A Critique of the PSE Brief
on Indian Point

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HERSCHEL SPECTER

mhspecter@verizon.net

ABOUT THE AUTHOR

Herschel Specter, President of Micro-Utilities, Inc., holds a BS in Applied Mathematics from the Polytechnic Institute of Brooklyn and a MS from MIT in Nuclear Engineering. He is a Licensed Professional Engineer in the State of New York. He has had a long association with the Indian Point nuclear power plants starting as a member of the Atomic Energy Commission (now the Nuclear Regulatory Commission) where he was the Licensing Project Manager for the original licensing of the Indian Point 3 nuclear plant in the 1970s. In the 1980s the New York Power Authority hired Mr.Specter to manage the defense of Indian Point 3 in a federal adjudicatory trial in the wake of the Three Mile Island nuclear accident in Pennsylvania. Prior to joining NYPA, Mr. Specter served at diplomat rank for 5 years at the International Atomic Energy Agency in Vienna, Austria where he headed up an international effort writing design safety standards for nuclear power plants.

Mr. Specter has been Chairman of two national committees on emergency planning and was a guest lecturer for several years on emergency planning at Harvard's School of Public Health. He led an effort as a consultant to Entergy analyzing emergency responses during a hypothetical terrorist attack on Indian Point. Mr. Specter has presented testimony at the National Academy of Sciences on the Fukushima accident and on other nuclear safety matters and has been a guest speaker at many universities on matters of energy policy. Today he is one of 14 Topic Directors in Our Energy Policy Foundation, a group of about 1500 energy professionals who seek to bring unbiased and comprehensive energy information to our political leaders and members of the public.

Mr. Specter has been active on social and environmental matters. He has been a Big Brother and in 1971 had the honor of being selected as "Big Brother of the Year" for all of the USA and Canada. He also received a personal letter of commendation from the President of the United States for his work with the Youth Conservation Corps.

Mr. Specter was born in White Plains, NY and lives there now.

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1.0 EXECUTIVE SUMMARY

A recent report by PSE Health Energy, “Evaluating the potential for renewables, storage, and energy efficiency to offset retiring power generation in New York” provided an opportunity to examine the roles of renewable energy (RE), energy efficiency (EE), and energy storage more closely.[1] Moreover, the review of this PSE Brief yielded some other very valuable insights:

A. Burning fossil fuels not only worsens the existential threat of climate change, it exacerbates the lethality of the COVID-19 pandemic,

B. The PSE Brief has specific errors, but more importantly the whole concept of redirecting RE +EE away from reducing the threat of climate change to attempting to match the energy production of Indian Point (IP) is inconsistent with the goals of the Climate Leadership and Community Protection Act,

C. Even if RE someday matched the energy output of IP, it would not be a replacement for IP. In order for RE to play a larger role in the electrical power system it needs a cost effective energy storage technology that does not exist today. This intermittency will not be solved by present battery technology, leaving RE to depend upon the grid to assure adequate reliability of our electric power system. But the grid itself is becoming more carbon intensive as IP is phased out and more gas plants are queued up to come on line in the next few years.Nuclear power inherently has its own energy storage by having very high energy density fuel.

D. Nuclear power plants typically operate as base load plants because they produce large amounts of energy at a dependable constant rate. Wind power and solar energy, because they are variable and intermittent, are not well suited to be base load power sources. Plant operators can control the electrical output of nuclear plants up or down. By contrast, one can not cause the wind to blow harder or the sun to shine brighter. Until economical storage is developed it is not possible to achieve the same level of energy production control in RE systems as exists in nuclear plants. Nuclear plants have very high energy densities and can produce far more electricity than RE per acre of land. The compact size of nuclear plants per gigawatt-hour (GWh) makes them much easier to protect against the threats of climate change. On the other hand, RE has certain advantages compared to nuclear plants. However, this further emphasizes that matching GWh from nuclear power plants to GWh of RE, does not constitute an equivalence between RE and IP. Yet the whole theme of the PSE Brief is an attempt to show such an equivalence, but this can not be achieved by just matching electricity production from two very different technologies.

E. Much of New York State’s energy program is on a wrong track, and

F. Closure of IP marks the end of an effective environmental movement in New York State.

This critique of the PSE Brief is divided into three parts. Part One describes why RE + EE never replaced IP in the past and has not done so even after IP2 was closed down. IP2 is being replaced by gas and this fact refutes earlier claims by some that RE +EE would be able to match the energy output of IP2 immediately upon its closure.[2]

Part Two describes how, for years, the growth of fossil fuels has outstripped RE growth and how this discrepancy will accelerate as the IP plants are closed. This dominating growth of fossil fuel use spells the end of an effective environmental movement in New York.

Part Three offers specific comments on the PSE Brief and provides an alternative figure to Figure 1 in the PSE Brief. This alternative figure shows that even if every existing and planned solar panel in New York, be they behind-the-meter or part of a utility scale installation, plus every present and planned wind farm in New York, plus every off-shore wind turbine being brought on line, were perfectly executed in a RE plan to match the GWh from IP, this would take until mid 2028, at the earliest. This would cost billions of dollars and would result in about 35 million metric tons of carbon dioxide released to the environment, not including methane leakage, from gas plants making up for the RE energy production shortfall. It would also put more PM_{25} particles into the air that people breathe.

The energy production from IP is being replaced by fossil fuels, just like every other retired nuclear unit in the country. Conflicts between renewable/environmental advocates and the nuclear power community are distractions from the reality that fossil fuels are taking over much of the electricity supply in New York State with over 4,200 MW of additional gas plants scheduled to come on line in just a few years. Further, there are a number of important opportunities to deal with climate change using combinations of nuclear and renewable technologies that are being lost in the fog of this conflict.

As the PSE Brief stated, "*To meet climate targets, New York must rapidly deploy renewables and energy efficiency rather than expand gas infrastructure as Indian Point retires.*" This rapid deployment of RE + EE is just not happening, yet the gas and oil infrastructures are expanding. This PSE Brief also pointed out *"...it is possible that a portion of the plant's generation might temporarily be replaced by gas generation rather than renewables"*. Should specific errors in this PSE Brief be corrected, the Brief would show that "temporarily" could lead to at least eight more years during which time more gas generated electricity would be needed to offset the RE shortfall.

New York State has never had an acceptable plan to deal with the closure of IP and does not have one now. An acceptable plan would replace base loaded IP with a reliable, economic, and sufficient source of carbon-free electricity with the same temporal distribution and equivalent energy storage capabilities, but only after the climate change threat had been resolved. IP has already achieved such goals by producing 80% of the carbon-free electricity in downstate New York. The IP units are highly reliable, running over 90% of the time. These IP plants generated 16,695 GW-hrs of clean electricity in 2019, meeting 25% of the electricity needs of NYC and Westchester County.

This is a critical moment for the environmental movement in New York. Replacing IP with gas would greatly diminish or even destroy any hope of obtaining a low carbon future in New York. Regardless of one's position on Indian Point, the key issue is whether or not Indian Point will be replaced by gas. This critique should serve as an invitation to PSE Health Energy and others to address the issue of "How do we get New York to start to phase out gas?"

2.0 PART ONE: RE +EE NEVER REPLACED INDIAN POINT

2.1 Introduction

For years RE + EE have beneficially been used to reduce gas usage. Where is the evidence that a very different application, using RE + EE to replace IP, can actually be accomplished? This has never been done before as indicated by IP2's and IP3's high capacity factors; these nuclear units were either producing large amounts of carbon free electricity, or they were shut down for refueling, off-line maintenance, or repairs. There is no evidence that RE + EE ever replaced IP. It is also shown that RE is both far too small to replace IP2 + IP3 and lacks economic storage to overcome its inherent variability.

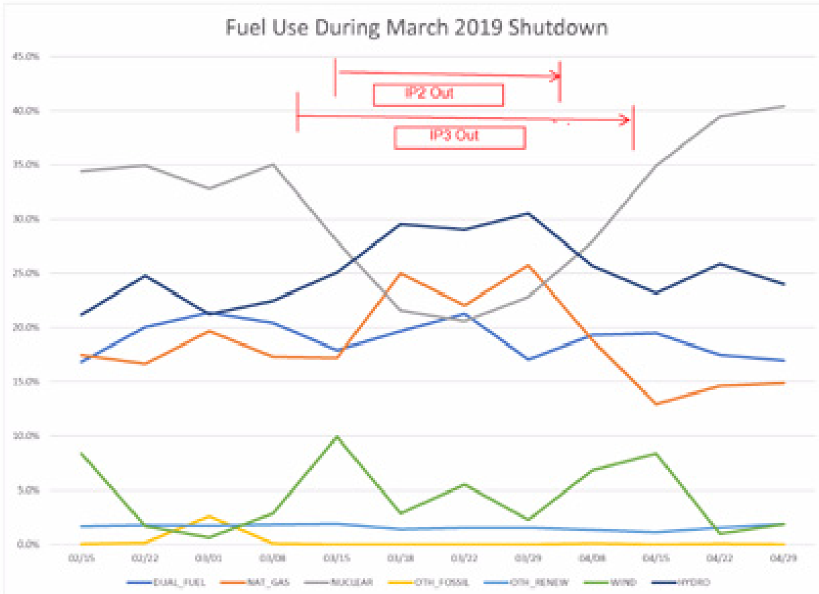
In addition to these general observations, one can view the actual performance of RE for any time period throughout the year by going to the NYISO dashboard. This was done for three special occasions: (1) during an unusual event in March, 2019, (2) during a very hot day in July, 2109 and (3) during the one week before and the one week after IP2 was closed. In all three cases a large increase in RE would have been very valuable, but that did not happen. Why there was no large increase in RE under these times of increased need for RE is explained in Section 3.1. EE is not capable of producing GHG-free electricity, as discussed in Section 3.2.

