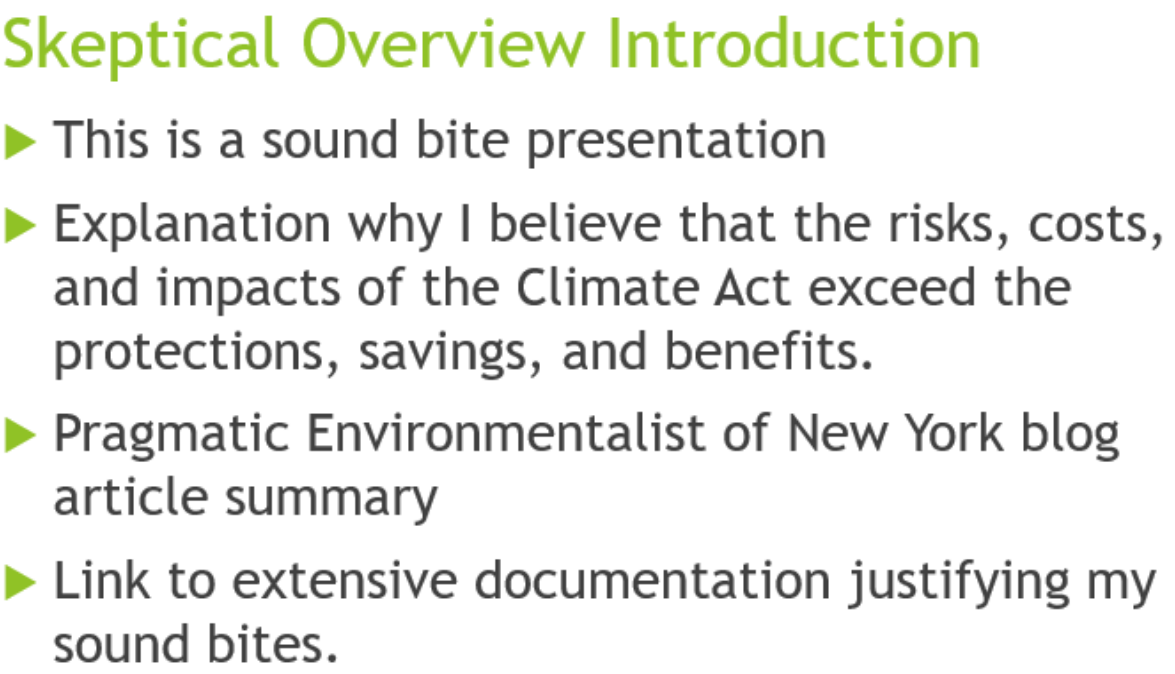
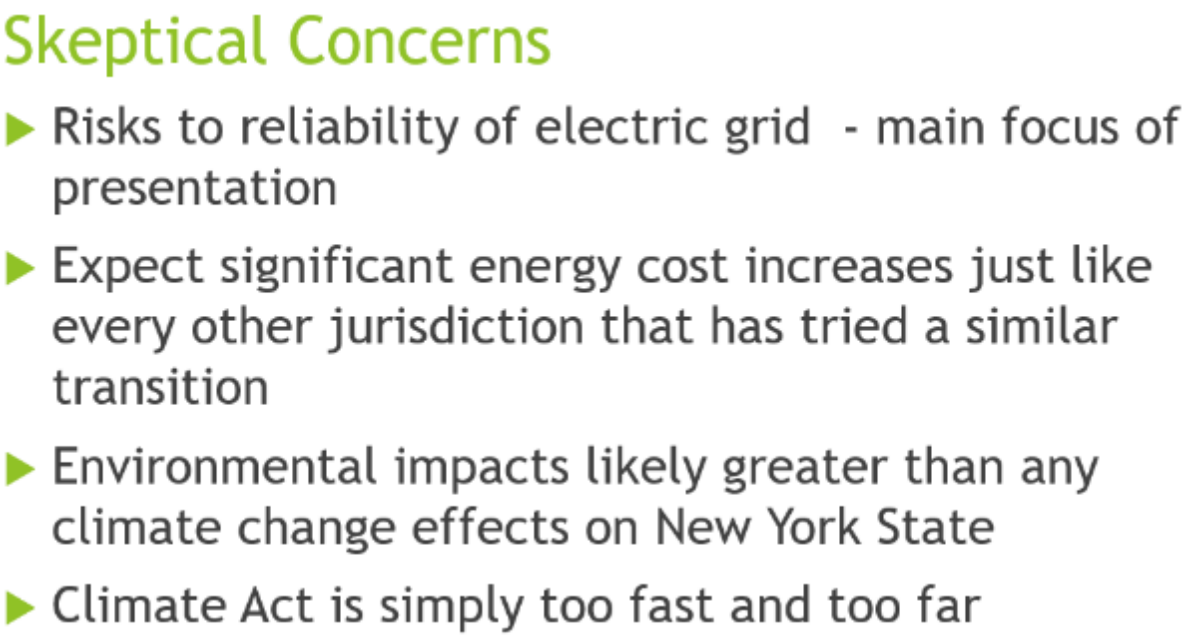
Documentation for Skeptical Overview of the Climate Act Presentation November 28, 2022
Central New York Chapter Air & Waste Management Association November 29, 2022



Key Points:

- This is a sound bite presentation
- It is an explanation why I believe that the risks, costs, and impacts of the Climate Act exceed the protections, savings, and benefits.
- Pragmatic Environmentalist of New York
- Link to extensive documentation justifying my sound bites.

This will be a sound bite presentation where I will describe the key reasons why I believe that the risks, costs, and impacts of the Climate Act exceed the protections, savings, and benefits. There will be a Pragmatic Environmentalist of New York blog article summarizing the presentation that includes a link to extensive documentation justifying my sound bites. There is simply not enough time to provide all the justification for my arguments.



This presentation is an overview of my findings related to reliability, affordability, and environmental impacts. I am going to focus on risks to the electric grid and the fallacy that existing renewable energy technology is up to the transition task. In every instance, my evaluation of the components of the transition plan has found that issues are more complicated, uncertain, and costly than portrayed by the State. Moreover, they have not provided a feasibility analysis to document whether their list of control strategies could work. In addition there is no implementation plan. The Climate Act is simply too fast and too far.

New York's Climate Leadership and Community Protection Act (Climate Act) has been the primary focus of this blog since 2019. I have authored over 250 posts on the Climate Act and submitted 23 comments on the Draft Scoping Plan.

I believe the Climate Act targets and schedule are too ambitious given the emphasis on renewable energy technology to not cause more harm than good. It is simply too fast and too far.

Introduction

- Air pollution meteorologist from the electric generating sector
- Background
  - Emissions
  - Transport and Diffusion Modeling
  - Environmental Impacts
  - Regulatory Response

I believe my background and experience are uniquely qualifying to evaluate the Climate Act. As an air pollution meteorologist I have direct background and experience in all the components of a rational approach to human effects on the climate. Couple that with over 40 years in the electric utility business I have a good understanding of the electric system.

I have been in the environmental field for over 45 years. For the last several years I have authored the Pragmatic Environmentalist of New York blog that describes environmental issues from a pragmatic viewpoint. Pragmatic environmentalism is all about balancing the risks and benefits of both sides of issues. Unfortunately, public perception is too often driven by scary one-sided stories that have to be rebutted by getting into details. This blog shows the both sides of environmental issues and will get into the details necessary to support the other side of the story.

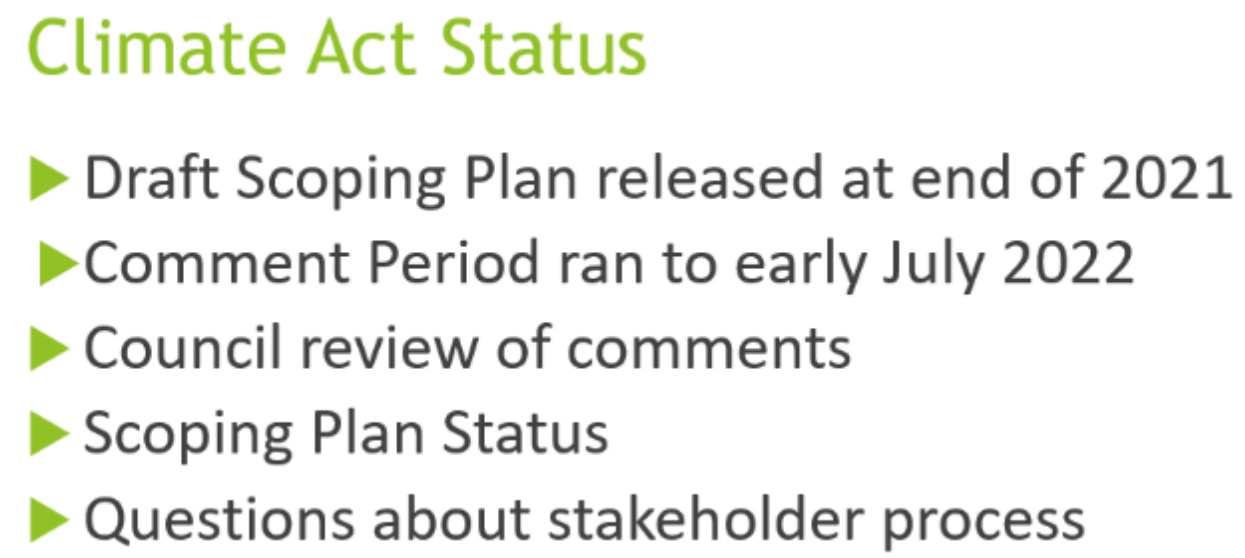
Before retirement from a non-regulated generating company, I was actively analyzing energy and air quality regulations that could affect company operations and was responsible for the emissions data used for compliance. The opinions expressed on my blog and in this presentation do not reflect the position of any of my previous employers or any other company I have been associated with, this content is mine alone.

Roger Caiazza Résumé

Overview of Climate Act

- Climate Leadership and Community Protection Act (Climate Act) has a net-zero goal by 2050
- Climate Action Council is responsible for the transition Scoping Plan
- Integration Analysis informed the Draft Scoping Plan
- Final Scoping Plan is due January 1, 2023
- Implementing regulations will be promulgated in 2024

- Climate Act is a political document written to appeal to specific constituencies that demand zero risk from climate change but ignore the impacts of alternatives. There is no benign way to make power.
- Climate Act Progress
- Climate Leadership and Community Protection Act (Climate Act) has a net-zero goal by 2050
    - The Climate Leadership and Community Protection Act (Climate Act) mandates reduction of New York's statewide GHG emissions by 40% from 1990 levels by 2030 and by 85% from 1990 levels by 2050.
    - Net-zero means remaining 15% of emissions is supposed to be offset by sequestration
    - Important to this discussion is a target of 70% renewable energy sources in the electric sector by 2030 and 100% zero-emissions electricity by 2040
- Climate Action Council is responsible for the transition Scoping Plan
    - 22 members chosen by ideology not expertise
    - Mostly agency heads
    - Governor and majority leaders picked more of the at large members
- The Scoping Plan is supposed to outline how the New York energy system will transition to net-zero
- Integration Analysis generated the numbers that underpin the Scoping Plan



- Draft Scoping Plan
  - Released at end of 2021
    - 331 pages
    - 24 chapters
    - Massive spreadsheets
  - Comment Period ran to early July 2022
    - Public Hearings
      - 700 people spoke
    - Stakeholder Comments
      - ~35,000 comments received
      - ~25,000 comments "potentially the same or substantially similar", i.e., form Letters
      - All comments will be "acknowledged"
    - Comment process was treated as an obligation not as an opportunity to improve, correct, or clarify the scoping plan
  - Council review of comments
    - Staff filtered the comments
    - Presentations to Council listed themes with very little specificity
    - Clear bias in presentation – anything inconsistent with narrative was disparaged, downplayed, or ignored
    - No comments on Integration Analysis were discussed
  - Scoping Plan Status
    - All the topics have been discussed at the Council
    - The Council is reviewing a red line version of the scoping plan to finalize by the end of the year

2023 Plan

- Climate Act Requirements
  - Establish greenhouse gas limits for 2030 and 2050 by end of 2020
  - Complete Scoping Plan by end of 2022
  - Implement Council's recommendations by end of 2023
- Stakeholder Process
  - CLCPA mandates a public comment and consultation process before promulgating regulations
  - Once the regulations are proposed the State Administrative Procedures Act requires public comments

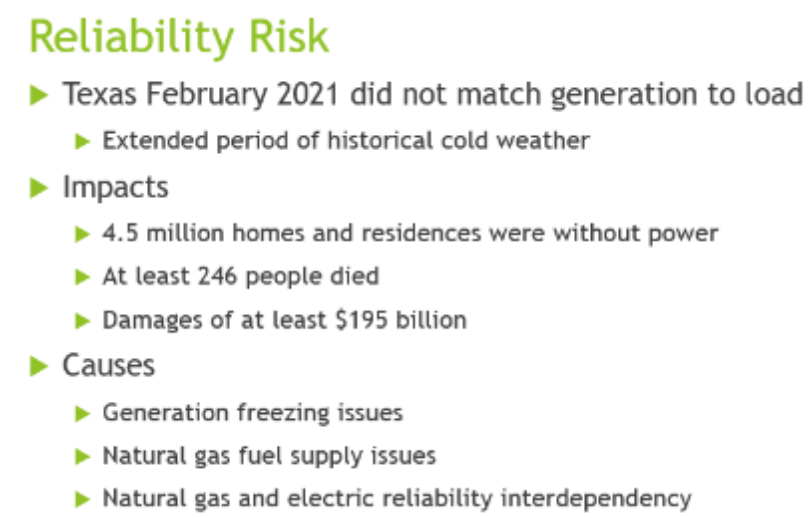
- Implement Council's recommendations by end of 2023
  - Climate Act required DEC to promulgate regulations to establish the overall statewide GHG emission limits for 2030 and 2050.
- Stakeholder Process
  - Climate Act mandates a public comment and consultation process before promulgating regulations
  - Climate Act requires DEC to implement the Council's recommendations by January 1, 2024.
  - Regulations must ensure that the statewide GHG emission limits for 2030 and 2050.
    - "[e]nsure that the aggregate emissions of greenhouse gases from greenhouse gas emission sources will not exceed the statewide greenhouse gas emissions limits
    - ….[i]nclude legally enforceable emissions limits, performance standards, or measures or other requirements to control emissions from greenhouse gas emission sources,"
    - "reflect, in substantial part, the findings of the scoping plan."
  - Climate Act requires DEC to complete a public comment and consultation process before it can promulgate the 2024 Implementing Regulations.
  - Before DEC can promulgate these enforceable regulations, the CLCPA requires public workshops and consultation with the Council, the Environmental Justice Advisory Group, the Climate Justice Working Group, representatives of regulated entities, community organizations, environmental groups, health professionals, labor unions, municipal corporations, trade associations and other stakeholders.
  - At least two public hearings and a 120-day public comment period must be provided. Only after this extensive stakeholder process concludes is DEC authorized to proposed the 2024 Implementing Regulations.
- Once the regulations are proposed the State Administrative Procedures Act requires public comments
  - 60 day public comment period
  - Public hearings
  - Response to comments

Risks to Electric Grid Discussion

- De-carbonization strategy is to electrify everything possible using zero-emissions generating resources
- Future grid relies on intermittent and diffuse wind and solar resources
- Discussion points
  - Existing grid
  - Generation resource planning
  - Current New York State system
  - Projected New York State system
- Ultimate problem is the need to match generation resources with electric load

Key Points

- De-carbonization strategy is to electrify everything possible using zero-emissions generating resources
- Presentation will describe
  - Existing grid
  - Generation resource planning
  - Current New York State system
  - Projected New York State system
- Electric grid reliability requires that generation resources match electric load at all times



Key Points Why worry?

