Chapter 1 regarding the most effective use of nuclear power generally.) The text states that fusion could eliminate complex and difficult fuel supply chains for uranium. However, fusion will also likely require its own set of difficult to procure materials needed for superconducting magnets, lasers, and other exotic components.

4 Issues for Consideration

4.1 Technological Readiness

As discussed in our comments on Chapter 1, the availability of fission-based advanced nuclear reactors is a matter of "commercial" readiness, not "technological" readiness. Technological readiness, however, is an issue for fusion. We recommend that this distinction be made clear. If the section is intended to discuss both technological and commercial readiness, then we recommend changing the title to "Technological and Commercial Readiness" or simply "Readiness." In the first paragraph of this section, we recommend replacing the word "unchanging" with "understood." Designs change but the fundamentals are understood.

In the fourth paragraph, the sentence saying that all nuclear options except fusion use "several new forms of uranium fuel" is incorrect. All advanced Light Water Reactors use LEU fuel, which is readily available and consumed in conventional nuclear plants today. HALEU fuel may not be commonly used in most reactors today, but it is not a "new form" of uranium fuel either. Beyond uranium, other fuels such as thorium, a uranium/thorium mix, and fuels derived from existing nuclear waste are also possible. Notably, when existing nuclear waste is used as fuel in certain advanced reactors, long-lived actinides are reduced to short-lived fission products. At the end of the paragraph, the example of Natrium and delay caused by lack of HALEU is dated and thus misleading. A statement should be added that with federal support, a domestic supply chain for HALEU is now being developed so that the Natrium reactor can begin operating in the early 2030s.

Questions:

• How can the State and its stakeholders access sufficiently objective and transparent information on technical readiness?

• At what level of technical readiness should the State begin more intensive consideration of new advanced reactors within energy plans?

These questions seem to suggest that the State would pre-select technologies for consideration before requesting proposals from the marketplace. Given the dynamics of nuclear technology development, an alternative approach might be better. We suggest that New York maintain technology neutrality, but encourage vendors of reactors featuring different technologies at different readiness levels to make proposals. The State should allow vendors that offer immediate readiness to make their best case, as well as vendors that offer reactors with different advantages but perhaps lower readiness levels. Eventually determinations would be made, weighing all factors. Please see our discussion of "Next Steps" in comments on Chapter 5.

Reactor designs that have a high readiness level should feature shorter planning and deployment timelines. We hope New York can take advantage of this with the first reactors built in our state. However, not all the additional nuclear capacity that New York needs will be built at the same time, and the longer timelines associated with later additions should allow for consideration of technologies with a currently lower readiness level.

We also find that the question is as much one of whether New York wants to be on the cutting edge of innovation or not. One could argue that Natrium is not "ready" since the reactor design does not yet have NRC approval. However, construction has already begun in Kemmerer, Wyoming, turning the town and state into a hotbed of economic activity.

4.2 Licensing, Safety, and Siting

4.2.1 Safety Risks and Perceptions

This subsection begins with the valid statement that "All nuclear reactors must possess safety systems that, in the event of irregular operating conditions, can control (stop) the fission reaction, ensure the adequate cooling of fuel, and prevent the release of radioactivity in the environment." However, the text does not clearly distinguish between and discuss these three conditions.

(1) Control (stop) the fission reaction

In a couple of places, the draft Blueprint alludes to the possibility of a "runaway" chain reaction (and suggests that HTGR reactors avoid this). However, no reactor in the western world is physically capable of a runaway reaction, including existing conventional reactors. All reactors in the U.S. must demonstrate net prompt reactivity coefficients to comply with NRC regulations.[25] Today's reactors also employ automated systems that stop the fission reaction in case of external triggers, such as loss of grid power or earthquakes. Advanced reactors combine this with mechanisms that rely on fundamental laws of physics to halt the fission process.

(2) Ensure the adequate cooling of fuel

New reactor designs (Gen III+ and Gen IV) have features that either provide enough coolant for 72-hour walk-away safety (AP1000), have core catchers that safely handle an overheating of the reactor core (EPR), or rely on laws-of-physics mechanisms to ensure the effective dissipation of heat (Gen IV). SMRs also benefit from a smaller core interacting with the heat-absorbing environment. Other advanced reactor designs are immune to meltdowns due to the type of reactor fuel (either

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[25] See NRC Regional 10 CFR Part 50 Appendix A, General Design Criteria 11. https://www.nrc.gov/reading-rm/doc-collections/cfr/part050/part050-appa.html ; see also https://www.nuclear-power.com/nuclear-power/reactor-physics/nuclear-fission-chain-reaction/reactivity-coefficients-reactivity-feedbacks/

liquid or extremely stable TRISO fuel) that can safely reach extremely high temperatures.

(3) Prevent the release of radioactivity in the environment

Even in the case of a reactor core meltdown, today's reactors are capable of preventing a release of radioactivity into the environment. In the U.S., containment structures keep radioactive materials inside, catalytic hydrogen reformers prevent the build-up of explosive gasses[26], and filters remove any harmful radioactive material from air or steam if venting is necessary. For reactors using TRISO fuel, "containment" is achieved in the extremely stable structure of the fuel itself that prevents the expulsion of radioactive material.

The evolution discussed in the third sentence of the second paragraph in this subsection is not from conventional LWR to SMR. The evolution is from conventional reactors generally (which includes LWR and heavy water reactors) to advanced nuclear reactors (which can be large-scale reactors like AP1000, SMRs, or microreactors). The phrase "geometric design" is unclear. We suggest changing the text to say: "Advanced nuclear reactors have evolved from conventional reactors of the past to achieve necessary safety functions through passively safe and inherently safe systems such as gravity fed emergency cooling and heat dissipation through natural convection."

The last sentence of the second paragraph incorrectly implies that only HTGR and fast reactors have a negative reactivity coefficient. At high temperatures, conventional light water reactors also have a negative reactivity coefficient and cannot experience a runaway reaction. In the event of a meltdown during which water boils off, the nuclear chain reaction stops entirely because no moderator is present. As previously mentioned, any reactor with a positive reactivity coefficient would be illegal in the U.S.

We find the third paragraph to be vague and hyperbolic. The second sentence suggests that the design of advanced nuclear reactors might somehow be vulnerable to climate change. Yet reactors are designed to operate over wide temperature and stress conditions. Climate-related increases in outdoor temperature cannot affect plant safety. Because of the inherently and passively safe features of advanced reactors, a severe storm event conceivably attributable to climate change—even one resulting in the loss of electricity or flooding—would not impact safety either. In France, reactor operation has been occasionally reduced in the summer at some sites to comply with thermal heat discharge limits, but this is not due to safety concerns. Furthermore, advanced reactors can be designed to avoid this. Nuclear facilities are designed to withstand major earthquakes and aircraft impacts, so the vague supposition that weather or climate might pose a threat to plant safety is without merit. We note that the footnoted reference is from a Government Accountability Office Report, to which the NRC responded. In its response, NRC stated: "The layers of conservatism and defense in depth incorporated into NRC's processes provide reasonable assurance regarding any plausible natural hazard and combinations at a site for licensed operational lifetime of the reactor, including those that could result from climate change."[27]

The fourth paragraph claims that "the success of a sodium-cooled fast reactor's ability to prevent a runaway reaction relies on the temperature of the coolant remaining stable, which is questioned under

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[26] Catalytic hydrogen reformers were not present at Fukushima. However, they are required in U.S. reactors.

[27] U.S. Government Accountability Office, "Nuclear Power Plants: NRC Should Take Actions to Fully Consider the Potential Effects of Climate Change" (April 2024). GAO-24-106326. https://www.gao.gov/assets/gao-24-106326.pdf ;
See Appendix IV. Comments from the Nuclear Regulatory Commission, March 7, 2024.

certain conditions." This statement is misleading. Any reactor licensed in the United States must have a *net* negative power and temperature reactivity. While it is true in sodium-cooled reactors that coolant expansion has a positive effect on reactivity, this is not the only temperature-dependent effect on reactivity. To be licensed, a reactor must be balanced by the *negative* temperature coefficients of reactivity for the system as a whole.[28] The draft blueprint references a source that assumes a reactor design that would be illegal in the U.S.[29]

The same paragraph alludes to unexplained scenarios in which TRISO fuel might be defective in some way. Yet there is no discussion of the fundamental design aspects of such reactors to limit public exposure to radiation. In a sodium-cooled reactor, the working fluid is not under high pressure. Therefore, even in the event of an accident that exceeded design parameters, radioactive material would not be violently expelled from the facility. TRISO fuel was specifically designed to enhance safety. Hyperbolic assertions are not uncommon for the author that the draft Blueprint cited in footnotes for this paragraph.

The fifth paragraph conflates two different concerns: concerns regarding the NRC's ability to ensure safety expressed by opponents of nuclear power and concerns regarding adequate staffing expressed by proponents. We agree that the NRC should increase staff, particularly staff with expertise in advanced technologies, so as to avoid delay in the deployment of new reactors, but we do not question the NRC's ability to ensure safety.

Questions:

- **How can the State participate in or monitor NRC safety licensing processes for each design that may be built within New York?**

- **How can the State adopt and improve best practices in nuclear safety?**

New York should respect the legal authority, qualifications, and expertise of federal agencies. The Atomic Energy Act (AEA) of 1954 established the Atomic Energy Commission (AEC) to promote the "utilization of atomic energy for peaceful purposes to the maximum extent consistent with the common defense and security and with the health and safety of the public."[30] The Nuclear Regulatory Commission (NRC) was then created by Congress in 1974 as an independent agency to ensure the safe use of radioactive materials for beneficial civilian purposes while protecting people and the environment.[31] Federal law prohibits the NRC from delegating its regulatory power relating to the safety of nuclear power plants and nuclear material production.[32] While New York is an "Agreement State" the authority granted to it by the NRC does not extend to the regulation of nuclear energy generation facilities.[33]

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[28] These include fuel thermal expansion, fuel Doppler broadening, coolant expansion (reducing neutron capture), coolant expansion (increasing neutron leakage), fuel assemblies bowing away from each other, and control rod driveline thermal expansion.

[29] T. G. Theofanous, C. R. Bell. Nuclear Science and Engineering Volume 93, 1986. An Assessment of Clinch River Breeder Reactor Core Disruptive Accident Energetics https://www.tandfonline.com/doi/abs/10.13182/NSE86-A17751

[30] EPA (Feb 2024). Summary of the Atomic Energy Act https://www.epa.gov/laws-regulations/summary-atomic-energy-act

[31] About NRC https://www.nrc.gov/about-nrc.html

[32] The Connecticut General Assembly Office of Legislative Research (Apr 1997). State Oversight of the Nuclear Regulatory Commission https://www.cga.ct.gov/PS97/rpt/olr/htm/97-R-0459.htm

[33] https://www.nrc.gov/agreement-states/new-york.html

New York does not need to replicate the regulatory apparatus of the NRC, a highly specialized agency with a $1 billion annual budget.[34] The NRC has a total workforce of nearly 3,000 full-time-equivalent employees, with 30% of the permanent staff being engineers.[35] The NRC also recognizes that advanced nuclear designs can incorporate different fuel forms, coolants, and barriers that limit the potential release of radioactive material beyond the site boundary.[36] This has driven a transition towards a regulatory approach that is performance-based, technology-inclusive, risk-informed, and consequence-oriented.[37] Such an approach will allow for more effective evaluation of operational and safety features over a broad range of reactor designs.

