Critique of NYSERDA's Draft Plan

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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. At the Atomic Energy Commission in the 1970s he was responsible for the licensing of the Indian Point 3 nuclear power plant. In the 1980s the New York Power Authority hired Mr. Specter to defend its Indian Point 3 nuclear plant in a federal adjudicatory trial. He and his team of experts prevailed in court. Mr. Specter served at diplomat rank for 5 years at the International Atomic Energy Agency in Vienna, Austria where he led an international effort writing design safety standards for nuclear power plants.

Mr. Specter has been Chairman of two national committees on nuclear power plant emergency planning and was a guest lecturer for several years on emergency planning at Harvard's School of Public Health. He analyzed emergency responses for a hypothetical terrorist attack on the Indian Point power plants which were located in the nation's highest population density area. 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 in 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. While voluntarily serving as President of Big Brothers of Washington, D.C., the number of boys the agency helped was doubled. 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

This document is a critique of the "New York State Climate Action Council's Draft Scoping Plan" prepared by NYSERDA with the assistance of E3 and Abt Associates, herein called the NYSERDA Draft Plan. The major conclusions are:

A. Climate change is a reality. Record high carbon dioxide levels in the atmosphere have been measured (1) and there has been a marked increase in the earth's heating rate.(2) In the last five years $500 billion dollars of damage in the United States has been attributed to the effects of climate change and the potential for further damage will increase as the atmospheric concentration of greenhouse gases (GHG) rises. The most recent report from the United Nations show that as the threat from COVID-19 has subsided, the release of GHG has accelerated significantly. The more we delay, the greater the ongoing damage. However, implementation of this NYSERDA report would put New Yorkers and the environment at significant risk. This report appears to be a continuation of the failed energy policies that New York has had for years. (See Appendix C)

B. The NYSERDA report fails to satisfy the requirements of either the Climate Leadership or the Community Protection portions of the CLCPA.

C. The consequences of failing to effectively deal with climate change are immeasurably large. Therefore it is imperative that we take actions that reduce the probability of failure to near zero levels. It is commonplace now when analyzing high consequence, low probability events to use a technology called Probabilistic Risk Analysis (PRA). Among the many advantages of PRA is it examines many different scenarios and a distribution of multiple outcomes is presented, each outcome with its own uncertainty band. Decision-makers are far better informed with this level of information. It is important to know which scenarios have the greatest uncertainties and what factors drive these uncertainties. FigureA-1, published by the National Renewable Energy Laboratory, shows that as the deployment of renewable energy increases, so does its difficulty and costs. At high deployment levels an unresolved seasonal problem emerges. This unresolved seasonal problem is a large energy gap that occurs when solar plus wind energy are insufficient to meet demand. Neither NREL on a national level, nor the Brattle Group, nor the Analysis Group, nor NYSERDA analyses on a NY State level have presented a plausible solution to this gap issue. Further, the gap issue appears to be getting worse, driven by climate change. In recent years very large wind lulls have formed which diminish, if not eliminate, wind farm contributions for extended periods of time. No uncertainty analysis is presented in the simplistic analysis generated by NYSERDA, nor is it recognized that it should be.

D. Being subjected to the risks from wind lulls is a matter of choice. If we choose an extreme scenario, like 100% renewable energy, we are electing to put ourselves at great risk. As shown in Figure A-2 and TABLE A-4 there are other scenarios which have much lower costs, require far less land, fewer megawatt-miles of transmission lines, and less short term battery costs. Clearly these scenarios are superior to the 100% renewable energy scenario and they are much more in line with the goals of the CLCPA. However, these superior scenarios are not 100% renewable energy scenarios. What the NYSERDA report should have done is to point out that the pre-selection of 100% renewable energy is inconsistent with Community Protection.Why should low and middle income people pay for an electric system that is needlessly expensive? High costs for electricity also drive away business from New York and costs jobs. The NYSERDA report did not demonstrate that it has taken a least cost approach to New York's energy future.

E. The NYSERDA report should have recommended that the mandate requiring "100% renewable energy" be reworded as "100% clean energy", where clean energy includes nuclear energy and fossil fuels, with carbon capture and sequestration and combinations thereof.

F. The NYSERDA report has an obligation to the citizens of New York and their elected officials to explain its avoidance of nuclear energy when the United Nations' Intergovernmental Panel on Climate Change (IPCC), the International Energy Agency, the Clean Air Task Force, and many others, have called for much greater use of nuclear energy for cost-effective decarbonization. The NYSERDA report should explain why New Yorkers should have confidence in the path that it has chosen when there are no successful all-renewable energy advanced nations. Germany's Energiewende is a failure. California's closure of its nuclear plants has been a disaster. New York State's energy history shows that, for many years, its support for imported fracked gas greatly exceeded its support for local renewables. Citizens in New York who today largely depend upon natural gas for heating and for electricity are experiencing very rapid increases in their energy bills. Local newspapers attribute part of this rapid increase to the closure of the carbon-free Indian Point nuclear units. New York State's former administration's opposition to nuclear power put the State at risk as far back as 2014 (See Appendix C) and continuing opposition to nuclear power has put Governor Hochul into an emergency energy situation, as described by the New York Independent System Operator in a report it published in November, 2021.(3)

G. Not only is the NYSERDA analysis simplistic, it contains significant data and modeling errors which invalidate its calculations and conclusions. The magnitude of the NYSERDA error just due to faulty capacity factors is 36,717 Megawatts. This error alone is close to the size of the whole electricity generation system in New York today, 39,295 Megawatts. The NYSERDA report's design criteria for our electricity grid are significantly different from New York Independent System Operator's approach and far less reliable. Unless corrected, implementing the NYSERDA report would lead to an unreliable and costly electricity system that fails to achieve its decarbonization goals. The NYSERDA report is silent on how to build and install the huge number of solar panels and wind turbines it claims it needs in a timely manner.

H. Significant cost savings, reduced land and materials use, and a reduced number of new transmission lines are achievable with a mix of conservation, renewable energy, nuclear energy and/or fossil fuels with carbon capture and sequestration. The NYSERDA report failed to sufficiently bring this observation forward, even though it is of fundamental interest to the public and its elected officials and has been widely discussed in present energy analysis literature.

In view of these major deficiencies, this NYSERDA report should be withdrawn.

2.0 Structure of This Critique

The driving force behind the enactment of the Climate Leadership and Community Protection Act is the belief that climate change represents an existential threat to life on this planet. As such, the probability of failure to properly deal with climate change must be made as close to zero as possible. Our best science and engineering tell us that extreme scenarios, like the 100% renewable energy approach in the NYSERDA report, do not represent least risk pathways.

The people and their elected officials need to receive energy analyses that are agnostic, i.e., no energy source is given special preference and no energy source is excluded for political reasons. The first principal of Climate Leadership is to tell the truth, even if it means that NY State would have to rewrite some of its energy mandates.With so much emphasis on renewable energy, it is important to re-evaluate its strengths and limitations.

It cannot be overemphasized that the goal of this critique is not to attack renewable energy by identifying its limitations. Renewable energy must be part of our energy future. One goal of this critique is to prevent renewable energy development from stalling out because of growing technical problems and increasing public opposition. The path to further expansion of renewable energy is as a member of an energy family that also includes energy conservation, nuclear energy, and hydrocarbon fuels that have a zero net addition of greenhouse gasses to the atmosphere and to the oceans. This more inclusive approach leads to new opportunities with renewable energy/nuclear combinations that are not possible with either technology alone. Such energy combinations could be the basis for new industries and new jobs in NY State.

This critique is divided into two main sections. First there is a general discussion of the benefits and limitations of renewable energy. This is followed by a specific discussion of the NYSERDA report. Supplemental information can be found in the Appendices and in the References section.

3.0 Will Further Growth of Renewable Energy Stall Out?

3.1 Introduction

Renewable energy has made great progress in the past decade, especially in cost reduction. However, it is widely recognized that as the deployment of renewable energy increases, so do the technical challenges and public resistance to further expansion. There appears to be a growing wall of public resistance to deploying increasing percentages of renewable energy, be it because of land use, expansion of transmission lines, use of materials, cost, reliability, health issues, impacts on wildlife, aesthetic reasons and a growing opposition to an authoritarian form of government that imposes a particular energy source structure against the will of many local people. If the NYSERDA report's 100% renewable energy approach was attempted and stalled out, critical time and resources would have been lost and this could lead to enormous damage.

Costs can be an issue. The only operating offshore wind farm in the United States is Rhode Island's 30 MW Block Island Wind Farm. The economics of that wind farm have been subject to a great deal of criticism. The existing Block Island Power Purchase Agreement (PPA) specified that utilities pay $245/MWh for its electricity. With its 3.5%/year price escalation agreement, the cost will rise to $470/MWh by 2035, the last year of this PPA. The average wholesale price for electricity in New England in 2019 was $30.67/ MWh. **Reports, like the NYSERDA report, must be totally transparent and comprehensive in reporting the costs to achieve the scenarios it favors.**

Land use can be an issue.

In one report (4) it was claimed that a high renewable energy deployment future for the U.S.would need 590,000 square kilometers, an area roughly equal to the size of Connecticut, Illinois, Indiana, Kentucky, Massachusetts, Ohio, Rhode Island, and Tennessee put together. This figure did not include the land area that additional transmission lines would occupy.

Others claim that the needed land area for the solar portion of high deployment RE future would only occupy about 0.5 percent of the USA land area.(5) Can both of these statements be true? Land use for onshore wind power was extensively analyzed in a recent National Renewable Energy Laboratory report (6) which concluded that siting wind power is significantly dependent on local attitudes and regulations. National projections of 2050 onshore wind power capacity varied from + 7% (49 GW) under the least restrictive siting regime to a decrease of 37% (270 GW) in the most restrictive siting regime. NREL has calculated that those areas that have the most restrictive land use regulations may still achieve high onshore wind power capacities by greater generation. If this greater generation is achieved by using much larger onshore wind machines, this may stir up further public resistance. Such social uncertainties are not reflected in the NYSERDA report's analysis. **The lesson for New York is use a local consent-based approach to siting renewable energy sources or run the risk of a backlash that could cause further growth of renewable energy to stall out.**

Using New York State (NYS) as an example, to install large upstate wind and solar farms, some forests will be cut down and some food producing farms bought out. There already is considerable local resistance to this. For example, in White Plains, NY local citizens fought against installing solar panels in a cemetery because to do so would require cutting down an old stand of trees.If increasing the renewable energy contribution requires State and/or the Federal governments to become too authoritarian, people rebel. Such rejection of the States' energy plans has already begun. As reported in the Oneanta, New York Daily Star *"But a process for turbo-charging reviews of green energy projects is now under legal attack, with an assortment of rural towns, bird conservation clubs and citizen groups arguing the state government has stripped localities of sufficient time to evaluate the plans"*.(7)

3.2 **The Importance of High Energy Density**

Many of these growing technical and social challenges of all-renewable energy futures can be traced back a single inherent renewable energy property: low energy density.