- Electric Grid in Texas in February 2021 did not match generation to load
- Weather related issues due to freezing rain, snow and then extended cold weather
- Causes
    - Generation freezing issues
    - Natural gas fuel supply issues
    - Natural gas and electric reliability interdependency
    - Unplanned load shedding
    - Load shedding coordination

Impacts

- Worst energy infrastructure failure in Texas history
- 4.5 million homes and residences were without power
- At least 246 people died
- Damages of at least $195 billion
- Grid was "seconds or minutes away from" complete failure

Weather

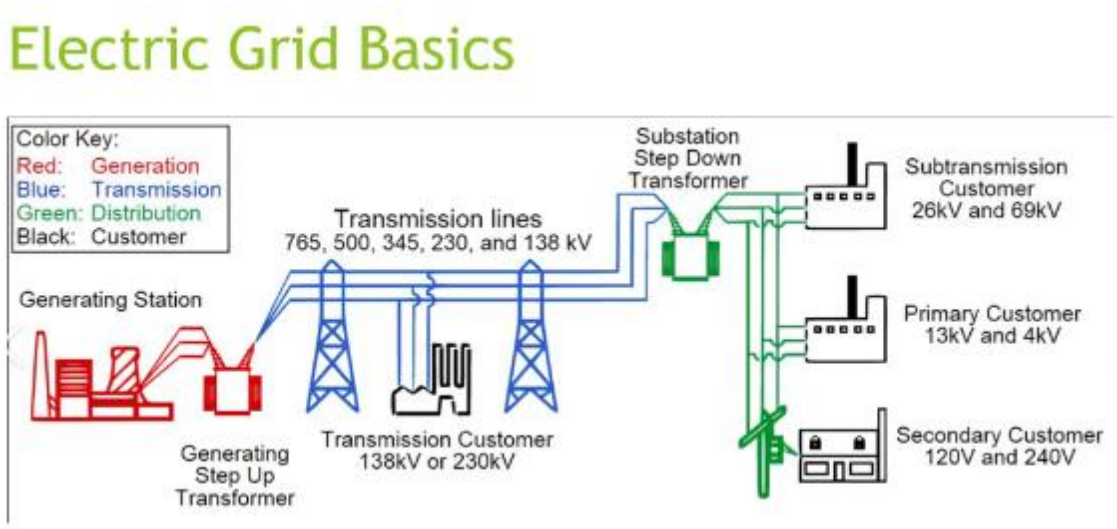
- Feb. 11-12: Freezing rain
- Feb. 14-17: Snow and extended period of below freezing temperatures
- Many low temperature records broken

Causes

- Report | The February 2021 Cold Weather Outages in Texas and the South Central United States
- Presentation | February 2021 Cold Weather Grid Operations: Preliminary Findings and Recommendations

Generation Shortfalls

- 1,045 individual generating units experienced 4,124 outages, derates or failures to start, of which 604 were natural-gas fired generators.
- During the week of February 14, 2021, for over two consecutive days, ERCOT averaged 34,000 MW of generation outages, 49%, or nearly half of ERCOT's 2021 actual all-time winter peak load of 69,871 MW.



Electric Grid Diagram

- Generating Station turbine generators convert mechanical energy into electric energy using water, steam, or other means to spin the turbines
- Power output from generating plants is stepped up at substation transformers for long distance transmission
- Substation transformers step down the power for the distribution system

Introduction to Stability

Modern power grids are complex machines that require a near instantaneous balancing of various electro-mechanical properties. In the US, traditional generators provide three phase voltage and current sinusoidal waveforms that alternate 60 times per second. Every rotating generator within each of the "Interconnections" shown in the following map must be in synchronism with every other generator within that same Interconnection. While the voltage or current wave forms can lag or lead each other by a little bit, they can't get us much as a whole cycle ($1/60^{th}$ of a second) behind or ahead of any other generator without causing a major system problem. A major problem would involve serious events which would include generation tripping off line and possibly including a collapse of at least some portion of the grid. Generators in Miami, Ontario, Kansas and New Orleans remain in synchronism around the clock with each other.

Understanding this phenomenon involves challenging math, engineering and computer modelling that are hard to summarize. If you want to get more into the details you might check out these Lectures (part 2 and part 3).

The grid is built upon and supported by heavy rotating machinery. Synchronous spinning generators combine with power lines and loads to make up complex electro-mechanical machine that must maintain stability. Stability refers to the ability of the system to stay in synchronism, balance loads and generation and maintain voltages following system disturbances. Intermittent generation (wind/PV solar) does not rotate in synchronism with the grid. As such they do not have performance characteristics that support the grid as well as synchronously rotating generators (hydro, coal, gas, nuclear plants) do.

The system must be able to ride out power imbalances caused by faults and outages. Greater penetrations of non-synchronous generators (inverters used for PV Solar and Wind) tend to make the system, all else equal, less stable. Without expensive additional equipment and the wasting of some power output, inverter control delivers power based on the performance of the PV solar or wind resource, not the needs of the grid. Synchronous generators on the other hand can naturally respond to grid conditions and work to support stability. This report by a NERC Task Force provides more detail.

Electric System

- New York is in the Eastern Interconnection

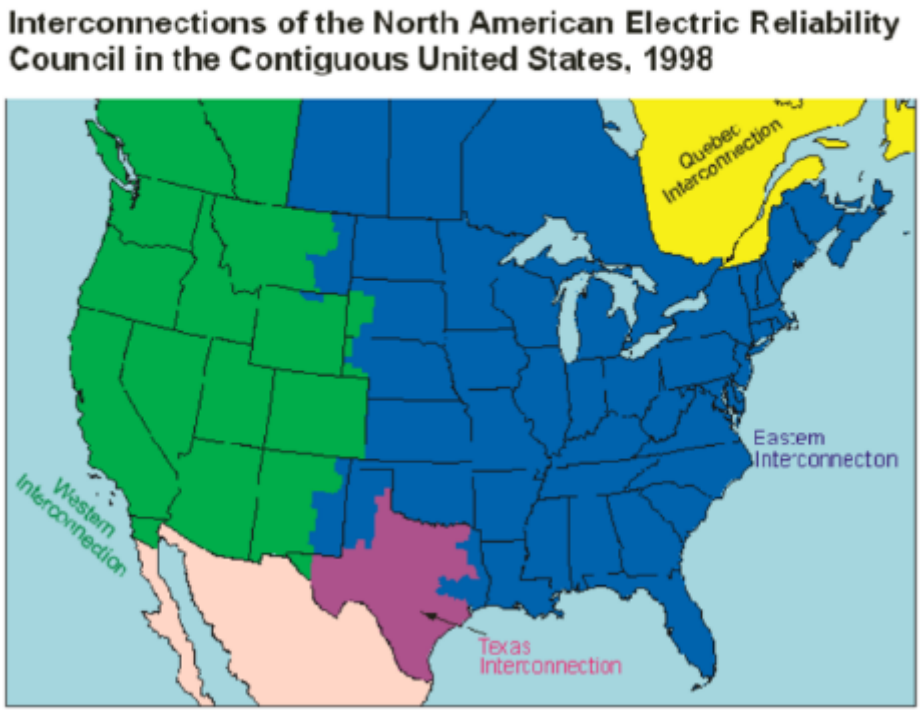


Figure 1: North American Interconnecting Electric Systems

Key points

- Incredibly all the fossil, hydro, and nuclear generating stations in the blue Eastern Interconnection work together in the world's largest machine.
- The generating turbines are synchronized and operators keeps the voltages as constant as possible in the entire area
- Wind and solar are inverter based resources that are asynchronous

Myth 2 – The US has a third world grid. The Eastern Interconnection is the largest, best machine ever built. It's highly reliable, flexible and economic. The idea that it, or the other two US grids, function as third world grids or are less than smart has been promulgated by entities hoping to make a buck (GE/Siemens) and by those who wanted to hide the costs of adding renewables to the grid (Wind/Solar).

While utilities have had occasional (and unacceptable) blackouts– they have learned from these and made improvements to lessen the likelihood of such events. Much of what is being called for as regards a smart grid has little or nothing to do with reliability. Pushing what is new and different is good for consultants, those producing the new technology and those who want to subsidize specialized costs. The balancing voices speaking in defense of the current grid do not have the same incentives, motivations or resources and as such are not as widely heard.

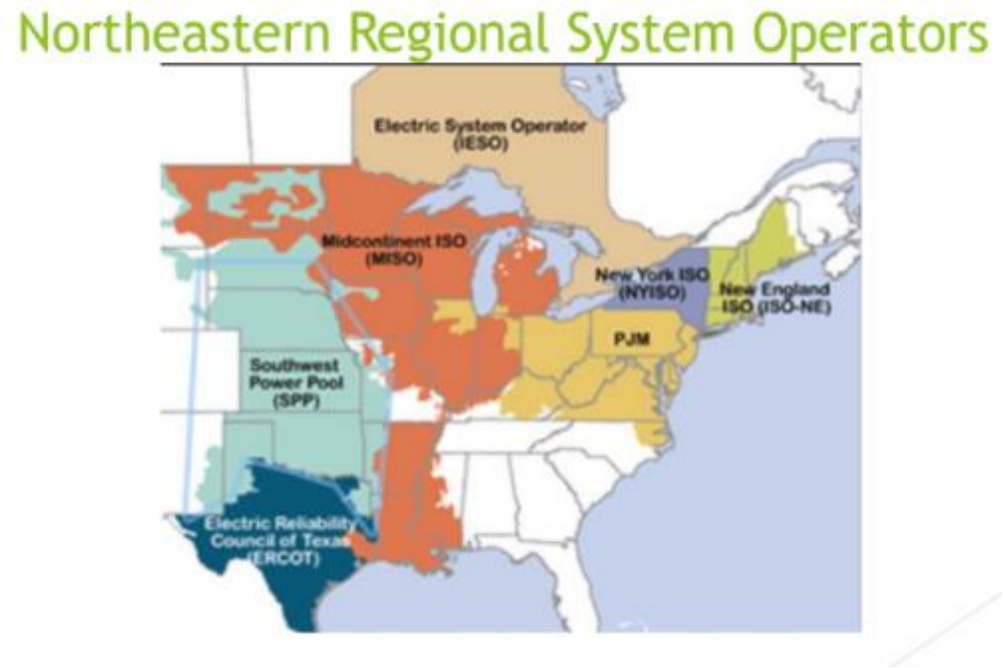


Figure 2: Northeastern Regional System Operators

Key Points

- Within Power the Eastern Interconnection system operators match the load with the generation in smaller regional systems
- They manage imports and exports between neighboring systems.
- New York has its own regional transmission operator – the New York Independent System Operator or NYISO.
- New York has unique system constraints related to New York City and Long Island

More information: Electric Grid Operators

Personal communication in response to question why SE USA has no RTO
From: Russell Schussler
Date: November 17, 2022 at 10:13:26 PM EST
The utilities in the SE did not choose to form/join a regional system operator. It was considered by them. There are pros and cons. It is/was not mandatory, You have to meet certain requirements assuring your system is open and fair if you don't join/form one. If you join you give up some autonomy , independence and control.

A better question to me might be why did the other regions join up. Duke, Southern Company, FPL, Dominion, Entergy, Amerin not big on being a single team. TVA in the middle has a lot of independence as a Federal entity. To me the regional systems always embed a hard arrangement to sell.

Traditionally most public utilities have been regulated by state public utility commissions (PUCs) Municipalities usually by their city. Sometimes state PUCs regulate municipalities and coops as well as IOUs, Each state in the southeast has a puc.

Figure 3 New York State Electric Control Areas

Key Points

- NYISO operates the electric grid for New York State
- There are 11 control areas with specific load, interconnection, and generation characteristics that must be addressed on a six-second basis to keep the lights on.
- New York State's major challenge is that there are limits to transmission to the highly populated New York City and Long Island control areas.
- Time scales are important for load management

Kevin Kilty: One of the most serious systems problems for renewable energy to solve is the various timescales of response required to make a reliable grid. There is first the very short time scale of fractions of a second needed for automatic control systems to keep frequency and voltage within prescribed limits. Next there is a daily time scale of response needed to handle the daily variations in load. Following this is an unknown amount of storage to handle outages resulting from weather that may last for 10 days or more. Finally, there is the issue of seasonal shifting of energy supply which requires either a large overbuilding of generation or massive long-term storage, or some hybrid in between.

Based on past New York experience there are specific requirements and limitations on generation and transmission mandated to prevent the reoccurrence of blackouts. After a blackout in July 2019 AMNY published a brief history of blackouts in New York City. In 1959 and 1961 surges in electrical use caused blackouts and "The outage spurred changes to better protect the city's power grid from future blackouts". The 1965 blackout was the first regional blackout and was caused by a transmission

problem in Ontario. As part of the response to that event New York set up a power pool to manage electricity generation and transmission. There was another blackout in 1977 that was limited to NYC directly related to the load pocket. It was caused by storms cutting off transmission into the City and in-City generation being unable to replace the load. Without sufficient local power, protective devices turn off overloaded lines and transformers to prevent physical damage to the equipment and this led to the outages. As a result of this blackout, reliability constraints were implemented to ensure that when storms threaten transmission into the City that sufficient in-City generation is available to prevent a re-occurrence.

Southern Australia recently had a blackout caused by the loss of a major transmission line. In the absence of that transmission there was too much solar power for grid stability: "afterwards there was suddenly an oversupply of energy in SA that couldn't go anywhere and the frequency surged far outside the normal range". This is an example of the unintended but inevitable effects of intermittent generation that can only be debugged by trial and error with the New Yorkers as the lab rats.

More information available here.

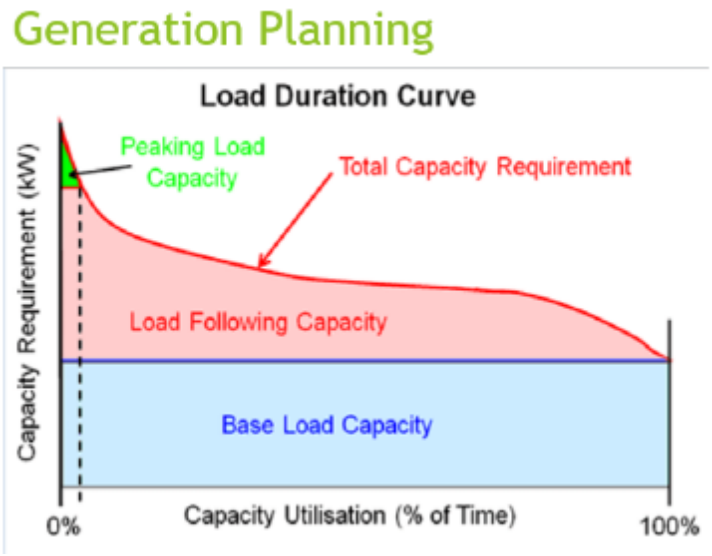


Figure: Load Duration Curve

Key points

- Generation planning has to deal with load management
  - Baseline ideal is to dispatch it and let it go
  - Load following generation dispatch deals with daily load variation
  - The biggest planning challenge is capacity and energy for peak loads
- New York City addressed the peak load problem with simple-cycle turbines dedicated for use to provide power when and where needed.
- Matching load when dependent upon renewable resources that cannot be dispatched and provide variable energy is a new and difficult challenge
- Problem is exacerbated by intermittent renewable energy availability associated with peak loads.
- Load peaks with the coldest and hottest weather but those conditions typically are low wind resource periods. Wind lulls in the winter when solar is low availability is a critical reliability issue

Generation Planning

A generation planner needs to make sure that there is enough generation capability on line to meet the peak demand and provide for reserve margins under forecast growth conditions. The limited peak hours account for a significantly disproportionate share of power system costs. The peak demand hour(s) on the left side of the curve drive the need for new generation. Once the need level is established, generation is selected to work with the existing system resources to provide for economics and reliable operation across all hours and load levels. The best resource mix will have a balance of baseload, intermediate and peaking generation resources. The balance is needed for the system to work effectively in the differing parts of the load duration curve. Typically baseload plants have higher fixed costs and lower incremental costs, so they are operated around the clock. Peaking resources typically cost less but have high incremental costs. If you don't have to run them very often the extra incremental fuel costs are made up for by the savings in fixed costs. Intermediate plants take the middle ground. Generally it costs more per installed MW for a more efficient plant. The more a plant is expected to operate the more those dollars can be justified. For illustration purposes the chart below illustrates

hypothetical cost distributions for potential peaking, intermediate and base load plants based on the percentage of the time they operate (capacity factor).