What was observed was that when IP2 and/or IP3 were not operating, the RE contribution remained small and fossil fuel use increased. RE + EE did not replace IP under a variety of actual events where such a replacement would have been far more preferable than turning to more fossil fuel use.

2.2 An Unusual Event in March, 2019

A unique opportunity presented itself in March, 2019 to demonstrate that EE and/or RE has the potential to replace IP. At the same time that the Indian Point 3 nuclear unit was shut down during a normal refueling outage, Indian Point 2 automatically shut down when a generator malfunctioned. According to reporter Thomas Zambito*"When Indian Point experienced an unplanned total shutdown in March, natural gas' contribution to the grid ticked upward while renewable sources like wind and solar continued to play a minor role"*. Further, Zambito wrote, *"With an assist from the grid's overseers, the state's energy sources shifted in a way that could offer a preview of what's to come in the years ahead when Indian Point is scheduled to shut down for good."*[2] This shift is towards greater use of gas. The NYISO dashboard was used to examine this unusual event and results are presented in Figure A-1 where the outage dates for IP2 and IP3 are plotted, as are the energy contributions from different energy sources. The simultaneous loss of both IP2 and IP3 (nuclear is the gray line) was compensated for by increased energy from hydro-power (dark blue), gas (orange), and dual fuel (gas/oil) sources, drawn in blue. One important observation is that the contribution from wind power (green) and from other renewable energy sources (light blue), not including hydro-power, was small before, during, and after this dual outage. **During that time of need, RE, defined here as wind power plus solar energy, methane, wood, and refuse did not and could not respond to the loss of both IP2 and IP3.**

FIGURE A-1 Fuel Use During An Unusual Event During a Very Hot Day in July, 2019



2.3 During a Very Hot day in July, 2019

It was fortunate that the simultaneous loss of IP2 and IP3 in March, 2019 occurred when the demand for electricity was at a seasonal low. To obtain an indication of the RE contribution when there is hot weather, July 30, 2019 was examined. On that date the peak temperature in New York City reached 94 degrees F. RE was not a major energy source during this peak demand day.

TABLE A-1 shows that the combination of wind energy and other renewables, exclusive of hydro-power, is quite small totaling only 3.3% for that day. July is the peak month for solar radiation in New York and yet the solar energy contribution was tiny. In January, about half as much solar energy would be generated.

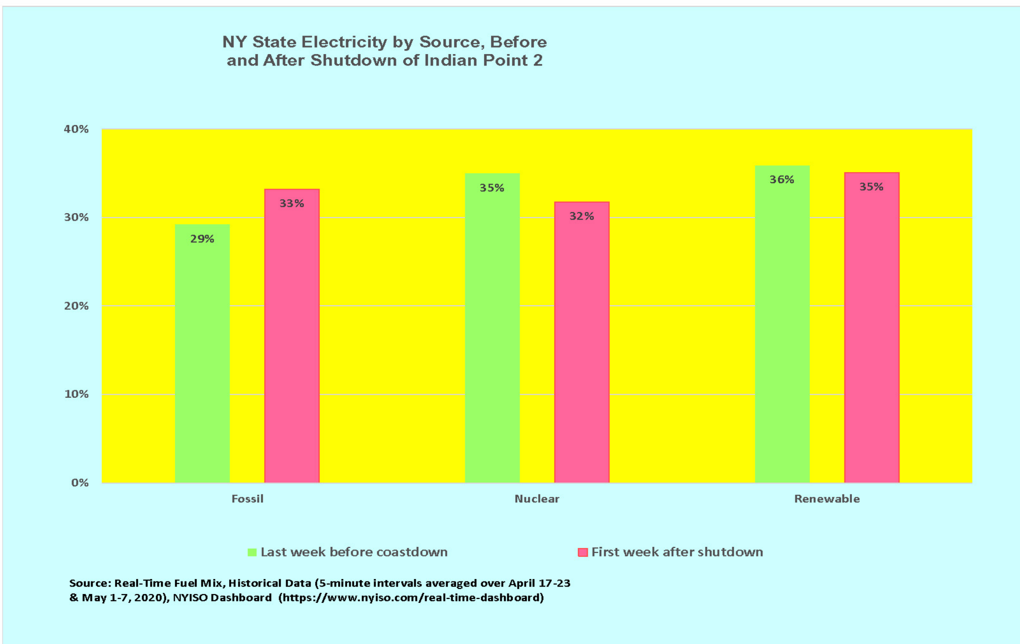
TABLE A-1 Fuel Use on July 30,2019

Energy source	Average Daily Megawatts	Percent
Dual Fuel	7,478	34.5
Natural Gas	4,830	22.3
Nuclear	5,226	24.1
Other Fossil	158	0.7
Other Renewables	274	1.3
Wind	427	2.0
Hydro	3,311	15.3
Total	21,704	100.0

2.4 Before and After the IP2 Closure

Even though some have claimed that RE +EE can replace IP2 right now, actual measured data refute this claim. Figure A-2 compares fuel use in the week before IP2 was closed and in the week after IP2 was closed. As expected, the nuclear contribution decreased. Renewables, including hydro-power, decreased slightly and fossil fuel use increased. Additional analyses show that wind power and other renewables were quite small in the week before and the week after the IP2 closure.

FIGURE A-2 Fuel Use Before and After the IP2 Closure



3.0 FUNDAMENTALS OF RE and EE

3.1 Renewable Energy-RE

As presented in Section 2 of this critique, data from the NYISO dashboard were used to expand our understanding of the role of RE. Three actual events were examined: the response of RE during an unusual event of March, 2019 when IP2 and IP3 were both simultaneously off line, the response of RE during the peak hot day of July 30, 2019, and the response of RE prior to and after the closure of IP2. Data taken over a multi-week time period encompassing the unusual event of March,2019 showed that the RE contribution was small before, during, and after this unusual event. This is typical. In all of the above three cases the electricity contribution from RE, exclusive of hydro-power, was small and unaffected by the events of the day.

This lack of an RE response in these situations when it is most needed is to be expected because neither wind power nor solar energy is a dispatchable source of electricity. A source of electricity is “dispatchable”, as defined here, means that the amount of electricity from this source can be increased or decreased in order to keep the grid’s electricity supply and demand in equilibrium. Hydro-power in New York can be increased by using stored water drawn from upstream water impoundments, and is thus dispatchable. If the normal supply of electricity unexpectedly decreases, as was the case in the March, 2019 unusual event, actions can be taken to increase the water flowing through the hydro turbines. Similarly, within limits, more gas can be burned in the gas turbines, if necessary, to keep the electricity supply equal to the demand.

As stated before, neither wind power nor solar energy are dispatchable sources of electricity. If more electricity is needed one can’t make the winds blow harder or the sun shine brighter. Similarly, in situations where the supply of electricity on the grid already is in equilibrium with the demand, excess wind power and/or excess solar energy may have to be wasted in order not to overheat the grid.[4] Until there are large amounts of dedicated energy storage, wind power and solar energy will not become dispatchable like hydro-power with its upstream water storage capability. So even among renewable energy sources there are differences with wind power and solar energy having less flexibility than dispatchable hydro-power. Wind and solar energy are not well suited to be base load plants. Finally, hydro-power capacity in NY State is not expected to grow significantly.

In 2019, wind power provided 4,454 GWh or about 3.3% of the state’s electricity production while solar energy, plus burning methane, refuse, and wood, collectively only produced about 2,700 GWh or 2.0% of the state’s electricity production.[5] Last year the IP units produced 16,695 GWh or 12.1% of the state’s electricity consumption, more than twice what wind plus all other renewables combined produced.

The comparatively small RE contribution, the lack of dedicated energy storage, the inherent intermittency and variability characteristics, the lack of historic supporting data showing that RE ever replaced Indian Point, its lack of dispatchability, the different temporal distribution of RE compared to IP and the data from the three events discussed above rule out RE as a replacement for IP. RE has an important job to do; replacing gas usage.

3.2 Energy Efficiency-EE

Two major insights about energy efficiency came out of conducting this review of the PSE Brief. The first insight was a comparison of RE to EE. They are often incorrectly treated as equivalent by adding the MWh generated by RE to the MWh reduced by EE. RE can directly put electrons on to the grid without increasing the release of greenhouse gases (GHG). EE does not produce electrons; it reduces the need to produce electrons, particularly in fossil fueled power plants. In New York State, with its near zero oil and coal generated electricity, the term fossil fueled plants, in practice, means gas-fired power plants. By reducing the number of Gigawatt-hours (GWh) produced by gas, EE reduces the amount of GHG and air pollutants that might otherwise had been released. In one sense EE and RE are similar, both RE and EE reduce GHG emissions by reducing gas usage. Yet RE and EE are also radically different. EE can not put GHG-free electrons directly on the grid, like RE can. What EE does is to create idle capacity at gas plants. Without EE, gas plants would be producing more GWh and correspondingly, more GHG, as these gas plants are run more often to meet the increased demand for electricity. With EE, the demand is lowered, less gas-fired electricity GHG is produced, and the idle capacities at the gas plants are increased. The idle capacity that EE created may be called upon if there is a decrease in supply, such as due to the closure of Indian Point, but this will generate more GHG. This more precise description of the role of EE not only affects this PSE Brief, it applies to all energy reports where the MWh generated by RE are incorrectly added to the MWh saved by EE.