With respect to safety, New York should consider nuclear power in the context of all forms of energy. As the draft Blueprint points out, nuclear has among the lowest levels of overall safety-related impacts of any major energy source. This is further confirmed through objective analysis performed by *Our World in Data,* a project of the University of Oxford, which included statistics for Three Mile Island, Chernobyl, and Fukushima.[38]

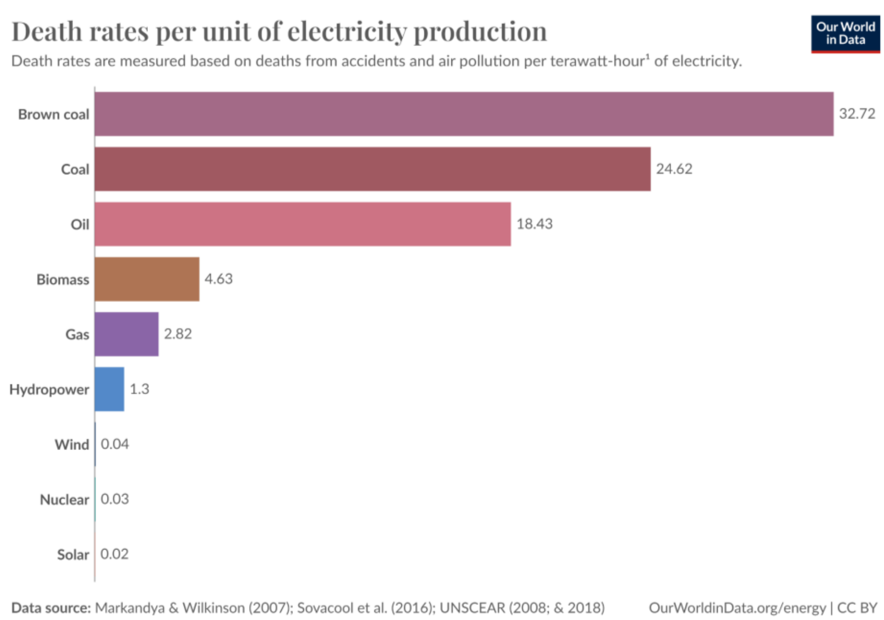

Figure 7. Source: Our World in Data

Needless to say, safety matters for any technology, and no human pursuit is immune from accidents. However, nuclear power in the United States has an exemplary track record, with safety improvements continuing over time. In fact, while there are no documented cases of radiological harm from Three Mile Island, industry-wide changes made following the incident there contributed to the extremely high

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[34] NRC (Mar 2024). Congressional Budget Justification: Fiscal Year 2025 (NUREG-1100, Volume 40) https://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1100/v40/index.html

[35] Nuclear Regulatory Commission (NRC) https://www.eeoc.gov/federal-sector/nuclear-regulatory-commission-nrc-0 ; NRC (July 2024).

[36] Doane, M. (2020). Population-Related Siting Considerations for Advanced Reactors (SECY-20-0045). Nuclear Regulatory Commission. https://www.nrc.gov/docs/ML1914/ML19143A194.pdf

[37] 115th Congress (2017-2018). S.512 - An act to modernize the regulation of nuclear energy https://www.congress.gov/bill/115th-congress/senate-bill/512/text

[38] Hannah Richie, "What are the Safest and Cleanest Sources of Energy," *Our World in Data,* in partnership with the University of Oxford. https://ourworldindata.org/safest-sources-of-energy

capacity-factor that nuclear plants throughout the country enjoy today. Safety is enhanced even further in the design of advanced reactors that employ passively and inherently safe features such as lower operating pressure, heat dissipation through natural convection, or gravity-fed emergency cooling.

Finally, it is important to recognize that by displacing fossil fuels, nuclear power saves lives. In 2013, climate scientist Dr. James Hansen calculated that nuclear power plants throughout the world had avoided 64 Gigatonnes of greenhouse gas emissions and prevented 1.84 million deaths due to air pollution.[39] Even more lives have been saved since then by their continued operation.

4.2.2 Physical Security

Concerns regarding security and proliferation were understandable in the past when nuclear energy was first being developed. However, the more than sixty-year track record of regulation, protocols, and international cooperation relating to non-proliferation since that time demonstrate that safety and security can be and has been achieved. The relationship between proliferation and commercial nuclear power must also be considered in the context of events that have transpired in the world. Countries determined to develop nuclear weapons have been able to do so without nuclear power. North Korea and Israel have nuclear weapons but no nuclear power plants, whereas South Korea, Japan, Sweden, Canada, and Germany have developed nuclear energy technology for peaceful purposes and do not have nuclear weapons. A nuclear power plant is not a readily accessible source of nuclear material, and enrichment requires sophisticated equipment. Moreover, a determined nefarious actor using sophisticated centrifuge equipment could produce weapons-grade material without a nuclear power plant.

The conflation of nuclear power with nuclear weapons has not curtailed the development of nuclear weapons which now number about 12,000. However, it has unfortunately hindered the peaceful use of carbon-free nuclear power that can benefit humanity and the planet.

Perhaps the most underappreciated value of nuclear power is its ability to actually make the world a safer place. In a broad sense, by providing abundant 24/7 energy, nuclear power can enrich the lives of people and eradicate poverty that leads to social desperation and political instability. However, it can also make the world safer in a very direct way by turning stockpiles of weapons-grade material into useful electricity. This is precisely what happened at the end of the Cold War through the highly successful Megatons-to-Megawatts program between Russia and the United States. For twenty years, weapon-grade material from the former Soviet Union was blended down to make low-enriched fuel for nuclear power plants in the U.S., thereby eliminating enough bomb-grade material for 20,000 nuclear warheads.[40] The bottom line is that curtailing the peaceful production of nuclear power will not eliminate a single nuclear weapon. Reducing nuclear arsenals will only be achieved by diplomacy, and nuclear power can actually help with that.

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[39] P. Kharecha, J. Hansen (2013). Prevented Mortality and Greenhouse Gas Emissions from Historical and Projected Nuclear Power, NASA Goddard Institute for Space Studies and Columbia University Earth Institute, Environmental Science & Technology. https://pubs.acs.org/doi/pdf/10.1021/es3051197

[40] Megatons to Megawatts, Centrus Energy. https://www.centrusenergy.com/who-we-are/history/megatons-to-megawatts/ ;
W. Broad (July 20, 2024). New York Times, Thomas Neff, Who Turned Soviet Warheads Into Electricity, Dies at 80. https://www.nytimes.com/2024/07/20/world/europe/thomas-l-neff-dead.html ;
(also discussed at Nuclear Symposium 2024: Uplifting Humanity: The Nuclear Fuel-Cycle (panel)
https://youtu.be/Pnj8vAjFuBo

The words of New York's former Office of Atomic Development in its report *An Atomic Development Plan for the State of New York* to Governor Rockefeller are as relevant today as they were in 1959:

> *The problem facing humanity today is not whether or not atomic energy can be wished out of existence, because this is impossible; the problem instead is to determine how best to control it and put it to work for constructive rather than destructive purposes. In our opinion, the best way to do this, in addition to any arms control agreements that may be entered into, is through the vigorous development of atomic energy for peaceful purposes.*[41]

Question:

• Do advanced nuclear facilities pose any significant physical security risks for the State, and if so, how can they be managed?

Under NRC regulations, nuclear power plants are among the most secure facilities in the country, incorporating measures that include physical barriers, authorization and intrusion detection, and armed personnel where appropriate.[42] After 9/11 and Fukushima, even more stringent requirements were established.[43] Spent nuclear fuel is held in secure casks that weigh approximately 100 tons each. It is also important to recognize that both existing and advanced reactors use fuels that are enriched to levels far less than required for weapons-grade material.

The NRC coordinates with the Department of Homeland Security, FBI, intelligence agencies, the departments of Defense and Energy, as well as state and local law enforcement agencies to ensure robust security. It would be far more difficult to illicitly obtain material from a nuclear power plant than from a hospital, research institute, or other less secure facility.

Question:

• Do recent cyber security events in other sectors highlight a need to assess potential cyber security risks for advanced nuclear facilities?

Ever since the attacks of 9/11, the NRC has required that the computer systems at nuclear power plants which monitor and control safety systems or that are involved in reactor operation are isolated from external communications. Security systems are also isolated from external communications, including the internet.[44]

Cyber security is a legitimate concern for a variety of industries, institutions, and critical infrastructure. This includes hospitals, schools, chemical plants, government buildings, data centers, financial institutions, telecommunication, transportation, and all forms of energy. However, due to physical safety features present within nuclear power plants, and especially inherently-safe features associated with advanced

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[41] Office of Atomic Development (Albany), An Atomic Development Plan for the State of New York, Dec 1, 1959. https://www.energy.gov/sites/default/files/2024-06/New%20York%20State%20Atomic%20Development%20Plan.pdf
[42] NRC. https://www.nrc.gov/security/domestic/phys-protect/areas.html
[43] NRC. https://www.nrc.gov/reactors/new-reactors/how-we-regulate/oversight/aia-inspections.html ; https://www.nrc.gov/docs/ML1835/ML18355A806.pdf
[44] NRC. https://www.nrc.gov/security/cybersecurity.html

reactors, the greatest concern with respect to nuclear power is likely to be that a cyber-attack could result in a temporary shutdown and loss of service to customers. But this is a concern for all power plants, substations, control centers, and grid infrastructure. A disproportionate focus on protecting nuclear plants from cyber-attack could leave other, equally consequential targets vulnerable.

4.2.3 Siting Challenges and Opportunities

We recommend including a reference and discussion of 10 CFR Section 100.10 - *Factors to be considered when evaluating sites.* The first sentence of the second paragraph should also clarify that the 20-mile NRC guidance applies to conventional reactors with population centers having a density of 500 people or more per square mile. The proper citation to reference for this is NRC Regulatory Guide 4.7, Revision 4.[45] At the end of the paragraph, it would be appropriate to add that advanced reactors that do not require a natural body of water for heat discharge have even more siting flexibility.

With respect to the siting, policy-makers are likely to be surprised by how much the general public actually supports nuclear power. Despite the efforts of naysayers, support for carbon-free nuclear energy continues to grow throughout the country as people learn about the technology's tremendous ability to provide abundant reliable energy, create high-wage jobs, slash greenhouse gas emissions, and conserve land. In fact, a recent study by the Pew Research Center found that support for nuclear is growing steadily nationwide with a majority in favor of the technology.[46]

This is particularly true in communities that have already experienced the benefits of nuclear power first hand. In 2022, Bisconti Research surveyed residents who live within ten miles of 52 nuclear power plants in the U.S. but who are not actually employed by the nuclear industry.[47] The survey found that 91% of plant neighbors held a favorable impression of their local plant, 88% were favorable to nuclear energy, and 78% would welcome a new reactor at the plant site. Even more, 86%, indicated that they would accept new SMRs. In another survey of 1000 adults, Bisconti found 88% of people living near a nuclear power plant supported nuclear power, compared to 77% in the general public.

