Where are the Jobs?

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About the Author

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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.

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1.0 Executive Summary

The "New York State Climate Action Council's **D**raft **S**coping **P**lan", herein identified as DSP, is incomplete, fails to demonstrate that it meets the goals of the CLCPA, the Climate Leadership and Community Protection Act, and has the potential to cause a net loss of jobs in NY State. These failings are a direct result of NYSERDA selecting an extreme energy scenario dominated by renewable energy rather than a mix of low carbon technologies, even though other published analyses have shown that many mixes of low carbon technologies are superior to extreme energy scenarios. Not only is the DSP inferior compared to a number of low carbon scenarios that use a mix of energy sources, it has serious shortcomings of its own. As such, the DSP should be rejected.

There are three main observations about the DSP and NY jobs, all discussed in this report:

A. The selection of an energy future dominated by renewable energy does not produce a significant number of new jobs in New York. The number of permanent jobs as a direct consequence of selecting a highly renewable energy future is likely to be well below one percent (1%) of the present NY workforce,

B. DSP's Appendix C says it all. It warned that*"New policies that increase the cost of energy, reduce the reliability of energy, or increase the cost of emitting GHGs could cause businesses to shift their production outside of New York, or avoid the State altogether and instead invest in out-of-state locations with lower energy and/or GHG emission costs."* What is the price per kilowatt-hour of DSP's electricity?

C. Solar energy panels and onshore and offshore wind turbines, the hardware at the heart of the DSP, are likely to be built outside of the United States. Other major components, like underwater cables and batteries, are likely to be built out-of-state. Installation of large offshore wind turbines will likely require specialized ships, none of which are built in New York.There are national and state energy security concerns about having the bulk of our renewable energy sources and their supply chains dependent on foreign countries.

There is a fourth observation with regard to the DSP:

D. The DSP estimates that it would take an enormous sum of money, around $3 trillion dollars, to achieve its version of a low carbon future. Much of this money is to be spent on actions like buying electric vehicles and improving the energy efficiency of our homes. Such expenses are common to many low carbon future scenarios and are not a special burden imposed by the choice of a scenario dominated by renewable energy. Similarly, many benefits like clean air and water, improved health conditions, and removal of the existential threat of climate change, are common to all low carbon futures **and are not benefits exclusively generated by a scenario that is dominated by renewable energy.** Even many of the 211,000 or so jobs claimed by the DSP, are common to all low carbon energy scenarios. For example, most low carbon energy scenarios would have about the same number of HVAC and house shell improvement jobs. Decision-making on our energy future should rest on which energy scenario is most cost effective, most reliable, is sufficient to cope with temperature extremes, and fosters energy independence.

2.0 Union Leaders Speak Out

The string of recent meetings held by the Climate Action Council (CAC) to hear the public's views on the DSP revealed deep divisions about our energy future. Strong arguments were presented in support of rapidly phasing out the use of fossil fuels because of the existential risks from climate change. Equally powerful arguments were made about maintaining a highly reliable energy system to avoid blackouts and brownouts that can cause fatalities and economic losses. Further, an unreliable energy system would be a huge economic setback as it could cause an exodus of businesses and jobs from New York. This latter concern, for some translates into maintaining the use of fossil fuels which NY State has become very dependent on in the downstate area.

It is not that one of these arguments is right and the other is wrong. They are both mostly correct and one must not trade one for the other. Achieving both environmental goals while maintaining high system reliability is very complex. The DSP with its extreme energy scenario of near total dependence on renewable energy makes it far more difficult to achieve success. Renewable energy is not the only low carbon energy source. Nuclear energy and fossil fuels with carbon capture and sequestration also are low carbon energy sources. Without providing any justification, the DSP threw out two of the three tools in the low carbon energy future tool box. Not only were these two low carbon technologies eliminated, so were potential attractive combinations of technologies such as nuclear/renewable energy combinations. Studies show that such combinations can achieve benefits that would not be available to any single technology acting alone. Educated compromises by our elected officials have to be made to strike a good balance among competing energy goals, like balancing reliability with greenhouse gas emissions, requires using all the tools at hand. The CAC would have been far better served if the DPS presented a plan that incorporated the use of all of the low carbon technologies integrated in a cost-effective manner.

The Unions are well aware of the warning in DSP's Appendix C that high electricity prices can drive businesses, tax revenues, and jobs out of New York while inhibiting new investments. They have watched California shut down its nuclear plants which has led to high electricity prices, blackouts and increased use of fossil fuels, including importing coal-based electricity from Wyoming. The California situation has become so dire its Governor has periodically asked owners of electric vehicles not to recharge their cars. Similarly, Germany's massive attempt at its all renewable Enrgiewende program has not protected it from the impact of its dependence on Russian fossil fuels or reduced its usage of filthy lignite coal. The cost for electricity in Germany, prior to recent substantial increases in natural gas prices, was 0.323 US dollars per KW-hour. In France the cost is 0.173 US dollars per KW-hour. Over 70% of France's electricity comes from nuclear power and its GHG releases per person is lower than Germany's. The Unions know that nuclear jobs are among the highest paying energy jobs at a median hourly wage of $39.19 while wind power jobs have a median hourly wage of $25.95 and solar at $25.48 (1) Unions know that for many renewable energy projects the number of permanent jobs is far less than the number of jobs during the construction phase. Short term jobs in solar energy in construction, manufacturing, and professional services are 8 times larger than long term solar system maintenance services.(2) The extreme scenario approach presented in the DSP has met with resistance among Unions in New York whose principle responsibility is to protect the jobs of New York workers.

For example:

A. “If New York has any hope of achieving its clean energy goals in this decade and beyond, we need to maintain reliability while pursuing technologies like zero carbon nuclear much more aggressively.”, John Murphy, International Representative of the United Association of Journeymen & Apprentices of the Plumbing and Pipefitting Industry.

B. “Our upstate nuclear plants provide high-paying, quality jobs to generations of families and tax revenues for the communities that host them.”, Mike Bradshaw, IBEW, local 97.

C. “We oppose taking zero-carbon nuclear power offline.”, James Slevin, President of the Utilities Workers Union of America.

3.0 Where Are The Jobs?

3.1 Introduction

While the DSP did not provide comparisons between its extreme scenario and other scenarios that use a mix of low carbon energy sources, some jobs information is known. In NY State today there is a total of 9,380,800 jobs with 7,937,300 in the private sector and 1,443,500 jobs in the public service sector. DSP's Job Study reported 211,000 or so additional jobs in New York for the DSP extreme energy scenario. This increment of jobs represents only 2.3% or so of the present NY workforce. However, there is no connection between many of these 211,000 jobs and DSP's extreme emphasis on using renewable energy. Many of these jobs would exist regardless of the sources of clean energy. The DSP's Job Study states that over half of these jobs would be in HVAC and in installing building shells to reduce energy losses. Such jobs are common to all energy scenarios. This sets an upper limit on the number of jobs that are a direct consequence of having a very high deployment of renewable energy. This upper limit is less than about 106,000 jobs tied to renewable energy or less than 1.1% of the present workforce. Some projects report a large number of jobs, such as Empire Wind with 800 jobs for a 816 MW project. It is not clear if the 800 jobs, if accurate, are just during the construction and installation phase or permanent jobs.What has been learned is that the number of permanent jobs in large renewable energy projects often is a small percentage of the temporary jobs during the construction phase. It appears that the actual permanent New York jobs directly tied to this emphasis on renewable energy would be well below the 106,000 jobs limit.

These HVAC and building shell jobs are mostly service-related jobs, not industrial jobs where products are manufactured that could be sold outside of NY State.A further review of this 211,000 NY jobs estimate shows that a number of these jobs may never materialize and many are not sustainable unless there are state programs to subsidize many low-to-middle income families so that they can purchase items like electrified space heating systems.

