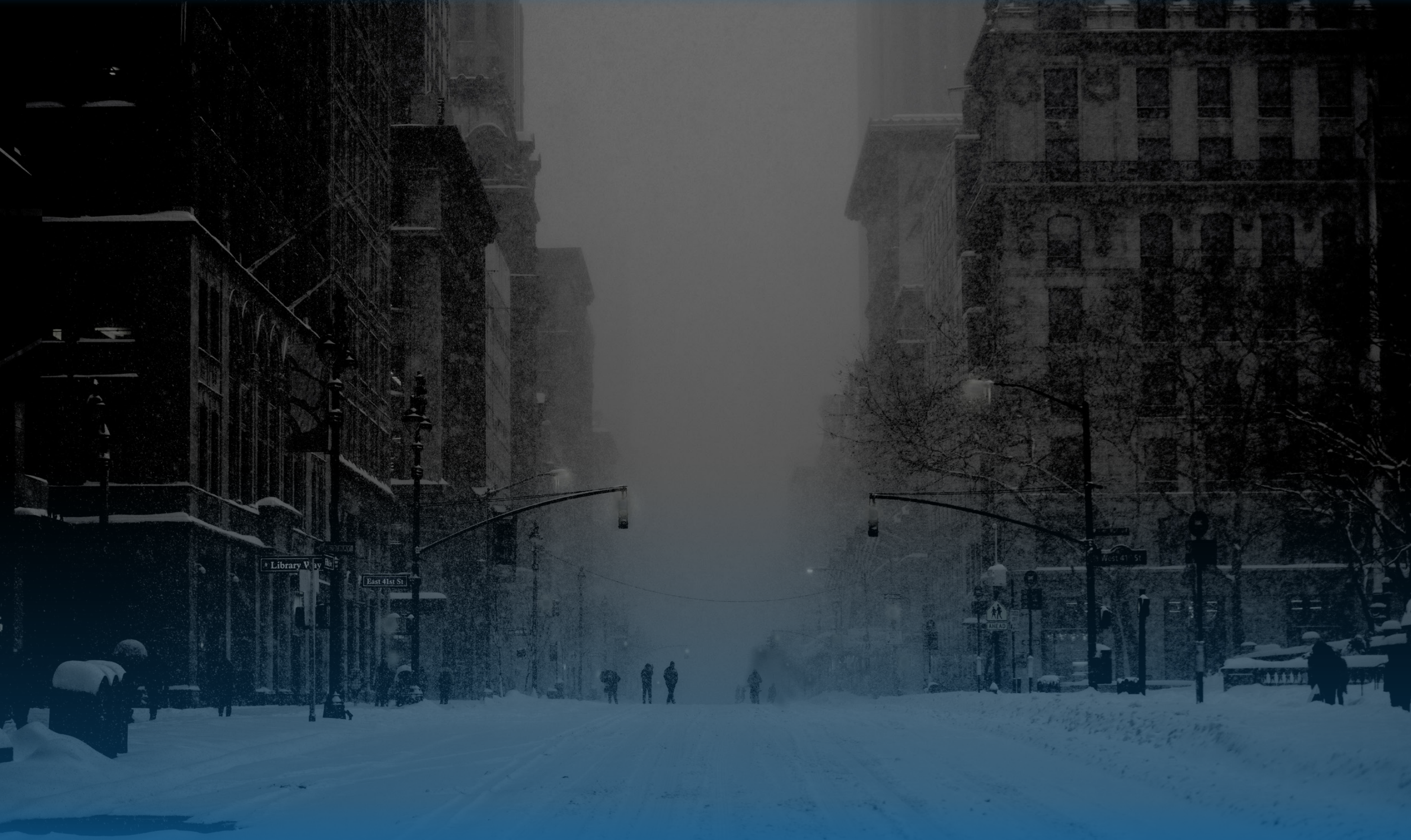

COLD AND DARK?

New York's Risky Energy Future

by James Hanley

April 2022

EMPIRE CENTER

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New York's Risky Energy Future

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New Yorkers can easily imagine a harsh winter day, with bitterly cold temperatures in the single digits, overcast skies and still air that stings to inhale.