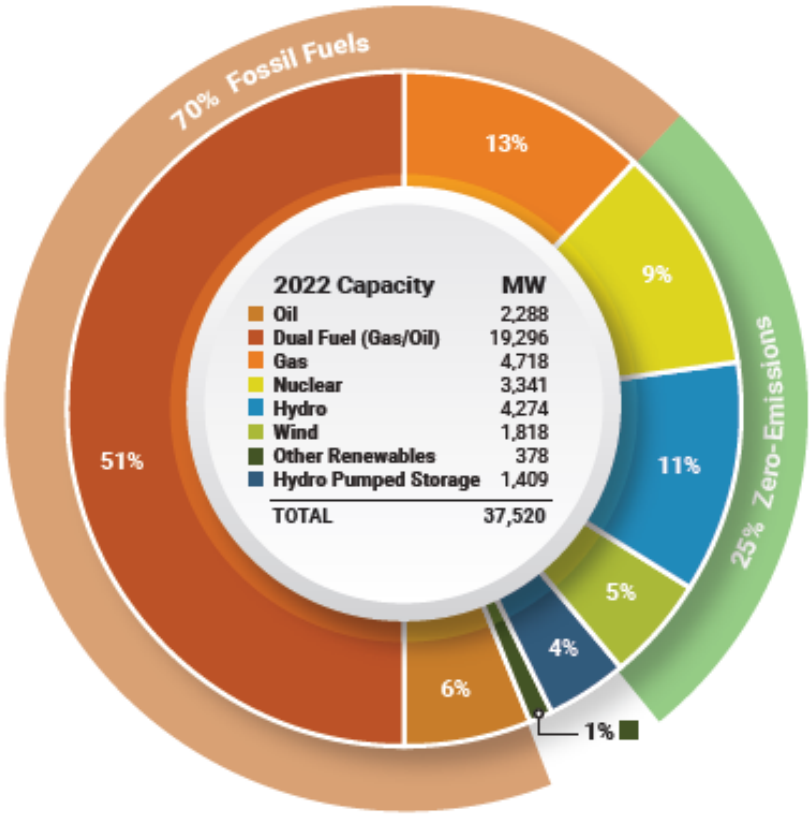
New York Peaking Power Plants

New York electric grid was designed by traditional electric utilities to meet their requirements cost effectively. The State has its own independent system operator largely because of the chronic transmission constraints in New York City and on Long Island

In order to address peak load capacity Consolidated Edison of New York installed around 100 simple-cycle peaking turbines to provide peaking power in the early 1970's. They provided dedicated power when needed and where needed. More on this later.

New York Generating System Capacity 2022

Figure 11: **Summer Installed Capacity (MW) by Fuel Source - Statewide, Upstate and Downstate New York: 2022**



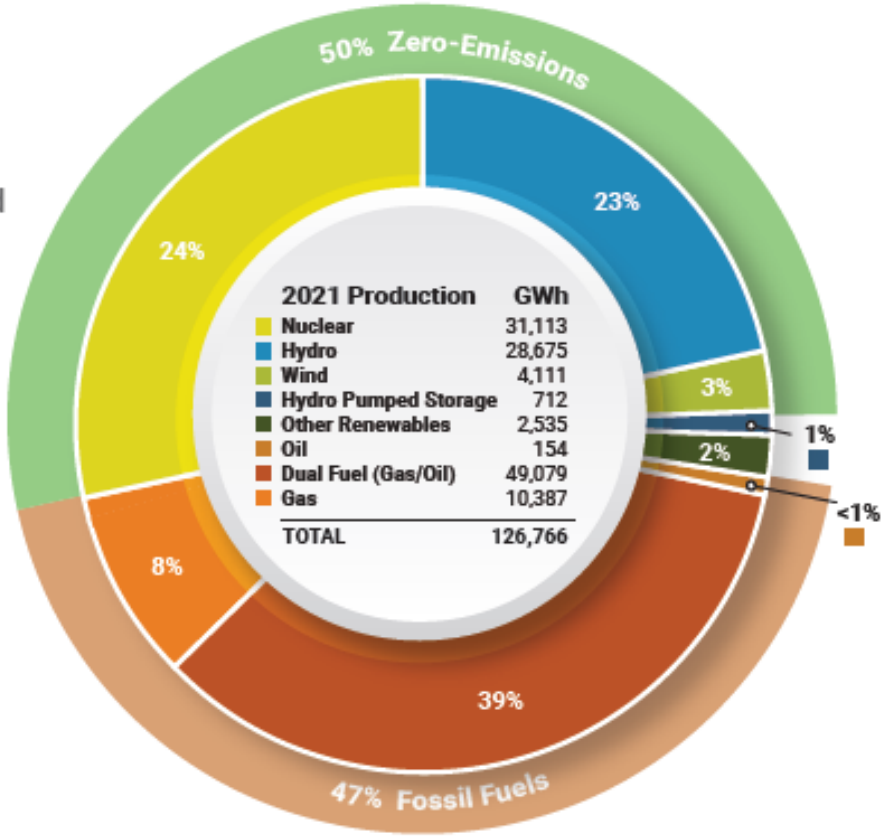
[NYISO 2022 Power Trends Report]

Key points

- 70% of installed capacity is fossil fueled
- 25% is zero emissions
- Wind and other renewables (solar energy, energy storage resources, methane, refuse, or wood) account for 6% of installed capacity
- NYISO does not measure distributed solar directly. In their accounting it reduces the load so less generation is needed.

New York Generating System 2021 Energy Production

Figure 12: **Energy Production by Fuel Source (GWh) - Statewide, Upstate and Downstate New York: 2021**



NYISO 2022 Power Trends Report

Key Points

- 50% of energy generated is zero-emissions
- Climate Act target "Increase renewable sources to 70 percent by 2030" does not include nuclear
- 24% of renewable source energy produced is hydro and hydro pumped storage
- Wind and other renewables (solar energy, energy storage resources, methane, refuse, or wood) account for 5% of energy produced
- 29% of the energy produced is from renewable sources – far less than the 70% by 2030 target
- Is it feasible to develop over 29GW of renewable resources between now and 2030 with supply chain issues, constraints on permitting, procurement, and construction with development of supporting infrastructure also needed?

New York Capacity Factors

New York State 2021 Capacity (MW), Generation (GWh) and Capacity Factors (%)

Fuel Source	Capacity (MW)	Generation (GWh)	Capacity Factor (%)
Nuclear	3,341	31,113	91%
Hydro	4,274	28,675	77%
Hydro Pumped Storage	1,409	712	6%
Dual Fuel (Gas/Oil)	19,296	49,079	29%
Gas	4,718	10,387	25%
Oil	2,288	154	1%
Other Renewables	378	2,535	77%
Wind	2,191	4,111	22%

Key points

- Nuclear is a key contributor but NYS recently shut down 2,000 MW at Indian Point
- Peaking power is produced by oil and spare capacity in the gas and dual fuel units
- Oil is a unique NY thing but imagine difficulty replacing that capacity
- Latest year of NY land-based wind only had a 22% capacity factor

Data from NYISO 2022 Power Trends Report except for nuclear and wind which come from the NYISO 2022 Gold Book with adjustments for Indian Point 3 retirement and the addition of Cassadaga and Roaring Brook industrial wind facilities during the year. Capacity factors for wind resources are based on nameplate capacities.

Other renewables include solar energy, energy storage resources, methane, refuse, or wood.

Optimistic Clean Energy Transition

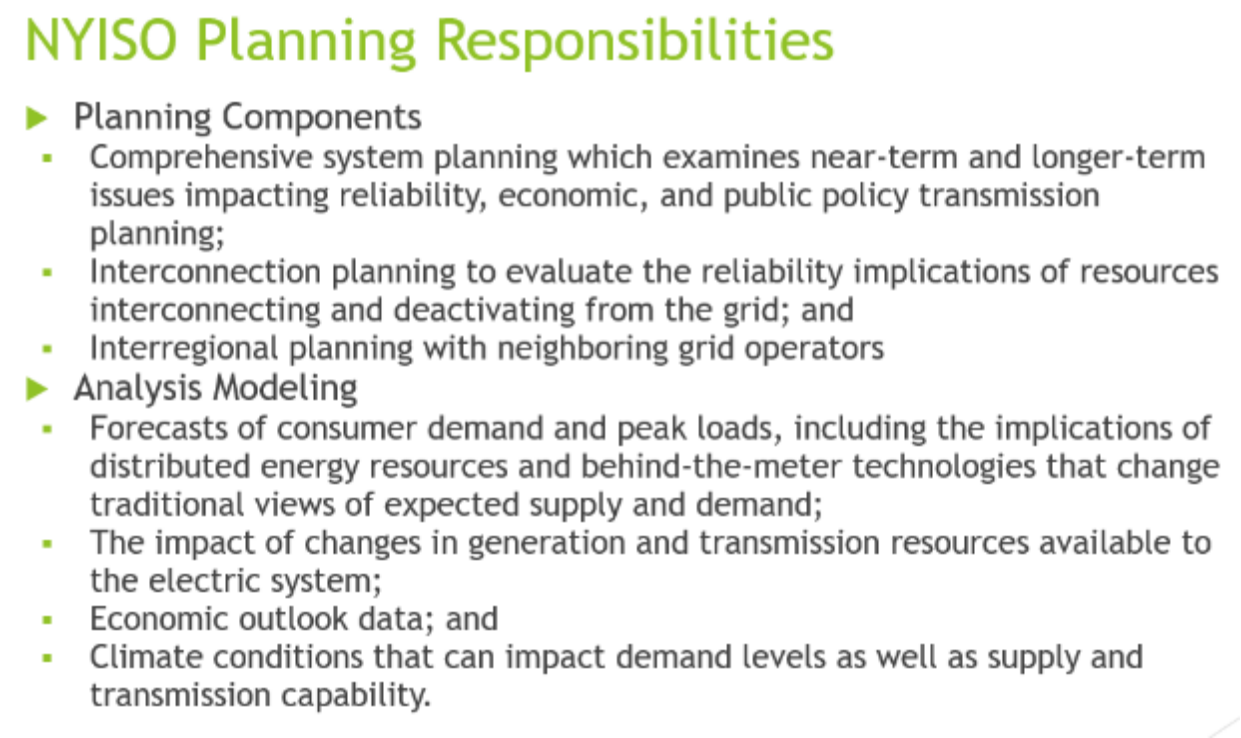
- New York Times staff writer David Wallace-Wells
- "In fact, according to one study, 90% of the world now lives in places where building new renewable capacity would be cheaper than building new dirty capacity. And indeed, in a lot of places, it's already cheaper to build new renewables than even to continue running old fossil fuel plants."
- "…we should be going all in on renewables here. We shouldn't be building new coal or new oil or new gas capacity."
- Key problem is he is referring to capacity

Key Points

- Renewables are the cheapest form of energy is a common talking point
- This is a perfect example
- We shouldn't be building any fossil plants because renewable capacity is cheaper
- Capacity may be cheaper but getting the energy to your home when you want it is different

National Public Radio Fresh Air: "A new climate reality is taking shape as renewables become widespread". Dave Davies interview with New York Times staff writer David Wallace-Wells.

Not included in presentation



Key Points

- NYISO has planning responsibilities for keeping the lights on
- The analysis modeling addresses all the complexities of the NY electric system

NYISO Planning Responsibilities

The NYISO's planning responsibilities are composed of three primary components:

■ Comprehensive system planning which examines near-term and longer-term issues impacting reliability, economic, and public policy transmission planning;

■ Interconnection planning to evaluate the reliability implications of resources interconnecting and deactivating from the grid; and

■ Interregional planning with neighboring grid operators

Topical grid studies are also conducted to fulfill an essential element of our mission to be the authoritative source of information, and to provide independent analysis and data to stakeholders, asset owners, investors, and policymakers.

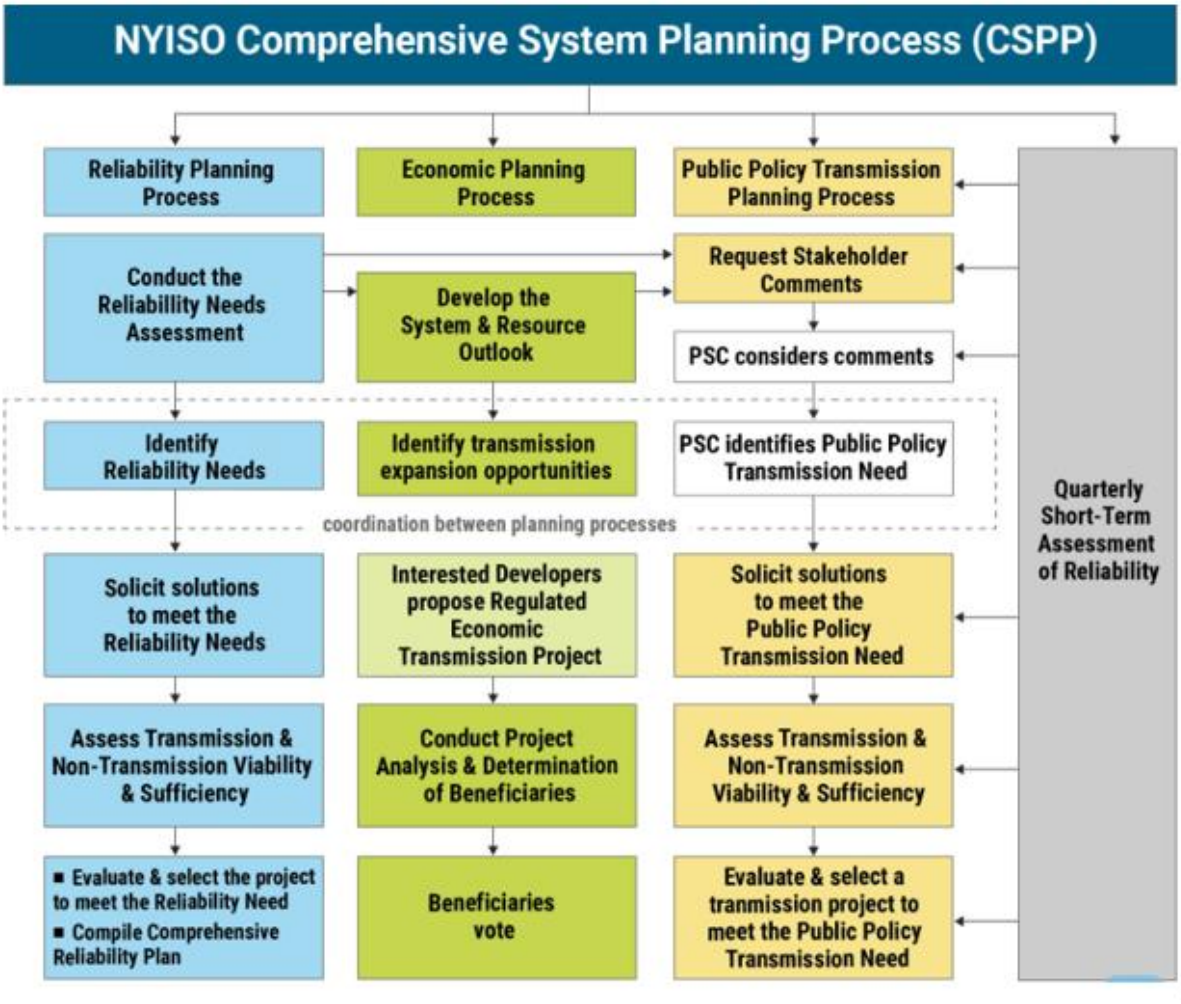
The NYISO's planning studies use sophisticated models to assess the capability of the transmission system and the adequacy of resources to meet New York's electricity needs. There are numerous factors considered in these models, including:

■ Forecasts of consumer demand and peak loads, including the implications of distributed energy resources and behind-the-meter technologies that change traditional views of expected supply and demand;

■ The impact of changes in generation and transmission resources available to the electric system;

■ Economic outlook data; and

■ Climate conditions that can impact demand levels as well as supply and transmission capability.