The DSP three trillion dollar investment could create a significant number of renewable energy industrial jobs, but they will mostly be outside of NY State and, more troubling, many likely will be outside the United States and possibly in China.

3.2 In-State Jobs

The DSP's JTWG Job Study, page 6, claims that at least 211,000 jobs will be created in NY if the Draft Scoping Plan were implemented. Over half of these jobs would be in the residential HVAC (heating, ventilation, and air conditioning) area and in the residential shell energy conservation area. These are one time service jobs that do not produce services or products that could be sold outside of New York.

As stated before, the DSP's near exclusive use of renewable energy does not provide any special advantage to energy conservation activities. Energy conservation, like reducing heat losses in the residential and commercial sectors, is independent of the choice of source of clean electricity. Energy conservation belongs in all energy future scenarios regardless of the mix of energy source technologies. Choose a mix of energy sources and you will still need HVAC and building shell workers.

Unlike huge energy projects, such as offshore wind farms and enormous solar farms, these residential HVAC and residential shell jobs are door-to-door retail jobs. Their implementation depends upon individual decisions by many people with low-to-middle incomes. This certainly is not the decision-making process that goes on corporate board rooms where access to large sums of money is possible. A major aspect to local decision-making is the ability to pay. According to the U.S. Energy information Administration, one in three U.S. households face a challenge in meeting energy needs. This is further complicated by different tenant/owner energy self interests in rental situations. If a large number of people cannot afford or are unwilling to electrify the places they live in, fewer of these HVAC and residential shell improvement jobs will be created unless there is some kind of governmental financial support program.

According to testimony submitted by the Consumer Energy Alliance at the April, 2022 CAC meeting in Albany: *"CEA issued an analysis in 2021 using open-source consumer data which found that a natural gas service ban could cost New York homeowners over $35,000. The statewide report examined a broad review of the considerations families and New York households would face such as appliance models, home configuration, labor, and remodeling to comply with the energy ban. The Scoping Plan noted that there are 4.9 million single family homes in New York and by 2030 "more than 200,000 homes <u>every year</u> will need to upgrade to all-electric and energy efficient systems to meet CAC's recommendations." Using CEA's back of the envelope cost scenario, that could be an additional compliance cost of over $7 billion per year for homeowners."* Also, according to the CEA submittal to the CAC *"...more than 1.3 million New York City households were 60 days behind in their utility bills, which is about 20% of the city."*

It should be possible to minimize this total electrification/ low-to-middle income issue by offering consumers a wider range of choices including using a net zero carbon source of synthetic methane (CH_4), the identical chemical compound as the natural gas we burn today. If synthetic methane were available in large quantities, low-to-middle income families could continue on as they are today without having to meet the 200,000 transformed homes per year DSP target or the rapid transformation called might proceed at a more gradual pace. This option requires that the carbon dioxide (CO_2) emitted by burning this synthetic methane be offset by an equal or larger amount of CO_2 removed from the atmosphere and/or oceans. Renewable energy and nuclear energy could be used to extract CO_2 from the atmosphere and/or the oceans. This CO_2 would be combined with hydrogen, H_2, to make synthetic methane where the hydrogen would be generated by using renewable and nuclear energy to split water molecules by an electrolysis process. In summary, the total mass of CO_2 generated by burning this synthetic methane would be matched or exceeded by the mass of CO_2 initially removed from the atmosphere and the oceans. This arrangement results in a zero net increase in the release of CO_2 to the atmosphere while removing the burden of the cost to electrify every home space and hot water gas heating systems (or replace gas ranges and gas clothing dryers). This would also greatly reduce the billions of dollars that would end up as stranded costs tied to the use of fossil fuels.

Similar processes can be used to generate methanol (CH_3OH) for the transportation sector. Again there would be a net zero contribution of CO_2 to the atmosphere in this process. Flex cars today can operate with methanol. Methanol can be modified to make jet fuel, solving a major air travel issue.

Net zero carbon liquid and gaseous fuels that are chemically identical to the fossil fuels we use today opens up vast opportunities to make better energy policies and programs. However, making these synthetic fuels and creating a system that results in a net zero CO_2 addition requires a lot of money and additional large sources of energy. By limiting itself to renewable energy, the DSP greatly reduced the flexibility of the CAC to strike balances which could meet both climate change goals and simultaneously meet high reliability requirements.

3.2.1 Temporary Versus Sustainable Jobs

Lessons can be learned from the 30,000 acre Alle Catt wind farm in upstate New York. This 340 MW wind farm would employ 182 people during construction, but this would shrink down to just 11-13 permanent jobs once operational. The permanent jobs are in the range of 6-7% of the temporary construction jobs.

Slide 40 of the DSP indicates a NY State capacity of 10,199 MW for onshore wind. At the Alle Catt rate of 13 permanent jobs per 340 MW, statewide the number of permanent jobs for onshore wind power would be about 487 jobs.

A similar significant job shrinkage may occur in the jobs identified by DSP's JTWG. Once all residences have been improved with better insulation and efficiency upgrades in their home appliances, what happens to the home shell improvement jobs? This concern also applies to the jobs installing solar panels and onshore and offshore wind turbines. The construction phase is job intensive, but once the construction phase is over jobs may be limited to replacement and maintenance activities.

The Port of Coeymans, New York is expected to provide 230 jobs for a 9 GW (gigawatt) offshore program. The DSP calls for 19 GW to 36 GW of offshore wind power which implies about 500 to 1,000 jobs at this site. The purpose at the Port of Coeymans is to construct advanced foundation components ranging from 12 to 120 tons each and as tall as 40 feet that would attach to the foundations the wind turbines would stand on.

As mentioned before, NY State, the rest of United States, and much of the developed world would have to go through a massive re-industrialization to achieve a low carbon future. New industries will be spawned, like factories that produce standardized small modular nuclear power plants, and supply chains that support these new industries. Yet the course that DSP lays out is centered on service-type jobs that have little prospect of producing products that would be sold in markets outside of New York. Very few new industrial jobs are envisioned in the DSP yet it is industrial jobs that produce better wages and have the potential for being long lasting. The DSP's approach to job creation scheme seems to shrink from the **L**eadership portion of the C**L**CPA. This is not the entrepreneurial spirit that made New York the Empire State.

3.3 Out-of-State Jobs

3.3.1 Introduction

It is important to differentiate between manufacturing and service types of jobs. Service type jobs, like HVAC building shell jobs, are necessary, valuable, and local. They do not produce a product which could be sold to customers outside of NY State. Because the whole United States will have to undergo a massive re-industrialization to achieve a low carbon future, many of the same products needed in New York, like air-sourced heat pumps, will be needed elsewhere. Unless NY State becomes a major manufacturer of energy-related products needed on a national scale, a great opportunity would have been lost.

Many of the finished products that New Yorkers would have to pay for to implement the DSP comes from out-of-state or out-of country locations. A few examples are provided below.

3.3.2 Out-of-State Job Examples

3.3.2.1 Electrified Transportation

NY State is not a center for the manufacture of electrified cars, trucks, or busses. NY should examine if there are opportunities to manufacture charging stations or even high pressure hydrogen storage tanks to be used in the transportation sector.

3.3.2.2 Batteries

IM3NY of Endicott, New York has received significant funding to build lithium-ion cells. This “Gigafactory” is designed to build 1 gigawatt-hour’s worth of lithium-ion cells per year. At this rate IM3NY should build 28 GW-hours worth of batteries by 2050. According to slide 40 of the DSP 16 to 19 GW of batteries will be needed. Slide 44 identifies these batteries as eight hour batteries, so up to 152 GW-hours of battery storage will be needed by year 2050.