Now imagine that same winter where restrictive provisions of the state's far-reaching energy agenda have caused massive power outages.

Across the state, windmills sit nearly motionless. Solar farms languish under gray skies. The natural gas-fired power plants that once could have provided backup electricity have been shuttered, deemed not clean enough. The state's remaining nuclear power plants may also have been shut down. Only hydroelectric generation remains. And it falls far short of meeting the state's electricity needs.

Most homes have been forced to change their heat source from natural gas to electric, causing electric demand to skyrocket. As demand surges past available supply, city after city goes dark, leaving people without heat in the bitter cold.

Hundreds, perhaps thousands, die. Some die from hypothermia in their own homes, others because they cannot turn on necessary medical devices. Millions are left without light or heat on the coldest days of the year.

This isn't just hyperbole. Look no further than what happened in Texas in February of 2021 for an example. As a polar vortex hit the state and electricity demand went up, multiple energy sources went off-line. During the resulting blackout, between 246[i] and 750 people died,[ii] and property damage totaled nearly $200 billion.[iii]

Nobody wants this to happen in New York. But the Climate Leadership and Community Protection Act (Climate Act) dramatically increases the state's risk of such an event by 2040. Unless action is taken now to revise the way New York pursues its climate goals, the state will have insufficient electrical power to meet demand by 2040, making the risk of a catastrophic blackout unacceptably high.

BACKGROUND: *THE CLIMATE LEADERSHIP AND COMMUNITY PROTECTION ACT*

The Climate Act was passed in 2019 and signed into law by Governor Andrew Cuomo. It set certain goals for reducing New York's greenhouse gas emissions and created a Climate Action Council to draft a "Scoping Plan" to guide implementation of the law.

The ultimate goal of the Climate Act is to reduce the state's greenhouse gas emissions by eighty five percent by 2050. The law also requires seventy percent renewable energy by 2030, including 9,000 megawatts (9 gigawatts) of offshore wind by 2035, and one hundred percent zero-emission —producing no greenhouse gases—electricity by 2040 (see figure 1, page 3). To accomplish these goals, not only do new generating resources need to be zero-emissions, but existing fossil-fuel fired

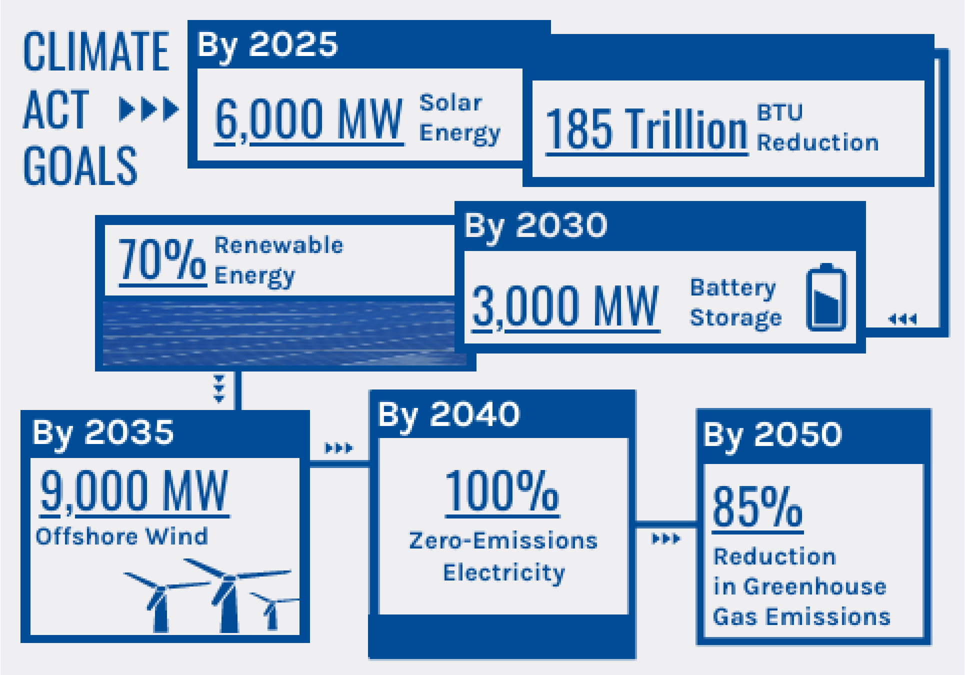

Figure 1: Climate Act Goals

Source: Climate Leadership and Community Protection Act

sources, including natural gas, will have to be eliminated within 18 years.