Key Points

- Description of the process is beyond the scope of this presentation
- Note that there is a new component “Develop the System & Resource Outlook
- Specifically added to address the long-term planning needs of the Climate Act transition

Key Points

- These are the key findings of the first NYISO Resource Outlook report.
    - Unprecedented buildout of new generation
    - Load will increase when we electrify everything
    - Transmission is necessary and must be expended to get diffuse renewables to NYC
- I agree completely with them and am very concerned that the Climate Action Council is ignoring the implications to the feasibility of the transition plan.
- DEFR must be developed is a nice way of saying it does not exist today and in order to be compliant with the Climate Act it must be conjured up.

The 2021-2040 System Outlook report is summarized on the NYISO website:

> Released in October, NYISO's 2021–2040 System & Resource Outlook (the Outlook) examines infrastructure investment needs as the electric grid evolves over the next 20 years to meet requirements of state, federal, and local climate policies.
>
> The report is intended to inform state policymakers, investors, and stakeholders regarding different pathways the state can take to achieve electrification of transportation and heating sectors of the economy, and the decarbonization of the power grid while maintaining reliability of the system. Electrification refers to the process of phasing out fossil fuels for heating and cooling, appliances, automobiles, and trucking.

The *2021-2040 System & Resource Outlook* can be downloaded from NYISO and a datasheet summary of key takeaways of the *Outlook* report is also available.

Generation Resource Outlook Modeling

- NYISO examined three scenarios in their analyses
- **Baseline Case:** This is a "business-as-usual" type scenario looking at the electric system as it performs today, aligning with the NYISO's Comprehensive Reliability Plan to define the demand, generation, and transmission assumptions.
- **Scenario 1 - uses industry data and NYISO load forecasts, representing a future with high demand: 57,144 MW winter peak and 208,679 GWh energy demand in 2040**
- **Scenario 2 - uses assumptions consistent with the Climate Action Council Integration Analysis. It represents a future with a moderate peak but a higher overall energy demand: 42,301 MW winter peak and 235,731 GWh energy demand in 2040.**

Key Points

- NYISO recently released the first Resource Outlook
- Outlook analysis was based on three scenarios
- Baseline is business as usual
- Model compares different policy options relative to BAU
- I will compare their scenario 1 to the Integration Analysis

I compared the NYISO Resource Outlook modeling analysis with the Integration Analysis modeling. The Outlook analysis was based on three scenarios. In order to evaluate the effects of different policy options, this kind of modeling analysis projects future conditions for a baseline or business-as-usual case. The evaluation analysis makes projections for different policy options, and then the results are compared relative to the business-as-usual case. NYISO ran two policy scenarios: one based on their estimates of future demand and one that tried to simulate the Integration Analysis projections. I compared their scenario 1 to the Integration Analysis in the presentation.

Integration Analysis Modeled Scenarios

- Reference Case: Business as usual **plus implemented policies**
- Scenario 1: Advisory Panel Recommendations
- **Mitigation Scenarios – These meet the Climate Act Targets**
- Scenario 2: Strategic Use of Low-Carbon Fuels
- Scenario 3: Accelerated Transition Away from Combustion
- Scenario 4: Beyond 85% Reduction

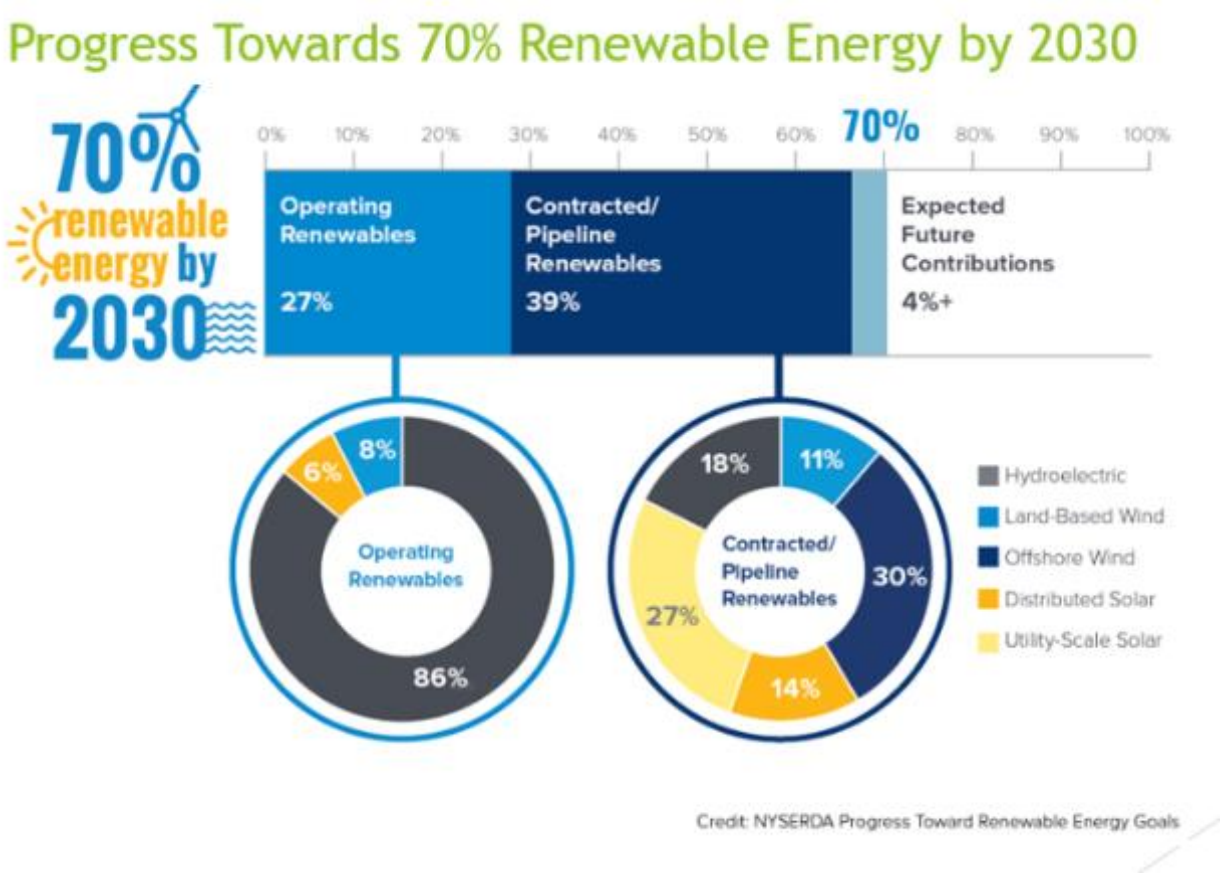
Key Points

- Integration Analysis Modeling used for the Draft Scoping Plan
- Reference case instead of a BAU case is different practice and motivated
- Advisory panels made recommendations for control measures – they did not meet targets
- Integration Analysis came up with three scenarios that meet targets
- All costs provided in Draft Scoping Plan were relative to the Reference Case

The Integration Analysis modeling was used to develop the Draft Scoping Plan. It is important to note that contrary to usual practice the Integration Analysis baseline was a reference case that included "already implemented" programs. In other words there are some programs incorporated into the Reference Case that only exist to reduce GHG emissions. This definition of the Reference Case instead of a Business-As-Usual case is different practice and motivated to get a specific answer.

The Integration Analysis considered four different policy projections. The first considered the Advisory Panel recommendations for control measures, but the modeling showed that they did not meet the Climate Act targets. The Integration Analysis came up with three mitigation scenarios that did meet the targets. The model used for the analysis is not as sophisticated as the NYISO model. Modelers plugged in a set of control measures at varying efficiencies until they met the targets. Note, however, they have not claimed that the scenario measures as scoped out will provide electricity that meets current reliability standards. In my opinion this approach gave the impression to the Council that meeting the targets would be relatively easy. Council members requested scenarios that considered a faster implementation schedule and more reductions that the 85% target. The cost/benefit results claim that those more stringent scenarios provide more benefits primarily because of reduced costs. I think that is a counter-intuitive result so my comparison was against Scenario 2: Strategic Use of Low-Carbon Fuels.

Not Include in the Presentation



Key Points

- According to the Official web site we are on pace to meet the 70% by 2030 target
- 39% contracted/pipeline renewables is misleading
- Much of that 39% is not permitted and very little is under construction
- In the case of offshore wind development the infrastructure to support construction is nowhere near ready to support what is needed

Installed Capacity (MW) NYISO Outlook Scenario 1 and Integration Analysis Mitigation Scenario 2

Resource	NYISO Outlook Scenario 1				Strategic Use of Low-Carbon Fuels			
	2019	2030	2035	2040	2020	2030	2035	2040
Nuclear	5,400	3,364	3,364	3,364	4,860	3,355	3,355	3,355
Fossil	26,262	21,232	21,234	0	26,388	21,579	18,078	0
Hydro	6,331	7,537	7,540	7,540	5,754	7,345	7,345	7,348
Land-base Wind	1,985	9,086	12,612	19,087	1,917	5,574	10,060	12,242
Offshore Wind	0	5,036	9,000	9,000	0	6,200	9,906	14,364
Solar	2,148	14,731	15,504	15,874	2,592	18,852	28,994	43,432
Storage	1,405	4,410	5,793	11,450	2,185	4,435	7,226	12,149
DEFR	0	420	7,053	44,750	0	0	0	21,015
Other					327	327	327	327
Total	43,531	65,815	82,099	111,066	44,023	67,667	85,292	114,232

Comparison of projected capacity

> Extraordinary development of renewables by 2030

> Key differences – NYISO - more onshore wind, less offshore wind, less solar, and more DEFR

> Existing storage is pumped hydro – new storage is batteries

> Compare 2040 DEFR to existing fossil

Comparison of Integration Analysis and NYISO 2021-2040 Outlook Report Generation Resources

I have written that the Climate Action Council has not confronted reliability issues raised by New York agencies responsible for keeping the lights on. The first post (New York Climate Act: Is Anyone Listening to the Experts?) described the NYISO 2021-2030 Comprehensive Reliability Plan (CRP) report (appendices) released late last year and the difficulties raised in the report are large. The second post (New York Climate Act: What the Experts are Saying Now) highlighted results shown in a draft presentation for the 2021-2040 System & Resource Outlook that all but admitted meeting the net-zero goals of the Climate Act are impossible on the mandated schedule. Recently I wrote about the "For discussion purposes only" draft of the 2021-2040 System & Resource Outlook report described in the previous article and the concerns raised. I compared the NYISO Resource Outlook and Draft Scoping Plan Generating Resource Projections and argued that they needed to be reconciled. At the October 25, 2022 Climate Action Council meeting (presentation and recording) Carl Mas described the differences between the NYISO resource projections and his Integration Analysis projections and I wrote about that here.

The spreadsheet that I used to prepare this table includes the input data extracted from the NYISO and Integration Analysis spreadsheet used. I described each of the resource categories in the table here.

Generation (GWh) NYISO Outlook Study S-1 and Integration Analysis Mitigation S-2

Resource	NYISO Outlook Scenario 1				Strategic Use of Low-Carbon Fuels			
	2019	2030	2035	2040	2020	2030	2035	2040
Nuclear	45,429	27,444	28,338	27,092	38,318	26,452	26,452	26,452
Fossil	50,520	19,987	14,516	0	70,449	24,562	19,651	0
Hydro	40,034	46,342	46,392	46,391	37,481	49,978	50,084	49,165
Land-base Wind	4,416	26,971	38,297	59,362	4,796	16,817	34,039	41,165
Offshore Wind	0	20,186	35,460	35,647	0	25,657	41,016	59,778
Solar	2,812	19,884	20,800	21,273	3,908	32,965	52,781	80,620
Storage	612	7,004	10,084	21,339	-90	-1,007	-1,666	-2,543
DEFR	0	0	0	34,005	0	0	0	3,342
Other					2,721	2,721	2,721	2,721
Total	143,821	167,818	193,887	245,109	157,584	178,145	225,078	260,701

Comparison of projected energy production

> Note differences between modelers with DEFR, wind and solar

> Note that NYISO has DEFR generating 14% of the energy in 2040 but Integration Analysis is 1%

> Key differences – they are calculating storage differently solar may also be different

Comparison of Integration Analysis and NYISO 2021-2040 Outlook Report Generation Resources

Capacity Factors (%) NYISO Outlook Study S-1 and Integration Analysis Mitigation S- 2

Resource	NYISO Outlook Scenario 1				Strategic Use of Low-Carbon Fuels			
	2019	2030	2035	2040	2020	2030	2035	2040
Nuclear	96%	93%	96%	92%	90%	90%	90%	90%
Fossil	22%	11%	8%		30%	13%	12%	
Hydro	72%	70%	70%	70%	74%	78%	78%	76%
Land-base Wind	25%	34%	35%	36%	29%	34%	39%	38%
Offshore Wind		46%	45%	45%		47%	47%	48%
Solar	15%	15%	15%	15%	17%	20%	21%	21%
Storage	5%	18%	20%	21%	0%	-3%	-3%	-2%
DEFR		0%	0%	9%				2%
Other					95%	95%	95%	95%

Key Points

- Integration analysis capacity factors are unrealistically high – that means more capacity will be needed
- Wind in 2020 according to their model is 29% but wind in 2021 was 22%
- DEFR capacity factors are different

Renewable Electric Grid Concerns

- Wind and solar are intermittent resources and their availability/output often does not match or support system needs.
- The success of wind and solar installations is highly location specific.
- Wind and solar do not readily supply essential reliability services.
- As wind and solar generation increase penetration it will become more and more challenging for other resources to subsidize their expansion.
- Wind and solar make the study, control, and operation of the power system more complicated and uncertain
- Widespread deployment of wind and solar would require that power be transmitted across great distances (or you would need an unrealistic and incredible amount of battery storage.)