As a point of comparison the world’s largest battery today at Moss landing, California only has 1.2 GW-hours of capacity. Based on these figures between now and 2050 the Endicott “Gigafactory” would only produce 18% of the battery capacity the DSP identifies as needed in year 2050. The actual percentage that the Endicott “Gigafactory” could produce compared to what would be needed st. year 2050 would be far less than 18% because many batteries would have reached the end of their design life well before year 2050. If one assumes that, by 2050, batteries have a 20 year lifetime, then 5% of the batteries would have to be replaced per year, on average. Five percent per year of 152 GW-hours equals 7.6 GW-hours per year for replacement. Just the replacement market far exceeds the 1 GW-hour per year battery production rate of the Endicott “Gigafactory”. Unless there is a very large expansion of NY’s battery production capacity between now and 2050, out-of-state or out-of-country sources of replacement batteries would be necessary and with them goes the jobs to manufacture these replacement batteries.

3.3.2.3 Solar Panels

The electricity generation calculated for PV systems in slide 41, scenario 2 of the DSP is 125,295 GW-hrs. According to the National Renewable Energy Laboratory's PV watts calculator, a standard 4KW solar panel (25 square meters) produces 4,762 KW-hours (AC) per year in Ithaca, New York. Based on this Ithaca figure, there would be a need for 26.3 million solar panels to fulfil the DSP. since there is about a 14% energy loss between the direct current generated by the solar panel and the AC capacity utilized by the DSP, some 14% more DC generating panels would be needed, bringing the total up to about 30 million single axis tracking panels. Are the jobs to build this huge number of solar panels going to be in New York or somewhere else, like China and built with slave labor?

3.3.2.4 Onshore Wind Turbines.

According to the DSP some 12,728 MW of onshore wind power capacity is to be built. If this capacity is to be accomplished using 5 MW wind turbines, then 2,546 such large machines would be needed. This would require 141 onshore wind turbines to be installed in NY each year for the next 18 years, until 2040, i.e. two installations every five days for 18 years. If the size of the wind turbines are limited to 3.5 MW to reduce public opposition then 3,631 wind turbines would be needed with an installation rate around 200 wind turbines per year until year 2040. How many permanent jobs are there today to maintain the present wind turbines in New York and where were these onshore wind turbines manufactured?

Some interesting insights on jobs and land use can be derived from the 340 MW, 30,000 acre Alle Catt wind farm. As mentioned before only 11-13 permanent jobs will be created. At a rate of 13 jobs per 340 MW of capacity, the DSP for 12,728 MW of onshore wind power would only create 487 permanent on site jobs.

A recent report by NREL made the observation that land use requirements per megawatt of installed capacity has increased considerably since the year 2000. (3) In the earlier years the installed capacity per square kilometer was 7.0 MW. This has decreased to only 2.2 MW per square kilometer, a decrease of 68%. It appears that NY State is also exhibiting a similar trend. The 30,000 acre Alle Catt wind farm will only house 340 MW. This is equivalent to only 2.8 megawatts per square kilometer. At that rate the 12,728 MW of onshore wind turbines ill require 1,755 square miles of New York State. if the number of MW per square kilometer slips down to 2.2 MW/ $(km)^2$ then 2,234 square miles of New York State would be required.

With significant opposition to siting wind turbines in rural areas in New York the modest number of 487 permanent jobs in onshore wind power is unlikely to be reached.

The two Indian Point nuclear reactors, IP2 and IP3, had a combined capacity of around 2,100 MW and the Indian Point site was only 240 acres yielding 8.7 MW/acre. Alle Catt is 340 MW for 30,000 acres or 0.011MW/acre. The ratio of the nuclear site's land usage per MW to that of Alle Catt's land use is 8.7/0.011 = 791.

With such a large disparity in land use it is understandable that there is growing resistance to new onshore wind power. Other comparisons show even greater disparities. In terms of energy production per unit of area where the nuclear capacity factor is 0.95 and the onshore wind only 0.26, according to the NY Independent System Operator, NYISO, the ratio would be (791)(0.95/0.26) = 2,890. Nuclear power can produce close to 3,000 times more energy per acre per year than onshore wind in New York.

The job disparity is even larger. The two Indian Point nuclear plants employed about 1,000 workers who were paid higher than average salaries. This results in approximately 1,000 jobs per 240 acres versus 13 jobs per 30,000 acres, a ratio of 9,624 to one. Per acre of land these nuclear plants were 9,624 more jobs intensive than onshore wind. On a dollar of wages per acre of land the disparity between higher paying nuclear power and onshore wind would be even larger than 9,624 to one.

Many towns in upstate New York are resisting the industrialization of rural New York with massive solar and wind farms. Instead of a consent-based approach to siting these large renewable energy projects, New York State has stripped these locations of the protection they had under Home Rule legislation. Law suits have followed. This removal of Home Rule protection is totally inconsistent with the Community Protection portion in the CLCPA. If some land use is inevitable when moving towards a low carbon future, then the best course of action is to maximize the number of well paying jobs per unit of land.The DSP falls far short of fulfilling this goal of the CLCPA.

3.3.2.5 Offshore Wind Farms - A Historical Perspective

When former Governor Andrew Cuomo first announced New York’s offshore wind program with great fanfare, it was described as “The world’s largest wind farm”. This large undertaking had a goal of 2.4 GW to be completed by 2030. As other east coast states announced their offshore wind programs, suddenly the NY program was increased to a capacity of 9 GW to be completed by 2035. Various studies followed on how to achieve a low carbon future based almost exclusively on renewable energy followed. The Analysis Group concluded that 21.1 GW of offshore wind would be needed by 2040. A similar study by the Brattle Group called for 25.1 GW by 2040.

The DSP calls for up to19 GW by 2050. However, the DSP also identified that there would be gaps in the production of electricity, particularly in the summer months. Similar gaps were identified by the Analysis Group and by the Brattle Group. In order to fill this gap between supply and demand the DSP presented two options, as shown on slide 44. One of these options is to rely on 25 GW of firm (dispatchable) energy and the other option was to further increase the capacity of offshore wind by an additional 17 GW, bringing the total offshore wind power capacity up to 36 GW. Note that 36 GW is 15 times bigger than what former Governor Cuomo boasted was “the world’s largest wind farm”. Nine more GW of solar energy would also be added to these additional 17 GW of offshore wind. Table A-1 below summarizes this history.

TABLE A-1 Number of Needed 15 MW Offshore Wind Turbines

Offshore Wind Plan	Manufacture and Installation Rate of 15 MW Turbines/Year*	Total Number of 15 MW Wind Turbines Needed
a. Original 2.4 GW Cuomo plan to be completed by 2030	27	160
b. Enlarged 9.0 GW Cuomo plan to be completed by 2035	55	600
c. Analysis Group, 21.1GW to be completed by 2040	88	1,407
d. Brattle Group, 25.1 GW to be completed by 2040	105	1,672
e. DSP, 19 GW by 2050	49	1,265
f. DSP to overcome energy gaps, 36 GW by 2050	104	2,400
g. DSP to overcome energy gaps, 36 GW by 2040	185	2,400

*. Start of operation assumed to be January 1, 2027, consistent with start-of-operation British Petroleum and Equinor recently filed with the Federal Energy Regulatory Commission.

3.3.2.6 Offshore Wind Farms - Analysis

There are large differences among the manufacture and installation rates in Table A-1. For example DSP f is about twice the size of DSP e. NY State's offshore wind program is to be supported by a number of facilities like at the Ports of Albany and Coeymans, facilities on Staten Island, and activities at the South Brooklyn Marine Terminal. Their capabilities are being set now. Each of these facilities will have constraints on what they can produce based on the size of their site, supporting utilities, etc. These sites may not be able to easily change from meeting the requirements of DSP e to DSP f so it is important to which plan forms the basis of the design of these facilities.