Three areas where low energy density is important to renewable energy are:

- Ability to withstand the effects of climate change,
- Manufacturing and installation capacity, and
- Social acceptance

3.3 Ability to Withstand the Effects of Climate Change

In general, solar, wind, and biomass have low energy densities. Because of these low energy densities large collection areas are necessary and this precipitates a number of other problems. Per kilowatt-hour of clean electricity, renewable energy is materials intensive, land intensive, and needs more miles of transmission lines, all of which have been opposed by the public.

Large collection areas also make renewable energy much more vulnerable to climate change than nuclear power. Each U.S nuclear plant today has its reactor surrounded by a strong containment building. These robust structures have safely withstood direct hits by category 5 hurricanes, tornadoes, huge earthquakes, and local floods. Their basic designs make them "hardened" structures. The areas used by solar and wind farms cannot be hardened and not just because of the high costs to do so. To cover them over to protect them from the detriments of nature would end their ability to enjoy the benefits of nature, such as collecting low energy density wind and sunshine. As an example of this vulnerability to nature, just a small snowfall, frost covering. or saltwater spray on proposed offshore solar panels reduces or eliminates their electricity output.

Besides renewable energy being less resilient to climate change than nuclear power, nature interferes with renewable energy in other ways. For example, in winter in New York and elsewhere, the sun sets before the evening peak demand for electricity occurs.Unless very large energy storage capacity is available, solar energy alone can not reduce peak winter demands. As space heating and making hot water becomes more electrified, the winter peak demand will be much higher, making the inability of solar energy to reduce peak winter electric loads a more important drawback.

Not only are there seasonal variations in solar output, but there also are geographical ones. A solar panel in New York would produce 41% less electricity per year than the identical panel in Los

Angeles. In New York solar energy has a capacity factor of 14%. This is like having a car that only operates one day a week. The optimum mix of energy sources would be location dependent. One cannot extrapolate the role of solar energy in southern California to New York. Similarly, onshore wind power in NY State can never match the capacity factors of wind turbines sited in the Great Plains.

Large offshore wind turbines are only built to withstand category 3 hurricanes. Stronger storms, like hurricane Maria, have torn the blades off of wind turbines. Wind turbines with category 5 hurricane protection would cost more. Ice storms have collapsed electricity transmission towers and renewable energy needs more miles of transmission lines per KW-hr. (See Appendix B)

While extreme windstorms would have the largest impact, small variations in wind speed are important too. For example, the New York Independent Systems Operator reported*“In 2019 there were 64 instances when wind resources supplied less than 100 MW to the grid for periods of more than 8 consecutive hours. 100 MW represented about 5% of the installed wind capacity in 2019”*. (8) That was during 2019. In 2020 there were 74 such instances.

Not only does the wind vary from year-to-year, there are moment-to-moment variations as well. The electricity produced by a wind turbine varies as the cube of the wind speed. As a hypothetical example, if a wind turbine experienced a decrease in the wind speed of 10%, going from 20 m/s to 18 m/s, there would be a potential decrease in electrical output of 27%. If there were a 10% increase in the wind speed, going from 20 m/s to 22 m/s, there would be a potential increase in electrical output of 33%. Shifts in wind speeds from - 10% to +10%, in this example, would result in a potential variation in electrical output of 60%. Published data on wind turbine output have shown large output swings in comparatively short time periods. Should wind turbines be connected to batteries with the goal of producing a steadier output, frequent charging and discharging may reduce battery lifetimes well below design specifications. This shorter battery lifetime has been observed in a Texas utility that has a large wind contribution. This Texas situation needs to be explored further by NYSERDA because of the huge number of batteries the NYSERDA report is counting on.

Beyond these frequent episodes of low wind speeds there are now global events that are the opposite of violent hurricanes: huge areas covered by still air over long periods of time.The creation of long duration lulls appears to be another impact of climate change. During the summer and early autumn of 2021 Europe experienced a long period of low wind speeds. The United Kingdom power company SSE, stated that its renewable assets produced 32% less power than expected. The latest Intergovernmental Panel on Climate Change report suggests that the average wind speeds over Europe will be reduced by 8% to10% as a result of climate change.(9)

Meteorologically, wind patterns are very large, much larger than the largest wind farms.This means that increasing the number of wind turbines in a wind farm is unlikely to overcome large scale wind lulls, but it could result in just having a larger number of simultaneously idle wind turbines.There are indications that the frequency of large area wind lulls may be increasing as the climate changes. Both of these climate related extremes, stronger hurricanes and huge lulls, challenge the ability of wind power to reliably meet a large fraction of our future electricity needs. Who knows what the wind patterns might be by 2050? This lack of knowledge adds uncertainty to large wind farm endeavors. The commitment to build a very large number of wind turbines with a specific design would have to be made well before future wind data became available.

Long duration and widespread lulls represent a potential significant risk situation. However, it should be remembered that risk significant lulls are a matter of choice. They are only important if we choose to be heavily dependent on wind power.

Nature can interfere with solar energy in other ways beside climate change. In 1815 there was a massive eruption of Mount Tambora. Enormous amounts of material was injected into the atmosphere. 1816 being known as the "Year Without a Summer."(10) The average global temperature decreased by 0.4 to 0.7 degrees centigrade because of all the airborne particles. Reduced sunlight led to massive starvation at many locations around the world. Reduced sunlight means less electricity from solar panels. Huge volcanic eruptions are rare, but not impossible. Ongoing eruptions in Tonga remind us of the great forces of nature and the need for diverse sources of energy. We have already seen a smaller version of this. Smoke from California fires impacted people as far away as the east coast. The moon appeared to have a brown/orange color while these fires were ablaze.

3.4 Manufacturing and Installation Capacity

This section quantifies how low energy density forces the need for huge numbers of solar panels and wind turbines in a 100% renewable energy future.

3.4.1 State Level Analyses

A. **The Brattle Group.**

Table A-1 compares Brattle Group's installed NY capacities in years 2024 and 2040. (11) To achieve this 100% renewable future by 2040, an unprecedented manufacturing rate and the installation rate would have to be achieved. Areas of exceptional growth are identified with a red color.

TABLE A-1 Brattle Groups's Installed NYS Capacities, 2024 and 2040, GW

Item	GW in 2024	GW in 2040	2040/2024
BioGen	0.1	0.0	0.0
Coal	0.0	0.0	0.0
Hydro	5.0	5.0	1.0
Kerosene	0.2	0.0	0.0
Gas CC*	11.0	12.5*	1.14
Gas CT*	3.0	12.5*	4.17
Gas ST*	8.7	8.7*	1.0
Nuclear	3.3	2.2	0.67
Oil CT	1.5	0.0	0.0
Oil ST	1.6	0.0	0.0
Pumped Storage	1.2	1.2	1.0
Solar	0.1	31.7	317
Solar BTM	4.5	6.4	1.42
Storage 2 hr	1.2	8.2	6.83
Storage 4 hr	0.0	5.9	Infinity
Wind Offshore	0.6	25.1	41.83
Wind Onshore	1.7	23.3	13.71

Capacity Imports	1.1	1.1	1.0
Demand Response	1.3	1.3	1.0
Flexible Load	0.0	3.2	Infinity
RNG Production	0.0	11.6**	Infinity
Total	46.2	159.8	3.45
* Supplied by RNG, total = 33.7 GW. ** With the energy needed to produce RNG, 45.3 GW.	N/A	N/A	N/A

The Brattle Group assumed the availability of RNG, renewable natural gas, yet undeveloped. This RNG was to be used to overcome long lull periods in wind power. Not only is there no clear path today to manufacture and install 33.7 GW of renewable natural gas, the NYS overall electric capacity would have to increase by 345%. The calculated solar contribution would need to increase by a factor of 317 to reach a capacity of 31.7 GW of installed solar energy by 2040. This is to be accomplished in just the 16 years between 2024 and 2040. This seems impossible. Add to this a projected need for an onshore wind power capacity of 23.3 GW.

B. **The Analysis Group**

Further insights on the immense infrastructure challenges that lie ahead are presented in the Analysis Group's report for NY State. (12) TABLE A-2 repeats Table ES-1 from the Analysis Group's report for the generation needs for NY State by 2040 for the CCP2-CLCPA Resource Set.

TABLE A-2 Analysis Group's Generation Capacity in MW, Year 2040

Land Based Wind	35,200
Offshore Wind	21,063
Solar (Behind the meter)	10,878
Solar (Grid connected)	39,262
Hydro Pondage	3,573
Hydro Pumped Storage	1,170
Hydro Run-of-River	913
Nuclear	3,364
Imports	2,810
Storage	15,600
Price Response Demand (Summer)	5,236
Price Response Demand (Winter)	3,412
DE Resources	32,137

The Analysis Group also provided information on the New York installation rate necessary to put the above resources in place, as adapted below in TABLE A-3. The differences between historical growth rates and those needed to meet 2040 goals are profound.

TABLE A-3 New York Required Rate of New Resource Development

	Wind, Onshore and Offshore, MW	Grid Connected Solar, MW	Required Wind Growth Rate, MW/Year	Required Solar Growth Rate, MW/Year
Existing Resources (2020)	1,985	57	N/A	N/A
1.Climate Phase II Reference Case R	39,962	34,354	1,899	1,715
2.Climate Phase II CLCPA Scenario	56,263	39,262	2,714	1,960
3.Grid in Transition Reference Case	23,522	30,043	1,077	1,499
4.Grid in Transition CLCPA Scenario	48,357	31,669	2,319	1,581
Historical Capacity Growth Rate,(2012-2020), MW/Year	N/A	N/A	**71.4**	**3.1**

The Analysis Groups' term DE stands for *dispatchable* and compliant with *emission* requirements. DE is comparable to the Brattle Group's RNG, Renewable Natural Gas. Similar to the Brattle Group, how to deliver this very large component of NY's projected 100% renewable energy future has not been identified by the Analysis Group. Some have suggested that land fills and dairy wastes might be sources of RNG. Waste energy from dairy farms is very small.(13)

Both NY State studies show that the expansion of renewable energy needed to meet State goals is enormous, as is the required and unprecedented installation rate.

3.4.2 National Level Analyses

A. **The Clean Air Task Force**

In addition to the infrastructure data at the state level there are infrastructure data at the national level in a report sponsored by the Niskanen Center and the Clear Air Task Force.(14) The opening paragraph in this report summarizes our infrastructure status: *"Though the details vary, a dominant theme in decarbonization studies is that any pathway to a net-zero carbon energy system in the United States will require a staggering build-out of electricity generation and transmission, zero-carbon fuels, and carbon sequestration"*.