The Climate Act also calls for saving energy by making homes more energy efficient, but two factors will increase net electricity demand in the future. First, the Draft Scoping Plan produced by the Climate Action Council calls for shifting homes from natural gas heating to electric heat.[iv] Second, a separate law requires that by 2035 all new cars and light duty trucks purchased in the state be zero-emission vehicles, the overwhelming majority of which will be electric and have to be recharged on the electrical grid.[v]

This all sets the stage for a severe shortage of electricity by 2040, with supply falling short of demand by ten percent, or in bad weather for wind and solar even more.

THE ESSENTIAL PROBLEM: *INCREASING DEMAND WITH DECREASING SUPPLY*

New York currently consumes 143 terrawatt hours (TWh) of electricity per year.[vi] Figure 2 (next page) shows the sources of that electricity. A full 40 percent comes from natural gas.

Because of 1) economic growth, 2) the mandated increase in electric vehicles, and 3) the Climate Act's mandate to shift home heating and cooking from natural gas to electric, the state expects future electricity use to increase between sixty-five and eighty percent.[vii] This means that the state will need between 236 and 258 TWh of electricity production in the future, as much as 115 TWh more than at present.

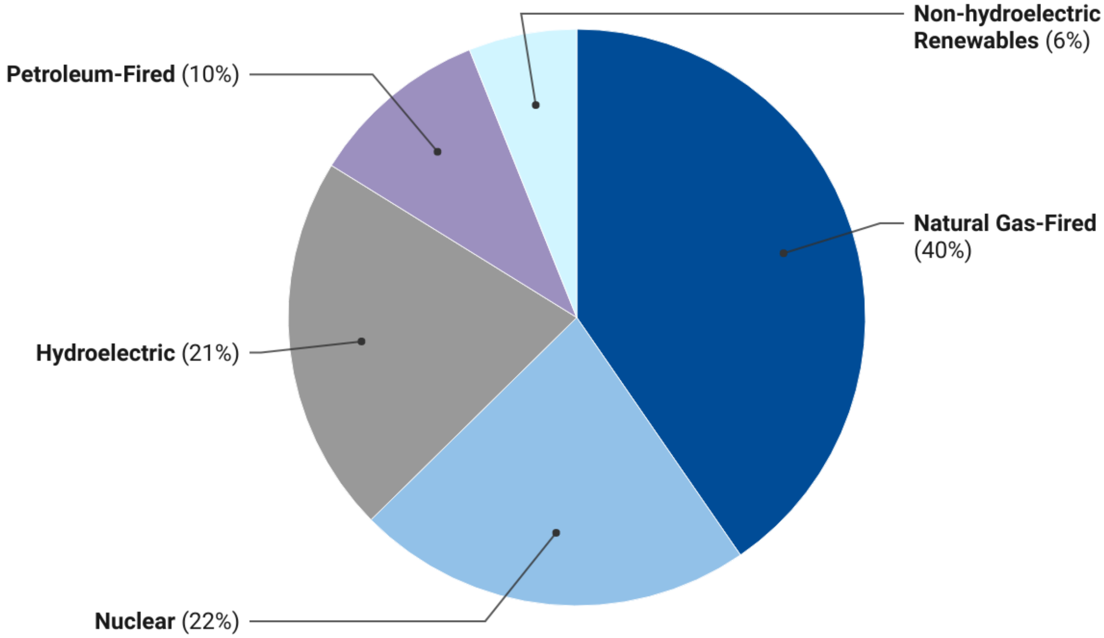

Figure 2: Sources of New York Electricity
Source: United States Energy Information Agency

Already New York has a declining energy profile as power generation facilities are being retired "faster than new resources are being developed."[viii]

These retirements include the Indian Point nuclear plant, which provided over 15 TWh annually to New York City before it was closed fully in 2021. It's possible that the state's remaining nuclear power plants could also be shut down. Two of the state's four nuclear generators are licensed only until 2029, and one until 2034 (the fourth is licensed until 2046). Anti-nuclear sentiment is strong.[ix] If political opposition causes those three generators to not be re-licensed, the state would lose approximately 19 TWh of nuclear electricity production before 2040.