The DSP can calculate the number of offshore wind turbines that must be installed by a particular date to reach specific goals, **but that does not mean that this number can be achieved. Without knowing the manufacturing and installation rate of the four supporting offshore wind facilities, it is unknown if the DSP option to add 17 more GW to handle energy gaps is feasible. It would be better to start with the manufacturing and installation rate of offshore wind turbines that these four facilities, them make a determination of the number of offshore wind turbines that might be available by 2040 and 2050, not the number of such wind turbines the DSP indicates is needed by 2040 or 2050.**

3.3.2.7 The Empire Offshore Wind Farm

The Empire offshore wind farm is a good example of how much of the money and jobs in large solar and wind projects in the DSP ends up out-of-state and out-of-country.

NY State has awarded the contact to build the Empire wind farm to two giant oil companies, Equinor **(Norway)** and British Petroleum **(United Kingdom)**. Since these large oil companies have not been in the offshore wind farm business, they hired VESTAS (which has built many wind turbines). VESTAS is a **Danish** company which may be transferring some of its manufacturing capacity to **China**. As to the actual installation of the VESTAS wind turbines, the Empire project turned to Maersk, a huge **Danish** shipping company with two locations in **New Jersey**. Maersk was the largest container shipping line in the world from 1996 to 2021. The underwater electric cable for this offshore project will be supplied by Nexans Energy USA which has manufacturing facilities in **South Carolina, Arkansas, and Texas.**

In order to meet the Jones Act requirements, the Empire project enlisted the help of the Kirby Corporation, headquartered in **Houston, Texas**. Kirby is the largest tank barge operator in the United States. Kirby has a new design to meet the Jones Act requirements using a combination of tug boats and a large barge.

How much money to be spent on the Empire Wind Project goes to NY State and how much goes out-of-state and out-of-country?

3.4 Where Are The New York Jobs?

The DSP has estimated that offshore wind should create about 6,800 jobs of which about 300 to 350 jobs would be at the Port of Albany and the Coeysman hub should lead to about 230 jobs. For the South Brooklyn Marine Terminal (SBMT) where staging, assembly operations and maintenance are planned, former Governor Cuomo announced that SBMT would create 1,200 jobs. These three locations add up to 1,780 jobs. Perhaps the offshore wind jobs at Staten Island will fill in most of the 6,800-1,780 =5,020 remaining job positions.

Some data are available on the number of solar energy jobs that might be needed to install DSP’s 61 GW of solar energy capacity by 2050. On average the installation rate would be 2.2 GW/year. nationally, in 2019 about 190,000 solar energy workers installed 13.3 GW of solar panels. At the DSP installation rate it would take about 31,400 construction jobs to accomplish the DSP solar goal. These potential 31,400 construction jobs will eventually end when the construction phase ends. Long term maintenance on solar installations appears to require about 21% of the number of jobs in the construction phase. That being the case, about 6,600 long term solar maintenance jobs would be needed.

Based on Alle Catt wind farm numbers, onshore wind farms would produce about 487 permanent jobs.Adding up all the estimated long term DSP jobs the total comes to about 14,000 long term jobs in the DSP that are a direct result of utilizing renewable energy. This figure is one tenth of one percent of New York’s present workforce. Even if this very approximate figure were increased by a factor of ten, the conclusion would be the same: The choice of a predominantly renewable energy future, does not lead to a large number of long term jobs.

As stated before, the purpose at the Port of Coeymans is to construct advanced foundation components ranging from 12 to 120 tons each and as tall as 40 feet that would attach to the foundations the wind turbines would stand on. Could the 230 workers at Coeymans manufacture 49 to 104 of these large steel components per year, as called for in TABLE A-1? Is there a disconnect between the authors of the DSP and others who are establishing the design specifications for these four State facilities?

Data on the number of permanent jobs in solar energy are hard to find. However an article in Forbes Magazine is instructive.(4) “Replacing High Paying Oil Jobs With Clean Energy Jobs Is Not So Easy”, Neil Edwards, Forbes Magazine, May 10, 2021. During the construction phase solar projects can create new, full time and well paying jobs that weren’t there before. As the Forbes article points out *“The downside is that installation and project management firms employ 66% of the fast growing solar workforce. By definition, employment with these companies is not permanent but short-term and contact-based.”*

This solar workforce situation resembles that of the wind power industry, the HVAC and the residential shell improvement industry. Once the construction phase is over the permanent workforce is likely to be a small fraction of the size of the construction work force. How many of the 211,000 jobs DSP projects would still be around in 2040 and in 2050? The permanent jobs are in manufacturing the solar panels. China accounts for 73% of all solar panel production jobs globally, The United States lags far behind with only 1%.

The semi-conductor business is the root of the solar energy technology. Federal efforts are being made to bolster the US semi-conductor industry. Taiwan Semiconductor recently announced plans to build a $12 billion dollar,1,900 job facility in the Phoenix, Arizona area. Samsung previously indicated that it was exploring sites in Texas, Arizona, and New York for a new U.S. chip plant. It has now chosen Texas for its new $17 billion 2,000 jobs, facility. Intel earlier this year announced plans to invest $20 billion in two new factories in Arizona.

Appendix C of the NYSRDA Plan identifies the semi-conductor industry in New York as one of the top industries sensitive to the price of electricity. It would be ironic if the DSP, with its extreme emphasis on renewable energy, caused especially high electricity prices in New York that caused the very companies it needs to implement its own energy plan, to locate elsewhere.

3.5 Summary

The DSP does not generate a large number of in-state jobs. Very few industrial jobs would be created and some existing industrial jobs in the state will be at further risk if the DSP results in even higher prices for electricity than what we have now. From the data that are readily available, it appears that the majority of the renewable energy manufacturing jobs that the DSP would create would be outside of New York and even outside of the United States.

4.0 Energy Storage

The special relationship between energy storage and renewable energy is key to understanding the feasibility of the DSP scenario. Renewable energy storage challenges increase as the deployment percentage of renewable energy increases, eventually creating a storage challenge that has no practical solution at this time. If the DSP scenario is not feasible or not affordable, depending on it would be a threat to all jobs in New York.

The relationship between renewable energy and energy storage is unique. This is because the other low carbon energy sources, nuclear energy and fossil fuels with carbon capture and sequestration (CCS), already have energy storage built into them. Nuclear has energy storage right in the uranium pellets in the fuel assemblies. The amount of energy storage in today's fossil fuel system's pipes, storage tanks, and underground facilities is huge. Because renewable energy (RE) is intermittent and variable, it is necessary to provide backup energy sources and/or energy storage for times when RE is insufficient to meet demands. The need for energy storage is low when the percentage of deployment of RE on the grid is low. Other sources of electricity and/or energy storage make up for these RE production gaps.In effect, at low renewable energy deployment, the electric grid acts like a "big battery", compensating for RE intermitttency. Unfortunately, many of the compensatory actions in this "big battery" run on fossil fuels, mostly natural gas.

Locations where there are a large number of solar panels, like California, rely on storage and natural gas to provide electricity during night time hours. Natural gas is burned even during the day as a standby should cloud formations reduce solar energy output or when wind speeds drop or demand goes up.