Key Points – Only discuss first three points

- Intermittent means you have to have storage
- Location specific means a plan is needed to encourage development where resource is better
- Reliability services are the key reason that wind and solar are far more expensive than fossil

Further Information: Climate Act Misinformation: Renewable Energy Reliability Risks summarizes The Penetration Problem Part I: Wind and Solar – The More You Do the Harder it Gets and The Penetration Problem Part II: Will the Inflation Reduction Act Cause a Blackout?.

I have consolidated extensive information on the transition to an electric grid that relies on wind and solar energy resources here. I recommend three posts for a good overview of energy planning issues for an electric power generation and transmission system with the amounts of wind and solar resources envisioned for any net zero program. The post entitled "Transmission planning: wind and solar" discusses how the transmission system is impacted by renewable resources. A second post, "All megawatts are not equal, explains that different types of generating resources bring different benefits to the electric system. The final post discusses the problem of balancing system loads and resources in a system impacted by wind and solar.

Essential Reliability Services

- Table 1 in "Getting to 100%: Six strategies for the challenging last 10%" prepared by authors from the National Renewable Energy Lab.

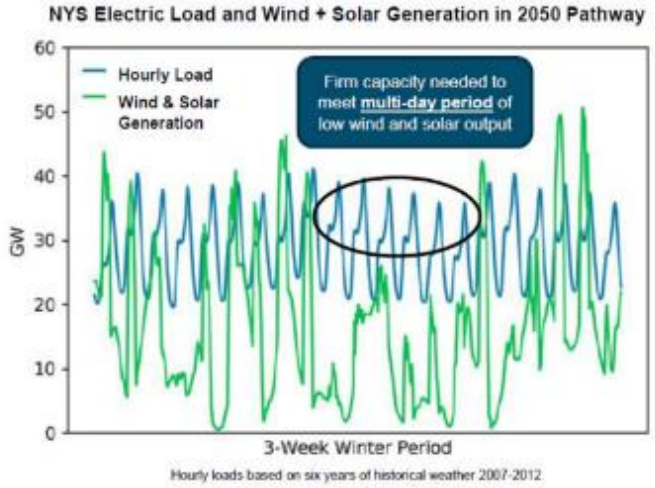
System stability	
Frequency stability	Ability of the system to automatically respond to deviations in system frequency
Voltage stability	Ability of the system to maintain voltage within safe limits
Rotor angle stability	Ability of synchronous machines to remain synchronized after being subjected to a disturbance
Power-system protection	Ability to detect and respond to overcurrent conditions (faults) such as short circuits
Voltage control	Ability to form and regulate a 60 Hz waveform at the appropriate voltage at multiple points on the power system
Black start	Ability to provide power and energy to start other generators and establish a reference frequency after a system outage

Key Points

- There are ancillary services that must be provided to keep the transmission system going.
- Wind and solar do not provide those services so someone, somewhere else has to provide them at some additional cost

I summarized these services from the paper: Getting to 100%: Six strategies for the challenging last 10%

Ultimate Reliability Problem



Key points

- This graph illustrates the long-duration wind lull problem from an early presentation to the Climate Action Council.
- They have known about the problem all along but have basically pushed it aside as inconvenient.
- Note that it is based on evaluation of six years of data and I maintain you should be using as long a period as possible.
- I have argued in multiple venues that meteorological reanalysis data extending back to 1950 should be used to develop worst-case estimates.

The thing to remember is that in order to prevent catastrophic blackouts caused because intermittent wind and solar are unavailable NYISO is banking on DEFR capacity. Using wind, solar and storage only makes meeting the worst-case renewable resource gap very difficult.

In their presentation to the Power Generation Advisory Panel on September 16, 2020 Energy and Environmental Economics (E3) included a slide titled Electricity Supply – Firm Capacity. Consistent with the above the slide states: "The need for dispatchable resources is most pronounced during winter periods of high demand for electrified heating and transportation and lower wind and solar output". The slide goes on to say: "As the share of intermittent resources like wind and solar grows substantially, some studies suggest that complementing with firm, zero emission resources, such as bioenergy, synthesized fuels such as hydrogen, hydropower, carbon capture and sequestration, and nuclear generation could provide a number of benefits. Of particular interest is the graph of electric load and renewable generation because it shows that this problem may extend over multiple days.

Caiazza Personal Comment on Renewable Energy Resource Availability

I submitted comments explaining why an accurate and detailed evaluation of renewable energy resource availability is crucial to determine the generation and energy storage requirements of the

future New York electrical system. I described the history of blackouts in New York and specific lessons from Texas that must be incorporated into New York planning to prevent a similar problem in New York. I explained that in order to ensure electric system reliability for an energy system that depends on renewable generators and energy storage, the resources available during periods of low wind and solar energy production must be known. To date, many studies do not consider the importance of worst-case conditions on reliability planning and I believe that the Draft Scoping Plan also fails to address this issue. I showed that there is a viable approach that could robustly quantify the worst-case renewable energy resources and provide the information necessary for adequate planning. I recommended that such a study be commissioned as soon as possible to determine if the existing estimates of New York's electrical energy renewable resources are adequate.

More information at: Climate Leadership and Community Protection Act Ultimate Problem

DEFR Alternatives

- Draft Scoping Plan Appendix G
  - In Scenarios 1, 2, and 4, DEFR represents a combination of existing and new combustion-based resources (i.e. combustion turbines and combined cycle gas turbines) that convert to utilizing hydrogen as a zero-carbon fuel. In Scenario 3, firm zero-carbon capacity represents a combustion-free resource, modeled as hydrogen fuel cells
- Getting to 100%: Six strategies for the challenging last 10%
  - Seasonal storage
  - Variable renewable energy
  - Demand-side resources
  - Other renewable energy
  - Nuclear and fossil with carbon capture
  - Carbon dioxide removal

Key Points

- Draft Scoping Plan acknowledges need for DEFR and proposes seasonal hydrogen storage as a placeholder
- NREL authors described six DEFR strategies
  - Seasonal storage is hydrogen or some other kind of long term storage solution
  - Renewable energy is basically overbuilding with BESS aka activist "existing" technology
  - Activists also claim that demand side resources can flatten the load peaks so much less DEFR is needed
  - Other renewables cannot be scaled up enough in NY to meet identified need
  - Nuclear is a toxic option for NY politicians
  - Carbon capture is unacceptable to the activists and has technological challenge
  - CO2 removal is way out there
- Others claim that only minimal storage is needed because renewables are available somewhere else
- Activist current solution to fulfill DEFR is BESS with stored renewable energy

A major reason I am skeptical about the reliability of the Climate Act zero-emissions grid is that DEFR alternatives are problematic. Some of the resources like geothermal aren't readily available in New York or like hydro have limited opportunity for additional development. Although the nuclear development option has been raised at recent Council meetings given that the state just shut down 2,000 MW of nuclear I am doubtful that new nuclear is viable in New York. The rest of the options are pushing the technological and commercial development envelope so much that I don't think they will ever be viable and certainly not on the schedule proposed. See my comment on renewable energy systems and the second law of thermodynamics.

Draft Scoping Plan Appendix G: Integration Analysis Technical Supplement

In Scenarios 1, 2, and 4, the "zero-carbon firm resource" represents a combination of existing and new combustion-based resources (i.e. combustion turbines and combined cycle gas turbines) that convert to utilizing hydrogen as a zero-carbon fuel. In Scenario 3, firm zero-carbon capacity represents a combustion-free resource, modeled as hydrogen fuel cells.

I summarized key points in the paper: Getting to 100%: Six strategies for the challenging last 10% that described six potential ways to deal with peak load intermittency.

Six Strategies

Seasonal storage

Seasonal storage refers to the use of electricity to produce a storable fuel that can be used for generation over extended periods of time later:

> *This group of technologies is not well defined, but it could include batteries with very low-cost electrolytes capable of longer-than-diurnal durations. Because of the requirement for very low-cost energy storage, most seasonal storage pathways focus on hydrogen, ammonia, and other hydrogen-derived fuels stored in geologic formations.*
>
> *Hydrogen produced using electricity to split water (i.e., electrolytic hydrogen) is a form of storage because the energy it carries can be converted back to electricity. Electrolytic hydrogen technology has been used at an industrial scale since the early 20th century. Although currently higher cost than hydrogen from natural gas reforming, electrolytic hydrogen production costs can be reduced if low- cost electricity, such as zero-cost otherwise-curtailed renewable energy, is used.*

In the New York implementation plan the dispatchable emissions-free resource (DEFR) place holder is hydrogen produced using wind and solar. In addition to the irrational ideological prohibition against combustion sources there are technological issues for New York. The report notes that "current high-cost electrolyzers need to operate almost continuously to recover their capital expense" and that "Storage and transport costs would add to the delivered cost of hydrogen".

The New York ideologues plan is to use hydrogen in fuel cells, but the report notes:

> *Fuel cells have diverse applications, but their use for bulk power generation is currently limited. Given the range and scale of applications especially for transportation, substantial capital cost reductions for fuel cells are possible. With low capital costs for combustion turbines and future potential cost reductions for fuel cells, the economic case for hydrogen mainly hinges on lowering the cost of electrolytic hydrogen.*

Variable renewable energy

This approach is "technologically conservative, as it relies only on technologies currently being deployed at gigawatt (GW) scale". The seasonal mismatch problem is addressed by overbuilding wind and solar resources as well as adding more transmission capacity. Diurnal storage is deployed to fill hourly supply gaps and excess wind and solar is curtailed during high-resource periods. The authors claim: "Increasing oversupply during high-resource times decreases the amount of storage necessary to supply low-

resource times." The authors admit that wind and solar "curtailment in such systems can reach 35%–50%". There is an associated problem. As more wind and solar resources are added to minimize storage requirements, those additional resources markedly increase curtailment rates for all those resources.

Other renewable energy

The study claims that "geothermal, hydropower, and biomass are renewable energy resources that do not rely on variable solar and wind resources and have higher capacity credit". While the report claims that these resources can play an important role in a net-zero-emissions power system the fact is geothermal and hydro resources depend on certain physical site constraints so there is not a lot of potential availability in New York. The main problem with biomass is that there are limits on how much could be produced and it is not enough to be a major contributor to the overall energy needs. In New York there are members of the Climate Action Council that believe that zero-emissions means no combustion so there is an ideological constraint as well.

Nuclear and fossil with carbon capture

The study notes that "Nuclear and fossil with carbon capture and storage (CCS) are widely cited as potentially important resources in a decarbonized electricity system". There is no question that nuclear is the only emissions-free dispatchable resource that could be deployed in sufficient quantities to provide all needed baseload power. The report notes that: "The existing nuclear fleet comprises reactor designs with large nameplate capacities and designed to operate near their maximum output potential", and that "Advanced nuclear reactor designs are typically smaller in scale and more flexible"
. Consequently, nuclear might be viable for the last 10% problem. Alas New York, for example, on one hand worries about an existential threat of climate change but shuts down 2,000 MW of zero-emissions nuclear generation which suggests that this option is off the table.

The report notes that "Fossil CCS plants have yet to be deployed at scale, but some studies find significant deployment potential, including from retrofits of existing fossil fuel-fired Plants". This option runs into the ideological constraint of no combustion. A fossil plant capturing CO2 has a derate of about one third because of the energy needed to run the equipment required to capture and compress the CO2 so that it can be transported and sequestered underground. Finally, in order to safely store the CO2 particular geologic formations are required which limits where these facilities can be located.

Carbon dioxide removal

The report describes carbon dioxide removal (CDR) strategies which are "dedicated efforts to reduce atmospheric CO2 levels. In theory this can offset emissions from carbon-emitting power generation so that fossil-fired units can operate to fulfill the last 10% requirement. This is too far fetched to be credible in my opinion.

Demand-side resources

Net-zero advocates are enamored with "smart planning" approaches that reduce load which reduces generating resource requirements. The report notes that "Demand-side resources, also referred to as demand response or demand flexibility, have unique properties compared with the supply-side solutions". The report explains:

> *To a limited extent, they are already relied upon for grid planning and operations today. By reducing electricity consumption during times of system stress, these resources help avoid capital expenditures associated with new peaking capacity. Through flexible scheduling or interruption of electricity consumption, they can also reduce operating costs or be used for important grid reliability services.*

While there are indisputable advantages, I think that advocates lose track of the limitations. There are demand-side programs in place today but the applications are limited. Today's programs limit reduction requests to rare instances of limited duration primarily to shave peak loads primarily by large industrial or commercial users. The problem is that applying demand-side options as a last 10% strategy for decarbonization "requires them to be reliably available over extended multi-day periods". This means that they cannot be used for residential heating and cooling loads and electric vehicle charging. Moreover, the report notes that "Large-scale commercial or industrial customers can provide multi-day response, but extended interruptions would negatively impact these capital-intensive (non-power) applications". As a result, I don't think this approach will provide adequate reductions when needed the most.

Environmental Justice Solution for Peaking Power

Recall that Consolidated Edison of New York installed peaking turbines to provide dedicated power when needed and where needed for the peak load conditions. In response to ever stricter control standards to meet the ozone national ambient air quality standard DEC promulgated limits on these peaking turbines that required the installation of control equipment or retirement. The timeline was negotiated with the NYISO to ensure that reliability standards were maintained.

I also noted that I believe much of the peaking power requirement is now supplied by existing steam electric boiler units that burn oil and gas. However, environmental justice activists have been arguing that is no longer appropriate and propose instead to replace the fossil generating units with battery electric storage systems (BESS) powered by renewable energy generated elsewhere.

In 2020 the PEAK Coalition released a report entitled: "Dirty Energy, Big Money" that vilified peaking power plants in New York City. The PEAK coalition's goal is to "come together to end the long-standing pollution burden from power plants on the city's most climate-vulnerable people". They claim their efforts are the first comprehensive effort in the US to reduce the negative and racially disproportionate health impacts of a city's peaker plants by replacing them with renewable energy and storage solutions.

At the time I evaluated the technical analysis for the PEAK Coalition report by Physicians, Scientists, and Engineers (PSE) for Healthy Energy. I described my evaluation in three detailed technical posts. The first post provided information on the primary air quality problem associated with these facilities, the organizations behind the report, the State's response to date, the underlying issue of environmental justice and addressed the motivation for the analysis. The second post addressed the rationale and feasibility of the Coalition's proposed plan relative to environmental effects, affordability, and reliability. Finally, I discussed the Physicians, Scientists, and Engineers (PSE) for Healthy Energy report Opportunities for Replacing Peaker Plants with Energy Storage in New York State that provided technical information used by the PEAK Coalition. Because those were technically oriented and long, I also prepared a simpler summary post that addressed all my concerns. Last month I followed up with a post describing the apparent preferred alternative to use of battery energy storage systems to store renewable energy generated elsewhere.