In the above referenced report the following infrastructure estimates were made:

- More or less completely replacing the current bulk electricity system, including existing zero-carbon sources at the end of their life, by mid-century, and increasing total generation capacity from today by a factor of four, from 1,100 GW to 4,000 GW.

- Adding wind and solar at an accelerating rate, ending the 30-year period until 2050 with annual additions five times faster than today, even as the best sites are taken early. This would be a wind and solar fleet that at peak could produce three times as much electricity as all types of power plants combined can generate today.

- Adding 500-1000 GW of mostly new, clean capacity that guarantees a steady output such as nuclear, gas with carbon capture, hydrogen-fueled turbines, and long duration energy storage, up from 875 GW today.

- In doing so, expanding the total land area requires for electric generation (apart from transmission) by a factor of 13, with wind and solar taking up 590,000 square kilometers, an area roughly equal to the size of Connecticut, Illinois, Indiana, Kentucky, Massachusetts, Ohio, Rhode Island, and Tennessee put together.

- Building 100,000 km of new CO_2 pipeline infrastructure, a twelve-fold expansion, and developing hundreds of CO_2 storage sites able to store 1.3 billion tons of CO_2 per year, handling more fluid than U.S. oil production does today.

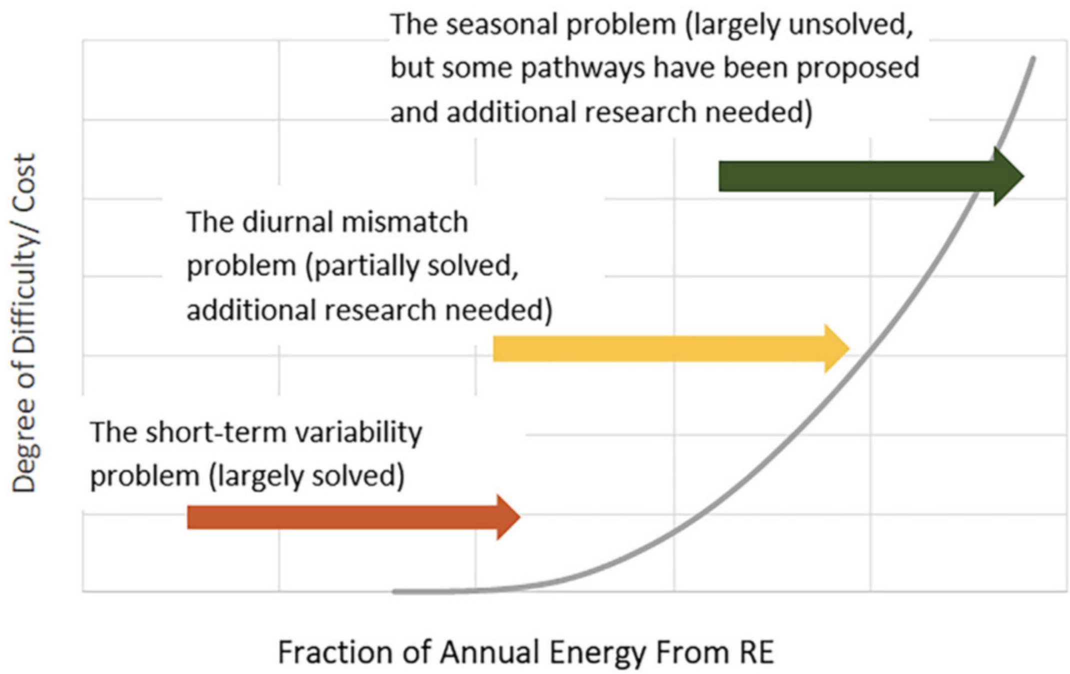
- More than tripling the capacity of the long distance U.S. transmission network, while adding tens of thousands of shorter generation ties to connect wind and solar farms to bulk transmission lines.

B. The National Renewable Energy Laboratory (NREL)

FIGURE A-1 was published by a group of NREL scientists in the Joule journal.(15) This figure is a qualitative description of the degree of difficulty/cost of renewable energy as a function of the fraction of deployment of RE. The greater the deployment of RE, the greater the difficulties. At very high levels of deployment there are largely unresolved seasonal problems. These are the same unresolved problems identified before, such as long lasting lulls in wind energy.

FIGURE A-1 appears to be an analysis depicting increasing technical difficulty/cost with increasing deployment of renewable energy. FIGURE A-1 may be misinterpreted by some, believing that RE difficulties will not begin until around the 80% RE deployment level. However, there are other sources of difficulty besides those caused by technological issues. These additional issues relate to social values and to infrastructure issues and these issues are being raised now. Land area issues are a growing concern and the NREL has revised downward the amount of land that might be available for RE Projects in locations with public opposition and restrictive siting regulations. Net metering subsidies for homeowners with rooftop solar panel systems are now being challenged in that lower and middle income citizens who do not own a house are ending up subsidizing higher income people with houses through surcharges in their electricity bills.

FIGURE A-1 Fraction Annual RE vs. Degree of Difficulty/Cost



In 2020 renewable energy contributed 19.8% of the nation's energy of which wind was 8.4% and solar 2.3%. Hydropower, which may have already reached its maximum contribution was 7.3% and biomass was 1.4%. Many low carbon energy future studies look to solar energy and wind energy (mostly offshore) to be the main sources of additional renewable energy in the future. Together, wind + solar today add up to 10.7% of the nation's energy today. Yet, already there is increasing push back against further expansion of these two renewable energy sources. Objections to renewable energy are largely centered around significant land use, opposition to large increases in the transmission network, high costs for renewable electricity, aesthetic objections, and health concerns. Further, resistance to wind and solar energy has been expressed by people concerned about the need for massive amounts of concrete and steel and a national security issue of depending on other countries for rare metals used in wind turbines,   These difficulties are already happening in the zero to 10% deployment range in FIGURE A-1, and are likely to worsen as RE deployment increases.

Enormous numbers of solar panels and wind turbines will need to be built and installed at an unprecedented rate by year 2040. Like land use issues, these infrastructure challenges are starting at deployment levels well below the 80% mark. Just recently, a request was sent to FERC to delay New York's first offshore wind turbines by a year and one-half, citing difficulties in obtaining key permits and government approvals.

3.5 Social Acceptance and Clean Firm Power

Land use is a source of contention for renewable energy, but there are other social acceptance issues.A 100% renewable energy future requires a large expansion of the number of MW-miles of transmission lines. Historically, expanding transmission lines has often met with considerable public resistance. Unfortunately people often consider having adequate electricity as a civil right and then turn around and resist the additional nearby transmission lines needed to have such adequate electricity. For years NY State talked about an "Energy Highway", a high voltage direct current system meant to bring upstate renewable electricity to the NY City area. There was considerable public resistance to this idea, especially in the more densely populated areas in downstate New York, and this idea was allowed to quietly fade away.

More recently NY State has sought again to expand its transmission capacities. One can hope that these latest efforts succeed. However, Riverkeeper already is on record in its opposition to the CHPE, the Champlain Hudson, Power Express, because major portions of this transmission line would be placed along the bottom of the Hudson River.

This New York experience is far from unique. In Shasta County, California the County's Planning Board unanimously voted on June 23, 2021 to reject the Fountain Wind project citing the project's impact on the environment, the scenery, and the long-term harm it would do to the area's economy. (16)

It is noted that this resistance to wind power has occurred in New York and California, two states which claim to be leaders in renewable energy. Since 2015, according to published media stories, about 300 government entities across the nation have moved to reject or restrict wind energy projects. (17)

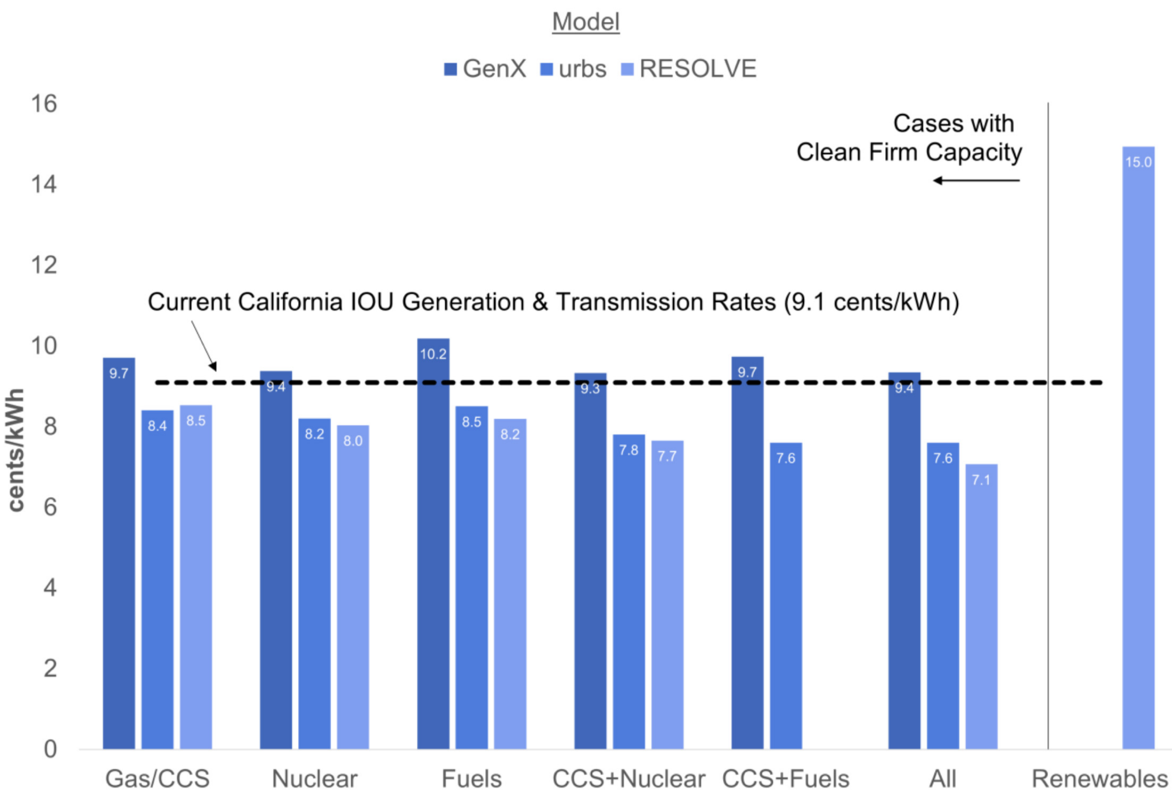
The cost of electricity, land use, and miles of transmission wires are all important social issues. All would be reduced by adding clean firm power. Clean firm power is nuclear energy, fossil fuel energy with carbon capture and sequestration or combinations of both. Once clean firm power is added the energy mix is no longer 100% renewable energy. Stated differently, the needs and wishes of the public are better served by an Energy Family approach.