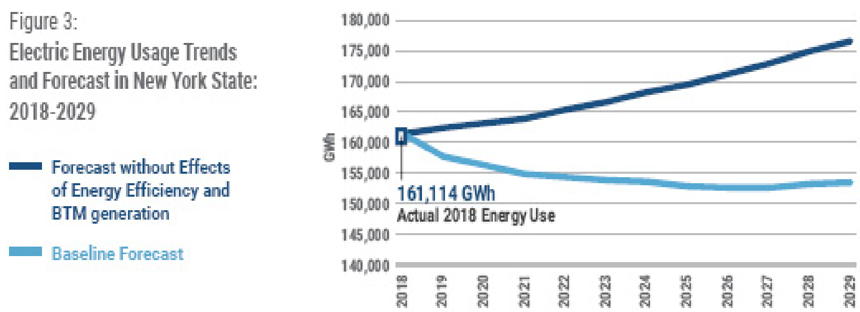
As a hypothetical example, imagine a gas plant that was producing 5,000 GWh/year of electricity when a highly effective energy efficiency program was implemented, resulting in this same gas plant only producing 4,000 GWh/year. Even though its output was reduced by 1,000 GWh/year, the physical structure of the gas plant was unchanged. If need be, the gas plant could revert back to producing 5,000 GWh/year. So a more comprehensive way to look at energy efficiency is that EE reduces the amount of gas fired electricity and by doing this it increases the reserve capacity of gas fired electricity that could be put back into service, if necessary.

In summary, EE goes through an intermediate step of creating idle capacity at gas plants. Replacing the electricity otherwise generated at Indian Point with EE actually means replacing Indian Point with electricity generated from idle gas capacity. This misuse of EE leads to an increase in GHG releases.

3.2.1 Additional EE Information From NYISO

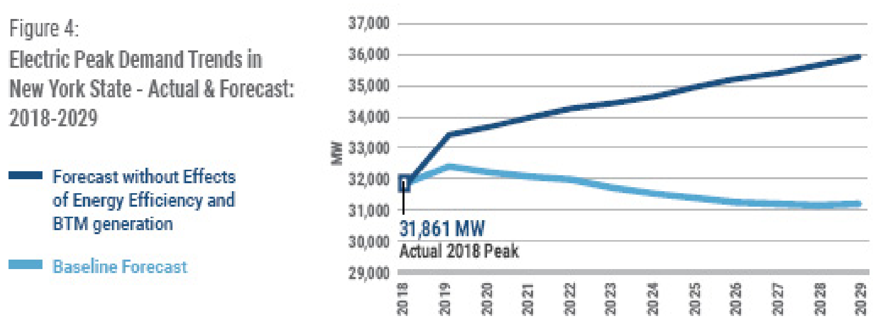
NYISO provides additional information about energy efficiency in Figures 3 and 4 of its 2019 Power Trends report, reproduced in this critique. Figure 3, reproduced as FIGURE A-3 below, shows that there are significant GWh reductions in the forecast electric energy usage because of energy efficiency. With little coal or oil electricity production and with nuclear power plants and hydro-power running at high capacity factors, these projected GWh reductions will be in gas generated electricity. **Because of EE, these projected reductions will be in gas usage and will have significant environmental benefits.** For example, there is a projected decrease in electric energy use in year 2027, i.e., gas use, of about 22,000 Gigawatt-hours due to the benefits of energy efficiency and behind-the-meter generation (mostly distributed solar). This would result a GHG savings of about 9.4 million metric tons of CO_2 in just one year, compared to having this gas burned in a modern combined cycle plants.

FIGURE A-3 Energy Efficiency Impacts on Electric Energy Forecasts, GWh



NYISO's Figure 4, reproduced as FIGURE A-4 below, shows the impact of energy efficiency on the peak megawatts needed in the electricity supply system. Peak electricity demand in New York is mostly met by burning gas. Any other use of EE, such as attempting to replace the Indian Point nuclear units, is an inferior use of EE compared to using EE to reduce gas usage.

FIGURE A-4 Electric Peak Demand in New York State-Actual & Forecast 2018-2029



The PSE Brief has made a similar connection between energy efficiency and gas usage. On page 2 of the PSE Brief it is stated "... the local region has add enough energy efficiency to reduce summer peak load by 190 MW...". The summer peak load is met by gas.Therefore the PSE Brief seems to be stating that EE reduces gas usage.

If it was attempted to use EE to replace some of the GWh generated by Indian Point, it would be have to be done by burning more gas. Since the goal is to transition away from gas use, then EE does not belong in Figure 1 of the PSE Brief. Indian Point does not produce GHG and any process that does, directly or indirectly, produce GHG is cannot be a replacement for Indian Point.

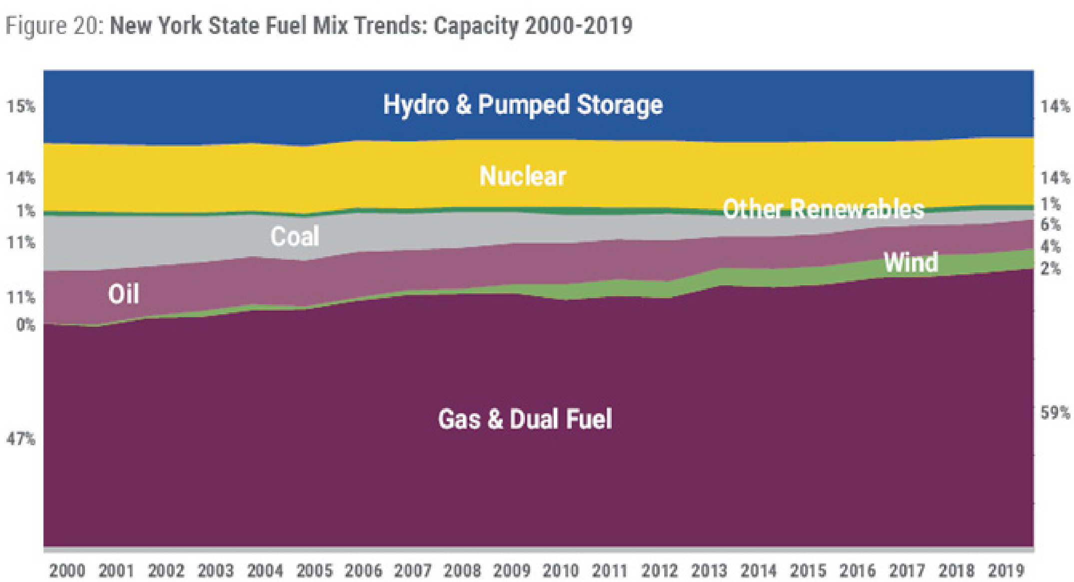
4.0 PART TWO-THE END OF EFFECTIVE ENVIRONMENTALISM

4.1 The Growing Use of Gas in New York

4.1.1 Years 2000 to 2019, Gas Outpaces Renewables

Shutting down the Indian Point nuclear units should not be looked upon as an isolated event but rather as major step in series of actions where fossil fuel use, gas and oil, diminish the possibility of a low carbon future for New York. Closure of these two carbon-free nuclear units may be a harbinger of future nuclear plant closures, such as the upstate nuclear plants when their licenses expire in about ten more years. Less obvious, but equally important, closure of IP may mark the **end of any chance for the environmental movement** in NY State to achieve its clean energy goals.The following figure published by NYISO is instructive.[6] The PSE Brief has also used this NYISO figure and made similar observations about the growth of fossil fuel use in New York.

FIGURE A-5 NY Fuel Mix Trends: Capacity 2000-2019



Between year 2000 and 2019 New York's generating capability from natural gas and dual-fuel facilities grew from 47% to 59% in 2019, a 12% increase in the percentage of the fuel mix capacity that comes from gas and dual-fuel sources. During this same time period coal declined from 11% in 2000 to 2% in 2019. Additionally, oil capacity declined from 11% to 6% of the mix in 2019. Between 1990 to 2016 New York's GHG emissions in the electrical generation sector decreased from 63.01 to 27.72 millions of metric tons released per year, largely due to the phasing out of coal and reduced oil use, which more than offset increased use of gas and dual fuel facilities. However, NY State is now at a point where there are no more coal use reductions available and, as discussed below, gas use will certainly rise and oil use may start to rise too.

NYISO's fuel mix figure also shows that hydro and pumped storage have remained flat over this past 20 years and their energy capacities are not expected to rise. Other renewables, like solar, burning methane, wood, and refuse, are tiny, representing a very small portion of the mix. Their small total capacity has also been rather flat over this time period.

Wind energy has grown from about zero to about 4.5% over this time period. While commendable, this has to be compared to the 12% growth in capacity in gas and dual fuel capacity. There is an inherent conflict here. Wind power reduces GHG releases while using gas and oil increases GHG releases. Clearly, the gas and oil have outstripped the growth in wind power capacity by a ratio of 12/4.5 = 2.7 or about 270 percent. Figure A-5 stops in 2019 and therefore does not display the impact of adding the 1020 MW Cricket Valley plant. It is not clear if the CPV plant in Orange County is included in Figure A-5.