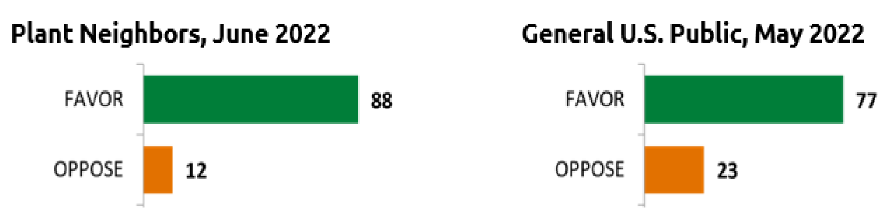

Figure 8. Source: Bisconti Research

[45] US-NRC (February 2024), General Site Suitability Criteria for Nuclear Power Stations, Regulatory Guide 4.7, Revision 4. https://www.nrc.gov/docs/ML2334/ML23348A082.pdf

[46] Pew Research Center (August 5, 2024). Majority of Americans Support More Nuclear Power in the Country. https://www.pewresearch.org/short-reads/2024/08/05/majority-of-americans-support-more-nuclear-power-in-the-country/

[47] Bisconti (June 2022). Reverse NIMBY: Nuclear Power Plant Neighbors Say "Yes." Bisconti Research, Inc. https://www.bisconti.com/blog/9th-national-survey-of-nuclear-power-plant-neighbors

Nuclear power enjoys support in New York around operating plants as well. In fact, by unanimous vote, the Wayne County Board of Supervisors adopted a resolution in July 2024 which calls for the relicensing of the Ginna Nuclear Power Plant on Lake Ontario while expressing a strong desire to secure new nuclear plant construction.[48]

Question:

• What process should the State use to engage in siting conversations with stakeholders?

One of the most practical locations for a new nuclear power plant is where an existing one already exists. This is not only advantageous because of proximity to transmission infrastructure, supply chains, and a trained workforce. It is also where community support is highest. Communities that surround nuclear power plants understand the technology because residents work there, because they appreciate lasting high-wage union jobs that are a hallmark of the industry, and because they experience the economic benefits that result.

Many nuclear power plants also have expansion capacity since they were designed for more reactors than were built. The DOE recently completed a study of all 54 operating and 11 recently retired nuclear plants in the country.[49] Considering various environmental factors, DOE found that between 65 and 90 GW of additional capacity could be built at existing sites. Notably, 90 GW is nearly half of the additional capacity needed to meet the country's goal for tripling nuclear power generation. Within New York, the same study found that two existing sites could host additional reactors, totaling more than a gigawatt of additional capacity. In the past, the operator of Nine Mile Point even proposed adding a reactor with a capacity of over 1.6 GW.

In addition to existing nuclear plants, existing or retired fossil fuel power plants are ideal locations for clean nuclear power. Converting fossil fuel sites to nuclear leverages existing infrastructure, industry knowledge, workforces, capital, and supply chains. Again, transmission is fast becoming a bottleneck to the clean energy transition, including within New York.[50] Thus, locating an advanced nuclear reactor at an existing or retired fossil fuel site allows for the efficient reuse of existing infrastructure. Replacing fossil fuel plants with nuclear reactors also ensures continuity for communities that are reliant on power facilities for energy, jobs, tax revenue, and economic development. The federal Inflation Reduction Act recognizes these social benefits by offering an additional investment credit corresponding to 10% of capital costs, thereby bringing the total support to potentially 50% of capital investment. A premier example of this type of

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[48] Buchiere (July 2024). Wayne County Board of Supervisors push for new nuclear facility. https://www.fltimes.com/news/wayne-county-board-of-supervisors-push-for-new-nuclear-facility/article_283b3a2a-443f-11ef-8f49-c760c57e9372.html

[49] Department of Energy (Sept 2024). DOE Report Finds More Than 60 Gigawatts of New Nuclear Capacity Could Be Built at Existing Nuclear Power Plants https://www.energy.gov/ne/articles/doe-report-finds-more-60-gigawatts-new-nuclear-capacity-could-be-built-existing-nuclear

[50] Kinniburgh (April 2024). Clean Energy Transmission Battle Pits Speed Against Worker, Farm Protections https://nysfocus.com/2024/04/05/transmission-renewable-energy-transition-new-york ;
Lie, Srikrishnan, Doering, Kabir, Steinschneider, Anderson (Sept 2023). Heterogeneous Vulnerability of Zero-Carbon Power Grids under Climate-Technological Changes. https://doi.org/10.48550/arXiv.2307.15079

conversion is TerraPower's Natrium reactor which will replace a retiring coal-fired power plant in Kemmerer, Wyoming.[51]

New York should consider a consent-based siting process for all energy generation projects, including nuclear power. This would not only help communities learn about potential technologies, but also shape future agreements and compete to host facilities. Kemmerer actually competed with three other communities in Wyoming – Rock Springs, Gillette, and Glenrock – all of which were eager to host TerraPower's Natrium plant. The DOE is already using consent-based siting to identify locations for consolidated interim storage of spent nuclear fuel, thereby demonstrating a commitment to collaborative planning. The process gives communities ample opportunity to engage, address concerns, and shape the partnership while ensuring that economic, environmental, and social benefits are sustained over time. Stability for both the community and project is provided through community benefit agreements and binding long-term leases. Designed to foster mutual trust, the process allows communities to confidently move forward, knowing that the partnership will bring enduring benefits to both the region and energy transition efforts.

4.3 Environmental and Climate Justice

The second paragraph in this section does not accurately describe uranium mining today. Instead, it describes activities of the past, particularly during the early years of the Cold War when there was a rush to obtain uranium, particularly for weapons production. Uranium extraction methods have evolved significantly since then. In-situ recovery (ISR) has become the dominant form of uranium production worldwide (57%) and within the United States.[52, 53] Unlike hard rock mining (open pit or underground), ISR recovers uranium from permeable rock by pumping a water solution underground, dissolving the metal, and then returning the resultant solution to the surface for minerals recovery. ISR has minimal surface disturbance, minimal carbon footprint, and no tailing or waste rock generation, leading to high sustainability ratings.[54] It is also important to recognize that because of its very high energy density, relatively little mining is required for fuel extraction. In fact, with respect to both fuel and material extraction, nuclear power has the least mining requirements of any energy source.[55]

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[51] McCombs, B., & Gruver, M. (Jan 2022). In tiny Wyoming town, Bill Gates bets big on nuclear power. AP News. https://apnews.com/article/climate-technology-business-wyoming-bill-gates-19a36eb0bd65e0999d26c0cc122f6158
[52] https://www.nrc.gov/materials/uranium-recovery/extraction-methods/isl-recovery-facilities.html
[53] World Nuclear Association (May 2024). In-Situ Leach Mining of Uranium https://world-nuclear.org/information-library/nuclear-fuel-cycle/mining-of-uranium/in-situ-leach-mining-of-uranium
[54] Morningstar Sustainalytics (May 2024). Company ESG Risk Ratings: Uranium Energy Corp shows this U.S. ISR producer to rank 14 out of 238 globally in the Diversified Metals category. https://www.sustainalytics.com/esg-rating/uranium-energy-corp/1031306735
[55] The Breakthrough Institute (Apr 2024). Updated Mining Footprints and Raw Material Needs for Clean Energy https://thebreakthrough.org/issues/energy/updated-mining-footprints-and-raw-material-needs-for-clean-energy