Because the state's natural gas plants emit greenhouse gases, they would all have to be shut down under the Climate Act. If that happens, another 66 TWh, almost half of all electricity produced in the state, will disappear.

Even if the state doesn't forcibly shut these natural gas plants down, many are nearing the end of their lifespan and will need to be replaced, according to a recent NYISO report:

> A growing amount of New York's gas-turbine and fossil fuel-fired steam-turbine capacity is reaching an age at which, nationally, a vast majority of similar capacity has been deactivated.[x]

But replacing them may be politically impossible due to the Climate Act. In a sign of what's to come, the State's Department of Environmental Conservation recently denied permits to two new natural gas-fired power plants (both cleaner than the currently operating plants they would have replaced). These denials were explicitly justified by reference to the Climate Act,[xi,xii] portending future denials to build new gas-fired plants, even though, being more efficient, they would produce fewer greenhouse gases than existing ones.

On the plus side, the recently approved Champlain Hudson Power Express line would bring approximately 4.5 TW of electricity to New York City from hydroelectric dams in Quebec.[xiii] However this power may not be fully available in winter, when increased demand for electricity for heating in Canada will take priority over New York City's needs.

For the moment let's exclude wind and solar and look at the state's electricity shortfall without them. In the next section we'll add them back into the mix.

Excluding wind and solar, the worst-case scenario is that the state will need to add 115 TWh, but instead will have eliminated 80.5, leaving a gap of almost 200 TWh. In the best-case scenario, where future needs are on the low end of NYSERDA's expectations and all nuclear power plants are re-licensed, the state would still be 154.4 TWh short. By way of comparison, New York City uses about 53 terawatt hours of electricity per year, so this is equivalent to almost three New York Cities without power.[xiv]

But as noted, this does not include wind and solar. The Climate Act requires growth in both sources of energy. So can we produce enough wind and solar to fill that gap? The answer, in short, is no.

	Worst Case Scenario (in TWH)	Best Case Scenario (in TWh)
Existing Supply	143	143
Potential Nuclear Retirement	-19	0
Required Natural Gas Retirement	-66	-66
Champlain Hudson Express	0	5
Net Future Supply	***58***	***82***
Predicted Need	-258	-236
Shortage	**-200**	**-154**

Table 1: The Climate Act's Electricity Deficit
Source: Author's Calculations

WIND AND SOLAR CANNOT MAKE UP THE GAP

The gap between supply and demand must be closed with renewables to comply with the Climate Act, and as the development of significantly more hydroelectric power is unlikely, the deficit needs to be filled primarily by wind and solar. But because of their variable output, they will be unable to fulfill this need.

Not all power facilities of the same power rating are equal. Let's compare a 1 gigawatt (GW) nuclear plant to a 1 GW offshore wind farm. The nuclear plant has a capacity rating of around 90% (see sidebar, page 7), while an offshore wind farm has a capacity rating of around 50%. That means that even though both have a maximum power output of 1 GW, the offshore windfarm produces only 55% as much electricity over the course of the year as the nuclear power plant.

The reason is that the wind is not always blowing strongly enough to turn the wind turbine blades, or is blowing so strongly that the turbines have to be shut down to avoid damage. The nuclear plant only has to be shut down for maintenance or refueling, and may go an entire year without going off-line.

Natural gas plants can have a capacity factor as high as 90%, but average less because some are "peaker plants" that are only used a few hours a day at most to meet peak demand. And as figure 3 shows, onshore wind and solar have even lower capacity factors than offshore wind.