4.1.2 Beyond Year 2019, Gas Continues to Grow

As shown in the table below, the addition of the CPV and Cricket Valley plants is hardly the end of adding more gas power plants, some of which were old coal plants that have been refurbished to run on gas. Nine additional gas fueled projects are in various stages of development. The five upstate plants in zones A and C total 2,151 MW of gas capacity. The four gas plants in downstate zones J and G add up to 2,062 MW. New Yorkers are facing a surge in gas plant capacity of around 4,213 MW.

TABLE A-2 Additional Gas Plants

Plant Name	MW	Zone	Start of Service	Technology
Dunkirk Unit 2	75	A	April, 2020	Steam turbine
Dunkirk Units 3&4	370	A	April, 2020	Steam turbine
Renovo Energy Center	531	C	June, 2020	Combined cycle
Renovo Energy Center, Uprate	531	C	April,2021	Combined cycle
Tioga Country Power	644	C	May, 2021	Combined cycle
Ravenswood Gas	272	J	June, 2022	Combustion turbine
NRG Berrians	465	J	February, 2023	Combustion turbine
Danskammer	615	G	October, 2023	Combined cycle
Gowanus	710	J	May, 2024	Combustion turbine

Gas already has a large portion of electricity production in New York and it is growing rapidly. How do these new gas plants support NY State mandates to have 70% renewables by 2030 and an economy-wide greenhouse gas emissions reduction of 85% below 1990 levels by 2050?

4.1.3 Old Polluters and New Polluters

The Cricket Valley Energy Center (CVEC) claims that its new huge gas plant in Dover, NY:[7] *"...will be among the most efficient and lowest emitting power plants of its kind ever constructed."* In addition to producing vast amounts of CO_2, Cricket Valley has the potential to emit (PTE) the following criteria pollutants:

TABLE A-3 CVEC PTEs for Criteria Pollutants, Tons Per Year

NOx	CO	VOC	SO2	PM2.5/PM10	Lead
266.4	318.2	96.2	38.0	175.4	0.0013

If this is the best that fossil fuel technology can offer, what can be said about the nine new gas plants listed in TABLE A-2, some of which do not even use superior combined cycle technology? Note that Zone J is New York City and none of the gas plants planned by May 2024 there will use combined cycle technology.

There is local opposition to the Cricket valley and CPV plants. It is claimed that the CPV plant is the only plant in the country without a valid Title V permit, that there are 14 environmental justice communities within 5 miles of the CPV plant, one of which is only 400 feet from the plant. CPV is sited in the middle of a protected agricultural district. Riverkeeper pledged legal action against the CPV plant.[8] In spite of two years going by, no legal ruling has been announced by Riverkeeper on this action.

4.1.4 The Reliability of Gas-fired Electricity

As the PSE Brief points out, there is approximately 6,800 MW statewide of steam and gas-turbine capacity that will be near retirement age in New York by 2025. About 80% of the over-aged capacity is located in NYC. By 2022 the capacity in NYC at or exceeding the normal retirement age will be around 2,800 MW, larger than the 2,062 MW of additional gas plants identified in TABLE A-2 planned by May 2024. There could be a gas capacity deficit of at least 738 MW through May 2024, even if everything is built on schedule.

In NYC this potential capacity deficit from over-aged facilities is projected to increase by another 1,200 MW by 2026. NYISO has not identified any additional gas power plants to deal with this. NY State may have to turn to increased use of oil-fired electricity if these over-aged gas plants begin to fail and the remaining gas-fired electricity supply cannot keep pace with the demand.

Insufficient gas power plant capacity is just one pathway to an insufficient gas-fired electricity supply system. Another concern is the gas delivery network. There are new demands for gas as consumers convert from oil to natural gas for heating their homes and for making hot water. This has led to some utilities to declare moratoriums on hooking up new customers. As Consolidated Edison stated *"The demand for natural gas, however, is outpacing supply on the coldest days due to these conversions, preference for natural gas use in new building construction projects, and constraints on interstate pipeline that bring natural gas to customers in Westchester."*[9]

A similar situation has erupted with another utility, National Grid, which serves Brooklyn, Queens, and Long Island. NY State's Department of Environmental Conservation withheld a state water quality permit on a requested major pipeline addition, precipitating a declaration of a moratorium by National Grid for new gas customers in their service area. This conflict between energy reliability and impacts on the environment is not over, but involves a very dangerous temporary solution: delivering the needed additional gas by trucks. Not only is this more expensive than using a pipeline, it creates a new homeland security issue, as "truck bombs" roll along State and City roads in populated areas.

Most important, on May 15,2020 New York environmental regulators denied for the third time the water quality permit for the controversial Williams Northeast Supply Enhancement pipeline.[10] The water quality permit issue may eventually be averted by tapping into existing gas pipelines. This in turn might require these existing pipelines to run at higher pressures to increase their throughput to meet the needs of additional consumers. Higher operating pressures may result in more methane leakage.

4.1.5 Stranded Costs

The retirement age for gas turbine facilities is > 47 years and for steam turbine facilities, > 62 years.[11] As of 2021 there will be 1,897 MW of steam turbine plants in NY that are 62 or more years old plus another 2,811 MW of gas turbine plants 47 or more years old. It is assumed that most of the gas plants listed in TABLE A-2 to replace over-aged gas plants.

If the all the gas plants listed in TABLE A-2 are eventually closed down, along with their pipelines and other support infrastructure, on a schedule consistent with NY State's environmental mandates, the stranded costs would be enormous. This is further complicated by the fact that as the use of gas in electricity generation expands, so does everyone's dependence on a single energy source.

4.2 The Growing Use of Oil in New York

Oil consumption in NY City power plants is small compared to gas consumption. However, this may shift somewhat over time. Oil consumption peaks at cold weather. Climate change has been predicted to bring colder weather and more frequent polar vortices. One recent analysis of the effects of climate change on NYC concluded that over time NYC may become a winter peaking area. Difficulty in having adequate gas supplies because of climate change may cause more reliance on oil. Other actions may cause more reliance on oil. More people are resisting the construction of new gas power plants and new gas pipelines.

4.2.1 Polar Vortices

The frequency of polar vortices like also is affected by climate change. A specific instance of this was the polar vortex that struck New York in January, 2014 driving temperatures down as low as 4 degrees Fahrenheit. During this freezing weather IP2 and IP3 continued to produce electricity. These carbon-free power plants refuel every 18-24 months, typically in low electricity demand periods in the spring and in the fall. Under extreme operating conditions, including during polar vortex conditions, there is no concern about running out of uranium fuel. For nuclear plants there are no oil shortages, no fear of explosions caused by low gas pressure in the pipelines, no frozen coal train tracks, coal conveyer belts, or oil barges frozen in the East River, no "truck bombs" mired in deep snow, and no concern about solar energy supply/ demand mismatches caused by the winter sun setting hours before the daily demand for electricity peaks in the evening.

It appears that the PSC is preparing for burning more oil as the Indian Point Energy Center is phased out.[13] The following was published by the PSC's part of the winter assessment, *"the major electric generating facility owners in Southeast New York who own about 12000 MW of dual fuel generation capability were contacted. Staff found that these owners are continuing to implement lessons learned from the Polar Vortex winter of 2013-2014, including having increased pre-winter on-site fuel reserves, having firm contracts with fuel oil suppliers, conducting more aggressive replenishment plans, and having more pro-active pre-winter maintenance and facilities preparations."*

4.2.2 Maximizing Profits

OIl, especially low sulphur oil, is an expensive fuel. However, the NY State's dual fuel plants have already been constructed and adding more oil storage tanks is certainly easier than digging up streets to put in larger diameter gas pipelines. Building gas infrastructure is expensive too, especially to provide gas energy for infrequent events. Where is the optimum mix of gas capacity and oil capacity that would maximize profits for the fossil fuel industry? It may be at a point where more oil use is more profitable.

Burning more oil undermines NYC's goal to phase out burning oil in NY City. It would also diminish the value of replacing fossil fueled space heating and hot water systems in NYC with heat pumps since the electricity that energizes these heat pumps would be far more carbon intensive per kilowatt-hour than they have been with IP operating.

4.3 Health Consequences

It is well established that burning fossil fuels in power plants has health effects, especially respiratory health effects. With regard to chronic exposure to air pollution, the NYC Department of Health and Mental Hygiene found *"Further action is still needed to improve air quality, as it is estimated that current (2009-2011) levels of $PM_{2.5}$ still cause annually more than 2,000 deaths,4,800 emergency department visits for asthma, and 1,500 hospitalizations for respiratory and cardiovascular disease."*[12]

People in Environmental Justice areas are disproportionately affected by chronic air pollution.[14] Particularly concerning is that many of New York City's older gas plants are located in Environmental Justice areas, as shown in TABLE A-4. Climate change will make summers hotter and longer, plus polar vortices more frequent. Yet replacing Indian Point with gas and/or oil exacerbates concerns about climate change. By closing the Indian Point nuclear plants, New York has moved in the direction of more gas usage, backed up by oil usage when necessary.