A major step in analyzing the value of adding firm energy are analyses of possible California energy futures published by the Clean Air Task Force (CATF). See TABLE A-4.

TABLE A-4 Summary of Issues Related to the Need For Clean Firm Power

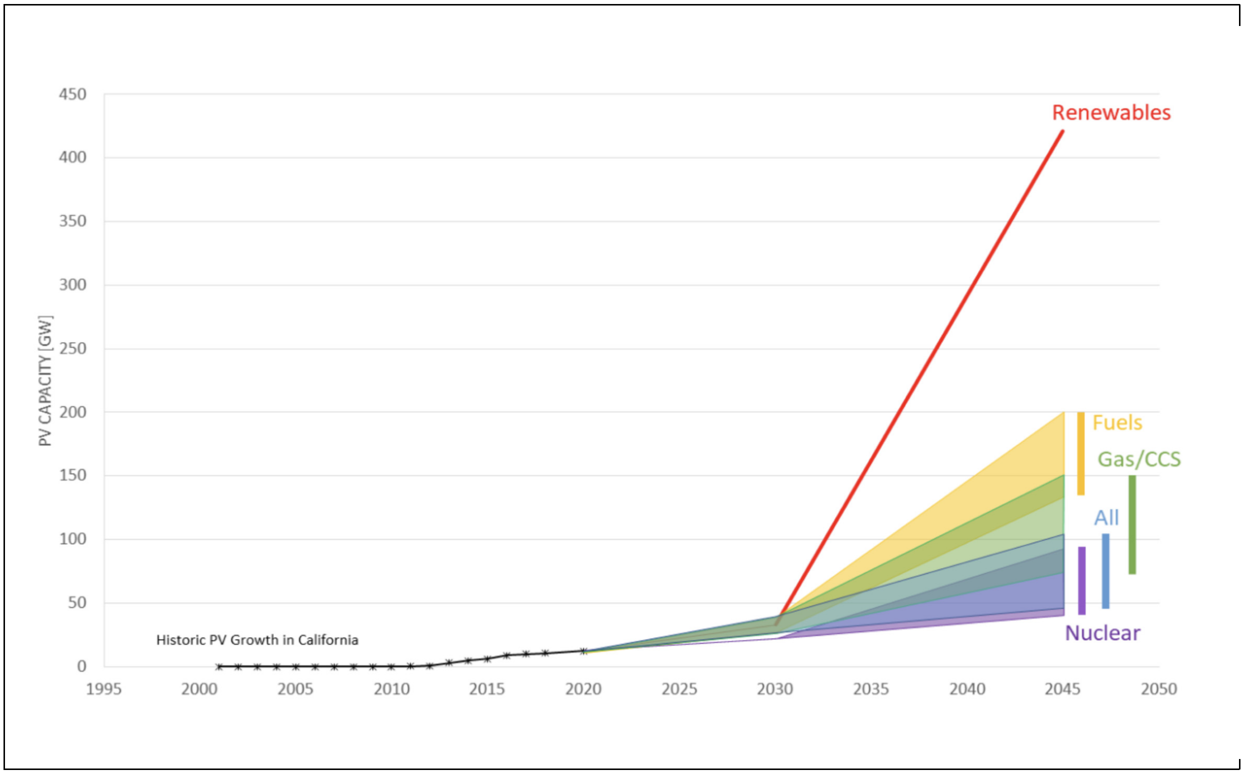
California Firm Power Issue	With Firm Power	Without Firm Power
Cost for Generation and Transmission	~9 cents/KWh	~15 cents/KWh
Solar and Wind Capacity	25-200 GW	470 GW
New Short Term Battery Capacity	20-100 GW	160 GW
New Energy Storage	100-800GWh	1,000 GWh
Land Use	625-2,500 square miles	6,250 Square Miles
Transmission	2-3 Million MW-miles	~ 9 Million MW-miles

FIGURE A-2 California Generation and Transmission Rate



The Clean Air Task Force also produced FIGURE A-2. Like the NREL analysis displayed in FIGURE A-1, this Clean Air Task Force figure showed large cost increases as the deployment of renewable energy increased. It also showed that many other scenarios that are not 100% renewable energy are far more attractive than the 100% renewable energy scenario.

FIGURE A-3 Growth of Photovoltaics



The addition of clean firm energy to the original 100% RE scenario marked an important improvement, but it did not go far enough.

3.5.1 Further Improvements in the CATF Analysis

A. Nuclear power and fossil fuels with CCS are treated as "corrective actions" to make significant improvements over a 100% renewable Energy future. However, the value of nuclear power and net zero fossil fuels is far greater than this role. In the CATF report nuclear power is treated much like today's gas peaker plants: only operating at times of peak demand. The CATF report assumes that these nuclear plants would only operate 2% of the time. Because of their high capital costs and low fuel costs, nuclear plants are run in a base load configuration, often achieving capacity factors larger than 90%. While better than the 100% renewable energy scenario, using nuclear power in a peaker plant mode is in poor economics. A simple improvement might be to expand the use of these nuclear plants to make hydrogen in exactly the same manner that the NYSERDA report assumes can be done by using excess solar energy to generate and store hydrogen. This approach would reduce the number of GW of nuclear needed, but would entail the construction of a hydrogen storage system similar to what NYSERDA has proposed. An economic analysis would be made to determine the lowest cost configuration of fewer nuclear plants but with the hydrogen storage system plus gas turbines that run off of hydrogen. If the nuclear plants and hydrogen gas turbines were co-located near salt caverns now used by the natural gas industry and sufficient water was available the whole hydrogen distribution issue would be greatly simplified.

B. The CATF report suggests about 30 GW of nuclear power and/or net zero fossil fuels be built to be available when the renewable energy deployment reaches such high levels that the cost increases non-linearly. A 30 GW addition of nuclear power is a very large undertaking, just for one State. If this 30 GW were to be comprised of a series of one GW nuclear plants, then, on average, about 3 new, one GW, nuclear plants would have to become operational every two years until 2040. There is no nuclear program in place today to accomplish this for California, let alone the rest of the country. It appears that the CATF report is implying that in order to make renewable energy more attractive to the public at the higher deployment levels, a major and rapid increase in nuclear power would be needed. Similar comments apply to fossil fuels with CCS.

C. If California were to build 30 GW of nuclear power plants, it should operate them as soon as possible. The sooner these nuclear plants start operating, the greater the decrease in GHG releases as the nuclear plants replace gas electric power plants. Rapid development of nuclear power minimizes the number of millions of tons of CO_2 equivalent now being released by California's gas plants and all the methane leakage from this fossil fueled system.

D. The CATF report ignores the importance of preserving the Diablo Canyon nuclear facility. It is inconsistent to talk about a large expansion of nuclear power in California and be silent about the loss of California's present largest source of carbon-free electricity. Rapid development of nuclear power and renewable energy sources enhances the creation of combinations of these energy sources which can be superior to renewable energy sources acting alone.

An interesting observation appears in this California analysis report, on page 7: "*An ambitious but achievable investment in clean firm power with a capacity on the order of California's gas fleet could, on the upside, eliminate the need for* ***10 times that amount of renewable energy***". (Emphasis added). Reducing the need for new infrastructure is consistent with meeting the goals of the CLCPA. Even though the data in TABLE A-4 do not represent an optimized use of firm power, it supports the conclusion that a broader, more inclusive, approach is superior to any extreme scenario like 100% renewable energy.

4.0 Review of the NYSERDA Report-Inaccurate Data

4.1 Wrong Capacity Factors

Fundamental to the determination of how many solar panels and how many onshore wind turbines will be needed for a low carbon future in NY State is the measured capacity factors of these renewable energy systems. These data can be obtained from NYISO's Power Trends reports. The table below compares NYISO's capacity factors for solar energy and onshore wind to NYSERDA's capacity factors and computes the shortfall in capacity due to the NYSERDA errors.

TABLE A-5 Comparison of the NYSERDA and NYISO Capacity Factors

	NYSERDA Report	NYISO	Capacity Shortfall, MW	Revised NYSERDA Slide 40, Scenario 3
Solar	0.219	0.140	34,175	94,738
Onshore Wind	0.325	0.260	2,542	12,728
Total Shortfall	N/A	N/A	36,717	107,466

To put this in perspective, this total shortfall of 36,717 MW can be compared to the total installed NY capacity of 39,295 MW in 2019. These basic errors are almost as large as the whole generating capacity of New York State in 2019. This also means that the NYSERDA slides 42,43, and 45 are incorrect. If the incorrect solar and onshore wind capacities listed in NYSERDA slide 40 were installed, large shortfalls in electricity production would happen. On the other hand, to prevent a dangerous shortfall, 34,175 MW of additional solar panels would have to be installed as well as 2,542 MW more of onshore wind. Costs, land use, MW-miles of transmission lines, and public opposition would similarly rise.

Supporting Analysis:

1. NYSERDA slide 40, installed capacity in 2050, Scenario 3: Solar 60,563 MW, onshore wind 10,166 MW. NYSERDA slide 41, Energy Production in 2050, Scenario 3: Solar 115,982 MWh, onshore wind 28,971 MWh.
2. NYSERDA solar capacity factor, (115,982 GWh)/[(60,563 MW)(8,760 hours)] = 0.219,

By comparison, NYISO's measured solar capacity factor for NY = 0.140

3. NYSERDA's onshore wind capacity factor,(28,971GWh)/[(10,186 MW)(8760 hours)] = 0.325,

By comparison, NYISO's measured onshore capacity factor for NY = 0.260

4. The NYISO capacity factors derived from Power Trends 2019, page 26.

4.2 Summary

The magnitude of these capacity factor errors is close to the total electricity production in NY State today from all sources. **These defects invalidate all of the NYSERDA report's analyses and conclusions.**

5.0 Review of the NYSERDA Report-Grid Modeling Errors

5.1 Introduction

The NYSERDA report's method of determining the adequacy of New York's electrical grid is a departure from decades of careful analysis by NYISO and others. NYISO projects what the peak electricity demand in the future might be and continuously updates this analysis as additional data become available. NYISO then adds a reserve margin of capacity to offset unforeseen losses in electricity generation and/or transmission and unanticipated increases in demand. NYISO then takes a further step to protect New Yorkers by establishing a quantitative reliability criterion, the LOLE, or Loss-of-Load-Expectation. For years NYISO has set LOLE at 0.1/year. This means that a blackout condition should not occur more frequently than a one day loss-of-load every ten years. A loss-of-load for even one hour is considered an event day when estimating LOLE. The NYISO practices have served New Yorkers very well and the NY grid, so far, is one of the most reliable grids in the nation.