The capacity factor tells us how many TWh we can expect the Climate Act's wind and solar projects to produce (see sidebar, page 7). The Act calls for 6 GW (six thousand megawatts) of installed solar capacity by 2025 and 9 GW (nine thousand megawatts) of offshore wind by 2035 (see figure 1, page 3). The sidebar shows the calculations for how many TWh will be produced by these energy sources.

The math doesn't lie — together the Climate Act's 6 gigawatts of solar and 9 gigawatts of offshore wind will only produce 52.5 of the minimum additional 154.5 TWh the state will need. That's less than one-third of what is needed to meet statewide needs, short 102 terawatt hours of filling the gap.

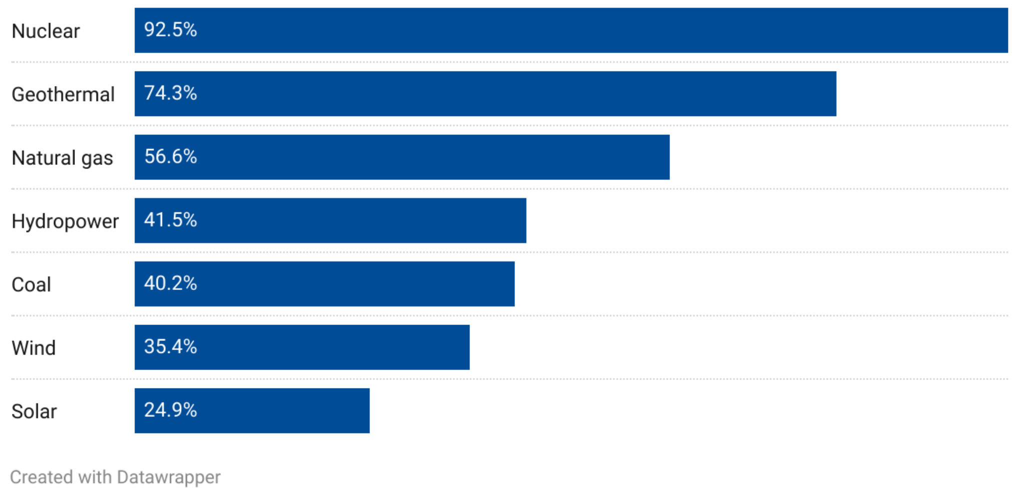

Figure 3: Energy Source Capacity Factors[xv]
Source: U.S. Energy Information Agency

CAPACITY FACTORS AND CALCULATING TERAWATT HOURS

Capacity factor is the ratio of the electrical energy produced over a certain time period compared to how much could have been produced if the power plant operated at full capacity over that time period. When we know the power rating of a power plant and its capacity factor we can calculate how many terawatt hours of energy it will produce in a year.

The following formula calculates how many Gigawatt hours (GWh) of electricity an energy facility produces in a year. Note that 1,000 GWh = 1 TWh.

Power rating x capacity factor x hours in the year = GWh

For the planned 6 gigawatts of solar by 2025, the math is
6 x .249 x 8,760 = 13,087.4 GWh (13.1 TWh).

And for 9 gigawatts of offshore wind, the math is
9 x .5 x 8,760 = 39,420 GWh (39.4 TWh).

Onshore wind currently provides 3.5 percent of the state's electricity needs,[xvi] which works out to about 5 TWh. That still leaves 97 TWh of needed supply.

NYSERDA has set a goal of 10 GW of distributed solar —solar located at homes or businesses or serving small communities rather than in large utility-scale operations.[xvii] This will provide another 22 TWh, still leaving us 75 TWh short of our needs.

Onshore wind and utility-scale solar will expand by 2040, although it's not clear by how much. The Climate Act doesn't set 2040 goals for those energy sources, and political and community pushback may delay projects. But let's assume that offshore wind, onshore wind, and solar, are all doubled by 2040. That provides another 79.5 TWh, giving us 159 TWh total, a bare 5 TWh annually above our minimum needs in the best case scenario, a margin too slim to ensure enough supply on very high demand days.

In summary, even with heroically optimistic assumptions, wind and solar cannot meet our energy needs by 2040 under the Climate Act's requirement of seventy percent renewables and one hundred percent zero-emissions electricity.