TABLE A-4 Gas Plants in Environmental Justice Areas

Rank	Name	NOx Controls?	Tons of NOx Emissions, in 2016	Located in Potential Environmental Justice Area?
1	Ravenswood	Yes	1,147	Yes
2	Arthur Kill	No	344	No
3	Astoria Generating Station	No	196	Yes
4	Narrows	No	199	Yes
5	Astoria Gas Turbine	No	119	Yes
6	East River	No	128	Yes
7	Gowanus	No	41	Yes
8	Astoria 1&11	Yes	69	Yes
9	59th Street	Yes	32	Yes
10	NYPA Astoria CC	Yes	36	Yes

In addition to the above plants, TABLE A-5 lists others.[15]

TABLE A-5 Additional Peaker Power Plants in NYC

Plant Name	Parent Company	Location	MW	Online Date
74 St.	Consolidated Edison	Manhattan	37	1968
Bayswater	LIPA	Queens	61	2002
Harlem River	NYPA	Bronx	94	2001
Hellgate	NYPA	Bronx	94	2001
Hudson Avenue	Consolidated Edison	Brooklyn	49	1970
Jamaica Bay	LIPA	Queens	61	2003
Joseph Seymour	NYPA	Brooklyn	94	2001
Kent	NYPA	Brooklyn	47	2001
Pouch	NYPA	Staten Island	47	2001
Vernon Blvd	NYPA	Queens	94	2001

There are chronic and acute health effects from air pollution. Before the COVID -19 pandemic it was well established that people in Environmental Justice areas were already exhibiting heightened health effects due to their chronic exposure to air pollution However, chronic exposure creates a pre-condition that worsens acute consequences during less frequent, but more severe situations.The COVID-19 virus attacks the respiratory system and people with pre-existing conditions like asthma, are disproportionately suffering from this pandemic. If gas and/or oil use is increased to replace Indian Point, especially in Environmental Justice areas, this adds to the large health consequences inequities, unfolding daily.

A national study at Harvard University investigated whether long-term average exposure to fine particulate matter ($PM_{2.5}$) is associated with an increase in the COVID-19 death rate in the United States.[16] This study concluded that an increase of only 1 microgram per cubic meter of $PM_{2.5}$ is associated with an 8% increase in the COVID-19 death rate.

4.4 New York Gets Slammed

All of New York City, Rockland County, and Westchester County in New York are classified as non-attainment zones because their air quality does not meet EPA standards. So before the pandemic even struck their long-term (chronic) exposure of people in these areas was too high. The following table lists the recorded deaths from COVID-19 as of May 13, 2020 for various NY State counties. The total number of fatalities in New York from COVID-19 as of May 13, 2020 was 20,153 almost exactly half of the fatalities for the whole United States.

At a 8% increase in the death rate per 1 microgram per cubic meter of $PM_{2.5}$, what would be the health impact if the 1,587 MW of combustion turbine technology power plants identified in TABLE 2 are placed into New York City should another similar coronavirus attack New York? What would be the impact of these 1,587 MW of combustion turbine technology power plants on chronic health effects? How many lives would have been saved in NYC if all of its electricity had come from clean energy sources like RE and nuclear power?

TABLE A-6 NY Deaths From COVID-19@ May 13, 2020

Area	Deaths
Kings County	4,636
Queens County	4,571
Bronx	3,268
Manhattan	2,022
Nassau County	2,004
Souffleed County	1,680
Westchester County	1,245
Staten Island	727

4.5 Economic Consequences

Like the rest of the nation, New York faces a long road to economic recovery once this pandemic is over. This difficult economic recovery should not be further hobbled by shortages of electricity because IP was prematurely closed. Unemployment figures are skyrocketing. Can anyone justify putting over 1,000 well paid employees and contractors out of work at a time like this, adding to the skyrocketing unemployment rates? Are we willing to lose the hundreds of millions of dollars in salaries, tax revenues, and community support each year that IP provides? That money should be pumped into the economy as part of the economic recovery.

In addition to health impacts, emissions from power plants are also harmful to New York's economy.[17] Emissions from NYC power plants are estimated to cost at least $62 million dollars annually. Further there is the major issue of stranded fossil fuel infrastructure costs and NY should not waste the billions of dollars it has invested in RE in a misguided attempt to match the GWh output of IP.

During extreme weather the demand for gas increases, as does gas prices. The steady output of Indian Point under all weather conditions moderates the cost of gas.

4.6 Environmental Consequences

Replacing IP with gas would be a huge environmental blunder. If IP were completely replaced by gas, at least an additional 7 million metric tons of carbon dioxide, CO_2, would be released into the atmosphere year after year, assuming this gas were burned in very efficient combined cycle plants. If methane leakage from gas supply systems were accounted for, the number of tons of carbon dioxide equivalent, CO_2e, would exceed 7 million metric tons per year, possibly as large as 15 million metric tons per year.[18]

Greenhouse gas (GHG) releases of this magnitude would negate the whole purpose of NY's recently passed Climate Leadership and Community Protection Act. For example, New York plans to build the world's largest 9,000 megawatt off-shore wind farm by 2035. This huge undertaking is intended to reduce the usage of gas in NY State. Because of the huge volume of GHG coming from the IP gas replacement plants year after year, it would not be until after 2040 that this off-shore wind farm showed a net reduction in accumulated GHG. A break-even date after 2040 is far too late to meet CLCPA mandates or to be effective in dealing with climate change.

No new fossil plants should be built in NY State henceforth. Cricket Valley should be the State's last gas plant to be constructed.

5.0 PART THREE-SPECIFIC COMMENTS ON THE PSE BRIEF

5.1 PSE Brief, Comment #1-General Discussion of Energy Efficiency

The inability of EE to replace Indian Point is already discussed in Section 3.2. Comment #1 adds some additional perspectives. The PSE analysis assumed an energy efficiency increase from 1%/year in 2019 to 3%/year in 2025. This would be a tripling in the growth rate of energy efficiency in just a few years. While desirable, is this tripling of the efficiency growth rate actually implementable?

New York is the most energy efficient state in the nation. One reason for NY State's high efficiency ranking is the long term high cost of electricity, particularly in the downstate region. People already have responded to this price signal and have taken steps to reduce their electricity usage. A second reason for NY's high ranking in energy efficiency is that many people live in apartment houses which, typically, have less outside exposed area per resident than single family homes. Generally speaking, that shape reduces energy use per person. Third, the NYC subway system is far more energy efficient than other means to get about in a big city area. NYC is the center for the finance industry which is less energy intensive than manufacturing industries. Many of the lower hanging fruit on energy efficiency may have been picked already, creating a diminishing returns situation on further investments in energy efficiency.

A few years ago a Synapse report, sponsored by Riverkeeper and the Natural Resources Defense Council raised some important issues about achieving energy efficient goals in New York State[19]: "*The CES order assumes annual incremental savings through energy efficiency of roughly 1.5 percent of overall electric energy demand, resulting in a reduction from ~160k GWh in 2016 to ~146k GWh in 2030. However, the CES order does not include any mechanism to ensure that these levels of energy efficiency are achieved, in contrast to the binding and enforceable 50 percent by 2030 renewable energy target enacted by the CES order. Nor has the Public service Commission enacted any other policies outside the scope of the CES order to ensure that the state achieves these levels of energy efficiency. Rather, existing policies (which consist primarily of Energy Efficiency Transition Implementation Plan (ETIP) targets and budgets for each of the state's investor owned utilities) guarantee only a small fraction of the 1.5 percent annual incremental savings.*"

Have these administrative defects been corrected?

5.2 PSE Brief, Comment #2-Specific Discussion of Energy Efficiency

As explained in Section 3.2, there is no historical evidence that energy efficiency has ever displaced the GWh produced by Indian Point nor is even capable of doing this directly. Therefore the energy efficiency components of the Recently Deployed (2017-2019) and the Accelerated Targets (2020-2025) columns should be removed from the PSE Brief's Figure 1.

5.3 PSE Brief, Comment #3-Peak Energy

The PSE Brief commented on the NYISO December, 2017 Deactivation report "Since *the report's release in December 2017, the local region has already added enough energy efficiency to reduce summer peak load by about 190 MW an the winter peak load by about 140 MW.*" However, peak loads are served by gas fired electricity, not by based loaded Indian Point. The word "peak" does not even appear in this NYISO report. There is no apparent connection between this comment in the PSE Brief and this NYISO report. Rather, the PSE Brief comment is supportive of the statements in this critique that energy efficiency decreases gas usage.

5.4 PSE Brief, Comment #4-Onshore Wind Power

There is considerable uncertainty in the growth rate of land based wind power. According to NYISO, the state's Clean Energy Standard anticipates as much as 17,000 MW of new renewable energy development upstate.[20] However, NYISO observed "In *its most recent award of REC contracts announced in January 2019, NYSERDA noted that it is supporting 20 large-scale renewable projects representing 1,654 MW of installed capacity. 93% of the awarded capacity will be located upstate (in load zones A-E) where clean energy resources are already abundant and access to load centers in southeastern New York is heavily constrained.*"

NYISO went on to state *"Absent investment to expand the transfer capability of the bulk power system, investment in renewables in upstate load zones runs the risk of bringing diminishing* *returns in terms of both renewable energy production and carbon dioxide emissions production goals. This is largely because nearly 90% of the energy produced in upstate New York already is derived from carbon-free resources. Because load in the region is not projected to grow, the addition of new renewable resources increasingly displaces other sources of clean energy generation in the region."*

The impact of these NYIO statements can be seen in Figures 24 and 28 of this 2019 NYISO report. Figure 24 shows that land based wind energy has already reached the point where it is already curtailed (dumped) during certain times of the year. Figure 28 shows that increases in land based wind generation has been quite flat since 2014.