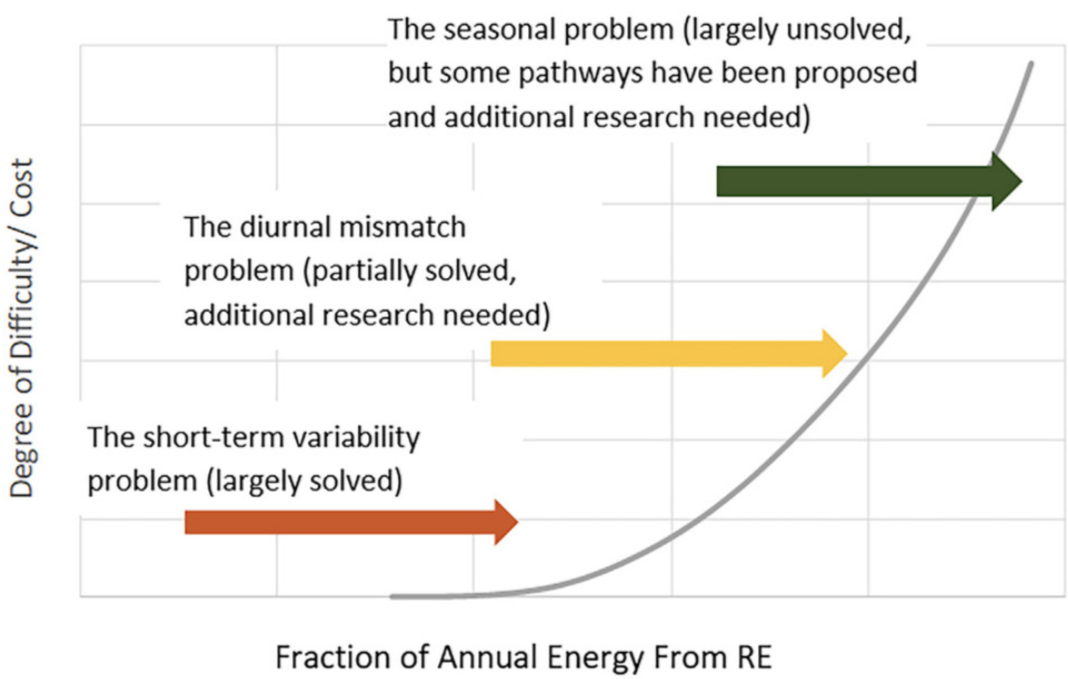
In the DSP, as the deployment of RE increases, fossil fuels would be phased out. While this moves in the direction of dealing with climate change, it reduces the ability of the grid to act like a big battery to support RE. Eventually this means that other forms of storage must be brought on to compensate for the increase in RE and the simultaneous decrease in storage provided by fossil fuels. Large banks of batteries might be used as an interim measure up to some level of RE deployment. However, batteries are expensive, are limited by the number of charge/discharge cycles and have reduced output at lower temperatures. As discussed later, onshore wind farms are experiencing a substantial number of events per year that reduce their electric output to quite low percentages, or even zero. Many of these onshore wind energy reductions last longer than 8 successive hours, i.e., longer than the output of the 8 hour batteries the DSP selected.Climate change may increase the frequency and/or duration of such onshore wind gaps.This means that adding batteries alone might permit a somewhat higher degree of renewable energy deployment, but it will not be sufficient to permit a 100% renewable energy future. This means that an alternative energy storage system is necessary to permit high renewable energy deployments.

Other studies have attempted to deal with this storage issue at high percentages of RE deployment. The Brattle Group turned to RNG, renewable natural gas.(5) The Analysis Group turned to DE, which is just the same as RNG, but with another name.(6) Neither the Brattle Group nor the Analysis Group know how their forms of energy storage can be generated in any practical way. The DSP turned to hydrogen, one of the most difficult substances in the world to deal with.

Hydrogen has a very low volumetric energy density. In order to raise the hydrogen volumetric energy density to resemble that of natural gas, it must either be compressed to pressures in the 10,000 to 15,000 pounds per square inch or cooled down to temperatures below 253 degrees centigrade, i.e.,near absolute zero temperatures. Hydrogen, because of its very small molecular size, presents far more of a leakage problem than methane. Hydrogen embrittles steel and has an ignition range 6 times wider than methane, making it more likely to explode.While there is great interest in hydrogen today, the DSP has not assembled a cohesive hydrogen plan that integrates hydrogen generation, hydrogen storage, and hydrogen distribution.

The energy storage challenge, along with other challenges, increases with greater deployment of renewable energy has been studied by the National Renewable Energy Laboratory (NREL), nicely summarized in Figure A-1 reproduced from the Joule journal. (7)

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



A major employer in the United States and in New York is the airline industry. Further, other industries depend upon the airlines to stay in business. However, aircraft, like large 18 wheeler trucks, are hard to near impossible to electrify to replace their use of fossil fuels. The DSP dealt with the energy needs of the airline industry by inventing "renewable jet fuel". How renewable jet fuel is to be produced and its cost is not fully discussed in the DSP. However two things are known: (a) renewable jet fuel, like today's jet fuel, would be a mix of hydrocarbons which, when burned, will produce carbon dioxide. Unless there is some means to capture or offset this airline produced carbon dioxide the whole purpose of the DSP could be undermined, and (b) it will take additional money and energy to produce renewable jet fuel and to capture or offset the carbon dioxide produced by renewable jet fuel. These additional costs and energy demand do not appear to be considered in the DSP. Some information is available on this subject from the Brattle Groups' analysis of a low carbon future for NY State where they relied on renewable natural gas. The Brattle Group analysis calculated that a total capacity of 33.7 GW of RNG would be needed to offset energy gaps in wind and solar. However, they calculated that another 11.6 GW of capacity would be needed to generate the RNG in the first place.

5.0 Firm Energy

The DSP presents two possible ways for dealing with the energy storage issue at high renewable energy deployments, as shown in slide 44. One possibility is to overbuild the whole system by adding another 17 GW of offshore wind, another 9 GW solar capacity and 31 GW of long duration storage which would require a much larger hydrogen system. The other possibility is to have 25 GW of firm (dispatchable) energy.

The overbuild approach has a number of drawbacks in addition to even greater reliance on hydrogen systems.As shown in TABLE A-1, comparing plans e and g, the annual manufacture and installation rate for these very large, 15 MW, offshore wind turbines would increase from 49/year to 185/year. DSP has not established what the manufacture and installation rates of the present four offshore facilities are and if they can even meet the 49 turbines/year manufacture and installation rate.

A second problem is that larger wind farms do not solve meteorologically caused problems, like lulls, wind speeds in excess of the wind turbine cut-off limit, and hurricanes at the category 3 or higher level. The size of the wind patters are far larger than the area taken up by the wind farm, even after 17 more GWs of capacity are added. The possibility of a long lasting wind lull covering a very large area is not a weather modeling prediction, it has already happened, as discussed later in this report.

It is possible to solve the energy storage issue for RE at high deployment percentages by turning to non-carbon sources of electricity that are dispatchable (or firm), like nuclear energy and/or fossil fuels with CCS. The DSP acknowledges, in slide 44, the possibility of using 25 GW of firm zero carbon capacity which could resolve the energy gap/energy storage challenge at high renewable energy deployment. This firm energy addition does more than prevent gaps from occurring between energy supply and energy demand. This firm energy eliminates the need for overbuilding the solar and wind capacity just to deal with these energy gaps. Not only would this eliminate the need to overbuild the whole system with more solar and wind capacity, the addition of firm energy would also eliminate the need for a hydrogen-based energy storage system. Firm energy produces other benefits including a reduction in land use and the number of MW-miles of transmission lines relative to a 100% renewable energy strategy.

The DSP approach to using firm energy is inconsistent with the CLCPA. It treats this 25 GW of firm energy like a patch or like today's gas peaker plants, only to be used to overcome shortfalls in the extreme renewable energy system it proposes. For the sake of discussion, suppose that these 25 GW of firm energy were met by building 25 new 1000 MW nuclear plants in the cost range from $3,500 per kilowatt of capacity (South Korea and China) to about $7,000/kilowatt (Vogtle, USA). At these construction costs, these 25 GW would cost between 88 to 185 billion dollars. Recalling that today the whole USA only has a total nuclear capacity of around 95 GW, twenty five new 1000 MW nuclear plants (25 GW) in New York by 2040 would be a mammoth program. Yet the DSP use of this enormous nuclear capacity is to only use it a small percentage of the time. Slide 41 calls for the share of annual generation across mitigation scenarios for the zero carbon firm resource to be just 1-2%. This is equivalent to these nuclear plants operating at a capacity factor of 2.8% instead of their typical capacity factors above 90%. This DSP treatment of firm energy is extremely wasteful, would run the cost of electricity up, and is at odds with the CLCPA.