WHAT OTHER SOURCES ARE THERE?

If the state is to meet its goal of one hundred percent zero-emissions electricity by 2040 it has to find more dispatchable – meaning they are available on-demand – emissions-free energy sources (DEFRS).[xviii]

Wind and solar are not available on-demand because of the variability of the weather.[xix] Said another way, the wind is not always blowing and the sun is not always shining when we need it. The problem is especially predictable for solar energy. Electricity demand follows a predictable pattern during the day, as shown in figure 4, with a morning ramp and an early evening peak. But in winter in New York, the morning ramp begins before sunrise and the evening peak occurs after sunset, both times when no solar power is available.

This is why dispatchable-on-demand resources are necessary. It's not sufficient that we can get a lot of energy from wind and solar. We need to get that energy at the exact time we need it, not before or after.

NYISO recognizes the gap created by the Climate Act and estimates that ten percent of our electricity supply in 2040 will have to come from these DEFRs.[xx] The Climate Action Council, which is responsible for writing the Climate Act's Scoping Plan, is also aware of the problem. The Draft Scoping Plan explicitly states that "there is a remaining need for 15 – 25 GW of [installed generation capacity] in 2040 to meet demand and maintain reliability."[xxi]

However, the Council does not identify a source for this generation capacity. It suggests possibilities such as "new long duration battery technology, RNG, (renewable natural gas) advanced green hydrogen, nuclear, overbuilding of renewable technologies or other new technologies."[xxii]

All of these are problematic. Long-duration batteries will almost certainly be developed, but batteries are not an energy source. They merely shift energy usage in time, and the cost of building sufficient battery storage to power a large city for an extended period of time will be vast. We cannot expect battery power to do more than help us meet a few hours of peak demand.

Overbuilding of renewables would also be costly and would not always solve the problem. Because of renewable energy sources' lower capacity factors, it would take

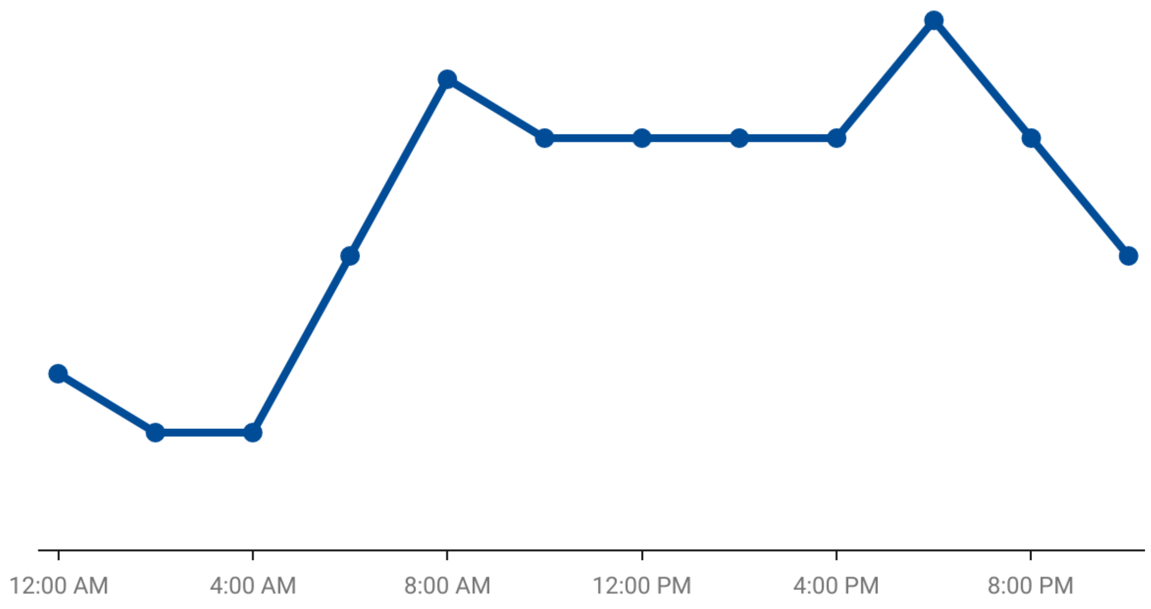

Figure 4: Standard Daily Demand Curve

Source: Author's Representation

an offshore wind farm of more than 2 GW of capacity to equal the 1 GW of capacity of a natural gas plant. To replace that minimum of 15 GW of needed generation capacity with offshore wind would require a minimum of 30 extra gigawatts of wind turbine capacity, more than quadrupling what the Climate Act calls for and at immense expense.