There is growing resistance upstate to additional onshore wind development.

Figure 1 of the PSE Brief needs to be modified to reflect this NYISO information and growing public resistance. Onshore wind does not belong in the Under Development (2020-24) column in PSE Brief's Figure 1. This potential source of renewable energy belongs in a new column where year 2024 is the left hand boundary. Further, it will take time to construct new on-land wind power. Annual installation rates should be used reflect that these projects can not be instantly put in place Use can be made of Figure 28 in NYISO's 2019 Power Trends report to estimate an optimum build rate for onshore wind power, putting aside concerns about growing local resistance to new installations.

Using this NYISO Figure 28, in 2008 onshore wind generated 1,282 GWh and by 2014 onshore wind generated 3,986 GWh. This is equivalent to an annual growth rate in onshore wind power energy production of about 440 GWh/year. Based on the PSE Brief's Figure 1 onshore wind will grow to about 2,200 GWh/year. If started in 2024, assuming Segments A and B of an upgraded transmission line (See comment #6) are completed on schedule and using an optimistic build rate of 440 GWh/year, this task would be completed in 2029.

5.5 PSE Brief, Comment #5-Offshore Wind Power

The PSE Brief, on pages 3 and 5, refers to 1,700 MW of offshore wind power off of Long Island available by 2024. These 1,700 MWs refer to two 2018 solicitation requests, one by Empire Wind for 816 MW and another by Sunrise Wind for 880 MW for a total of 1,696 MW or ~1700 MW. The 816 MW Empire Wind project is expected to connect to the grid at Con Edison's Gowanus substation. The 880 MW Sunrise Wind project has a planned interconnection point at the Holbrook and West-bus substations in the Town of Brookhaven. Note that Nassau and Suffolk counties in Long Island are not areas served by IP. Consequently only the 816 MW project should be considered as a potential partial GWh replacement for Indian Point. The PSE Brief assumed that 850 MW could be allocated to Zones G, H, I, and J by 2024.

On page 5, PSE stated that 1,700 MW of wind power would generate roughly 7,400 GWh annually.In order to produce 7,400 GWh from a 1700 MW installation one would need a capacity factor of 49.7%. However, the PSE footnote 13 on page 4 states that *"We assume a 38% capacity value summer and winter for offshore wind"*. If the words "capacity value" and "capacity factor" are meant to be equal, then there is a large discrepancy in the calculated 7,400 GWh. The 816 MW wind farm that connects to the Con-Edison Gowanus substation, multiplied by the NYISO capacity value of 0.38, would then produce 2,716 GWh/year. The PSE Brief's Figure 1 appears to have plotted the 7,400 GWh/year instead of 2,716 GWh/year, overestimating the offshore wind power by about 7,400-2,716 = 4,684 GWh/year. Figure 1 of the PSE Brief should be corrected to account for this 4,684 GWh/year discrepancy.

The PSE Brief states that these offshore wind power sites *"...will bring 1,700 MW on line by 2024..."*. This date has considerable uncertainty. As summarized by Sunset Park Reports, Julia Bovey, the Director of External Affairs at Equinor Wind USA (Empire Wind) stated in August, 2019 *"Equinor aims to start constructing the wind farm in 2022 and to start producing power in 2024. But port upgrades must be completed first. For that reason, the company hopes that the state will soon choose where it intends to invest in an assembly port."* Other issues were identified by Equinor last August, such as the need to build a new substation to convert energy into the correct voltage for the grid. Equinor plans to build concrete foundations for the wind turbine at the Port of Coeymans, south of Albany. The PSE Brief did not clarify if these August, 2019 scheduling issues have been resolved. With New York's economy badly damaged by COVID-19 delays in construction seem likely.

There are potential political issues as well. Greentech Media reported in February, 2020 that Vineyard Wind's offshore wind farm for Massachusetts will not reach completion in 2022 with the developer *"bowing to reality after the federal government confirmed a later-than-hoped permitting deadline for the project"*.

The 2,716 GWh Empire Wind project is in the Under Development (2020-24) category in Figure 1 of the PSE. Figure 1 needs to be redrawn so that the 2,716 GWh from Empire Wind is plotted as starting to produce electricity in 2024.This part of the offshore wind project is identified as phase one in this critique (See TABLE A-8).

NY State is committed to building 9,000 MW of offshore wind power by 2035, i.e. another 7,300 MW after 2024. It was assumed that this additional offshore generated electricity would be shared equally between NYC and Long Island. For phase two it was assumed that beyond 2024 the build rate would increase significantly in order to meet the 9,000 MW by 2035 target. A one year delay was assumed to retool the manufacturing centers to prepare for this higher build rate. Phase two electricity production would begin in 2025. It is assumed that the installation rate between 2025 and 2035 would be linear, i.e, 7,300 MW/10 years = 730 MW/year or 365 MW/year for NYC. At a capacity factor of 0.38, offshore power would add about 1,215 GWh/yr for each year between 2025 and 2035, if everything went according to schedule. Note that this assumed post 2025 installation rate would be 170% faster than the present offshore wind build rate. If this much higher build rate can not be achieved, or if the start date slips beyond 2025, it would take longer for RE to match the GWh produced by Indian Point and even more GHG would have to be produced by gas plants to prevent a shortfall.

5.6 PSE Brief, Comment #6-Improved Transmission Capacity

On page 4 of the PSE Brief there is a claim of 1,250 MW of new transmission capacity coming on line in December, 2023. If one refers to Figure 26 of NYISO's 2019 Power Trends report, two transmission projects are discussed, Segment A and Segment B. The PSC sought to increase transfer capability from central to eastern New York by at least 350 MW (Segment A) and from the Albany region through the Hudson Valley region by at least 900 MW (Segment B). These segments are in series. In order to bring electricity generated in Segment A down to the Hudson Valley region, Segment B must also be constructed to enable full use of Segment A. Because these two segments are in series their capacities are not additive. The maximum capacity that can be assigned to these segments is 900 MW, not 1,250 MW. Like offshore wind, onshore wind in Figure 1 should be put into a new category starting 2024 because of the proposed schedule for completing Segment B.

If this new 900 MW transmission line operated at 100% capacity all year long it would deliver 7,884 GWh/year. This would be an upper bound on the amount of RE that could be delivered from upstate NY to downstate NY through this transmission line. As shown in TABLE A-8, onshore wind would reach 2,200 GWh by 2029, upstate distributed solar would reach 2,800 GWh/year by 2030 and, if one assumes that all the utility scale solar was located upstate, this would add another 2,200 GWh/year by 2030. The sum of these three sources comes to 7,200 GWh/year. Several conclusions can be reached from this. the sum of the average output from these three sources, 7,200 GWh/year, is close to the maximum of 7,884 GWh/year that this 900 MW transmission upgrade can handle. On an annual average basis Segment B would appear to be adequately sized to accommodate all the upstate RE identified in the PSE Brief. however, both the solar energy and wind power vary with time. It is possible that the transmission line might not be able to carry all the electricity that upstate RE produces during peak production periods, especially in years 2028-2030.

The reverse situation would exist in the early years after this 900 MW upgrade goes into service. In these early years only a small fraction of this transmission upgrade would be needed. In order to be profitable, the transmission line operator might carry electricity generated by fossil fuel sources, thereby negating the environmental benefits of these new renewable energy sources.

5.7 PSE Brief, Comment #7-Energy Storage

The PSE Brief addresses the issue of energy storage on page 5: *"Sufficient storage must be added to allow renewable generation, rather than gas, to meet daily fluctuations in demand."* Unfortunately, the PSE Brief is correct. There is not sufficient storage and gas already is being used to produce the GWh previously produced by IP2. There are no batteries of sufficient size to deal with fluctuations or intermittent nature of renewable systems and unless there is a breakthrough on costs, a battery system of sufficient size would be prohibitively expensive. In reality, gas is being used across the country to overcome the intermittency of RE electricity production.

The following analysis explains why gas, not batteries, is used to overcome the intermittency of renewables.TABLE A-4 is a list of the largest global operational batteries either already in operation or expected to become operational by late 2020 or 2021.

The two Indian Point nuclear plants produced about 16,695 GWh/year or an average of 45.74 GWh/day. Even if huge areas could be found to place many square miles of solar panels to match the electrical output of IP, there would still be major energy storage issues in using solar energy. In January in New York City there is no sunshine for about 16 hours per day. If one assumes a low battery cost of $150/KWh, then the cost for batteries which would be able to match IP's output for just 16 hours of one day, would be about $4.6 billion dollars. As TABLE A-7 shows, even the world's largest batteries do not approach the 45.74 GWh size needed to replace Indian Point for a single cold day in January.

The longest sunlit days in New York City are in the summer with 14 hours of sunshine in late July. This means that 10 hours is the minimum number of hours of storage to cover nighttime energy needs. Using the above cost figures a summer only battery would cost about $2.9 billion dollars. This 10 hour storage battery would be up to 6 hours short in the January. These 6 hours would mean that more gas and/or oil would have to be burned.