6.0 Four Additional Reviews

6.1 Introduction

In addition to evaluating the DSP in terms of job creation, four additional reviews were conducted. These reviews focussed on the cost of electricity, system reliability, sufficiency of supply, and security issues. Poor grades in any of these four areas could discourage future investments in NY State and the jobs that these investments would create.

6.2 The Cost of Electricity

The cost of electricity is regressive in two ways. First, high electricity costs disproportionately burden low and middle income families. Second, high electricity costs can drive businesses, tax revenue, and jobs out of New York. Both of these regressive actions are inconsistent with the **C**ommunity **P**rotection portion of the CL**CP**A. These regressive actions would add to the difficulties identified before for low and middle income families to pay the large costs of replacing fossil fuel consuming appliances, like replacing a gas fired space heating system with an electric space heating system.

The DSP did not lay out the full impact of adding 25 GW of firm zero carbon energy. Fortunately, a California's energy future study provides a comparison of with and without firm energy, see TABLE A-2. (8) This California study is similar to the DSP in that it was based on 30 GW of firm energy whereas the DSP is based on 25 GW of firm energy.

TABLE A-2 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

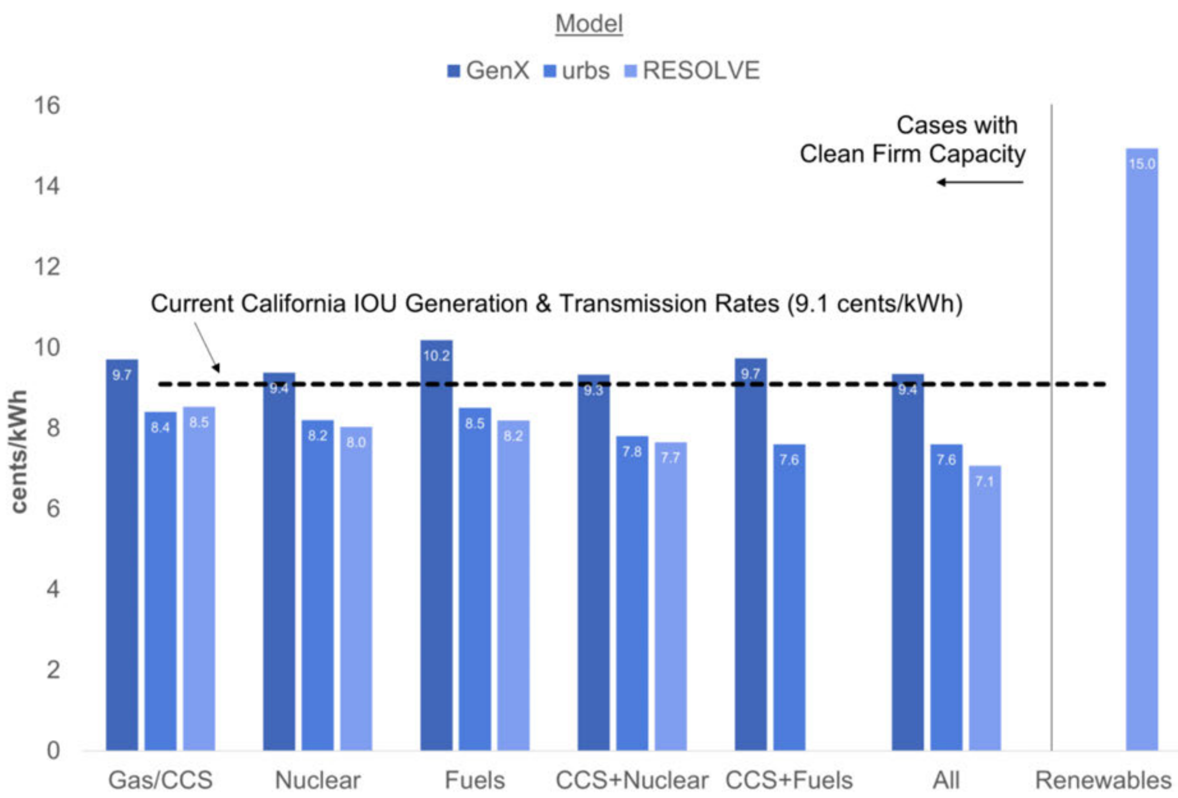
The difference between the cost for generation and transmission, with and without firm power is profound, ~9 cents/KWh with firm power and ~15 cents KWh without firm power, a 15/9 = 1.67 or 67% more expensive for the DSP type of extreme energy scenario.

Both the DSP and this California study are similar in another, but negative, way. Both treat all this firm energy like a "patch" to overcome the storage weaknesses in high deployment renewable energy scenarios. Both analyses assume that this large firm energy capacity would only be used 2-3 percent of the time. The DSP's 25 GW "patch" is about the size of a quarter of today's nuclear power plants across all of the United States. There is no environmental or economic justification for allowing such a huge State asset to be so underutilized. If the DSP is serious about adding 25

GW of firm energy, then it should recommend that efforts to implement such a huge program get underway as soon as possible. It should also recommend that the process to extend of the operating licenses of the upstate nuclear plants begin immediately.

There is additional information that demonstrates that mixes of low carbon energy technologies are more cost effective than an all renewable energy scenario, as shown in Figure A-2, below.

FIGURE A-2 California Generation and Transmission Rates



The above figure shows that there are many mixes of low carbon energy technologies that are far less expensive than the extreme all renewable scenario that the DSP has selected. Further, this conclusion was reached by three different analyses; by GenX, urbs, and by RESOLVE.(9)

Because TABLE A-2 and Figure A-2 show such large differences in cost with and without firm energy, more work needs to be done. When writing the DSP, NYSERDA should have produced the New York equivalent of TABLE A-2. Then NYSERDA should have estimated the number of NY jobs with and without firm energy.

Because of the very large difference in the cost of electricity in TABLE A-2 with and without firm energy in the California analysis, a detailed analysis of how the DSP affects the price of electricity in NY State and the subsequent impact on jobs should be made. In the meanwhile it is possible to make a preliminary estimate of job losses in New York as a function of the price of electricity. Bystrom has calculated for the Swedish manufacturing industry that a one percent increase in the price of electricity would result in a 0.3 percent decrease in manufacturing jobs (10) Using data for new York from the U.S. Bureau of Labor Statistics four areas were selected that might be sensitive to increased electricity prices. They are (1) manufacturing;(2) trade, transportation, and utilities;(3) information; and (4) financial activities. Their present employment figures, in thousands of workers are, respectively, 414.0; 1,453.2; 291.6; and 707.6 for a total of 2.87 million workers out of a total 9.38 million workers in NY. Using Bystrom's analysis, a one percent increase in the cost of electricity might result in a 0.3 percent job loss, we have (0.003)(2.87 million) = 8,610 jobs at risk per one percent increase in the price of electricity. A 25% increase in the price of electricity, based on the above conversion factor, would be enough to eliminate about 211,000 jobs, leaving New York with a **zero net jobs gain** after investing about three trillion dollars.

We do not know what the price of electricity might be under the DSP, but some rough estimates can be made. As one can see from TABLE A-2 the cost difference for electricity with and without firm energy was 15/9 or 1.666, a 67 percent difference. Comparing France, with its heavy use of nuclear power, to Germany, which still plans to phase out its few remaining nuclear plants, the price difference is 0.323/0.173 = 1.867 or an 87 percent price difference.

It is not that jobs alone are in jeopardy, it is whole industries. Industries that are energy intensive may go out of business. This is already happening in Europe which is experiencing a very significant rise in oil and gas prices. Fertilizer companies in England have closed because of high natural gas prices. Further, with high electricity prices, there would be a reluctance of new or expanding energy intensive industries to select New York to build a new manufacturing facility.