Similar calculations can be made for onshore wind and for solar power, which has an even lower capacity factor than wind. Either one would be far more expensive than building 15 GW of natural gas plants.

And the overbuilding still would not work because of the variable nature of solar and wind. Adding more solar does nothing when the sun isn't shining. As for wind, the idea is that the wind is always blowing somewhere, which is true on a large enough scale. But many weather systems that would have low wind speeds are larger than the state itself. In late 2021, for example, the entire continent of Europe experienced lower than usual windspeeds,[xxiii] and Europe is 72 times as large as New York state.[xxiv] We could build that 30 GW of offshore wind – requiring over 2,000 wind turbines – and yet all of them could be motionless, producing little to no energy, at the same time.

Nuclear power is capable of fully solving the problem of dispatchable emissions-free electricity, but given political opposition, it is unlikely that the necessary 10 or more nuclear power plants necessary to fill the supply gap will be allowed. This leaves renewable natural gas (a carbon-neutral fuel produced from organic matter) or green hydrogen (produced from water using emissions-free energy sources). Both of these would qualify as DEFRs, but these are not yet commercially available at utility scale,[xxv] and nobody knows if they will be by 2040.

According to NYISO in a recent comment to the state's Department of Environmental Conservation concerning the Climate Act:

> Electric system reliability margins are already close to minimum reliability requirements . . . [T]he New York grid may cross a "tipping point" in future years such that the transmission system and generating resources would not reliably serve electric demand.[xxvi]

The Climate Act does provide an escape route, if the state chooses to take it. Future natural gas-fired power plants can be approved if it is proven that they are necessary to ensure the stability of the grid. But as we have seen, the Department of Environmental Conservation (DEC) is already determining that new natural gas facilities are not necessary and not in compliance with the Climate Act.

By the time we reach the tipping point, the needed natural gas plants may already have been prohibited from being built. Even if the DEC then decided more natural gas facilities were needed for system reliability, it might be too late to plan, build and bring them online. And the DEC would certainly face political opposition to them.

This is how New York could accidentally walk backwards into a catastrophe that nobody intends to create.

THE WORST CASE SCENARIO: *A WINTER BLACKOUT*

Given the anticipated supply shortages, even if the state somehow manages to provide enough electricity generation through various sources, we can still expect reliability margins to be very tight. And that means any minor disruption in supply could lead to blackouts.

The Climate Action Council admits this is a problem, writing in the Draft Scoping Plan:

> There are also many weeks in the year—especially during the winter—in which the contributions from renewables and existing clean firm resources are not sufficient to meet demand.[xxvii]

So imagine a future winter day when a bitter cold front envelops the state. Wind speeds are low, as they tend to be in colder weather. Quebec is also in the deep freeze, so Quebec power authorities shift more of their hydroelectric power away from the Champlain Hudson Express to meet Canadian demand, reducing power to New York City. Electricity demand spikes as heat pumps have to work harder to heat homes.

As the grid threatens to collapse under the imbalance of supply and demand,

Figure 5: 2003 Northeast Blackout, Affected Area
Source: Lokal_Profil

NYISO institutes rolling blackouts, temporarily cutting off power to first one city, then another.

What happens next is unpredictable. New York is connected to a large multi-state and multi-province power grid called the Eastern Interconnect. NYISO will call for power supplies from energy producers outside New York, and perhaps that will restore system balance. If that can happen quickly enough, most people will never know how close they came to a blackout.

But if the cold weather system covers a large multi-state area, perhaps New York isn't the only state with high demand. Or perhaps the state's needs tip the balance for a large region, causing a multi-state blackout.