TABLE A-7 Largest Global Li-ion Storage Batteries

Project	Capacity, MW	Duration, Hours	Energy, GWh
Hornsdale Power-Australia	150	1.2	0.180
Stocking Pelham-UK	50	1.0	0.050
Jardeland- Germany	48	1.0	0.048
Minamisoma - Japan	40	1.0	0.040
Nishi-Sendai-Japan	40	0.25	0.010
Laural AES-USA	32	0.25	0.008
Escondito-USA	30	4.0	0.120
Ponoma-USA	20	4.0	0. 080
Vistra Moss Landing-USA (late 2020)	300	4.0	1.200
FP&L Manatee-USA (late 2021)	409	2.2	0.900
FP&L (date?)	100	4.0	0.400

It has been speculated that wind power might offset those time periods when the solar panels were not productive. The annual average capacity factor for land based wind power in NY State is only 0.26. Some of this limited output would overlap time periods when the sun was shining, leaving a smaller amount of energy to deal with the many hours when solar energy is unavailable. Even if land based wind power was much larger than what is projected for NY, approximately three quarters of the time there is no output. It is clear that a combination of land based wind power and solar energy would result in gaps in electricity production that would be very expensive to fill using present technology Li-ion batteries. Without energy storage overlaps in solar energy and wind power production could lead to increased wind and/or solar curtailments. A mismatch in an overbuilt solar energy capacity in California and transmission limits and/or demand limits have already led to curtailments there.

Offshore wind power has a higher capacity factor than land based wind power with a capacity factor of about 0.38. As such, on average, there would be no output over 62% the time from offshore wind. A year long, hour-by-hour, analysis would provide a more precise estimate of the lengths of time and approximate dates gaps might occur between electricity demand and wind + solar supply. Such analyses based on actual data are becoming more available. However, as shown below, the PSE Brief's recommended 730 MW, 4 hour of energy storage would be insufficient to fill in any gaps in electricity from wind/solar combinations longer than 94 minutes. These gaps in wind power-solar energy combinations would need large energy backup sources like gas or nuclear power. To be consistent with the CLCPA, gas should be avoided to make up for shortfalls in RE.

Page 3 of the PSE Brief considers a need to deploy 730 MW of storage to the downstate region, compared to the 44 MW of statewide storage today, as identified in footnote 11 of the PSE report. Typically energy storage just covers a 4 hour duration, therefore these present 44 MW only store 0.176 GWh. Even if this 730 MW increase were achieved and had a duration of 4 hours this would be equal to 2.92 GWh, as compared to the Indian Point daily generation of 44.65 GWh/day. Stated differently, 730 MW of storage with a 4 hour endurance would only produce the equivalent of about 94 minutes' worth (~ one and a half hours) of IP power production. Such energy storage is best used to partially reduce peak demands. The present 44 MW of four hour storage is approximately equal to 6 minutes of the IP2+IP3 output. Energy storage in Li-ion batteries today are mostly being used to smooth out short lived electricity quality issues and, to a lesser extent, to reduce a fraction of the peak load. Batteries are not being used to replace base load electricity, like what IP produces.

If economical energy storage is not available, then RE will be backed up by the electric grid which is increasingly dominated by fossil fuel generated electricity, especially as Indian Point is closed.

5.8 PSE Brief, Comment #8-Solar Energy

5.8.1 Distributed Solar Energy

For the purposes of this critique, downstate is defined as zones G+H+I+J. Upstate is defined as NYCA minus zones (G+H+I+J+K), where zone K is Long Island.

In creating Figure A-7 full credit was given for the 450 GWh of utility scale solar, 970 GWh of distributed solar and 450 GWh of onshore wind listed in the PSE Brief's Figure 1 under the column titled "Recently Deployed". These 1,850 GWh are plotted as starting in 2019 and continuing forward at that rate for an indefinite period of time.

Attention then turned to new sources of renewable energy. It was important to determine their start dates, their build rates, and to match their total build as assigned to them in Figure 1 of the PSE Brief. Using the PSE Brief's Figure 1, the distributed solar associated with the Under Development column is estimated to be capable of producing 1,670 GWh when fully developed. Similarly, the distributed solar associated with the Accelerated Targets is estimated to be 2,800 when fully developed.

As to the 1,670 GWh of distributed solar, this was assumed to take place in the downstate area, starting in 2020. Use was then made of NYISO analyses to estimate build rates.[21] NYISO reports a cumulative solar output for zones G+H+I+J of 1,367 GWh over the time span of 2020 to 2024. These data were used to estimate an average build rate of 1,367/4 =342 GWh/year. At this rate it would take 4.9 years to reach the 1,670 GWh/year level. For simplicity, it was assumed that this task was completed in four years, from 2020 to 2024, with a build rate of 420 GWh/year.

After 2024 it was assumed that all distributed solar installation took place upstate. Upstate build rates based on NYISO data from 2019 to 2030 average out at 459/GWh/year.[21] To reach the 2,800 GWh/year production rate would take 2,800/459 = 6.1 years, simplified to 6 years. This task would start in 2024 and would be completed in 2030.

5.8.2 Utility Scale Solar

Utility Scale Solar is estimated to be about 2,200 GWh. Since the PSE Brief states that *"...and NYSERDA large-scale renewable energy projects coming online in 2024..."*, Utility Scale solar is assumed to be a large scale project and to start in 2024. Data on projected utility scale solar build rates in New York for the time period starting in 2024 are not readily available. It was assumed that the build rate would be 370 GWh/year so that this task would be completed by 2030.

5.9 PSE Brief, Comment #9-GWh to GWh Comparisons Are Inadequate

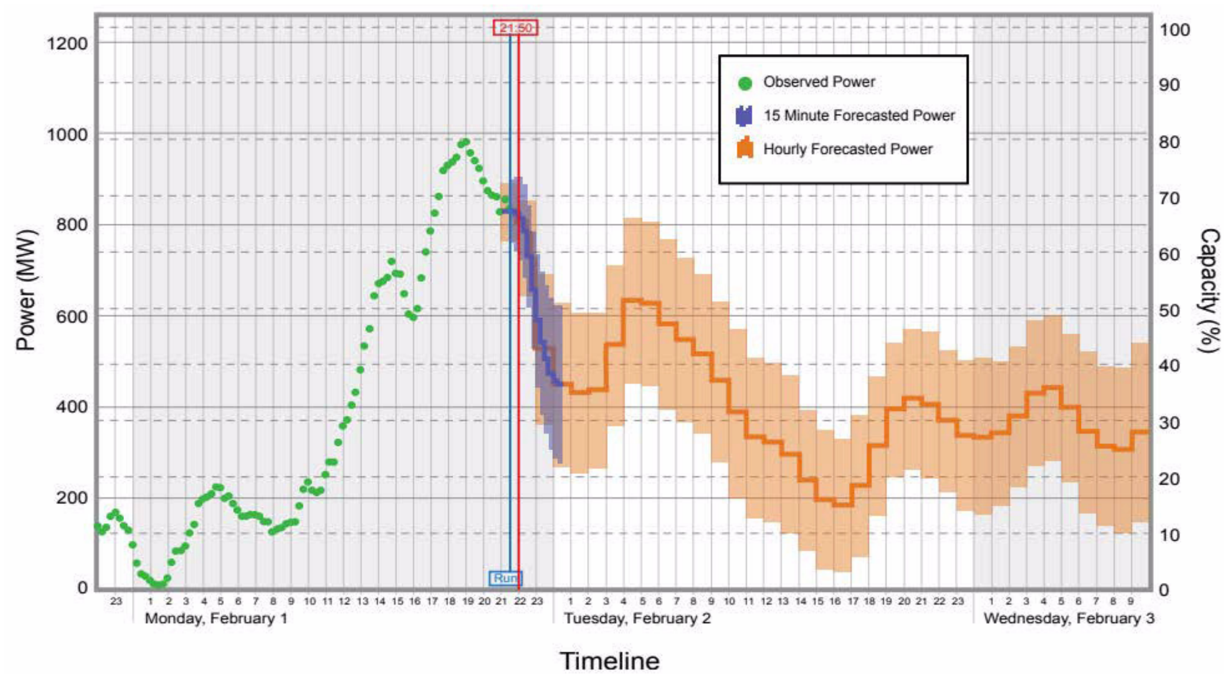
Even if there were enough GWh from RE sources to match the GWh from IP, this would not demonstrate that IP could be replaced by RE. There are a number of reasons for this as discussed in the Executive Summary. One of these reasons is because RE and IP have different temporal distributions. Temporal distribution issues shows up in a variety of ways in New York. As NYISO has pointed out in its Power Trends reports, in the winter time the sun sets before the peak load is experienced several hours later. Then there are times when the supply of wind generated electricity exceeds the demand and the excess wind generation is then wasted, i.e., curtailed. NYISO has presented figures in its Power Trends reports that display the hours when curtailment was necessary. These RE temporal issues do not happen for IP and other nuclear plants which operate in a constant output in all four seasons and throughout the day.

The PSE Brief recognizes the need to account for temporal distributions. On page 5 of the PSE Brief *"Hourly grid modeling will be necessary to determine the optimal siting and operation of storage to allow renewable resources to replace the consistent power provided by Indian Point and other nuclear facilities"*. However, the storage situation is more complicated than what the PSE Brief has described. Even when hourly data on wind power are available, sizing the storage system can be difficult because large swings in electricity output can happen in short time periods.