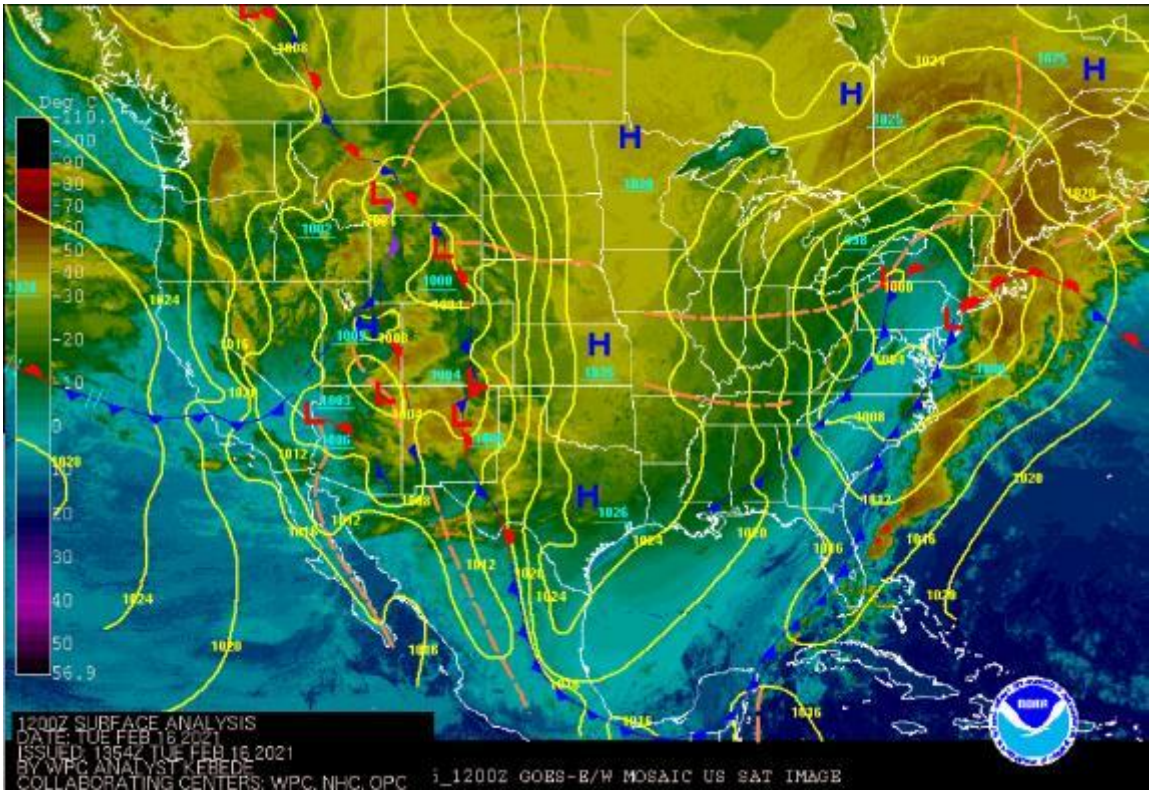
In my analysis of the Peak Coalition claims I concluded that the claims that peaking power plants are dangers to neighboring environmental justice communities are based on emotion. I found that the alleged impacts of the existing peaking power plants over-estimate impacts on local communities relative to other sources. The primary air quality health impacts claimed are associated with ozone and inhalable particulates that are secondary pollutants. While some inhalable particulates are emitted directly, most of the particulates and all of the ozone form after they are emitted and transported away from the disadvantaged communities peaking power plant closure is supposed to protect.

Not included in presentation

February 2021 Polar Outbreak

Not included in presentation because of time constraints. I originally planned to show the following weather slides to refute the claim that only minimal storage is needed because renewables are available somewhere else.

February 16, 2021 12Z

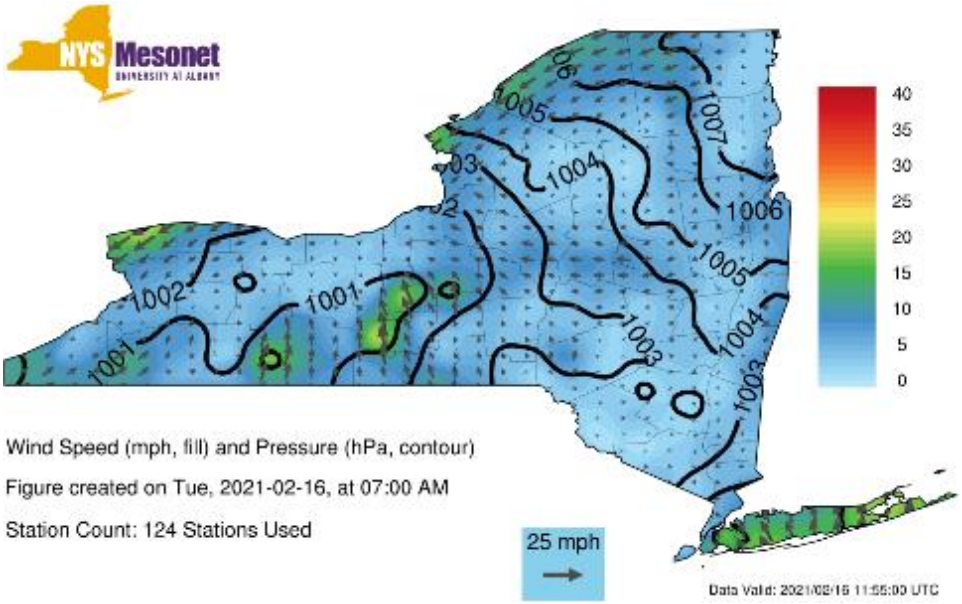


For illustration purposes consider the weather on several days in February 2021. This period included winter storms that precipitated the 2021 Texas blackouts. For each of the days I have provided the surface weather map at 7AM EST or noon Coordinated Universal Time ("Zulu Time") for the continental United States (CONUS).

The meteorological overview of the storm from the National Weather Service Weather Prediction Center described the storm associated with the weather maps shown here. A sprawling major winter storm spread east across the southern Great Plains on February 14 before turning northeast and crossing the Mid-South, Midwest on the 15th and lifting over New England into the Canadian Maritimes on the 16th. Heavy snow, sleet, and freezing rain impacted broad swaths of the southern, central, and northeast portions of the country causing great disruption to commerce and daily life. However, it was the combination of this wintry precipitation and the exceptionally cold air that followed this storm, which spilled down the length of the Great Plains and into the Gulf of Mexico which made this perhaps the most impactful winter storm in a generation.

Not included in presentation

NYS Mesonet Wind Speed and Pressure February 16, 2021 12Z

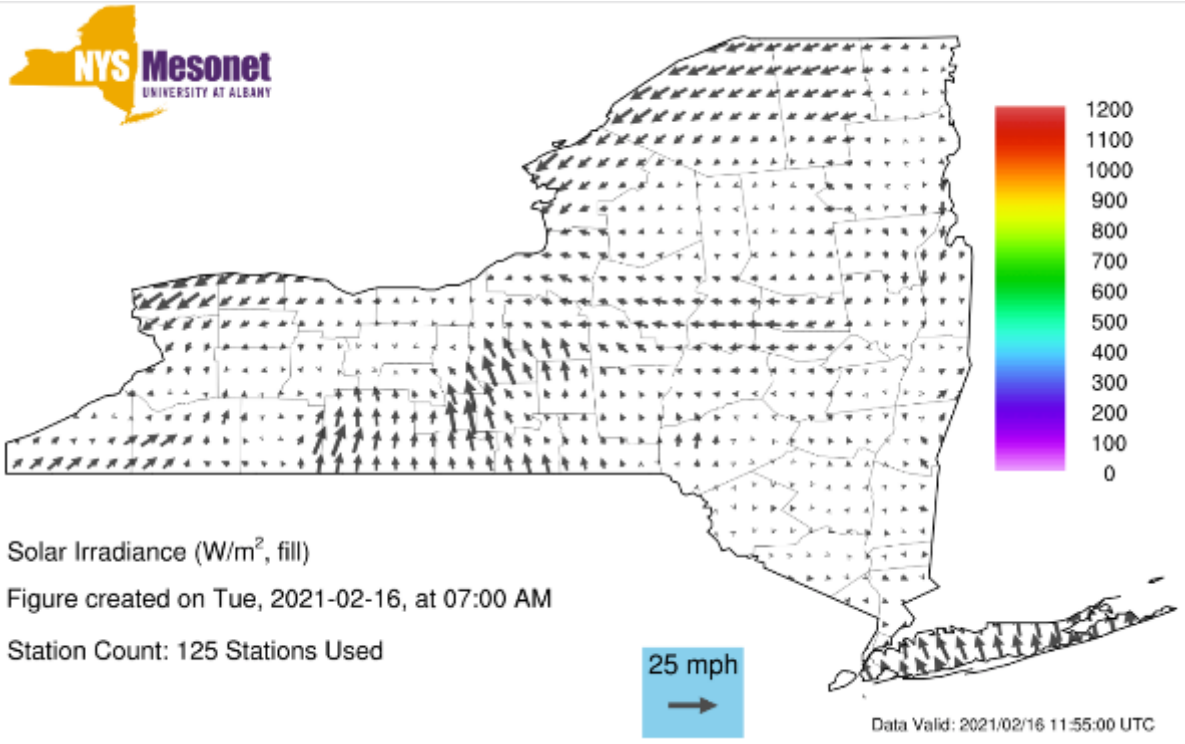


The New York State Mesonet collects data at 126 meteorological observing sites. There is an archive function for the sustained winds, pressure and wind vectors surface loop. I have extracted the New York wind field for each of the weather maps shown. Not shown due to space constraints is the legend: "Please use with credit to NYS Mesonet at UAlbany. For questions & problems, contact nbassill AT albany DOT edu".

I believe the start speed for most utility-scale wind turbines is between 5 and 10 mph. As a result any turbine in the lightest shades of blue were not providing power at this time.

Not included in presentation

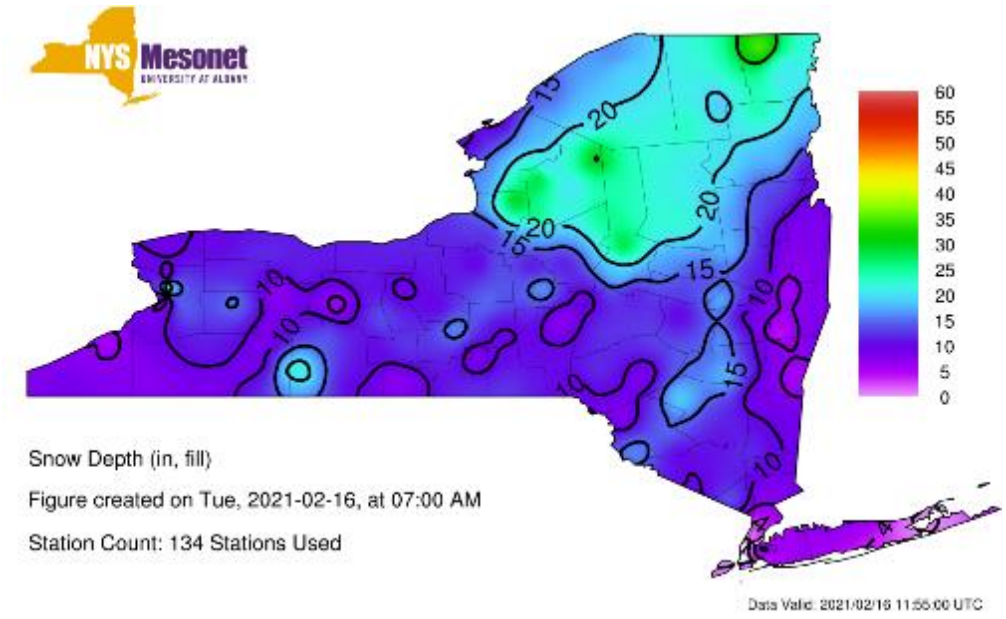
NYS Mesonet Solar Irradiance February 16, 2021 12Z



The Mesonet data also includes solar irradiance. This time of the year the solar resource is negligible at 7 AM as shown in this map.

Not included in presentation

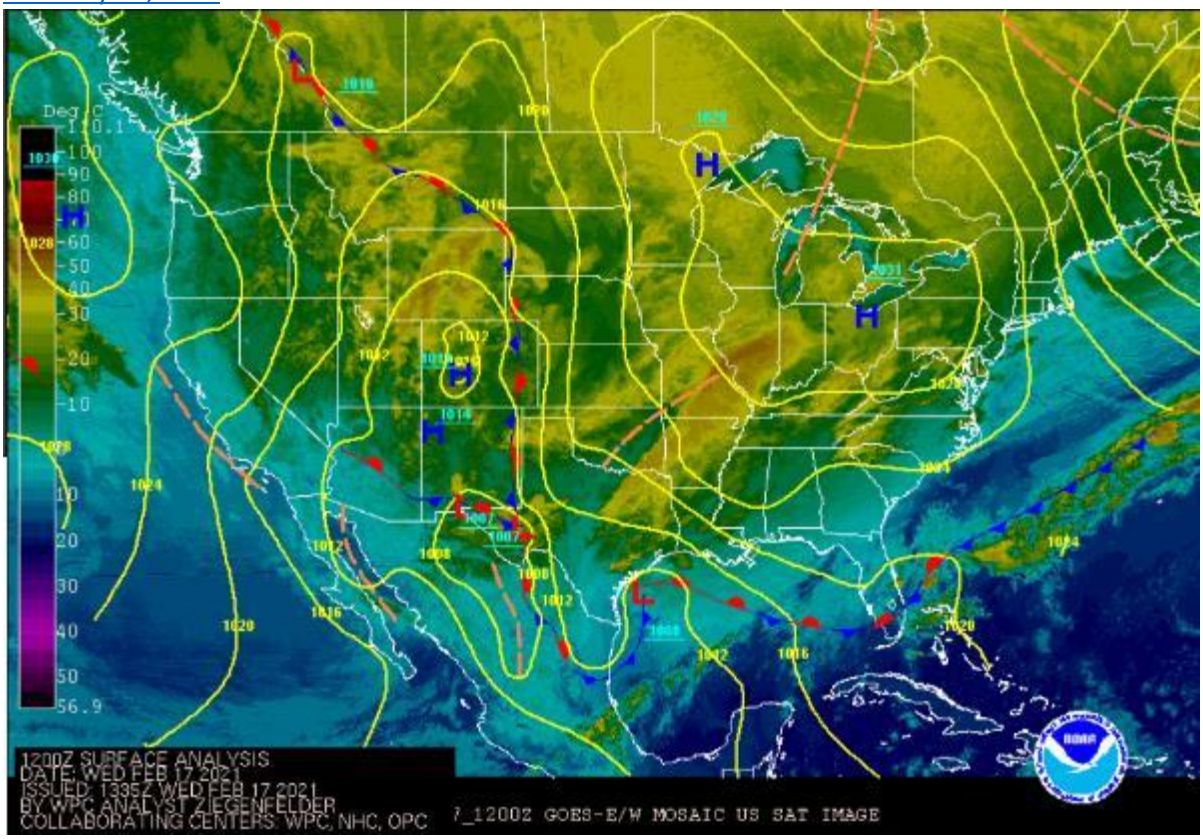
New York State Mesonet Estimated Snow Depth February 16, 2021 12Z



Importantly for this consideration of renewable resource availability there was snow across the state after this storm. I believe that many of the distributed resource solar panels including all panels that are laid flat would be covered with snow so that solar resource generation would be zero for the entire day even if the sun came out on this day.

To sum up, on the first day of this series the storm described in the previous paragraph is centered over NE Pennsylvania. As shown in the corresponding CONUS map there was a storm occurring at this time. I found it surprising that even as the storm was crossing the state there was a significant area of light winds with little wind generation expected. Solar after a snowstorm cannot be expected to be a significant source of energy simply because snow will cover many panels.