Appendix C of the DSP provides additional information on page C-12, which states that the largest NYS industries that may be most prone to leakage appear to be in the primary metals, chemicals, cement, glass, paper, and semi-conductor industries. The mining, quarrying, and oil and gas extraction industry has at least 450 jobs; the semi-conductor and related device manufacturing industry has 7,200 jobs; paper mills 3,800 jobs; alumina refining 500 jobs; glass manufacturing 1,300 jobs; and cement production 500 jobs. These six high energy intensity industries have a total of 13,750 jobs in New York. These industries would be the most at risk from higher electricity prices.

Appendix C also states *"However, the Scoping Plan does not contain provisions for a carbon tax or industry-specific allowance price that might present a much greater risk to EITE industries and thus require more dramatic special accommodations. Nonetheless, in the future, where State energy sector or emissions mandates threaten significant emissions leakage in industry, the State may wish to finalize an approach for which industries and businesses operating locations will be designated as EITE, as well as what benefits will be conferred for an industry's EITE status"*.

In effect, the Appendix C recommendation amounts to subsidizing energy price vulnerable industries, something NY State already selectively does. However there are limits to the amounts of money that can be shifted to cover these subsidies. Eventually these subsidies are paid for by the tax payers who would be, themselves, experiencing high electricity prices and, simultaneously, the large costs of replacing their fossil fuel burning vehicles, space and hot water heaters, etc. with clean electricity devices.A far better approach would be to use a mix of low carbon electricity sources that create a lower price of electricity in the first place.

The DSP should have provided an estimate of the price of electricity in its plan and the impact of that price on jobs and industries. NYSERDA should have performed a least-cost analysis in the DSP to determine how well its selected extreme energy scenario compares to energy futures with a mix of clean energy sources.

Even if the DSP resulted in acceptable electricity prices there are other considerations, such as system reliability and sufficiency, that must be acceptable in order to retain jobs in New York.

6.2.1 Ontario, Canada

A 2020 an energy panel provided a detailed analysis recommending an energy future of Ontario, Canada which heavily depended on a mix of two low carbon energy sources, nuclear power and hydropower. (11) The panel concluded that “The Smartly Integrated Solution Could Meet The Additional Demand From Electrification At Half The Cost Of A Renewables-Based Alternative”. This report also stated “This solution would smooth out demand for electricity, increase the efficient use of all assets, including storage, enhance system flexibility, and ultimately result in less generation, distribution, and transmission costs.”

6.3 System Reliability

Today New York State has the highest electrical system reliability requirements in the nation. This results in a stable source of electricity and is an attractive characteristic of the State. Will implementation of the DSP maintain this high standard?

In 2020 the contribution of wind power to the generation of electricity in New York was 4,162 GW-hours or 3.2% of the total generation. Slide 40 of the DSP projects that onshore wind, including wind imports, will grow to 16,745 GW-hours or 11.9% of the 2050 electricity generation. Projected offshore wind would add another 19,293 GW- hours for a total wind contribution of 36,038 GW-hours or 25.5% of the 2050 electricity generation.

However, NY State is already experiencing interruptions in electricity production in its onshore wind system. In 2020 there were 74 incidents where the wind fleet output remained below 100 MW for more than 8 consecutive hours. Note that 8 hours of decreased output is longer than the 8 hour duration from the batteries in the DSP. The 74 incidents in 2020 was an increase in the number of such incidents from previous years, with 64 such incidents in 2019. 100 MW represents about 5% of the installed wind capacity in 2020, i.e., there were 74 incidents in 2020 when onshore wind power only produced about 5% or less of its full production capability.

Because wind power only represented 3.2% of the State’s electricity generation in 2020 the frequent low electricity output from wind power could be absorbed by the grid. However, should wind power represent 25.5% of the State’s electricity production these lulls become much more important. There is no assurance that these wind power lulls can be offset by solar energy. Solar energy is not dispatchable; one can not cause the sun to set later in the day when such a wind power lull incident occurs. Instead, these lulls may have to be offset by energy storage beyond that available from battery storage, but the DSP hydrogen storage plan is far from certain.

Climate change may worsen the frequency and duration of lulls as weather patterns become increasingly variable. The importance of changing wind patterns affects wind power in two, somewhat opposite, ways. If there are more frequent occurrences when the wind speed is zero, or below the cut-in wind speed of the wind turbine, or just modestly above the cut-in wind speed of the wind turbine, then one would expect a higher incident rate than what NYISO is reporting now. Overbuilding the wind farms does not solve this concern because the areas affected by meteorological formations are much larger than the largest wind farms, i.e. possibly larger than the whole State of New York, including onshore and offshore wind farms. Of particular concern is an emerging wind pattern which covered an area larger than northern England with a lull that lasted months.(12).

Going in the opposite direction is the meteorological potential for more frequent higher wind speeds. Wind turbines have cut-in speeds and cut-off speeds. The cut-off speed is to protect the wind turbine's generator. Should wind speeds exceed the cut-off speed, no electricity will be produced from the wind turbine. Should wind speeds be in the category 3 or higher hurricane level, the wind turbines may structurally fail. Such high wind speed turbine structural failures have alreadyoccurred.

6.4 Sufficiency of Supply

In 2021 Texas was exposed to a three week long period of extreme cold weather from polar vortex conditions during which time electric power was unavailable for many. Those people who could get electricity paid exorbitant prices, but they were far better off than those who lost power. There were 57 fatalities and $195 billion dollars in damages from this extreme weather event.(13)

The 2003 heat wave that hit Europe caused an estimated 70,000 deaths. In the US heat waves kill more than 600 people per year on average, more than all other climate hazards.(14) The New York Independent System Operator, NYISO, recently warned that New York State, and particularly NY City, are facing major electricity shortages from high temperatures this decade.(15)Two energy margins, one in the generation of electricity and the other in the transmission of electricity, are shrinking and could fail to meet New York's reliability criteria if statewide temperatures reach the upper 90 degree F range. Because of climate change, increased frequencies and extended durations of extreme hot and extreme cold temperatures are anticipated.

The lesson learned from these tragedies is straightforward: **If there is a gap between energy demand and energy supply during times of extreme cold or extreme heat, fatalities and property damage are likely to occur. The CAC, which is New York's leading climate action/ energy committee, should respond to the alarming situation raised by NYISO and report its recommendations to the Governor.**

But there is another existential concern besides energy shortages. This concern comes from the production of energy. Fatalities and property damage are also happening from climate change. Climate change is largely attributed to the burning of fossil fuels and their release of greenhouse gases (GHG) into the atmosphere and into the oceans. Record high carbon dioxide levels in the atmosphere have been measured (16) and there has been a marked increase in the earth's heating rate.(17) 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 GHG rises. The most recent report from the United Nations shows that as the threat from COVID-19 has subsided, the release of GHG has accelerated significantly.

The DSP is designed to bring the addition of new carbon dioxide down to zero by around 2050. However, instead of having the atmospheric carbon dioxide concentration at present levels, the DSP would expose everyone to higher damage rates consistent with the higher 2050 carbon dioxide concentration levels. **So the second lesson learned is that the release of carbon dioxide and other greenhouse gases must be reduced as rapidly as possible.** In order to accelerate the reduction of atmospheric carbon dioxide levels it would take more capacity and more money than what the DSP has considered. The primary use of the 25 GW of firm energy that the DSP refers to should be used to reduce the atmospheric CO_2 concentration as quickly as possible and not just as a patch for shortfalls in renewable energy production. Reducing the CO2 concentration as rapidly as possible should save money because less climate change damage should occur. Add that saving to the savings of not needing a hydrogen storage system and the cost of building these 25 GW of firm energy might be paid for and then some.

A further complexity not considered by the DSP is the interaction between the atmosphere and the oceans. The carbon dioxide concentration in the atmosphere is in equilibrium with the carbon dioxide concentration in the oceans. As the carbon dioxide is drawn down from the atmosphere there would be a resultant evolution of sea water held carbon dioxide back into the atmosphere thereby slowing down the rate at which carbon dioxide concentrations in the atmosphere can be reduced. It appears that the DSP did not consider these atmosphere-ocean interactions or the cost and complexities of reducing their effects.