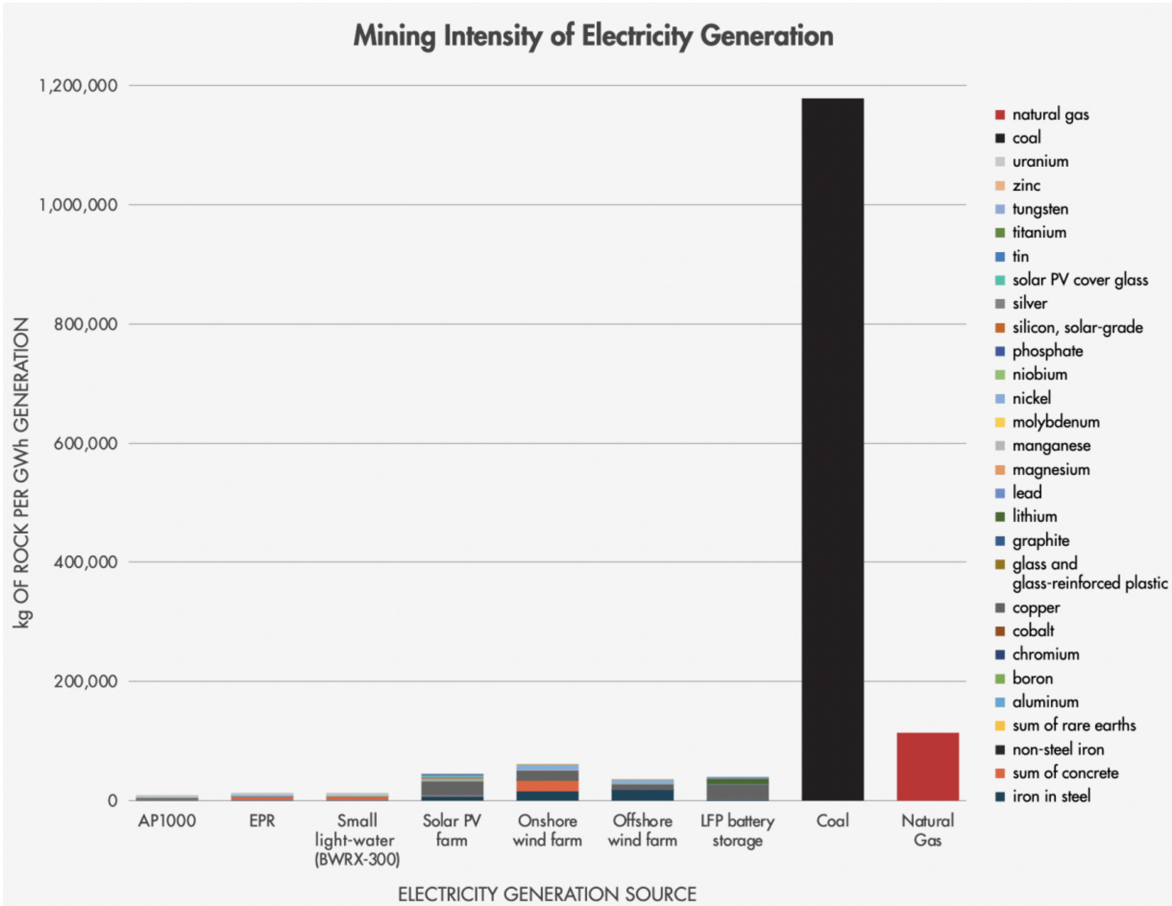

Figure 9. Source: The Breakthrough Institute

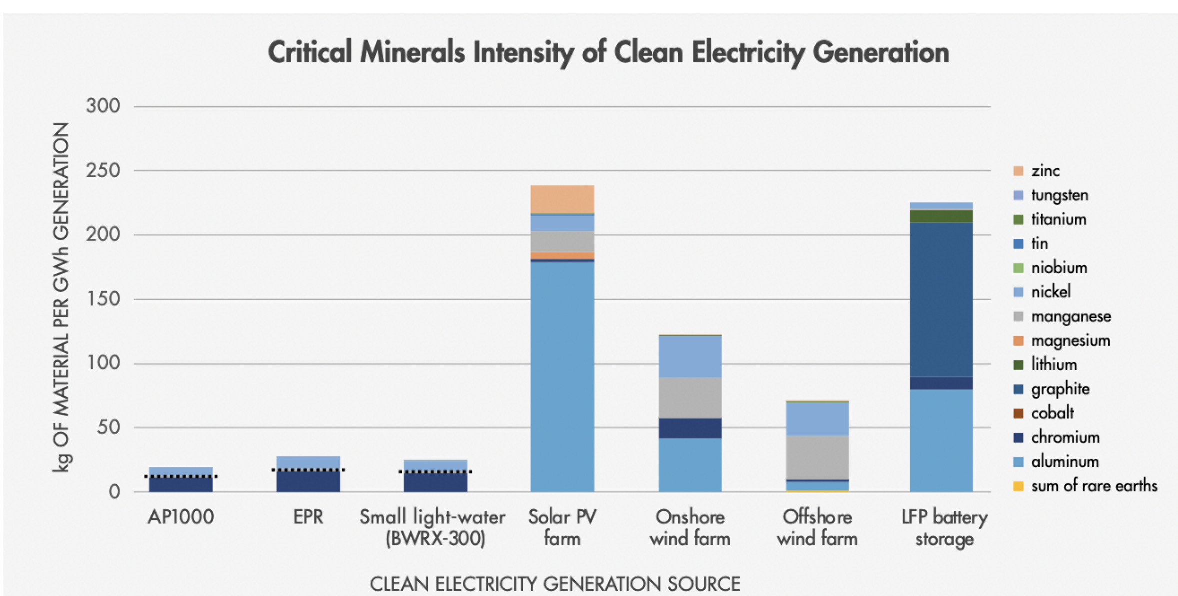

Figure 10. Source: The Breakthrough Institute

As previously discussed, and as the draft Blueprint acknowledges, nuclear power also occupies the least amount of land of any energy source. Because of its compact physical footprint and very small mining footprint, nuclear power offers the greatest potential to protect land–whether it be habitat for wildlife, farmlands for food production, or tribal land. We recommend that the draft Blueprint make this very clear.

We do not disagree with the last sentence which states that if new nuclear plants are sited, environmental and climate justice will be important to assess. However, we would assert that this holds true for all forms of energy supply, storage, and distribution–not just nuclear power.

Question:

• What role should the State play in promoting environmental and climate justice in the fuel cycle of advanced nuclear facilities in view of the fact that almost all of this activity will occur out-of-state?

Although the question correctly acknowledges that the fuel-cycle aspects of advanced nuclear power will occur largely out-of-state, the subject of environmental and climate justice is still relevant. However, it is relevant to all forms of energy, and it is relevant to both fuel and other mined materials. As discussed above, an objective comparison of clean energy options reveals that nuclear requires the least amount of mining and rock movement per unit of energy produced. Furthermore, in situ recovery has become the dominant form of uranium production worldwide and in the U.S.

Through reprocessing or the use of advanced fast-reactor technology, spent nuclear fuel can be recycled, thereby reducing the need for mining even more. In fact, it has been estimated that if used in fast reactors, the spent fuel presently stored at nuclear plants around the country could power the U.S. for a hundred years.[56] As previously discussed, weapons-grade material can also be down-blended to create LEU or HALEU fuels as took place during the remarkable *Megatons-to-Megawatts* program. This was not only a major win for international security, but also a major reason that domestic uranium mining subsided in the U.S. for several decades.

A comprehensive cradle-to-grave analysis of all energy generation technologies by the United Nations shows that nuclear has the lowest ecosystem impact, when considering climate change, land use, and human health.[57]

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[56] Clifford (June 2, 2022). The Energy in Nuclear Waste Could Power the U.S. for 100 Years, but the Technology Was Never Commercialized, CNBC. https://www.cnbc.com/2022/06/02/nuclear-waste-us-could-power-the-us-for-100-years.html
[57] United Nations Economic Commission for Europe (2022). Life Cycle Assessment of Electricity Generation Options https://unece.org/sed/documents/2021/10/reports/life-cycle-assessment-electricity-generation-options

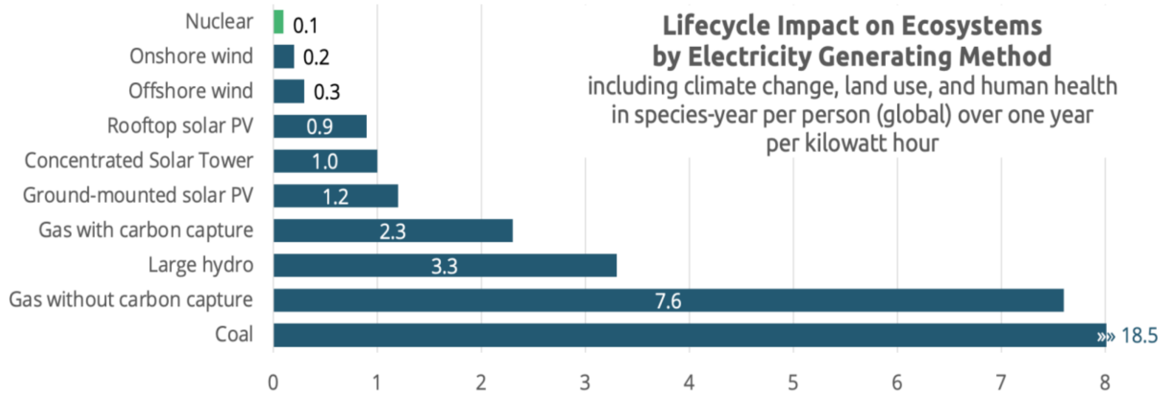

Figure 11. Source: UN Economic Commission for Europe

New York will promote environmental and climate justice – both locally and elsewhere – by advocating evidence-based decision-making, rather than by letting ideologically-driven actors control the narrative.

Question:

• How should siting advanced nuclear technologies incorporate the environmental and climate justice concerns of surrounding communities?

Nuclear plants generate well-paying jobs that enable vibrant, healthy, and prosperous host communities. New York's three operating nuclear energy plants support 25,000 jobs, contribute over $3 billion to New York's economy and generate $144 million state and local taxes annually.[58] Nuclear energy is produced with inexpensive fuel and high-skilled labor, the largest component of its costs.[59]

It should also be noted that communities affected by the closure of coal and other fossil fuel power plants are included in the federal definition of environmental and climate justice. Therefore, a focus on appropriately siting new nuclear at locations of closed fossil fuel power plants achieves climate justice and restores lost jobs. Replacing fossil fuel generation with nuclear power can help undo decades of injustice to communities that host or are adjacent to fossil fuel plants.

Needless to say, education is key to the acceptance of nuclear power. As discussed in our answer to the question on siting (subsection 4.2.3), New York should implement a consent-based siting process, through which communities can learn about the benefits of advanced nuclear technology, address concerns, and help forge effective agreements through which environmental, economic, and social benefits are achieved that serve both the host community and disadvantaged communities.

[58] Upstate Energy Jobs (n.d.). The Benefits of Upstate Nuclear Energy. https://upstateenergyjobs.com/nuclear-facts/
[59] Nuclear New York, Clean Energy Jobs Coalition-New York, A Campaign for a Green Nuclear Deal (July 2022). https://www.nuclearny.org/bright-future/

Question:

• How can New York's planning and oversight processes ensure that underserved and historically marginalized populations have equitable access to training and job opportunities in new nuclear projects?

New York should support the use of existing federal funding programs such as the $100 million DOE Nuclear Reactor Safety Training and Workforce Development Program.[60] NYSERDA should also develop Program Opportunity Notices (PONs) to support these goals, centering training opportunities with organizations whose mission includes workforce training of underserved and historically marginalized populations. One example is the Multi-Craft Apprenticeship Preparation Program (MAPP) with training locations in Rochester, Binghamton, and Albany.[61]

The nuclear industry has the highest paying and most unionized workforce of any energy sector.[62,63] Nuclear Power is also "Made in America" – a rare strategic sector that relies mostly on domestic supply chains, a STEM workforce, and expertise. Commercial nuclear power is also more gender diverse than the overall energy workforce, with a larger share of female workers (36% compared to 26%).[64]

Research by the International Monetary Fund confirms that nuclear has the largest economic multiplier effect of any energy technology.[65] It creates quality, well-paying union jobs for people and tax revenue for communities. By investing in advanced nuclear power, New York will be in the best position to deliver on its goal of providing 35% to 40% of benefits within disadvantaged communities.

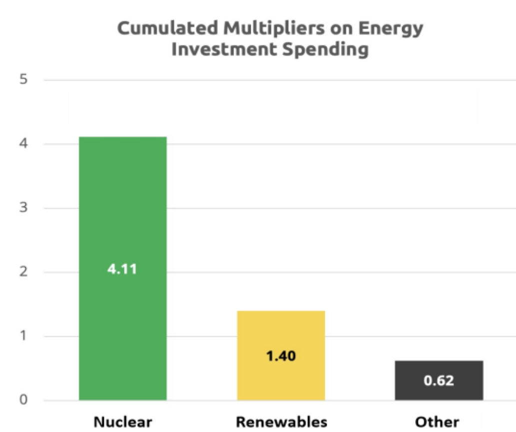

Figure 12. Source: International Monetary Fund

[60] Office of Nuclear Energy: Nuclear Reactor Safety Training and Workforce Development Program. https://www.energy.gov/ne/nuclear-reactor-safety-training-and-workforce-development-program
[61] Multi-Craft Apprenticeship Preparation Program. https://www.mappinc.org/who-we-are.html#who_we_are
[62] U.S. Department of Energy (September 2024). Pathways to Commercial Liftoff: Advanced Nuclear https://liftoff.energy.gov/advanced-nuclear/
[63] U.S. Energy & Employment Jobs Report (2023). National Report https://www.energy.gov/sites/default/files/2023-06/2023%20USEER%20REPORT-v2.pdf
[64] ibid.
[65] International Monetary Fund (2021). Building Back Better: How Big Are Green Spending Multipliers? https://www.imf.org/-/media/Files/Publications/WP/2021/English/wpiea2021087-print-pdf.ashx

4.4 Costs, Supply Chain Development, and Financing

4.4.1 Cost and Cost Uncertainty

This subsection of the draft Blueprint should be revised using current information from the updated DOE *Pathways to Commercial Liftoff: Advanced Nuclear* report that was released around September 25, 2024.[66] Not only is the information in the updated liftoff report more current than presented in the draft Blueprint; the updated liftoff report also provides a more comprehensive analysis of factors contributing to cost and schedule overruns of the Vogtle 3 and 4 reactors. As such, it also differs from the more skeptical discussion in the draft Blueprint. For example, the updated report explains that much of the "overruns" experienced by Vogtle can be attributed to underestimates of initial cost rather than unforeseeable events. It also delves into cost reductions seen from Unit 3 to Unit 4.

Table 2 of the Blueprint should be revised and additional information presented to more accurately describe these factors. These matters are further discussed in our answers to questions below.

Question:

• What is the likely realistic cost range for each technology, and how does this enter into the State's consideration?

This is a legitimate question, but also impossible to determine at this time with enough certainty to make valid comparisons. The Blueprint document should not attempt to draw conclusions about what advanced nuclear technologies to favor or reject based on cost at this stage, nor should cost be the single-most important factor in deciding what technologies to consider. Rather than speculating, a more effective approach would be to seek proposals from actual potential vendors where cost can be weighed along with other considerations.