February 17, 2021



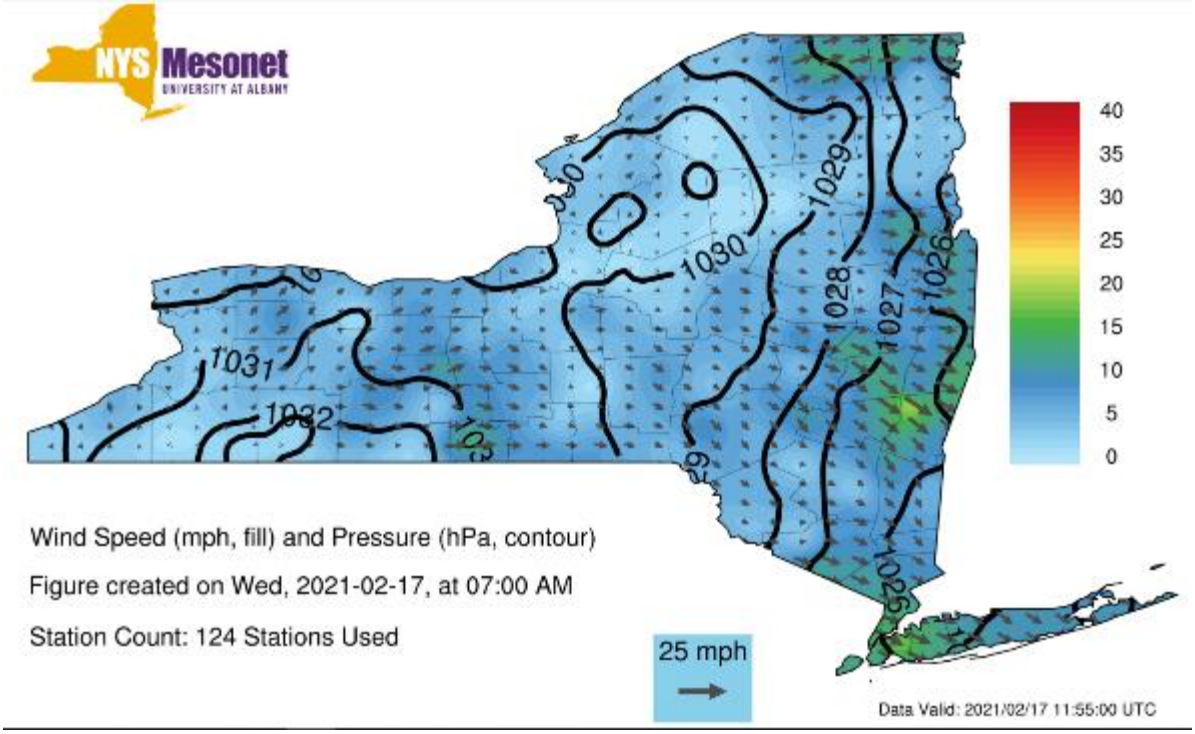
Key points

- Activist dismiss need for DEFR because the wind is blowing somewhere else
- Massive high pressure is associated with cold weather and high loads
- Need to get energy where it is needed when it is needed from a dedicated supply
- Where would we get power from where the wind is blowing in this example
    - To the NE transmission lines are powering southern NE and Boston?
    - To western Iowa past Chicago?
    - To Louisiana?
- Clearly this won't work

The next day shows just how big a polar vortex high pressure system can be. Remember that winds are higher when the isobars are close together. On this day there are light winds from New York to the southeast, west, and north including the proposed NY offshore wind development area. There are packed isobars in New England and in the western Great Plains and western Gulf Coast. In order for New York to use the wind energy at those locations wind turbines and the transmission lines between those locations would have to be dedicated for our use. Otherwise I think it is obvious that jurisdictions in between would claim those resources for their own use. It is unreasonable to expect that this could possibly be an economic solution.

Not included in presentation

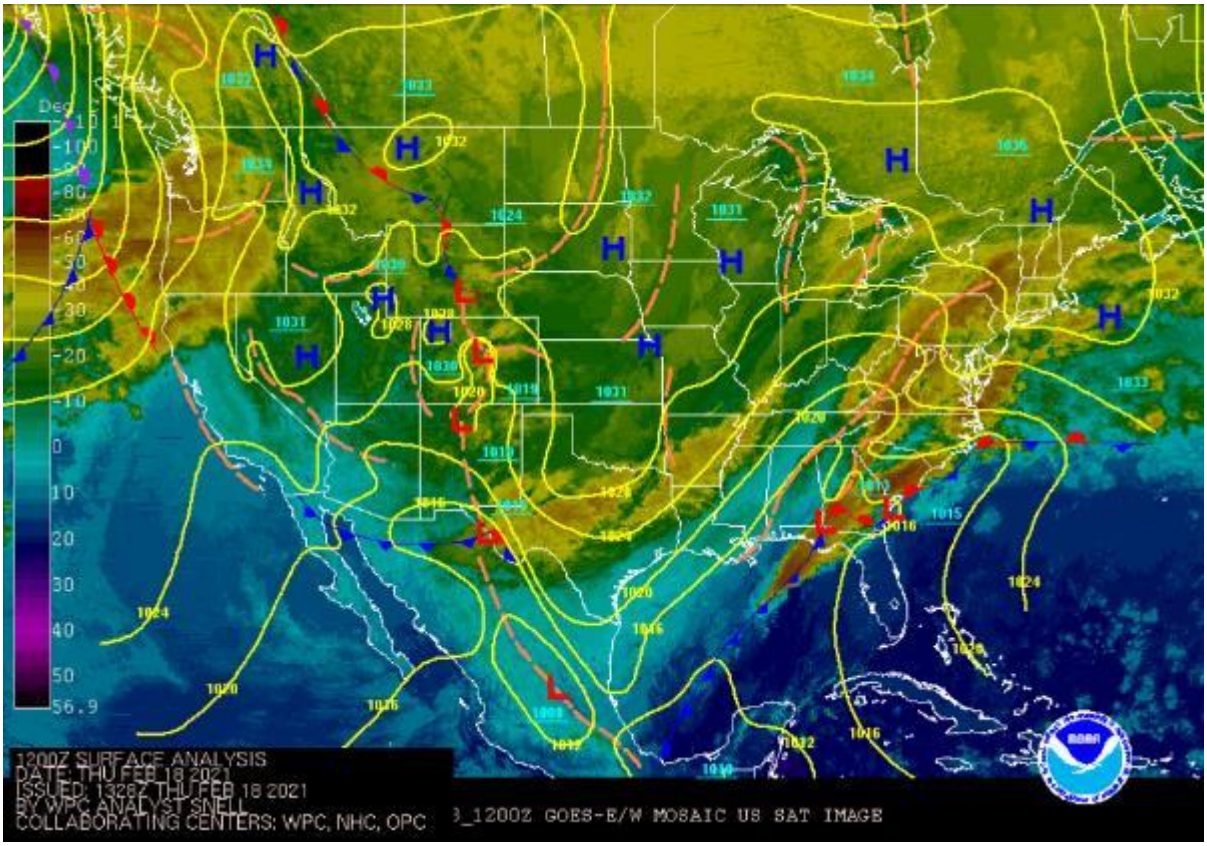
[NYS Mesonet Wind Speed and Pressure February 17, 2021 12Z]



New York wind resources were better on this day albeit the wind farms on the Southern Tier and the Tug Hill plateau appear becalmed.

Not included in presentation

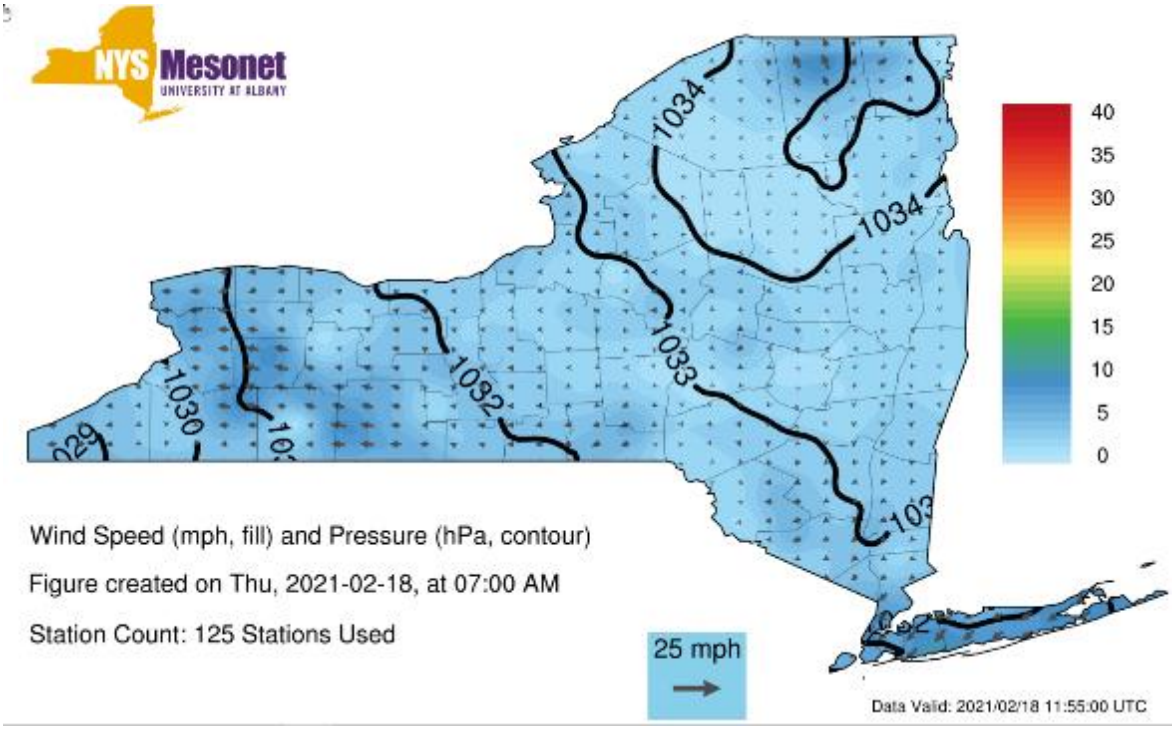
February 18, 2022



For the last day in this example, note that high pressure is in control over most of the northern tier of states. There might be wind resources generating to the SE but there are no transmission lines running along the mountains because there are no major population centers there.

Not included in presentation

[NYS Mesonet Wind Speed and Pressure February 18, 2021 12Z]



This is a classic New York calm period. It is unreasonable to expect that the wind resource could contribute any significant energy at this time.

NYISO Fuel Mix and Winds

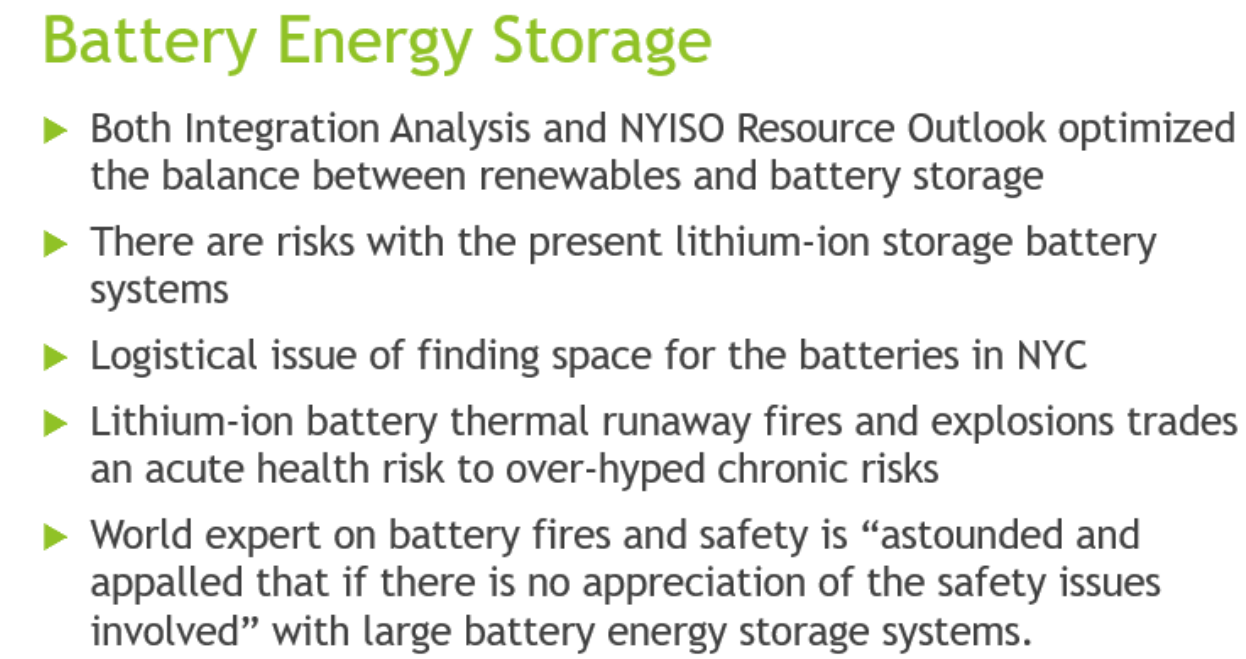
NYISO Daily Fuel Mix and Wind Capacity Factor (%) Wind Capacity (MW) 1,985.2

Date	Hour	Dual Fuel	Natural Gas	Nuclear	Other Fossil Fuels	Other Renewables	Wind	C. F.	Hydro	Total
2/16/2021	Day	108,424	74,094	126,157	70	7,186	11,988	25%	68,877	396,795
2/17/2021	Day	101,345	85,429	125,890	8,378	7,615	6,759	14%	79,203	414,619
2/18/2021	Day	103,597	96,219	126,325	655	7,438	4,103	9%	92,144	430,480
2/19/2021	Day	91,246	99,010	127,596	870	7,488	6,454	14%	87,296	419,960
2/16/2021	6	3,995	2,592	5,262	2	277	274	14%	2,329	14,731
2/17/2021	6	4,464	3,341	5,264	74	311	334	17%	3,012	16,800
2/18/2021	6	3,797	3,392	5,264	2	311	138	7%	3,037	15,942
2/19/2021	6	3,543	3,746	5,262	2	310	207	10%	2,922	15,992

Key points:

- NYISO fuel mix data for observed New York State worst case wind availability
- A high pressure system turns off all the wind in the state
- On 2/18/21 at 7:00 AM wind production was only 138 MW out of a New York total of 1,985 MW for a capacity factor of 7%.
- To replace fossil capacity 7,191 MW you would need to over build to 102,729 MW

I downloaded NYISO fuel mix data available at the NYISO Real-Time Dashboard to see how the wind resources produced during this period. As expected, the wind resources did tail off over these three days. At the time of the last map wind only generated 138 MW out of a New York total of 1,985 MW for a capacity factor of 7%. In order to replace the fossil generation that hour you would need to overbuild to 102,779 MW.



Battery Energy Storage

- Clearly over building wind is not a stand-alone solution so storage is needed
- Both Integration Analysis and NYISO Resource Outlook optimized the balance between renewables and storage but still found that DEFR was needed
- There are risks with the present lithium-ion storage battery systems
- Logistical issue of finding space for the batteries
- BESS thermal runaway fires and explosions trades an acute health risk to chronic risks
- World expert on battery fires and safety said:
    - “Global uptake of lithium-ion battery technology has “outstripped” our knowledge of the risks
    - He is “astounded and appalled that if there is no appreciation of the safety issues involved” with large battery energy storage systems.

Replacing Peaking Power Plants with Battery Energy Storage Systems

My article on battery energy storage showed that there are problems with this approach that have been ignored by the environmental justice advocates. At this time the advocates want the steam electric boilers currently providing peaking power to shut down and the DEC has is proposing to add Climate Act consistency requirements for permit renewals. The first fatal flaw for the battery solution is that the space required to simply replace the capacity of the existing power plants currently used is larger than what could be reasonably expected to be available in the City. In my blog post I did not attempt to determine how much energy would be needed but I suspect it would require at least several multiples of battery capacity.