The above issues are global in nature and beyond what NY might be able to affect. It appears that the DSP focussed on what renewable energy systems are needed to cope with expected normal conditions in 2050 based on existing weather records. However there are defects even in the sufficiency analysis for expected normal conditions. Based on the DSP's slide 40, it appears that the amount of hydrogen that must be generated to offset insufficient amounts of energy from solar + wind energy is based on the energy needs of a single week in January, 2050. Presumably, this would be the coldest week of the year under normal conditions. Even if the energy needs for that single week in January were met, the DSP did not show that there would be sufficient additional hydrogen available for the other cold weather weeks in winter when solar +wind might fall short of meeting energy demands. Instead of a calculating the amount of hydrogen needed for a single week under expected normal conditions, the DSP should have calculated the total amount of hydrogen needed for the whole year. There are other energy storage questions related to battery and pumped storage shown in slide 40. These are not energy sources in the same way that wind and solar are. There are round trip losses when a storage system goes through a cycle of ELECTRICITY IN-STORAGE-ELECTRICITY OUT. It is not clear if these energy losses have been accounted for.in batteries and in pumped storage.

It also appears that the DSP did not calculate the amount of hydrogen storage necessary to deal with extreme heat, as described by NYISO on their November, 2021 system reliability report or extreme cold as what happened during NY's 4 degree Fahrenheit polar vortex of January, 2014. Surviving a polar vortex similar to the one in 2014, but with the DSP's emphasis on renewable energy and with a highly electrified energy system, would be far more challenging. First, there would not be any fossil fuels to provide home heating or hot water or for electricity generation. Second, Indian Point nuclear Units 2 and 3 are now destroyed, even though their steady, large electricity output helped pull New York City and Westchester through this dangerous time. Unlike DSP's slide 40, one can not count on electricity imports. Neighboring states will also be affected by these large polar vortices. As reported by NYISO in its description of the 2014 polar vortex "...expected import transactions from other states did not arrive due to lost generation in other regions also impacted by the cold".(18) NYISO also reported that some hydro units had to reduce energy production due to icing.

Low temperatures also have effects on the systems that the DSP depends on. First there would be an increase in demand for electricity to meet higher space heating needs. However the energy that air sourced heat pumps can produce at low temperatures is well below summer production. Air sourced heat pumps at low air temperatures approach a coefficient of performance near1.0, i.e., making them have the about the same efficiency as simple resistance heating systems. Battery output decreases with lower temperatures. For electric vehicles there are two effects, lower output from the battery and a drain on the battery to provide heating for the passenger cabin. For equal total driving distances, the electric grid would have to provide more MW-hours for electric vehicles during low temperature events. There even is a decrease in the output of solar panels at low temperatures compared to their output at 70 degrees Fahrenheit of 0.26% per degree F. This would be about a 17% decrease at 4 degrees F, the low temperature reached by the 2014 polar vortex. Because the solar contribution during winter conditions already is quite limited, a 17% further reduction would only be a minor negative effect.

Because of the lethality of extreme weather events, the DSP should have presented an analysis of how well its highly renewable energy system would have performed under January, 2014 conditions.

The transformation to a highly electrified society has other, more subtle effects. The NY electrical system is designed today to handle peak loads, with a reserve margin. The same approach should be used in the future. As we electrify many fossil fuel burning systems, instead of the NY peak load occurring during the air conditioning season it would occur during the winter heating season. The combination of electrified space heating with the need to recharge electric vehicles may redefine when the peak demand may occur even under normal conditions. The peak demand for space heating likely will occur at night. The peak demand for recharging electric vehicles may also occur at night, as some studies suggest. Such overlapping cold weather peaks, during a time when the solar energy contribution is at a minimum and when wind power might experience a lull could be the "perfect storm". Instead of the day-by-day analysis performed by the DSP, and hour-by-hour analysis of polar vortex conditions is called for.

In order to keep electricity costs down, the electricity grid should make efficient use of its electricity generating capacity. In New York, the electric grid today is quite inefficient. Because a great deal of capacity is only used during peak summer demands, the present NY grid only has an overall system efficiency of about 38.6%. As we move towards a winter peaking system, the overall system efficiency should improve because there would be less demand difference between summer and winter. Electrification of space heating should help flatten the demand curve. This seasonal demand progress might be undone if the capacity of the whole grid has to meet very high peak demands that might occur at night during the winter because of two overlapping peak demands, described above.The present 38.6% figure might sink even lower if the grid has to be designed to meet peak hourly or peak day electricity demands. It is not clear if additional hydrogen storage solves this issue without also increasing the hydrogen-to-electricity devices, such as fuel cells. Adding still more capacity to deal with hourly peaks would further raise the price of electricity.

6.5 Security Issues

Not only would almost all renewable energy sources in the DSP come from sources outside of the New York, many sources are outside of the United States. This is more than an issue during the construction phase, it is a continuing problem because these source countries would supply replacement, maintenance and repair parts, and technical support. Such continuing dependence on our energy sources is a security issue.

7.0 Renewable Energy

This report argues against throwing out two of three of our low carbon technology tools to deal with climate change. The DSP, in effect, rejects nuclear energy and fossil fuels with CCS. This report's aversion to rejecting major low carbon technologies is equally applicable to retaining RE in the energy mix.While a number of limitations on RE have been pointed out, there also are limitations on the deployment of nuclear energy and the deployment of fossil fuels with CCS.

It must be made perfectly clear that comments about the limitations of RE are arguments against extreme scenarios of any kind, not against RE as a technology. RE should be used when it is the most cost effective choice. Further, separate analyses have shown that combinations of different low carbon technologies, like solar/nuclear combinations, offer benefits that are not achievable with either technology alone.

8.0 Conclusions

This review of the DSP has revealed a number of observations. First, the DSP has never explained to the public why it limited its investigations to an extreme scenario with renewable energy being the dominant source of energy. Such a choice needs to be justified, especially in view of energy failures experienced in Germany and California where similar extreme energy scenarios have been attempted and because a number of well known analyses have shown that such extreme energy scenarios are far from optimum.

The DSP itself demonstrated that, even with spending at least 3 trillion dollars, only 211,000 jobs would be produced, or just 2.3% of the present workforce. Many of these 211,000 jobs are not sustainable. For example, once a house has been well insulated, there is no need for a second round of insulation. Permanent jobs are often only a small fraction of the temporary jobs needed to erect an RE facility, as shown by the Alle Catt wind farm experience. Some of these 211,000 jobs may never materialize or may be years off unless NY State establishes a very large subsidy program to help low-to-middle income people deal with the high cost of switching over from burning fossil fuels to clean electricity.

Are we comfortable in creating a dependence on foreign vendors to built the major components of our energy supply system and also be responsible for their long term repair and replacement? Is this not a major security issue?

Also of concern is the expected high cost for electricity that a nearly all RE system would cause. There are a number of analyses that show that a far more cost-effective way to proceed is with a mix of low carbon energy sources. It is well established that high electricity costs are disproportionately burdensome for low-to-middle income families and are inconsistent with the CLCPA.

High electricity costs can drive out energy intensive industries from NY and discourage other energy intensive industries from investing in New York. The cost of electricity is so fundamental to the acceptance of the DSP it should have been presented on page one of the Executive Summary, instead it is almost impossible to find.

A close review of the DSP reveals technical defects like insufficient capacity to deal with extreme hot and cold temperatures or even provide enough stored energy to get though a whole year of projected 2050 normal temperatures. The DSP’s commitment to maintaining present State reliability criteria is unknown.

New York State and the whole country will have to undergo a huge re-industrialization to deal effectively with climate change. Some old industries will disappear but many new ones will be born. Instead of mapping out new strategies that could produce many new industries and new well paying jobs, the DSP makes a timid offering of a small number of long term jobs.

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