It should be accepted that reliable, long-lasting, firm carbon-free sources will be more expensive than short-lived, intermittent sources that require more infrastructure and support facilities to be useful. However, firm generation is essential to fully decarbonize the electric grid, and as previously discussed, nuclear power reduces total system-level costs. Individual project costs are likely to be impacted as much by specific implementation as by technology predictions. We therefore recommend focusing first in a holistic manner on the full costs and feasibility of system-level architectures that achieve the goal of zero-emission electricity, and then consider individual generator costs.

It is also important to recognize that the unit cost of nuclear reactors will decline as more are built. MIT recently conducted a detailed analysis demonstrating that future AP1000 reactors will realize substantial cost reductions compared to "first-of-a-kind" (FOAK) construction at Vogtle.[67] This is further illustrated in DOE's updated liftoff report, which found that even when accounting for inflation and higher interest rates, the next AP1000 reactors in the U.S. should realize substantial cost reductions by taking advantage of IRA benefits. These include LPO loans for up to 80% of eligible project costs (Vogtle was lower than this),

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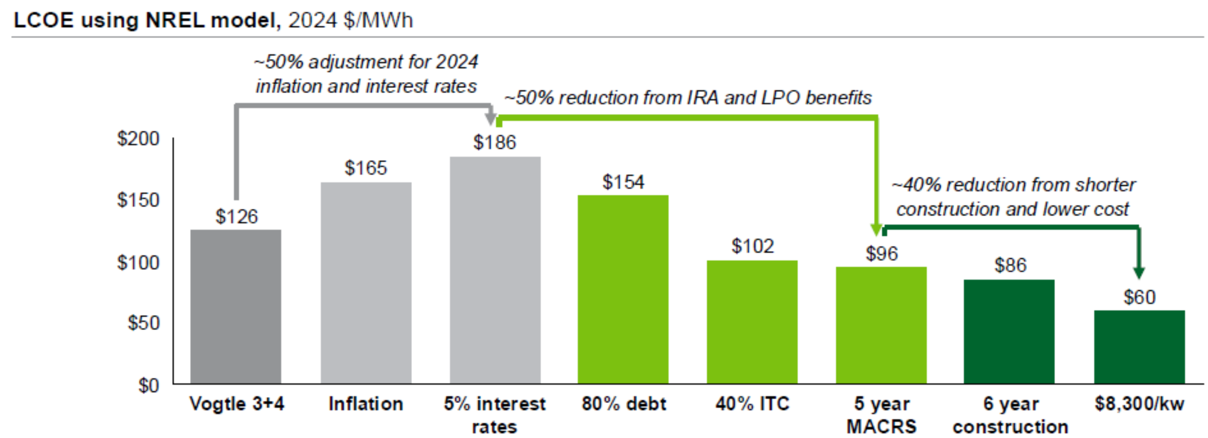
[66] U.S. DOE, The *updated* Pathway to Advanced Nuclear Commercial Liftoff https://liftoff.energy.gov/advanced-nuclear/

[67] Shirvan (July 2024). 2024 Total Cost Projection of Next AP1000 https://canes.mit.edu/2024-total-cost-projection-next-ap1000

Investment Tax Credits of 40% (assuming 30% base with a 10% adder), and a five-year Modified Accelerated Cost Recovery System (MACRS).



	Vogtle 3+4	Inflation	5% interest rates	80% debt	40% ITC	5 year MACRS	6 year construction	$8,300/kw
Overnight capital cost	$11,000	$15,000	$15,000	$15,000	$15,000	$15,000	$15,000	$8,300
Construction time	11 years	11 years	11 years	11 years	11 years	11 years	6 years	6 years
Interest rate on debt	3.5%	3.5%	5%	5%	5%	5%	5%	5%
Debt fraction	60%	60%	60%	80%	80%	80%	80%	80%
Tax credit	PTC (old)	PTC (old)	PTC (old)	PTC (old)	40% ITC	40% ITC	40% ITC	40% ITC
Depreciation	15 years	15 years	15 years	15 years	15 years	5 years	5 years	5 years

Figure 13. Source: DOE. Advanced Nuclear Liftoff

Question:

• How should the State assess the factors that affect the cost of new plants? The DOE Supply Chain Deep Dive report suggests "nuclear construction costs depend more on overall project management, experience accumulated over multiple units, regulatory interactions, contracting approaches, and local prices for labor and commodity inputs than on the direct costs of the reactor or any other equipment."

For large Light Water Reactors like the AP1000, South Korean APR1400, and European EPR, "nuclear island equipment" contributes a minor fraction (10%-22%) of the overall capital costs of a land-based project.[68] Most costs are indirect, relating to civil engineering and project management (yard, cooling, and instrumentation). Thus, project management and incentive alignment among vendors becomes essential.

[68] MIT Energy Initiative (2018) The Future of Nuclear Energy in a Carbon-Constrained World http://energy.mit.edu/research/future-nuclear-energy-carbon-constrained-world

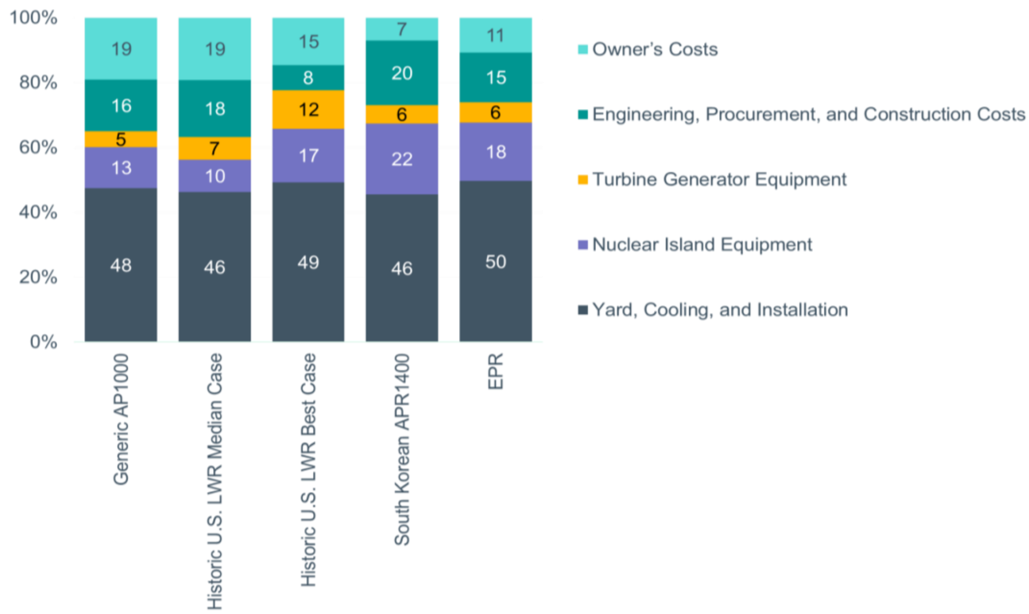


Figure 14. Source: MIT Energy Initiative

In 2020, the international energy and climate consultant LucidCatalyst explored the causes of nuclear cost and schedule overrun for the UK government.[69] It determined that the first challenge is to mitigate schedule risk for FOAK projects, and the second is to deliver meaningful cost reductions beyond FOAK to meet the expectations of investors, government, and consumers. The latter requires strategies to programmatically reduce construction time and total capital costs.

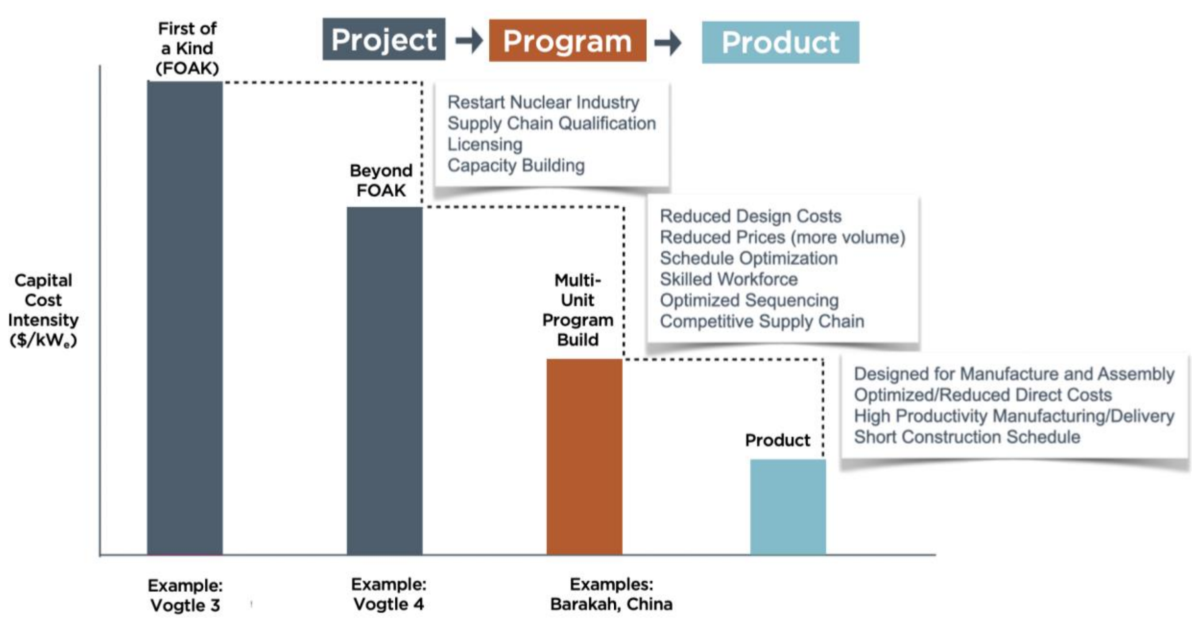


Figure 15. Source: LucidCatalyst

[69] LucidCatalyst (2020). The ETI Nuclear Cost Drivers Project: Full Technical Report https://www.lucidcatalyst.com/eti-nuclear-cost-drivers-full

The research team conducted more than 150 hours of interviews with experts in the U.K., France, South Korea, Japan, and the U.S. Checking cost driver rationales against publicly-available information, a comprehensive set of factors that contribute to low-cost and high-cost plants were identified:

Low-Cost Plants	High-Cost Plants
● Design at or near complete prior to construction ● High degree of design reuse ● Experienced construction management ● Low-cost and highly productive labor ● Experienced EPC consortium ● Experienced supply chain ● Detailed construction planning prior to starting construction ● Intentional new build program focused on cost reduction and performance improvement ● Multiple units at a single site ● Nth of a Kind (NOAK) design	● Lack of completed design before construction started ● Major regulatory interventions during construction ● FOAK design ● Litigation between project participants ● Significant delays and rework required due to supply chain ● Long construction schedule ● Relatively higher labor rates and low productivity ● Insufficient oversight by owner

Significantly, South Korean project managers recently completed the Barakah nuclear plant in the United Arab Emirates both on-time and on-budget.[70] Several characteristics of the project stand out:

- Barakah was a four-reactor project, enabling shared site infrastructure, a single mobilization effort, bulk purchasing, and shared overhead.
- Despite having no prior nuclear development expertise, the Emirates Nuclear Energy Corporation (ENEC) became an informed buyer and created incentives for all parties to improve costs and schedule.
- Korean Electric Power Corporation (KEPCO) led an effective consortium with expertise in construction management and supply chains.
- The selected APR1400 reactor was a completed design with prior successful real-world deployment in Korea.