At this time New York State is a summer peaking area. With the growth of air conditioning over the past few decades, the highest electricity demands occur on the hottest days. NYISO has continuously prepared for this by providing adequate generation and transmission capacities, with a reserve margin. However, all this is in the process of changing because New York is projected to become a winter peaking area. This shift to a winter peaking area is a consequence of trying to deal with climate change. In order to deal with climate change, the emissions of man-made (anthroprogenic) greenhouse gases (GHG) must be reduced to low or even zero values by mid-century. This is to be accomplished by eliminating or offsetting the burning of fossil fuels in the generation of electricity and in all the end uses in the transportation, residential, commercial, industrial, and agricultural sectors.

5.2 How the NYSERDA Report Differs From the Present NYISO Grid Design

First of all, the energy generation attributed to solar energy and onshore wind are wrong because of the incorrect capacity factors discussed in Section 4 of this document. Unless the correct capacity factors were utilized, there would be a large gap between the energy demand and the energy supply during the coldest time of winter and elsewhere throughout the year. Until these errors are corrected slides 42 through 45 are incorrect.

The NYISO approach to establishing the adequacy of the electricity system has been to estimate what the peak demand might be, add a reserve to that figure, and monitor it against a conservative reliability criterion.However, the impact of climate change requires a re-examination of what constitutes a peak demand situation. Extreme temperatures, both hot and cold, are happening more frequently and for longer durations. This situation is reflected in NYISO's recent Comprehensive Reliability Plan (3) where the effects of extreme heat was analyzed. This NYISO report showed that within this decade statewide temperatures in the mid-to-upper level 90s could cause the electrical grid in New York to be unable to deliver enough electricity in a reliable manner. At the other extreme, is the tragic event in Texas in January, 2021 where a polar vortex led to an estimated 702 fatalities and close to $200 billion dollars worth of damage. The NYSERDA analysis uses a typical coldest week in January. This is not the same as the peak demand that would come during a polar vortex event.To match the well proven NYISO approach, the NYSERDA report should estimate the peak demand during polar vortices in year 2050 when many of our end use devices were electrified, add a reserve margin, and utilize the LOLE criterion. The NYSERDA report should also account for the temperature related effects like the unavailability of imported electricity, the decrease in the coefficient of performance in air sourced heat pumps, the decrease in battery output, and the increase in demand from electric vehicles so that their driving ranges were not reduced by lower battery efficiency and the use of electricity to heat the passenger cabin, a decrease in solar panel output of about 0.26% per degree F relative to standard temperatures. NYSERDA needs to examine the impact of extreme hot temperatures on the efficiency of air conditioners, thermal power plants, a transmission lines. Extreme temperatures can cause equipment failures, such as stuck valves as was observed in a previous polar vortex in New York. Extreme temperatures cause increases in demand for electricity and decreases in the supply of electricity. None of this was not done in the NYSERDA report.

The NYSERDA report and the NYISO approach differ in other ways too, specifically on how to deal with long term lulls in wind power. A wide spread long duration lull, as recently occurred over all of England, would be devastating if it happened in the winter when the solar contribution is very limited and poorly timed with the demand. (9) Such a winter lull could eliminate both offshore and onshore wind power at the same time because of the huge size of wind patterns.

However, long duration wind lulls in warmer times of the year also present problems, even though a smaller contribution from wind power in warmer weather is expected compared to wind's winter contribution. During these warmer time periods excess energy from solar panels is assumed to use an electrolysis process to generate hydrogen. This hydrogen is to be stored until reconverted back into electricity during times when wind + solar fall short of meeting energy demands

Slide 42 of the NYSERDA report shows a Typical Spring Week in 2050, as if anyone today knows what a typical spring week in 2050 might look like. This slide shows the generation of excess solar energy and has an insert stating "Excess renewable energy can be used to produce hydrogen or charge another long duration solution". **This other long duration solution in the NYSERDA report is undefined.** In slide 42 there is energy contribution from both onshore and offshore wind power. However, if there was a long duration and widespread wind lull during this warmer time period, both onshore and offshore wind contributions likely would not be available. In such a case the excess solar energy normally used to make hydrogen would, instead, have to be used to meet ongoing demands for electricity. This, in turn means that there could be insufficient long term hydrogen storage for the winter months. So a wind lull in the summer could lead to energy shortfalls the following winter. Therefore long term lulls in wind power, be they in winter or summer, could create an energy tragedy similar to what happened in Texas.

The NYSERDA report's slide 43 is incomplete. It tries to show how a single week in January might be able to meet electricity demands if it can draw upon long duration storage. But there can be other weeks in the winter which also have shortfalls in their electricity production relative to that week's demand for electricity. Even if the shortfalls in these additional weeks are not as severe as the single week selected in slide 43, they would still need to able to draw upon long term storage. **The amount of energy needed to be generated for long term storage requires a full year's analysis, not just one week's worth.**

Various consulting groups have also come across this energy gap issue with in their 100% renewable energy analyses.The Brattle Group, in its analysis of New York's low carbon future used a term called RNG, Renewable Natural Gas. The Analysis Group used a term called DE, standing for dispatchable, emissions free energy, and the NREL, in its Joule report (15) just acknowledged that it did not yet know how to solve seasonal energy problems in 100% renewable energy scenarios.

However, the NYSERDA report claims that hydrogen is the solution. This hydrogen is to be stored until reconverted back into electricity during times when wind + solar fall short of meeting energy demands. The NYSERDA report assigns a 50% round trip efficiency for this electricity-to- hydrogen and back-to-electricity process. Since solar energy only has a 14% capacity factor in New York, the combination of solar energy and hydrogen under the NYSERDA report scenario may be as low as (0.14)(0.50) = 0.07 or just 7 percent efficient.

Hydrogen has a very low volumetric energy density. To increase the energy density of hydrogen to volumetric energy densities to be similar to that of natural gas, the hydrogen would either have to be cooled to minus 253 degrees, F (close to absolute zero) or compressed to 10,000 to 15,000 pounds per square inch. Hydrogen embrittles steel in piping and storage vessels and has a much higher leak rate than natural gas because of its very small molecular size. Because of these fundamental physical characteristics it is difficult to design practical hydrogen distribution and storage systems.To be credible, the NYSERDA report needs to explain how it would overcome all these hydrogen challenges as well as the very unattractive low overall efficiency of solar electricity to hydrogen and back again to electricity that the NYSERDA report is promoting.

In summary, the NYSERDA report's use of hydrogen for long term storage is based on an unproven technology and would be very inefficient; it did not explain how the piping and storage vessels would overcome hydrogen's high leak rates and its ability to embrittle steel. The NYSERDA report only analyzed one week's energy needs in January, when a full year needed to be analyzed; did not address long lasting lulls in either winter or summer; did not analyze peak conditions such as during polar vortices and extreme heat; and did not account for the effects of extreme temperatures, high or low, on equipment operability.**The NYSERDA report's analysis of long term storage and grid design is inadequate.**

The NYSERDA report's alternative to long term storage is to have 25 GW of zero-carbon firm capacity. Yet this major source of clean energy is only scheduled to operate 1-3% of the time, i.e., to act as clean energy peaker plants. If one assumes that new nuclear power cost $5 billion dollars per GW, then 25 GW of zero-carbon firm capacity would cost $125 billion dollars which would be paid for by the public. How can one justify having a $125 billion dollar investment be inactive except for brief periods of time? **Such a wasteful, inefficient arrangement would raise the cost of electricity for everyone and would be particularly harmful to low and middle income citizens.**

An alternative to zero carbon firm capacity is suggested in the NYSERDA report's slide 44. Here 17 more GW of offshore wind plus 9 more GW of solar are to be added to a scenario that is already overtaxed with huge numbers of solar panels and wind turbines that would have to be manufactured and installed at an unprecedented rate. The 17 GW of additional offshore wind would be useless during a widespread wind lull. The additional solar would still be subject to low capacity factors and the very poor overall efficiency of a solar-to-hydrogen-to-electricity system. The adequacy of the 31 GW of long duration storage may not be sufficient if it is only there to handle a one week duration in winter. **Determining the capacity of long duration storage requires an analysis of a whole year’s worth of storage requirements.**

5.3 Additional Issues With the NYSERDA Report

1. Even if all the graphs and tables in the NYSERDA report were correct, this report is significantly incomplete. There is no analysis to determine if NY’s industrial base can produce all these solar panels and wind turbines rapidly enough or if they can be installed rapidly enough to meet CLCPA goals. As one example of how important this is, consider the installation of offshore wind turbines; a task NY State has never accomplished. Unless NY State decided to only use floating offshore wind turbines it will need large, specialized vessels called Jack Ships. There are no jack ships in the United States at this time. One. a 472 foot long vessel. is under construction at a cost of about $500 million dollars and an estimated construction time of three years. These are very large ships and not all shipyards might be capable of building them. One of the largest jack ships to go into service off of England’s east coast was built in China. China also has one of the world’s largest facilities for constructing the very large cranes needed to lift the heavy nacelle and turbine blades into place. So, even if New York could manage to build large offshore wind turbines, these wind turbines might sit idle on a wharf waiting years for a jack ship to install them. Unless it is repealed, New York would have to be compliant with the Jones Act which controls certain activities of merchant ships. Meeting this law could greatly slow down the installation of offshore wind power. The construction of a second smaller jack ship, 260 feet long, the Eco Edison, was just announced. This second vessel is to be delivered by 2024.
2. There are significant differences between the Phase 2 Climate Impact and Resilience Study performed by NYISO and the NYSERDA report. These differences need to be justified.
3. Slide 40 of the NYSERDA report calls for 61 to 65 GW of solar energy. To achieve the GW-hrs that solar energy is credited for in the NYSERDA report, these figures have to be corrected for their wrong capacity factors. When corrected, the required solar capacity becomes 95.4 to 101.7 GW. Assuming tight packing of 4 acres per MW the area needed for 101.7 MW is 412,900 acres or about 626 square miles.The five boroughs of New York City is 302 square miles. Even under a tightly packed configuration an area somewhat larger than twice the size of New York City would be required. A more realistic analysis would account access roads and support infrastructure one would need 6-7 acres per MW. This translates into an area of 938 to 1,096 square miles, over three times the size of the City of New York. Additional land area would be needed for the 2,542 MW of onshore wind. More land area would be needed for all the additional transmission lines.
4. As shown on slide 40, there is a significant amount of battery capacity in the NYSERDA report, in the range of 16 GW to 19 GW. At 4 to 8 hours of battery storage this comes to 64 GW-hours to 152 GW-hours. The largest battery in the world today is the 1.2 GW-hour battery at Moss Landing in California. What is being proposed here is a battery system 127 times larger than the world’s largest battery system. If battery costs as low as $100 per KW-hour could be achieved, battery costs would amount to $6.4 to $15.2 billion dollars. If a 1000 MW electric nuclear plant cost $5 billion dollars and had a 0.90 capacity factor it would produce

7,884 GW-hours per year. This would be about 500 times the output of 19 GW of battery storage with an 8 hour capacity at about one third the cost. The nuclear plant would not have a limited lifetime due to charging and discharging cycles, as is the case for batteries, nor would its electricity output decrease at low temperatures. It would seem that the NYSERDA report has made a very uneconomical choice by using such a large amount of batteries.