For example, a recently published report by the National Renewable Energy Laboratory provides observed and forecast hourly power output from a wind facility in the United States. [22] As the data show, in the course of a single day in February, the power output varied from zero to almost 1000 MW. It is noted that there are wide bands on the hourly forecast wind power, on the order of 300 MW in this case. Given hourly data like those presented by NREL, reproduced in Figure A-6, does the technology exist to determine the optimal siting and operation of storage the PSE Brief considers necessary? Battery storage is useful in maintaining high electricity quality, like keeping variations in system voltage levels acceptably small. Batteries can be useful in reducing the use of peaker plants. However, cost effective battery technology is not available today to fully support RE. These more limited applications of battery storage may explain why NY State only has 44 MW of statewide storage today, as identified in footnote 11 of the PSE report.

The relationship between energy storage and RE is complicated. The buildup of RE must be done in concert with energy storage otherwise a situation like what has happened in California could occur in New York. California has raced ahead with constructing a great deal of solar energy capacity, but relies on the centralized grid as a back up. This has produced what is called the “duck curve” where centralized systems are now operated in an a less cost effective way. The output from these centralized plants rapidly decreases as the sun rises in the morning and rapidly increases at sundown. This has converted a rather constant output from the centralized system to a complementary variable one to match the solar variability. This is not an economical way to run the centralized system. Further, these gas burning centralized systems always have to be in a standby mode, burning gas, to fill in the slack if there is a sudden drop in the RE output. California had to sacrifice the environmental benefits of solar energy in order to maintain overall system reliability by constantly burning some level of gas. It is a failure to major build RE systems without their necessary storage systems This is a cautionary tale for NY State. Without low cost energy storage, how does NY State avoid its own “duck curve” as it races forward to build a very large RE system, like a 9,000 MW off-shore wind farm needed to meet its own renewable energy mandates?

FIGURE A-6 Observed and Forecast Hourly Wind Power



6.0 AN ALTERNATIVE FIGURE TO THE PSE BRIEF'S FIGURE 1

Based on the information provided in TABLE A-8, Figure A-7 is an alternative to Figure 1 of the PSE Brief.

TABLE A-8 Input Information for Redrawing PSE Brief Figure 1

Item	Action	Comment
A. Energy Efficiency.	EE deleted from PSE Brief Figure 1.	See Sections 2, 3.2, and Comments #1 and #2.
B. 1,850 GWh/Year from "Recently Deployed" column in PSE Brief Figure 1.	Full credit given, starting at 2020.	450 GWh/yr, from utility scale solar + 970 GWh/yr from distributed solar + 450 GWh/yr from onshore wind.
C. Onshore wind.	Start in 2024, complete by 2029 at which time this source would produce 2,200 GWh/year. Build rate of 440 GWh/year.	See Comment #4.
D. Offshore wind.	Phase One: Install an annual capacity for NYC of 2,716 GWh/year by 2024. Phase Two: Start in 2025, end in 2035. Build rate at 1,215 GWh/year.	See Comment # 5.
E. Distributed solar, downstate.	Start in 2020, complete by 2024, at which time this source would produce 1,670 GWh/year. Build rate at 420 GWh/year	See Comments #6 and #8.
F. Distributed solar, upstate, transmitted to downstate.	Start in 2024, complete by 2030, at which time this source would produce 2,800 GWh/year. Build rate at 470 GWh/year.	See Comment #8.
G. Utility scale solar.	Start in 2024,complete by 2030 at which time this source would produce 2,200 GWh/year. Build rate at 370 GWh/year.	See PSE Brief, page 6.

Figure A-7 is an alternative presentation of the PSE Brief's Figure 1. This alternative presentation shows, in white areas, clean energy production from both Indian Point and renewable energy sources. The darkened area, filled with tiny dots representing $PM_{2.5}$ particles, comes from fossil fueled plants that also add large quantities of GHG to the atmosphere.

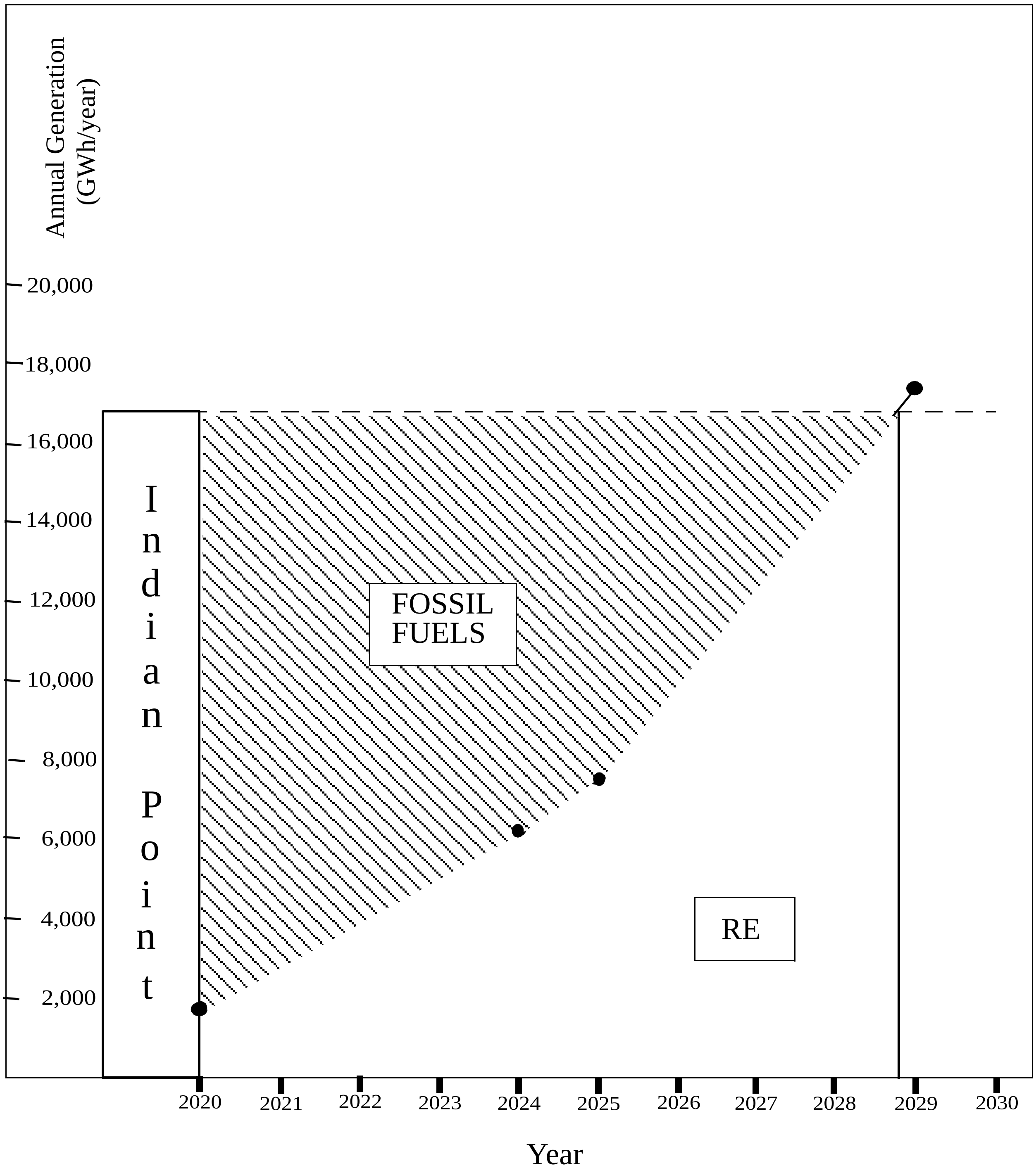
Figure A-7 used, in full, all of the sources of RE in the PSE Brief's Figure 1. Start dates for different RE projects also came from the PSE Brief. Instead of assuming that all RE projects was fully productive at their start dates, installation or build rates, were used. These build rates were derived from several NYISO documents. When evaluating the transfer of RE from upstate areas to downstate areas, crosschecks were made to assure that transmission capacities were not exceeded and that the announced date of the completion of the new upstate to downstate transmission line was adhered to.

Figure A-7 is an intentionally optimistic drawing. All RE projects were assumed to start on time and reach completion using a build rate equal to or larger than actual experience. Therefore the calculated date by which RE might achieve the same GWh output of IP2 +1P3, is the earliest date possible, mid 2028.

Before RE GWh/year matched the 16,695 GWh/year electricity production of IP2 + IP3 there would be a shortfall which was assumed to be filled by burning gas. Using both NYSERDA data on the number of millions of metric tons of CO_2 released from the electrical generation sector in 2016 and the number of GWh in the electricity sector generated in 2016, it was possible to estimate the millions of metric tons of CO_2 per GWh of the mix of gas facilities in New York. This ratio was used, along with this alternative Figure 1 to estimate the amount of greenhouse gases produced through mid 2028 by the gas used to overcome any shortfall in energy. This estimated figure came to about 35 million metric tons and did not account for methane leakage.

It is highly improbable that any meaningful attempt will be made to match the energy output of Indian Point with RE. It is much easier to put billions into mega projects like the world's largest off-shore wind farm while building more gas plants and laying more gas pipelines.

FIGURE A-7 Alternative Figure to PSE Brief's Figure 1



7.0 END NOTES

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the total becomes 10.2 to 12.6 MMT/year. Since the CPV + Cricket Valley plants have about a 25% GWh shortfall compared to IP, replacing this shortfall with gas would increase the $CO2_e$ release even further. For additional information on methane see "Assessment of methane emissions from the U.S. oil and gas supply chain", Ramon A. Alvarez, et al, Science, 13 July, 2018.

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