This resulted in one of the fastest clean energy deployments in history.[71] It also serves as an example of how New York can avoid the cost and schedule overruns that occurred at the Vogtle plant in Georgia. By contrast, Vogtle began construction with an incomplete design, an immature supply chain, and an

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[70] Decouple Media (April 2023). His Excellency Mohammed Al Hammadi, the CEO of the Emirates Nuclear Energy Corporation https://www.youtube.com/watch?v=6vtc3fD_jvc

[71] The Radiant Energy Group (Nov 2023). Insights from the World's Fastest Build-outs of Clean Electricity https://www.radiantenergygroup.com/reports/insights-from-the-world-s-fastest-build-outs-of-clean-electricity ;
The ETIC Nuclear Cost Drivers Project (September 2020). Lucid Catalyst. https://www.lucidcatalyst.com/eti-nuclear-cost-drivers-full

untrained workforce.[72] Nonetheless, the AP1000 design is now complete, there is a supply chain infrastructure, and Vogtle has trained over 30,000 workers.[73] In fact, even within the recent two-unit Vogtle build, major improvements in construction time and cost were realized from Unit 3 to Unit 4. Vogtle is not a correct anchor point for predicting the cost of additional AP1000s since many of those FOAK costs will simply not recur.

Improvement in Time to Complete Key Milestones Between Vogtle Units 3 and 4

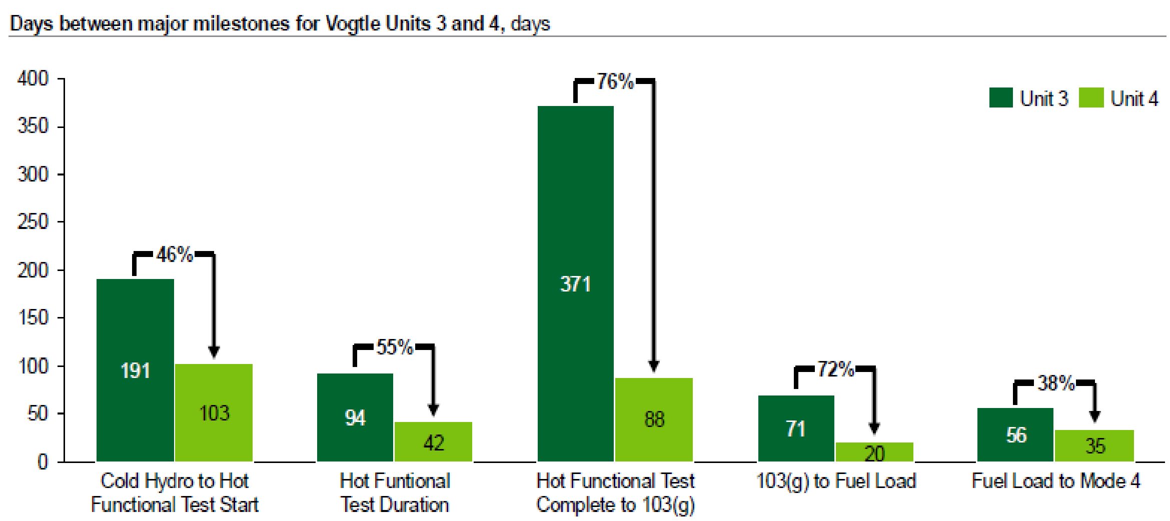

Figure 16. Source: DOE Advanced Nuclear Liftoff

Creating a committed order-book of several reactors for a given design will be important to establish cost and schedule certainty.[74] One way of achieving this could be through a regional consortium involving New York and other states that would enable the pooling of resources to overcome FOAK challenges and limit risk exposure on individual projects. We note that New York has led regional efforts in demand aggregation and supply chain alignment for both offshore wind and clean hydrogen, so a similar effort could be appropriate for advanced nuclear. Through a regional consortium, participants would be able to convene large energy consumers (data centers, industry), utilities, Regional Transmission Organizations, and nuclear technology vendors to develop a common understanding of issues, standardize reactor designs, and schedule multi-unit projects. Furthermore, by pooling financial resources, FOAK investors could benefit from "Nth-of-a-kind" (NOAK) savings. (See further discussion of this in our comments on Chapter 5, *Next Steps*.)

[72] U.S. Department of Energy (September 2024). Pathways to Commercial Liftoff: Advanced Nuclear https://liftoff.energy.gov/advanced-nuclear/
[73]ibid.
[74]ibid.

4.4.2 Construction and Labor Supply Chain Development

Questions:

• How should the State consider construction supply chain issues in its consideration of advanced options? If so, what level of plant- or design-specific examination is appropriate?

• How do national supply chain shortages impact economic development of advanced nuclear technologies in the State?

• Can State-level policies influence supply chain improvements?

• Do national supply chain shortages create an opportunity for economic development of supply chain-related business into the State?

• How can the State assess and improve nuclear workforce readiness, and is there an opportunity to export readiness training nationally?

Global and national supply chain shortages, like those seen in recent years due to geopolitical conflicts and the COVID-19 pandemic, are unpredictable. However, one way to reduce exposure to these risks is to prioritize domestic supply chains. The industrial base needs to expand substantially for the U.S. to triple nuclear generation by 2050. New York can be at the forefront of reaping the benefits of this industrialization with the proper incentives and business environment.

A strong domestic supply chain and favorable economies of scale will develop as demand increases. The delays and cost overruns of the AP1000 builds at Vogtle were partly due to work starting before designs were finalized, but also because the factories producing technology modules were operating at low volumes.

New York should collaborate with other states facing similar challenges and coordinate their plans to offer vendors more attractive economies of scale. By pooling requests for proposals, vendors could compete to build not just two or three reactors, but six, twelve, or more under a single bid. This approach would significantly reduce costs for future nuclear reactor projects, ensuring the growth of a robust supply chain, a skilled workforce, and competitive pricing through mass production.

New York has the necessary expertise, nation-leading apprenticeship programs, and financial sophistication to capture the economic rewards of carbon-free nuclear power.[75] Early investment in technical and process training by the State or with public-private partnerships can ensure a sufficient workforce to cater to the growing needs. With respect to training, the State can evaluate skilled labor gaps and further invest in community colleges and trade schools to ensure that necessary skills are developed.

[75] Nuclear New York, Clean Energy Jobs Coalition-New York, A Campaign for a Green Nuclear Deal (July 2022). https://www.nuclearny.org/bright-future/

4.4.3 Project Development and Financing Concepts

Questions:

• What is the nature of and level of development and cost risk that the state can consider in advanced nuclear technology projects?

• What policies and policy levers does the State have to reduce or allocate these risks?

• How can the value of federal incentives be maximized?

• Beyond workforce and supply chain opportunities, what could be the potential value in advancing demonstration sites?

Federal incentives from the Inflation Reduction Act are available for nuclear technologies along with other clean energy technologies. For example, up to 50% of the cost of building nuclear plants can be paid for through Investment Tax Credits alone. Additionally, the federal Loan Program Office (LPO) offers favorable debt financing and loan guarantee options through the Title 17 Clean Energy Financing program.[76] This critical tool is designed to accelerate the deployment of clean energy and decarbonization technologies to promote good jobs, support supply chains, and enable an equitable energy transition. The Federal Financing Bank (FFB) is comfortable with issuing loans for up to 80% of reasonably anticipated eligible Project Costs. Loan terms can be up to 30 years and interest rates are extremely attractive (treasury rate + 0.375% + risk-based charge).

Beyond private sector participation, State Energy Financing Institution (SEFI) Supported Project loans are available to a state, tribal, or Alaska Native entity to provide financing assistance or credit for eligible clean energy projects.[77] LPO provides a toolkit for SEFIs to learn more.[78]

Given the AP1000's high readiness level, along with a strong domestic supply chain and an experienced workforce, this reactor should be considered for early deployment. However, additional incentives are also available for novel reactors, including support from the ADVANCE Act, signed into law by President Biden in July 2024, following Congressional passage with strong bipartisan support.[79]

Large-scale clean energy procurements, prompted by Renewable Portfolio Standards (RPS) and other mandates, have helped to reduce the cost of onshore wind and solar around the country. New York is now also trying to replicate such a strategy for offshore wind. The State should initiate a similar program to induce the deployment of firm clean generation, including advanced nuclear.[80] Such a commitment would

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[76] Department of Energy Loan Programs Office (n.d.). Title 17 Clean Energy Financing. https://www.energy.gov/lpo/title-17-clean-energy-financing

[77] Department of Energy Loan Programs Office (n.d.). Title 17 Clean Energy Financing – State Energy Financing Institution (SEFI)-Supported Projects https://www.energy.gov/lpo/state-energy-financing-institutions-sefi-supported-projects

[78] Department of Energy Loan Programs Office (n.d.). State Energy Financing Institution (SEFI) Toolkit https://www.energy.gov/LPO/SEFIToolkit

[79] DOE https://www.energy.gov/ne/articles/newly-signed-bill-will-boost-nuclear-reactor-deployment-united-states

[80] Such a program has also been considered by the Biden administration
The White House (Dec 2021), *Executive Order on Catalyzing Clean Energy Industries and Jobs Through Federal Sustainability.* https://www.whitehouse.gov/briefing-room/presidential-actions/2021/12/08/executive-order-on-catalyzing-clean-energy-industries-and-jobs-through-federal-sustainability/

help the private sector secure attractive financing terms from institutional capital pools to cover construction costs. This, in turn, would significantly reduce the delivered energy price of high-capital-cost projects that last many decades, like nuclear.

NYSERDA has recently indicated that it will provide close to $150 per megawatt-hour "strike price" guarantees for offshore wind.[81] However, offshore wind is intermittent generation with a capacity factor of less than 50%. It cannot ensure the provision of electricity when needed. To be useful, offshore wind, like other intermittent generation, requires significant additional support infrastructure (storage and backup generation) that incurs additional cost. If procurements at this price level are justified for offshore wind, then the State should consider the procurement of "firm" clean power, like nuclear, that is available 24/7 at a premium. If New York is to successfully and affordably decarbonize its electric grid, clean energy procurement rates should be structured to appropriately value the system-level services that "firm" generation provides.

In addition to this, New York should consider technology-neutral Power Purchase Agreements for firm clean energy for electricity consumption by state government buildings and affiliated institutions (such as the State University of New York). As the State has an interest in ensuring the reliability of New York's grid, it is appropriate for the State to contribute to the purchase of firm clean energy itself.

The EFI Foundation has also demonstrated how a cost stabilization facility that centers on a special loan mechanism provided would help risk sharing by private sector developers.[82] New York can implement a similar effort, or work to put such a mechanism in place at the LPO.

As we discuss in our comments on Section 4.4.1 and Chapter 5, New York could also limit its exposure to project risk by participating in a regional consortium with other states to collaborative plan for and share in the deployment and financing of advanced reactors serving customers within and outside of the NYISO control area. By pooling resources, FOAK investors could benefit from NOAK savings, while all participants benefit from deploying a fleet of reactors that must start with the construction of the first. That said, by actually supporting a demonstration project or FOAK reactor in New York, the state would be able to position itself as a leader in advanced nuclear technology, and ensure that business and industry in New York reap the early benefits of reliable carbon-free energy.