5. If large land based wind turbines, at 5 MW each, were used to meet the12,728 MW of capacity shown in TABLE A-5, some 2,546 such wind turbines would be needed to be built and installed by 2040. That averages out at about 141 per year for the next 18 years. Based on the recent request sent to FERC by BP and Equinor, both giants in the petroleum industry, to delay New York's first offshore wind turbines by a year and one-half, such build and install rates appear to be very optimistic, if not impossible.
6. The NYSERDA report does not present reliable cost figures. It shows a total cost of $3 trillion dollars, but a net cost, compared to the Reference Case, of less than $500 billion. However, it does not show what the Reference Case will cost, or even exactly what its contents are.
7. The NYSERDA report is incomplete in that there is no discussion of how it is responsive to the Community Protection portion of the CLCPA. Perhaps the worst offense is in upstate NY occurred when Home Rule has been stripped away from rural communities and replaced by a process that makes public participation difficult. There are 1,694 onshore renewable energy projects, I MW AC or larger, already planned for New York and the NYSERDA plan would greatly increase this. (See Appendix C) Some call this the industrialization of rural New York and strongly object to it. Local areas are taking NY State to court. These heavy handed actions by NY State are clearly inconsistent with the Community Protection part of the CLCPA. The NYSERDA report makes no mention of these ongoing law suits even though law suits like these could derail the whole RE effort.
8. People are angry about the CPV plant in Orange County and its impact on surrounding environmental justice areas. This plant has operated without obtaining all of its environmental permits. In another NY area, fishermen off of Long Island have complained about offshore wind farms that could diminish their ability to earn a living.
9. Perhaps the most useful land use discussion is presented in the Clean Air Task Force (CATF) report on California's need for clean firm power. (14) The CATF report calculated that a 100% renewable energy future in California would require 6,250 square miles, bigger than the combined size of Connecticut and Rhode Island. This land use estimate may not include the additional land needed for the approximately 6 million more MW-miles for transmission lines dedicated to the solar and wind farms. California has an area of about 164,000 square miles. The required land area for 100% renewable energy in California would be 6,250/164,000 = 0.038 or 3.8%,which is a considerably larger percentage than the 0.5% figure others have claimed for the solar portion of a high RE deployment scenario.(5) With firm power from nuclear energy and/or fossil fuels with carbon capture the required land according to the CATF report is reduced to 625 to 2,500 square miles. The CATF report goes on to say *"Recent reports of the solar resource in California indicate that 2,500 square miles may actually exceed the amount of land fit for utility-scale solar but not subject to restrictions (such as conservation easements or national park status). Moreover, the estimates of available land for utility-scale do not account for other restrictions, such as excessive slope, ownership problems, and access to transmission lines. New estimates currently underway will account for these and*

will probably decrease estimates of land availability". Again, the NYSERDA report is incomplete in that there is no analysis of land use issues.

5.4 Conclusions for Section 5

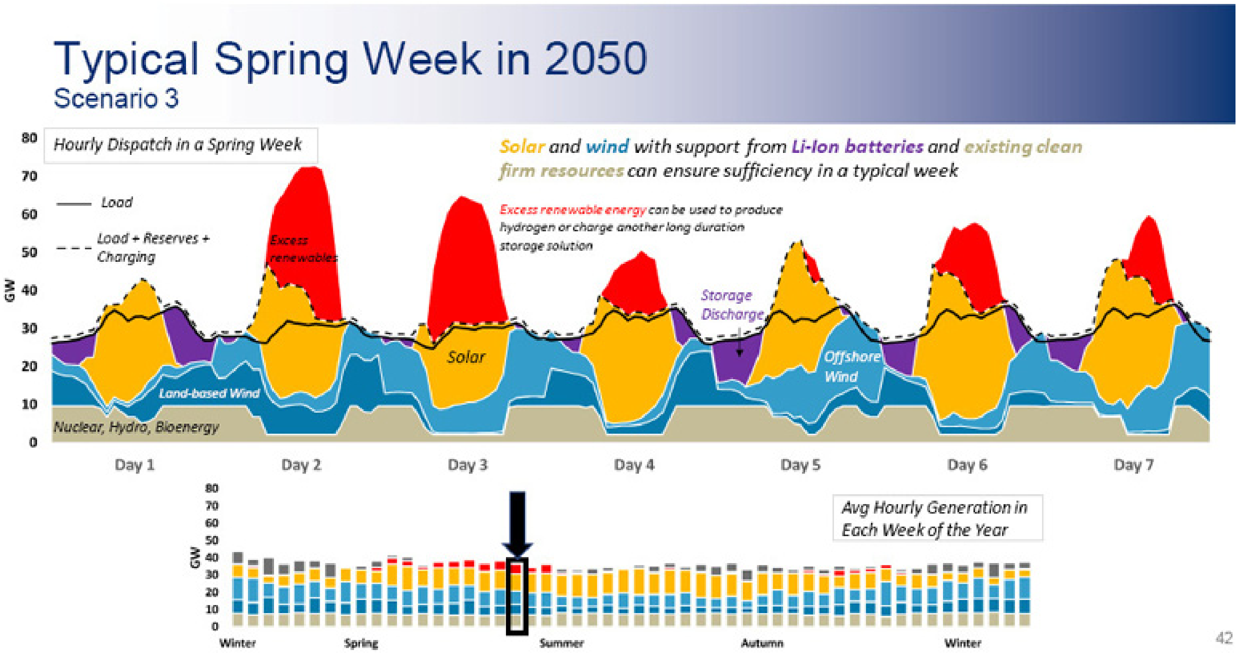
The NYSERDA plan has departed from NYISO's approach to maintaining the electrical system's reliability. No justification was offered that justified this departure from NYISO's practices that have served New Yorkers very well for many decades. The NYSERDA report does not address extreme weather conditions such as very high and very low temperatures and widespread wind lulls. When sizing the amount of hydrogen to be placed into long term storage it did not determine if energy gaps might occur for 51 other weeks in the year. Instead of just analyzing one week in January, a full year's analysis is needed. Long duration storage relies upon unproven hydrogen technology. The NYSERDA report's suggestion as an alternative to using zero-carbon firm capacity would require the addition of 17 GW of offshore wind farms on top of the planned 19 GW of offshore wind in Scenario 3, for a total of 36 GW. To put these numbers into perspective, when former Governor Cuomo first announced that the 2.4 GW of offshore wind power to be built by 2030 would be the "world's largest offshore wind farm". Later, as other east coast states began to announce their plans for offshore wind farms, New York suddenly announced a new offshore wind farm project of 9 GW by 2035. If 2.4 GW would have been the world's largest wind farm, then 9 GW would have to be the largest wind farm in the whole solar system. NYSERDA's 36 GW of offshore wind farm(s) must therefore be the largest wind farm in the whole galaxy.

The grid model used in the NYSERDA report is incorrect and inadequate. Most important is the observation that a 100% renewable energy future is an extreme scenario and that a mix of energy sources comes much closer to meeting the cost, reliability, social justice, and climate change goals that gave rise to the CLCPA in the first place.