We've seen such blackouts before, most recently in August 2003, when 50 million people in the U.S. and Canada were without power for periods of a few hours to four days (see figure 5, page 10).

That summer blackout reportedly contributed to 100 deaths.[xxviii] The stakes are higher in the winter: as noted earlier, the February 2021 Texas blackout killed between 245 and 750 people.

On a large scale, a winter blackout could easily become one of the most deadly and costly weather-related catastrophes in U.S. history.

WHAT CAN BE DONE

Reassess Goals and Timeline

First, the state should reassess the goals and timeline of the Climate Act. The cause of the risk New York faces is the rush to implement renewable energy faster than a reliable electricity supply can be created.

Supporters of the Climate Act have prioritized the end without analyzing the viability of the means. But wanting a particular outcome, however badly it is desired, is not sufficient to make it happen.

And in the end, what is the value gained from this rush to renewables? New York contributes less than one-half of one percent of global greenhouse gas emissions. If the state cuts its emissions to zero, the effect on global greenhouse gas emissions will be negligible, especially as China and India are still rapidly increasing their emissions,[xxix] which will overwhelm New York's reductions. This means the state has time to act – the dates set in the Climate Act are merely political choices and pushing them back will not have any meaningful effect on combatting climate change.

Recognizing this risk does not mean the state should take no action to reduce emissions. But it does mean that the means should be matched to the ends.

Keep Using Natural Gas as Necessary

Second, the Climate Act and the Scoping Plan should be revised or amended to emphasize that reliability of the energy supply is the primary consideration as the state takes measures to reduce its greenhouse gas emissions.

This means recognizing the limits on solar and wind as non-dispatchable energy sources. And pragmatically it means building new energy sources in addition to, not in place of, current ones. We must keep all existing energy sources online and permit new more-efficient greenhouse gas-emitting sources as needed until a reliable alternative supply of energy has been developed.

The continued use of natural gas does not mean being reckless about greenhouse gas emissions. New York has already dramatically reduced its emissions of greenhouse gases by shifting from coal to natural gas,[xxx] and replacing older natural gas plants with more efficient new ones will continue to reduce the state's carbon footprint.

Nearly every blueprint for deep decarbonization of the economy calls for continued use of natural gas for several decades. For example, from this report prepared for NYISO:

> Fossil-fuel fired generation (including natural gas) will be needed for reliable power system operations through this transition, to support electrification of other sectors, and help manage the greater variability of increasing quantities of weather-dependent renewable generating resources.[xxxi]

Keep Existing Nuclear Power

Third, the state should work to ensure the relicensing of current nuclear facilities past 2029 and 2034 to ensure they remain open. While it is not ideal to subsidize any power-generating facility, as these nuclear plants require, the state cannot afford to lose these sources of reliable emissions-free electricity at this or any future predictable point.

Promote All Emissions-free Resources, not Just Renewables

Fourth, we should not get confused between renewables and emissions-free resources. The true goal is to reduce emissions, not to simply shift to renewables. This means that in addition to Governor Hochul's plan to make New York a hub for research into utility-scale green hydrogen[xxxii] the state should also strive to become a magnet for the development of advanced nuclear, which is lagging in the United States.[xxxiii]

In addition, New York should reduce barriers to conduct research in capture and the reuse or sequestration of the carbon produced by burning natural gas.

Maintain and Expand Gas Pipelines

Finally, the state should allow for the rebuilding and extension of natural gas transmission pipelines. The alternative for decades to come is to move natural gas by truck, which increases greenhouse gas emissions instead of reducing them. In addition, energy companies are working on blending larger amounts of hydrogen with natural gas, so these same lines would be necessary for the state's own hydrogen-reliant energy plans.

CONCLUSION

Before the state gets itself into a position where it risks not having sufficient electricity to meet demand, we need to pause and act cautiously. New York's Climate Act may be well-intended, but it is short-sighted, and creates great risks for the people of the Empire State. Energy shortages would drive up the cost of the Climate Act by hundreds of billions of dollars and could cost hundreds of New Yorkers their lives.

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