[81] M. French (February 29, 2024) Offshore wind costs double for consumers as New York keeps early projects on track, Politico. https://www.politico.com/news/2024/02/29/offshore-wind-costs-new-york-projects-00144143
[82] EFI Foundation (Oct 2023) A Cost Stabilization Facility for Kickstarting the Commercialization of Small Modular Reactors https://efifoundation.org/foundation-reports/a-cost-stabilization-facility-for-kickstarting-the-commercialization-of-small-modular-reactors/

4.4.4 Fuel Supply Chain Development

Questions:

• What level of assessment of fuel supply chain issues do stakeholders think is appropriate for further consideration of advanced nuclear technology options?

• What form and level of fuel supply assurance should be part of future state considerations of specific advanced nuclear technology options?

Advanced nuclear power plants based on Light Water Reactor technology are unlikely to experience LEU supply chain issues. However, fuel supply chains could initially be a concern for advanced nuclear reactors that require HALEU. Fortunately, significant progress is being made in domestic enrichment to resolve this. As previously discussed, sources of more highly enriched uranium can also be down-blended to produce HALEU. In the future, "waste" from existing and advanced reactors will also contribute to the fuel cycle of advanced reactors through recycling. In 2024, seeking to wean the U.S. from dependence on Russian supplies, Congress provided $2.7 billion to incentivize a domestic fuel supply chain.[83] By moving towards nuclear new builds, New York will provide market signals to the private sector that create supply chains, and help to accelerate the resolution of these issues.

4.5 Fusion Reactors

Questions:

• What steps are appropriate for monitoring the progress of fusion power plants?

• At what point should further steps be taken by the State either to promote fusion as an option or to consider how fusion would fit into its energy planning and permitting processes?

The State should be realistic in its approach to fusion. As discussed in our comments on Section 3.4, nuclear fusion is still in the research phase, and far from development of a commercially-viable design capable of producing electricity. Furthermore, fission already offers many if not all of the advantages that fusion promises: reliable, abundant carbon-free energy with minimal impact on the environment.

A decision to pursue fusion energy should be based on careful evaluation of its benefits and readiness rather than in response to unfounded concerns over fission. If fusion reactors approach technical and commercial readiness, they should be considered. However, at this time, the technical readiness of fusion technology has to be considered more distant than that of any fission concept.

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[83] DOE (July 2024). Newly Signed Bill Will Boost Nuclear Reactor Deployment in the United States
https://www.energy.gov/ne/articles/newly-signed-bill-will-boost-nuclear-reactor-deployment-united-states

4.6 Waste Generation and Disposal

It appears that the "waste" discussed in this section is spent nuclear fuel. However, there are different types of waste, so this should be made clear.

Spent fuel produces radiation and heat that requires shielding. Today, spent fuel from conventional light water reactors are initially held in pools, where about 20 feet of water is sufficient to provide adequate shielding.[84] After a few years (3 to 10), radiation and heat from the spent fuel has decreased significantly. The spent fuel is then transferred to secure dry casks which continue to provide shielding and dissipate heat. Although longer-lived transuranic elements that produce less intense radiation remain, the more radioactive fission products in spent fuel substantially decay within a couple hundred years.[85] Notably, advanced fast reactors allow for more complete consumption of nuclear fuel that can eliminate longer-lived transuranics.

The third paragraph states that advanced reactors produce waste that is "similar" to conventional reactors. However, waste streams differ both in composition and physical form, depending on the type of advanced reactor.

Question:

• How can the State evaluate and prioritize advanced nuclear technologies based on their waste management capabilities and overall environmental impact?

The concern over spent fuel ("waste") from nuclear reactors is more perceptual than technical.[86] As discussed in the draft Blueprint, the volume of spent fuel is minimal, especially compared to the amount of electricity produced. In fact, a uranium pellet the size of a gummy bear produces as much energy as a ton of coal. Consequently, the entire volume of spent fuel from commercial nuclear power in the U.s. could fit within a single Walmart. Whereas the fossil fuel industry releases its waste into the atmosphere where it contributes to air pollution and climate change, spent nuclear fuel is compact and contained. Nobody has ever been harmed by spent fuel in dry cask storage.

The low volume, compact, and contained nature of spent nuclear fuel makes it very manageable. It can be recycled through reprocessing–as has been done in France for decades–or used with little or no reprocessing as fuel in fast reactors. Given its beneficial use, spent nuclear fuel should not be considered waste, but instead a resource for the future. Ideally, fast reactors will eventually become part of the state's energy portfolio since they can consume spent fuel. However, there is no compelling reason to prioritize, or to exclude, a particular type of advanced reactor based on waste management alone. Providing reliable energy for a robust economy while reducing greenhouse gas emissions and air pollution ought to be the State's focus of attention.

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[84] U.S. NRC, Spent Fuel Pools. https://www.nrc.gov/waste/spent-fuel-storage/pools.html

[85] U.S. NRC Backgrounder on Radioactive Waste. https://www.nrc.gov/reading-rm/doc-collections/fact-sheets/radwaste.html

[86] World Nuclear Association (updated August 12, 2024). Radioactive Waste–Myths and Realities. https://world-nuclear.org/information-library/nuclear-fuel-cycle/nuclear-waste/radioactive-wastes-myths-and-realities

Question:

• How can the State work with the federal government to manage nuclear waste?

New York can work with the federal government by cooperating in on-site storage at nuclear plants, the development of reprocessing capabilities in the U.S., and the development of a permanent disposal methodology. In the future, reprocessing may even be possible on-site at nuclear plants utilizing closed-loop technology being developed by Exodys Energy, based in New York.[87]

5 Next Steps

What Other States Are Doing

New York can benefit greatly from processes already underway in other states that are actively evaluating how to incorporate advanced nuclear power into their climate, energy, and economic growth plans. Some examples leading in this effort are Texas, Ohio, Kentucky, and Virginia.

In August 2023, Governor Abbott of Texas directed the Public Utility Commission of Texas to establish a working group to "study and plan for the use of advanced nuclear reactors."[88] In his letter to the Commissioner, he wrote:

> *Nuclear energy is a proven, reliable, and dispatchable generation resource. It will become even more critical as Texas' need for reliable power continues to grow. The State of Texas must plan now to best harness these new advanced technologies and ensure the future of the Texas grid and our position as the energy capital of the world.*

The Texas working group consists of credentialed stakeholders including the Public Utility Commission, nuclear energy companies, several advanced reactor developers, business leaders, and institutions with the express purpose of determining how to ensure timely deployment of advanced nuclear technology, research incentives and permitting, and work with the state's grid operator. The working group is scheduled to issue findings and recommendations by December 2024.

Similarly, in 2023, the state of Ohio created an Ohio Nuclear Development Authority, overseen by a nine-member board that is appointed by the governor.[89] The Authority was created for the express purpose of boosting research and development of advanced nuclear reactors, commercial isotope production, and nuclear waste reduction and storage technology within the state. To fulfill these objectives, the Authority is empowered to develop a strategic plan, foster public-private partnerships, approve agreements with the NRC and DOA for the joint development of advanced nuclear reactors, and support education about the isotope industry. The Authority will also work with industry, academia, and federal agencies to develop advanced nuclear components for safety, advanced fuels, instrumentation, and spent-fuel handling. Significantly, the Authority is directed to prioritize projects that reduce nuclear waste and produce

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[87] Exodys Energy https://www.exodysenergy.com/
[88] Public Utility Commission of Texas: Texas Advanced Nuclear Reactor Working Group https://www.puc.texas.gov/industry/nuclear/
[89] Ohio's Nuclear Development Authority. https://lpdd.org/resources/ohios-nuclear-development-authority/

beneficial isotopes. Members of the Ohio Nuclear Development Authority consist of individuals from three stakeholder groups within the nuclear engineering and manufacturing fields of safety, industry, and engineering research and development. Specific industry credentials and experience must be demonstrated for each.[90]

Kentucky has recently created a Nuclear Energy Development Working Group consisting of the state's Public Service Commission, electric utilities, the Tennessee Valley Authority, U.S. Nuclear Industry Council, DOE National Laboratory, the Nuclear Energy Institute, and others. The group has already produced a report with specific recommendations for the structure of a Kentucky Nuclear Energy Development Authority (KNEDA), as well as an outline of activities to be pursued over the next several years to further the deployment of nuclear power.[91] KNEDA is empowered to develop nuclear capacity and promote economic incentives, research financial support and permitting, engage communities transitioning from fossil fuels, work with the NRC on siting and streamlining, determine how to share investment risk, and work with DOE and others on technology to recycle spent fuels. Kentucky is also developing a financial assistance program with KNEDA for locating and developing nuclear energy-related projects.

Of particular interest, Governor Youngkin of Virginia has announced a plan to make his state a leader in reliable clean energy by developing a Nuclear Innovation Hub.[92] To be located in southwest Virginia, the Nuclear Innovation Hub will deploy some of the first commercial SMRs in the country, support workforce development, and develop spent fuel recycling technology. The hub will also assist in the deployment of nuclear-hydrogen projects at existing and future reactors statewide. Recognizing the ground-floor opportunity to be an incubator for innovation, Virginia is not shying away from first-of-a-kind projects. Supporting this effort, the state has also established a Virginia Nuclear Energy Consortium (VNEC) consisting of universities, utilities, and reactor technology companies with a mission to establish the state as global leader for business development, research, training, and information on nuclear energy.[93]

For a comprehensive account of actions being taken by states around the county on advanced nuclear power, see the interactive NARUC-NASEO Advanced Nuclear State Action Tracker.

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[90] Ohio Legislative Service Commission, Boards and Commissions: Ohio Nuclear Development Authority https://www.lsc.ohio.gov/publications/boards-and-commissions/ohio-nuclear-development-authority

[91] Report to the Kentucky Legislative Research Commission Pursuant to 2023RS SJR 79, Kentucky Office of Energy Policy, November 17, 2023. https://eec.ky.gov/Energy/Documents/Final%20Report%20SJR79_11.17.23.pdf

[92] Case Study: Virginia's Advanced Nuclear Future, Nuclear Innovation Alliance https://nuclearinnovationalliance.org/case-study-virginias-advanced-nuclear-future

[93] Virginia Nuclear Energy Consortium: Virginia is Nuclear. https://virginianuclear.org/

States Evaluating or Pursuing Advanced Nuclear Technology

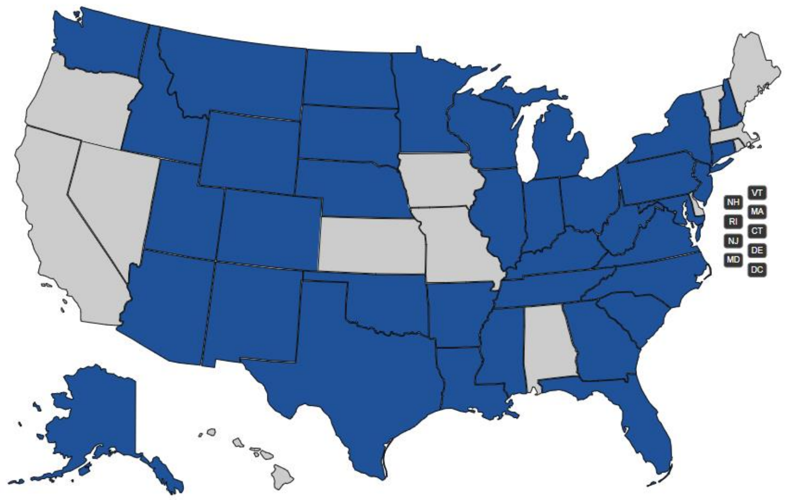

Figure 17. Source: NARUC-NASEO Nuclear State Action Tracker

Establish a New York Advanced Nuclear Working Group

New York should likewise seize the opportunity created by Governor Hochul to establish itself as a leader in nuclear innovation for the 21st century. Indeed, the Empire State has been a leader historically in nuclear technology, from the development of reactors on Lake Ontario to Knolls naval propulsion laboratory in Schenectady. Building on that legacy, advanced nuclear technology can supply clean energy for the state's growing manufacturing sector, to power data centers for AI, and to meet the needs of all New Yorkers as the electrification of other sectors doubles demand. New York has already demonstrated regional leadership with respect to hydrogen hubs. It is entirely consistent for the State to lead on nuclear energy as well.