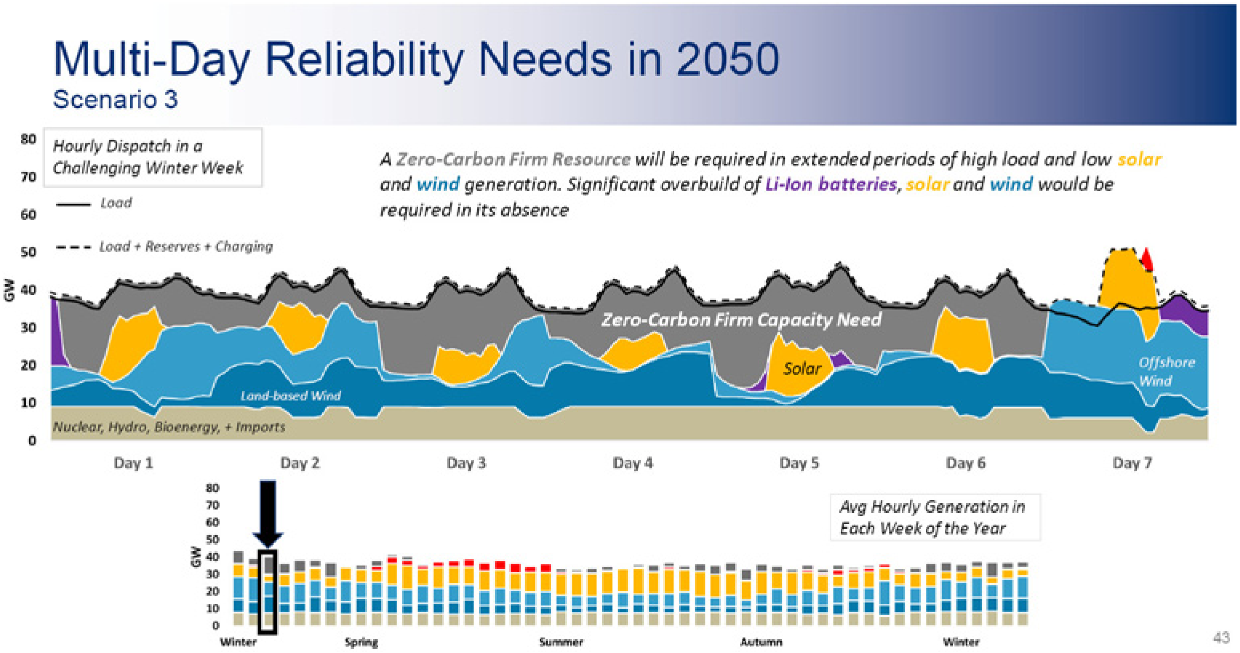
6.0 Appendices

6.1 Appendix A- Several Slides From the NYSERDA Report

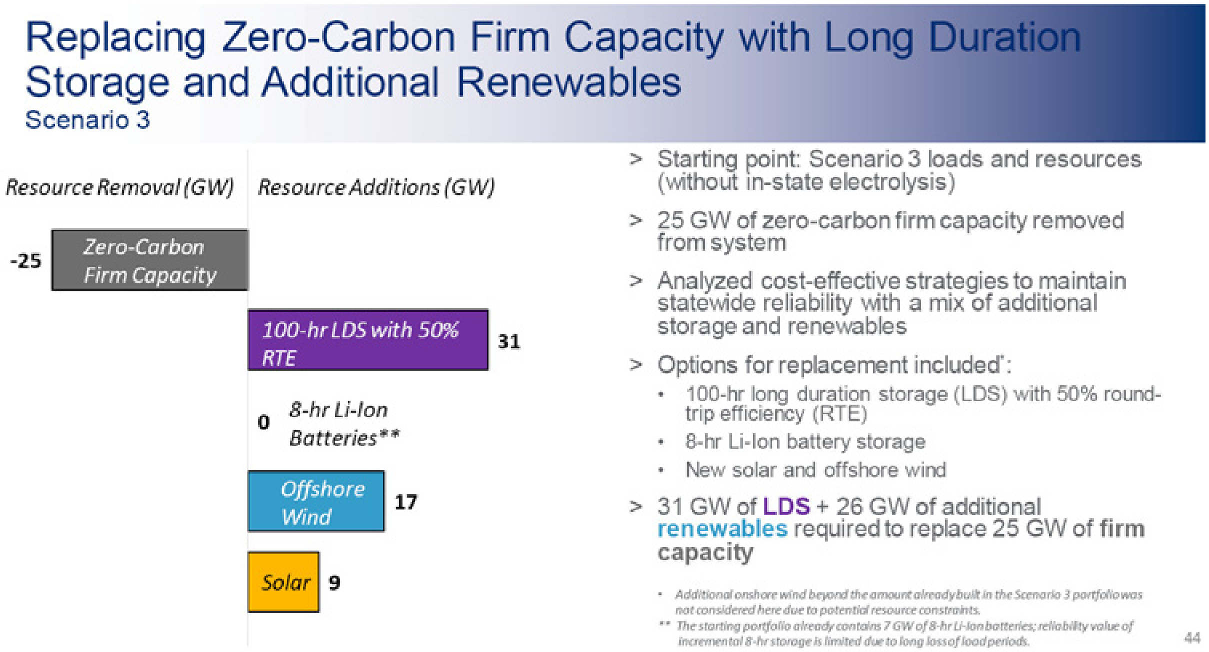
6.1.1 SLIDE 42



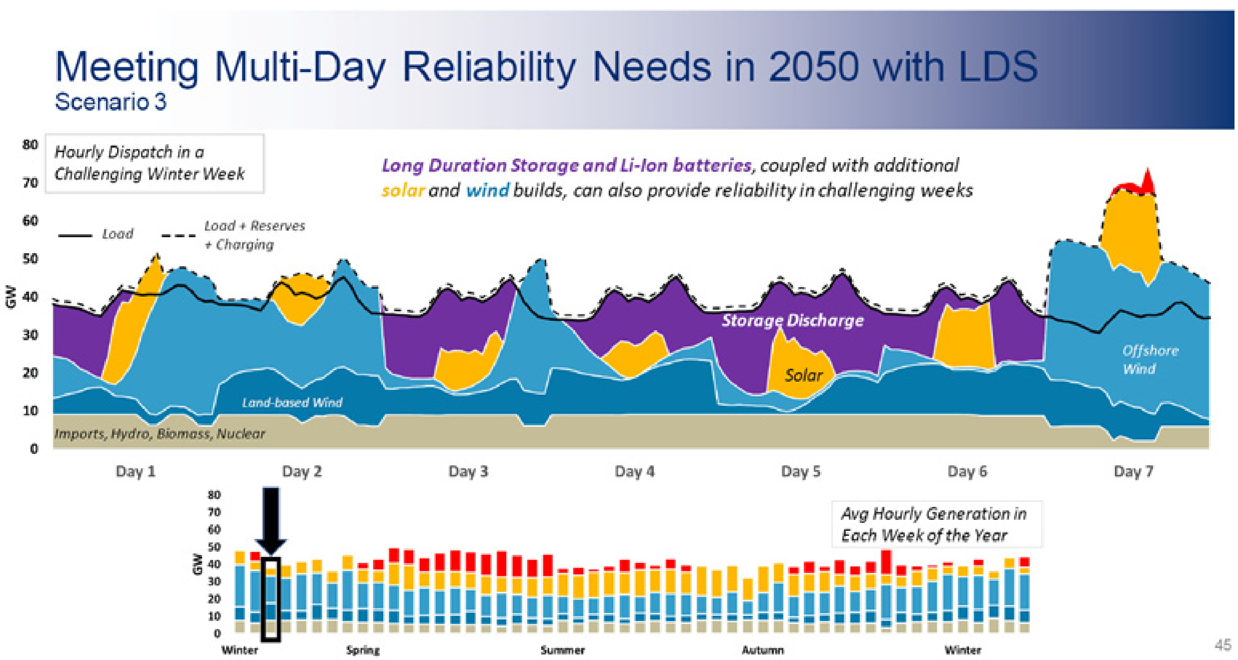
6.1.2 SLIDE 43



6.1.3 SLIDE 44



6.1.4 SLIDE 45



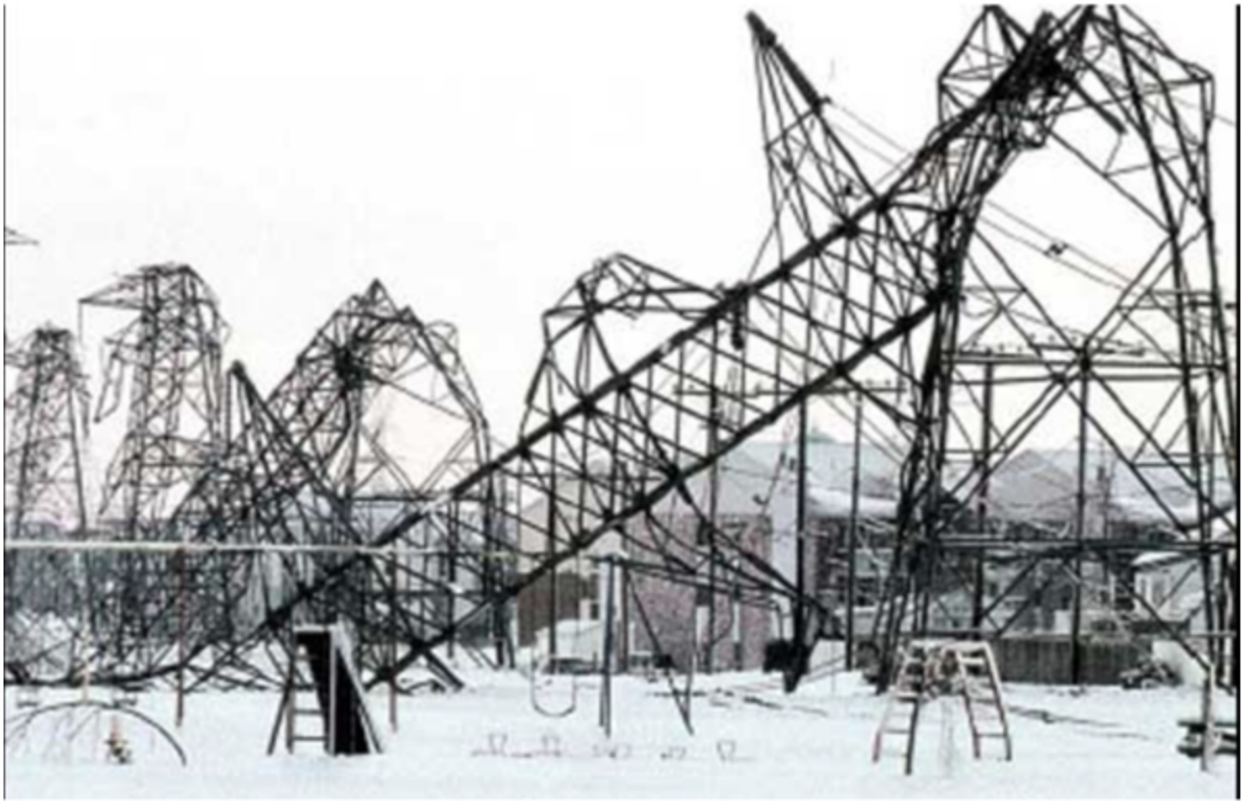
6.2 Appendix B -Impacts of Extreme Weather

6.2.1 Wind Turbines

FIGURE A-4 Impact of Hurricane Maria on Wind Turbines in Puerto Rico

6.2.2 Transmission Lines

FIGURE A-5 Impact of a Severe Ice Storm on Transmission Towers in Quebec, New York