We would add that New York is well positioned to take this on. In January 2024, Alyse Peterson, Senior Advisor for Nuclear Coordination and Radioactive Waste Policy for NYSERDA, became co-chair of the National Advanced Nuclear State Collaborative (ANSC). ANSC was formed by the National Association of Regulatory Utility Commissioners (NAREC) and the National Association of State Energy Officials (NASEO) with support of DOE in 2023 to enhance collective understanding of regulatory and policy issues surrounding the deployment of new nuclear generation and to support shared learning.[94] By joining ANSC in a leadership capacity, New York has already signaled its interest in deploying advanced nuclear power.

Specifically, we recommend that the Governor of New York appoint an **Advanced Nuclear Technical Working Group** similar to the one now functioning in Texas to study and plan for the deployment of advanced nuclear power plants.[95] Operating under the direction of the state's Public Utility Commission (comparable to New York's Public Service Commission), the Texas Working Group was created by order of

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[94] NARUC, Advanced Nuclear State Collaborative
https://www.naruc.org/core-sectors/electricity-energy/nuclear-energy/advanced-nuclear-state-collaborative/

[95] Texas Advanced Nuclear Reactor Working Group (fact sheet)
https://ftp.puc.texas.gov/public/puct-info/industry/nuclear/Working_Group_Fact_Sheet.pdf

the Governor to foster the deployment of new nuclear and overcome challenges, identifying financial incentives, regulatory impediments, and opportunities for accelerated permitting, determining changes needed to electricity markets, and engaging supply chain manufacturers. To achieve this, that working group is supported by four subgroups with areas of focus described as follows:[96]

- ***Development and Manufacturing**: To evaluate advanced reactor development and research, financial incentives, workforce, supply chain and siting considerations.*
- ***Market Demand/End User:** To consider the current and expected future demand for high quality nuclear power, as well the benefits advanced nuclear energy can provide to end-use customers in and out of the ISO grid.*
- ***State and Federal Regulatory:** To study and consider ISO market design, other state regulatory improvements, and federal regulatory process recommendations.*
- ***Higher Education and Research & Development:** To facilitate collaboration with higher education institutions and national laboratories to utilize research that has been going on for years in the space and evaluate current education and workforce pipeline to support this new industry.*

A similar model is appropriate for New York. Membership should include individuals with expertise in the nuclear industry itself, the state's electric grid, material science, regulation, and finance. Given the history of nuclear waste processing in New York, the potential for advanced nuclear technology to reduce the volume and radiologic level of nuclear waste, and the state's commitment to environmental justice, it may also be useful for New York to create a subgroup on **nuclear waste recycling**.

Like the Texas working group, in order to maintain momentum and establish New York as a technology leader, the New York Advanced Nuclear Technical Working Group and its subgroups should commence work immediately and meet frequently–either on a weekly or biweekly basis–to produce a detailed report to the Governor within a year. By swiftly appointing a technical working group and assigning it the above task, policy-makers will have the best information with which to make informed decisions.

Importantly, the Working Group and its subgroups should be composed of individuals with demonstrated technical credentials in the subject matter identified, who understand the need for reliable energy to support economic growth, and who will work together to make carbon-free advanced nuclear part of the state's energy portfolio.

<u>Other Collaboration</u>

In parallel with the above, we recommend that New York work with other states to establish a consortium for sharing in the financing and deployment of advanced nuclear technology within the region. As explained in the DOE's nuclear liftoff report and discussed in our comments, the economics of advanced nuclear power become increasingly attractive as more plants are built. By cooperating in technology selection, planning of projects, and development of supply chains and workforces, New York can help launch a new era of nuclear construction that will uplift economic and decarbonization efforts both in the state and

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[96] Rather than "ISO," the Texas working group fact sheet refers to the Electric Reliability Council of Texas (ERCOT), which is the Independent System Operator (ISO) for the Texas electric grid.

region. Moreover, by pooling financial resources, a regional consortium can secure an order-book of multiple reactors critical to Nth-of-a-Kind economies of scale. As part of a larger planning effort, such a consortium will additionally allow New York to benefit from the nuclear renaissance underway in Pennsylvania, Ohio, Maryland, and Virginia where former nuclear plants are being restored and new ones are planned.

Additionally, New York should engage resources of the New York Power Authority (NYPA), the largest state public power authority in the nation. In the past, NYPA was instrumental in the development of New York's upstate reactors, including the James Fitzpatrick power plant, named after its former chairman. The Authority was also an interim owner and operator of Indian Point Unit 3. As with its early investments in hydropower and nuclear, NYPA is well-suited to provide critical support for projects serving a public need. Credible advocates for public power recognize this as well. In its 2022 issue brief on nuclear energy, the American Public Power Association, which has existing since 1940, states:

> *The American Public Power Association (APPA) supports the continued use of nuclear power, a key source of baseload, emissions-free electricity. …APPA also believes that federal policies should continue to facilitate the construction of new nuclear facilities and further the development of advanced nuclear technologies, including small modular reactors (SMRs).*[97]

Whether through the direct construction of public works projects or in partnership with industry, investing in advanced nuclear power is consistent with NYPA's mandate to ensure reliable operation of the State's electric grid. We believe this is also consistent with its authority under the Build Public Renewables Act to develop technologies needed to complement renewables on the grid.

Needless to say, it will be important that bodies created to objectively evaluate the potential for advanced nuclear technology in New York be composed of qualified individuals and institutions that are open to the potential for new nuclear power in the state. Appointed bodies will not be effective if internally hamstrung by participants categorically opposed to fission or operating at cross-purposes to its mission. The Future Energy Economy Summit in Syracuse was effective, in part, because Governor Hochul was cognizant of this.

<u>A Case for Urgency</u>

The recent success of New York in winning major high-tech manufacturing investments and the explosive growth of data centers around the nation have brought attention to an inconvenient truth: New York has been limiting and reducing the supply of reliable electricity more than growing it in recent years. Although the "Green Chips" program succeeded in securing commitments from Micron to invest up to $100 billion in new manufacturing facilities, construction has not yet begun. And while new data centers planned in Virginia are being measured in multi-gigawatts of 24/7 electricity, the number of new data centers planned in New York amounts to a rounding error of those plans in comparison.

In the near term, New York must show a willingness and ability to secure the ultra-reliable power[98] that these new industrial loads demand or risk losing those industries and the economic prosperity they

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[97] American Public Power Association-Powering Strong Communities (June 2022) Issue Brief: Nuclear Power. https://www.publicpower.org/system/files/documents/70%202022%20PMC%20Issue%20Brief_Nuclear%20Power_FINAL.pdf

[98] Data Centers are classified by reliability tiers I-IV, ranging from 99.671% to 99.995 availability. *Data Center* Reliability Levels, GCore, August 12, 2021. https://gcore.com/learning/data-center-reliability-levels/

promise. While ensuring that decisions are based on appropriate deliberation, the state must also act swiftly to build the clean reliable power that will be needed. Failure to do so means that New York will stand in line behind other states who are already planning for advanced nuclear. The penalty for indecision is that businesses and jobs leave New York.

Data Centers Require Ultra-Reliable Electricity
(level of service for Tier I-IV facilities)

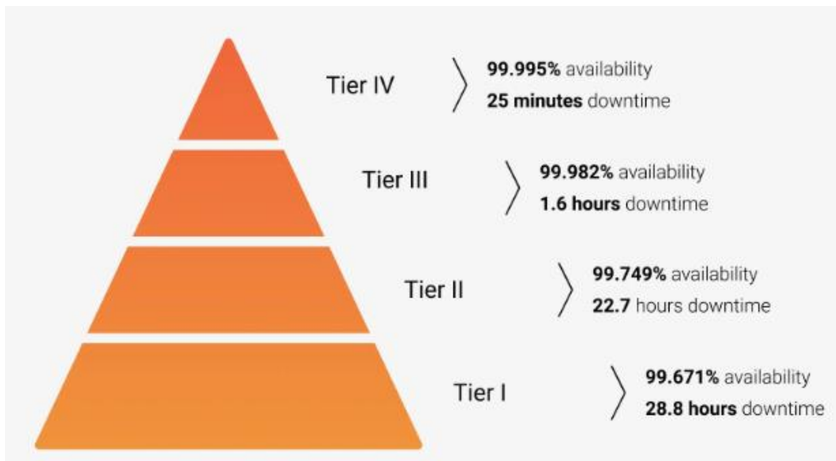

Figure 18. Source: GCore

Concluding Thoughts

The view that any technology not matching a narrow definition of renewable is a "false solution" has hindered action on climate change. Carbon-free nuclear power has the smallest physical footprint and smallest mining/material footprint of any energy source, thereby conserving farmland and nature. Operating in 28 states in the U.S. and 32 countries, nuclear power is as safe as renewable energy, and its "waste" is compact, contained, and recyclable. Advanced nuclear technology is not only essential to meeting climate goals, it is key to abundant reliable energy essential for economic growth. If New York hopes to dramatically reduce greenhouse gas emissions and ensure a prosperous future, it will reject ideologically-driven narratives and develop a realistic plan that embraces a diverse solution set. Other states are already exploring how to expand nuclear power, and Governor Hochul has indicated that she is committed to ensuring that the Empire State does not get left behind. Following her lead, it is now incumbent upon agencies, industry, and stakeholders to work together in bringing the tremendous economic and environmental benefits of advanced nuclear power to New York.

Similarly, the U.S. Department of Defense (DoD) has required that by 2030, 100% of the energy load required to maintain the critical missions of DoD installations have a minimum level of availability of at least 99.9% per fiscal year or higher. *Metrics and Standards for Energy Resilience at Military Installations*, DoD memo, May 20, 2021. https://www.acq.osd.mil/eie/Downloads/IE/Metrics%20and%20Standards%20for%20Energy%20Resilience%2020%20May%202021.pdf

Nuclear New York *is an independent, non-partisan, non-profit organization working for a prosperous decarbonized future and nature conservation. Its mission is to advocate for the peaceful use of nuclear technology to meet society's need for reliable, emission-free energy and provide well-paid meaningful jobs that underwrite vibrant, healthy communities. The organization conducts research and educational activities in New York and beyond.*

Mothers for Nuclear *is a grassroots organization of mothers, women, community members, and nuclear professionals who advocate for clean, sustainable, and reliable energy solutions that protect both the environment and the health of families. The organization recognizes that nuclear energy has a great story to tell and is committed to telling it from the perspective of women who care about their children's future.*

New York Energy & Climate Advocates *is a non-profit, volunteer-based organization comprised of scientists, engineers, environmentalists, and advocates for social justice who understand the reality of climate change and the moral imperative for timely action, employing effective solutions that work in the real world.*