6.3 Appendix C Impact of NY State Energy Policies

6.3.1 Land Use

FIGURE A-6 New York's Planned Sites for Renewable Energy and Battery Storage

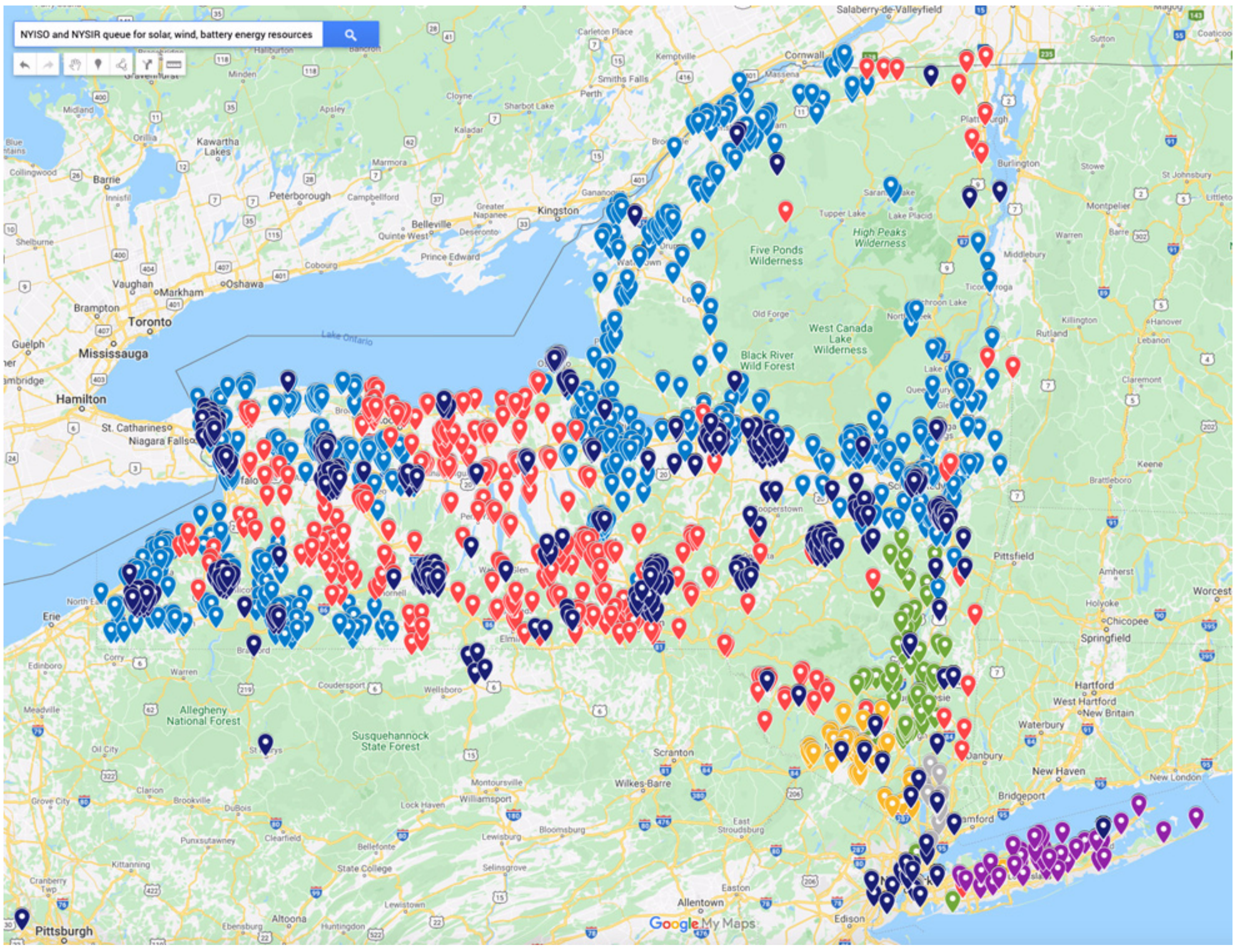


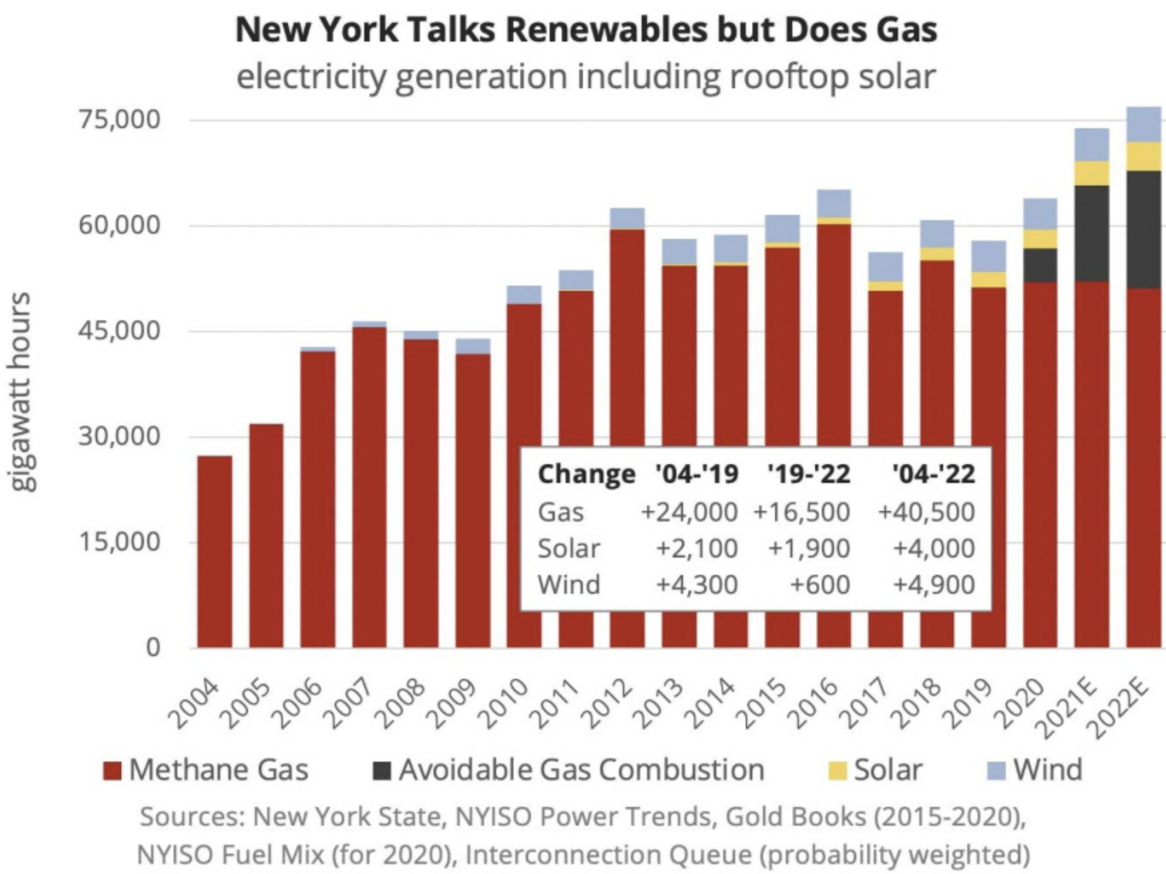
Figure A-6 represents what is planned for NY State at this time with 1,694 projects. A much greater impact that would occur if the NYSERDA report were implemented. As written in Section 5.3 of this critique, implementing the NYSERDA report would require 2,546 large, 5 MW, wind turbines.

Using NREL solar data for Ithaca, New York, in order to produce the 115,982 GWh called for in the NYSERDA report's slide 40, some 24.4 million solar panels would be needed. Just these panels alone, packed as closely together as possible, would require 235 square miles. These panels are the standard sized, 4 KW panels with an area of 25 square meters each.

FIGURE A-6 does not take into account areas occupied by transmission lines, service roads, set backs, etc.

6.3.2 Natural Gas Versus Renewable Energy

FIGURE A-7 New York Talks Renewables but Does Gas



Change	'04-'19	'19-'22	'04-'22
Gas	+24,000	+16,500	+40,500
Solar	+2,100	+1,900	+4,000
Wind	+4,300	+600	+4,900

In spite of claims of being a “Climate Change” leader, NY State’s actual history is one of increased use of fracked gas. All the benefits of renewable energy in terms of reducing greenhouse gas emissions are wiped out by the use of natural gas. As shown in the above figure the sum of the wind and solar energy in GW-hours for year 2022 is still far smaller than the GW-hours for methane (i.e., fracked natural gas) was back in 2004.

For many years the number of tons of carbon dioxide equivalent released from the electricity generation sector declined, even though gas use increased. This decline was due to the phasing out of coal which is more GHG intensive per KWh than natural gas.Today, there is virtually no coal burned in NY to produce electricity.The minimum GHG per KWh in NY likely happened around 2018 to 2019. GHG releases have since risen due to replacing Indian Point with gas.

6.3.3 NY State Risks Blackouts From 2014 to 2016

During the time period from 2014 to 2016, Entergy, then owner of the Indian Point power plants, was before an Atomic Safety and Licensing Board (ASLB), an independent arm of the Nuclear Regulatory Commission, seeking to extend the licenses of Indian Point 2 and Indian Point 3. Also before this ASLB was NY State and Riverkeeper who sought to prevent these license extensions.

During this time period NYISO produced annual Reliability Needs Assessments (RNAs). Conclusions reached by NYISO are summarized in TABLE A-6. If the Indian Point nuclear units continued to operate, New York's electrical grid's reliability would be adequate, that is LOLE $\leq$ 0.10. However, if Indian Point were closed, immediate reliability issues would occur.

Neither NY State nor Riverkeeper knew what actions the ASLB might take. If the ASLB ruled in their favor, the Indian Point 2 and 3 licenses would expire and NY State could have immediately been thrust into an unreliable grid condition. NY State and Riverkeeper were gambling with the health and safety of NY State citizens and the whole NY State economy, in spite of the serious warnings by NYISO. The multiple years spent by NY State and Riverkeeper before the ASLB were ideal for them. They gave the appearance of protecting New Yorkers from the (grossly exaggerated) risks from Indian Point while enjoying the benefits of a reliable grid.

All this ended when Entergy decided to stop pursuing these Indian Point license extensions. With much fanfare, former Governor Cuomo announced, on January 9, 2017, that these dangerous nuclear plants were to be shut down and would be replaced by non-carbon energy sources. To prevent an immediate reliability crisis, Entergy, NY State, and Riverkeeper agreed to keep Indian Point 2 operational until April 30, 2020 and Indian Point 3 operational a year longer until April 30, 2021. In spite of sounding the alarm for years about the dangers of these two nuclear plants, NY State and Riverkeeper signed a Closure Agreement which allowed Indian Point to operate several more years and they also withdrew permit objections they had imposed on Entergy.

In February, 2017 there was a joint meeting of the energy committees of the NY Senate and the NY Assembly to discuss the impact of the Indian Point closures. One of the legislators asked the lead NY State witness to explain what was the basis of establishing these very specific closure dates, years into the future.The reply from this State witness was that, unlike other states which give local areas very little time to prepare for the closure of a nuclear plant, NY State was being very generous in its treatment of these local areas. This generosity did not extend to these local areas and school districts, or even to the Westchester County Executive, who were blindsided by these secret meetings to close these nuclear plants. The lead NY State witness did not inform the State legislators that these additional years were needed to build gas replacement plants, leaving these legislators with the impression that the Indian Point units would be replaced by non-carbon sources of electricity as the then Governor had promised during his first public closure announcement and again during his State-of-the State.

In its December 13, 2017 Generator Deactivation Report, NYISO described a three step replacement process to deal with the IP closures. Three gas plants would be constructed and used to replace Indian Point. Even though this NYISO report directly contradicted the commitment the former Governor had made to the people of New York, he remained silent. Riverkeeper went through the motions of being outraged even though they were one of just three parties that established closure dates long enough into the future giving time to build these gas replacement plants. Indian Point 3 closed down on April 30, 2021. On its very last run it broke the world's record in the length of time it ran at full power. The price for gas to heat homes, make hot water, and run gas powered electric plants has recently skyrocketed. A Hudson valley utility blames this, in part, on the closure of Indian Point which immediately caused an increase in the demand for natural gas.

TABLE A-6 RNA Results for the 2014 to 2016 Time Period

Year	With IP Operating	Without IP Operating
2014	LOLE ≤ 0.10	***"Significant violations of transmission security and resource adequacy would occur in 2016 if the Indian Point plant would retire as of that time."*** Without IP a LOLE of 0.31 was calculated for 2016 in this RNA, equivalent to a possible one day blackout every 3.2 years.
2015	LOLE ≤ 0.10	***"Substantial uncertainties exist in the next ten years that will impact system resources...Depending on the units affected, the NYISO may need to take swift actions to maintain reliability."***
2016	LOLE ≤ 0.10	***"This scenario simulates the retirement of the Indian Point Energy Center by removing about 2600 MW of capacity from Zone H and finds that significant violations of resource adequacy criteria would occur immediately in 2017."***

7.0 References

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