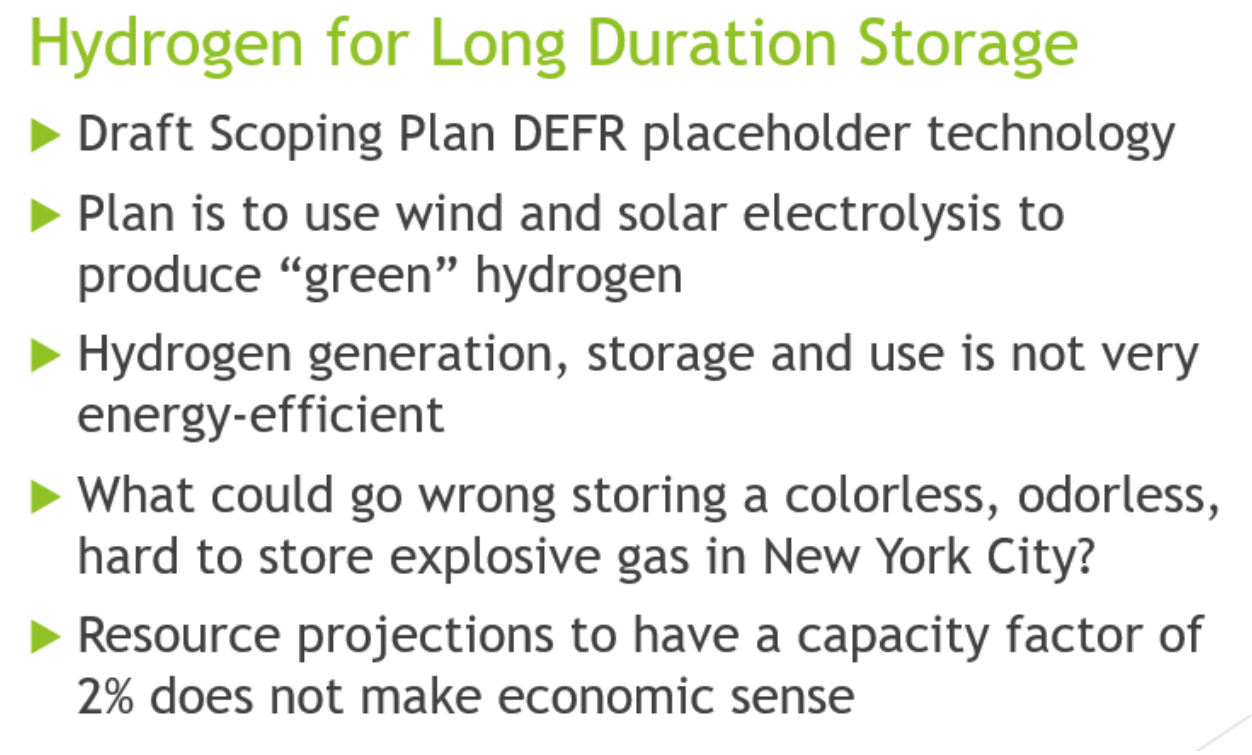
In addition to logistical implementation issues, there are environmental tradeoffs and safety risks. The Tesla Megapack lithium-ion batteries are similar to the ones in electric vehicles. Michael Mills explains that there is no such thing as a “zero-emissions” vehicle. He points out that you don’t eliminate emissions you export them. A single car battery weighing 1,000 lb requires mining 50,000 lb of ore.

The post focused on the potential risks of BESS thermal runaway fires and explosions. Paul Christensen, Professor of Pure and Applied Electrochemistry at Newcastle University in the United Kingdom gave a presentation at PV magazine's Insight Australia event in 2021 that describes the risks. He is one of the world's leading experts on battery fires and safety and said global uptake of lithium-ion battery technology has "outstripped" our knowledge of the risks. His videos of thermal runaway tests are terrifying. He also stated that he is "astounded and appalled that if there is no appreciation of the safety issues involved" with large battery energy storage systems. This is another feasibility issue that is unaddressed by the Draft Scoping Plan.

I conclude that until you have a viable alternative, and I submit that the renewable energy battery storage option is not viable, then it is premature to shut down the existing fossil fired peaking generation in New York City and the state. Not only will the closures have minimal effect on health impacts but closure could affect reliability. Given the impacts of New York City blackouts I don't believe any threats to current reliability standards should be accepted.

Furthermore, the proposed alternative of renewable energy and energy storage systems has to overcome space constraint issues and is not proven technology. When a leading expert on batteries says "Everybody has to be educated how to use these batteries safely", I think the best course of action is to follow his advice. It is not appropriate to make the residents of the disadvantage communities near a BESS become unwilling lab rats to test whether a technology that can generate toxic gases, fires, and explosions is appropriate in an urban setting.

Another unrecognized constraint by the environmental advocacy organizations is the financing model for a necessary resource that only operates a few times a year. Purpose-built peaking generation resources to this point have relied on the cheapest resource available such as simple-cycle combustion turbines. While an argument may be made that some renewable generation resources are competitive with simple cycle turbines the requirement in New York City is for a dedicated resource capable of providing peaking power on demand. That means that the renewable resources, the transmission to get that power to New York City, and the BESS to provide that power have to be dedicated to this requirement. I believe those costs will be several multiples greater than any fossil-fired alternative so financing and operation costs will be a problem.



Key Points

- Draft Scoping Plan DEFR placeholder technology
- Plan is to use wind and solar electrolysis to produce "green" hydrogen
- Hydrogen generation, storage and use is not very energy-efficient
- What could go wrong storing a colorless, odorless, hard to store explosive gas in New York City?
- Resource projections to have a capacity factor of 2% does not make economic sense

Caiazza Comment on Hydrogen as a Zero-Carbon Firm Resource

My Draft Scoping Plan comment addressed the use of hydrogen in some form or other as the Draft Scoping Plan placeholder technology for the Zero-Carbon Firm Resource or Dispatchable Emissions-Free Resource (DEFR) generally accepted as a complementary requirement when intermittent resources like wind and solar make up a significant portion of the electric grid resource mix. Energy storage is required for intermittent resources but the cost for exclusive reliance on batteries is unacceptably high. These resources are included to maintain reliability when the wind does not blow and the sun does not shine for long periods. I conclude that the Final Scoping Plan has to do a much better job documenting the use of hydrogen for this resource to be considered credible.

My comments summarize background information in the Draft Scoping Plan and from the New York Independent System Operator (NYISO). I describe the Integration Analysis description of the Carbon-Free Electric Supply and the hydrogen costs provided in an Integration Analysis spreadsheet. I also describe the on-going NYISO update to their System and Resource Outlook that addresses DEFR. I used a relevant article, Hydrogen Is Unlikely Ever To Be A Viable Solution To The Energy Storage Conundrum, as the outline for these comments.

The NYISO Power Trends 2022 report notes: “Long-duration, dispatchable, and emission-free resources will be necessary to maintain reliability and meet the objectives of the CLCPA. Resources with this combination of attributes are not commercially available at this time but will be critical to future grid reliability.” The Draft Scoping plan speculates without sufficient justification that the “zero-carbon firm resource” projections for the future can be met using hydrogen in one form or another. My concern is that the Plan does not provide enough reliable documentation to support the speculated use of hydrogen as the technology for this critical resource. The comments describe specific issues that need to be explicitly addressed in the Final Scoping Plan if the Climate Action Council is to make a compelling argument that this technology will keep the lights and heat on when needed most.

The Draft Scoping Plan calls for the use of so-called “green hydrogen” whereby hydrogen is produced by a carbon-free process of electrolysis from water. The first probem is that the costs for hydrogen produced using this technology are entirely speculative and by any reasonable basis of estimation will be extraordinarily high. Compared to the cost of production using natural gas natural gas to produce hydrogen, “green” hydrogen will be more than five times more expensive.

I used a Seeking Alpha analysis to estimate the hydrogen needed if it was combusted to make electricity or used to power fuel cells. For the NYISO and Integration Analysis scenarios I found that between 73 and 155 turbines sized at 288 MW would have to be dedicated for this resource application. At this time the world’s largest hydrogen fuel cell is only 79 MW so between 266 and 566 fuels cells of that size would be required.

My analysis calculated the generation energy needed for electrolysis to support DEFR projections. Scenaro 2 requires 3,342 GWh of energy for DEFR and 12,812 GWh for electrolysis which is about half the projected imported wind total in 2040. The Integration Analysis emphasizes the use of solar over wind and it appears that the electrolysis requirements are covered by the solar generation projections. Importantly, the NYISO draft Outlook Study projected DEFR requirements are an order of magnitude higher than the mitigation scenarios. As a result, the energy needed for the hydrogen to cover that need (130,353 GWh) is more than the projected total solar, land-based wind, and wind import energy (121,875 GWh) in 2040. The Climate Action Council must reconcile the differences between these two estimates because of the ramifications on the energy needed for DEFR using green hydrogen.

The difference in projections also exacerbates the problem associated with the critical winter-time wind lull DEFR condition problem. The mitigation scenarios call for much more solar capacity 43,432 MW than the combined land-based wind, imported wind, and offshore wind (26,606 MW) capacity. The Final Scoping Plan must ensure that an adequate amount of hydrogen is stored before the winter because the solar resource is so poor in the winter that it is unlikely that much if any replenishment during the winter can be expected. It is also critically important that the worst-case wind lull is defined correctly because it if is not then there will not be sufficient hydrogen available to cover the DEFR resources and blackouts will occur. The Climate Action Council must ensure the Final Scoping Plan addresses both of these issues to ensure a reliable electric system when it is needed the most.

There is a clear need for a feasibility analysis for the use of hydrogen as the DEFR. For example, where will all the combustion turbines, electrolyzers, pipelines, and fuel cells be located? I suspect that there will be significant permitting issues with all the resources needed. The capacity factors for this resource in the Draft Scoping Plan are 2% for all mitigation scenarios so there will be implementation issues. In the existing system the generating sources designed for peaking power for this reliability requirement

used the cheapest technology available (simple-cycle gas turbines). Meeting this requirement in the future using the hydrogen DEFR resource will be using the most expensive generating technology available.

There are numerous technical concerns that were not addressed in the Draft Scoping Plan. It is not clear whether the Draft Scoping Plan addressed the complex and energy intensive process of compressing and liquifying hydrogen for storage and transport. That will require large amounts of additional energy which may be additional cost not yet figured into the calculations. I could not determine if the Draft Scoping Plan proposed to use the existing natural gas network in all or part. Metal embrittlement caused by exposure to hydrogen will no doubt require major modifications and replacements for the existing infrastructure. These costs must be clearly identified and included in the Draft Scoping Plan.

This page contains links to the articles on the realities of the future of hydrogen energy use.

A succinct paper explaining was published by Baldur Eliasson and Ulf Bossel in 2003 – "*The Future of the Hydrogen Economy: Bright or Bleak?"* From that paper, energy lost in power transmission, operation of oil refineries and transport is usually less than 10% of the energy traded. The losses in hydrogen manufacture and transport are much higher and inherent to this element.

Report on Hydrogen and Climate Change

Hydrogen has to compressed or liquefied for storage and transport.

The rules of physics (not least thermodynamics) means that, whatever the power source, more energy will be expended than will ever be returned from the process of turning electricity into hydrogen gas, storing and distributing it. Which means it will not result in a net energy benefit.

Engineers from UNSW Sydney have crunched the numbers on green hydrogen production costs to reveal that Australia is in prime position to take advantage of the green hydrogen revolution, with its great solar resource and potential for export. However, the comments show:

- One of the biggest problems of hydrogen is how to contain it. The molecules are so small they leak out of almost anything. This study seems to stop at production and does not analysis of the cost of containment and distribution and safe transport of liquid hydrogen. One of the main advantages of petroleum based fuels is the trivial requirements for containment.
- Another problem is that it doesn't tell us how much hydrogen is created per square kilometer of solar collectors per day. How does this compare with demand? There's a reason industrial hydrogen production doesn't use electrolysis.
- Another missing analysis is thermal efficiency vs energy density. For this reason Elon Musk uses kerosene in his reusable Space-X rockets. Hydrogen fuel requires too much insulation, special mechanical components and fuel tanks that are massive. But we can use "free solar" to produce it….
- And hydrogen also does not work, at a fundamental engineering level, because… …. hydrogen gas is difficult, dangerous, expensive, and requires much higher energy to ship hydrogen gas by pipeline than to ship methane CH4.
- "Liquid hydrogen requires cryogenic storage technology such as special thermally insulated containers and requires special handling common to all cryogenic fuels.

- This is similar to, but more severe than liquid oxygen. Even with thermally insulated containers it is difficult to keep such a low temperature, and the hydrogen will gradually leak away (typically at a rate of 1% per day[7]). It also shares many of the same safety issues as other forms of hydrogen, as well as being cold enough to liquefy, or even solidify atmospheric oxygen, which can be an explosion hazard."
- The United States Department of Labor, Occupational Safety and Health Administration has some interesting comments on Hydrogen: "Hydrogen used in the fuel cells is a very flammable gas and can cause fires and explosions if it is not handled properly. Hydrogen is a colorless, odorless, and tasteless gas. Natural gas and propane are also odorless, but a sulfur-containing (Mercaptan) odorant is added to these gases so that a leak can be detected. At present, it is hard to tell if there is a hydrogen leak because it has no odor to it. Hydrogen is a very light gas. There are no known odorants that can be added to hydrogen that are light enough to diffuse at the same rate as hydrogen. In other words, by the time a worker smells an odorant, the hydrogen concentrations might have already exceeded its lower flammability limit.
  Hydrogen fires are invisible and if a worker believes that there is a hydrogen leak, it should always be presumed that a flame is present. When workers are required to fight hydrogen-related fires, employers must provide workers with necessary protective gear to protect them from such invisible flames and potential explosion hazards. There are several OSHA standards that may apply to employers who produce or use hydrogen."
- The cost of transportation and storage of cryogenic hydrogen was certainly not considered. Nor was the long-term embrittlement of the metals and leakage materials problem with its storage and delivery systems, leading special metals and seals considerations in any mobile vehicle design. Simply electrolyzing water from solar PV power to produce hydrogen is just a small part of the problem with liquid hydrogen energy as a fuel source.
  Storage in a gaseous phase would entail impossibly large pressurized tanks and then diffusion-leakage is a serious issue. The time-tested best way to store hydrogen is to attach it to a carrier atom like carbon (we'll call it a "hydrocarbon"). We could even store it then in very underground natural geologic formations in very large quantities. It is a stable dense liquid at standard temp and pressures and wouldn't mix with water much at all.
  Or we could bind it to a metal substrate like nickel or lithium in a battery (Ni-MH, Li-ion).
  Or 4 H's could be combined with molecular nitrogen to make a very nice high energy molecule, but it might be somewhat toxic to handle and you wouldn't want to breathe it or get it in your eyes. We could give it a snappy name like *hydrazine*.

Green hydrogen is too expensive to have any widespread application. That's because most of the input energy – electricity from offshore wind farms – is very expensive and much of it will be unavoidably wasted in the conversion to hydrogen.

Every time I meet a proponent of switching from CH4 to H2 I ask them questions like explain the Joule Thomson effect, the relevance of Ortho and Para ratios from electrolysis, the effect on linepack storage using H2, deflagration or diffusion combustion and NOx production, etc etc. Every time I get blank looks back. It seems proponents of green issues usually have not got a clue what they are talking about. Never mind, as you say, just pop a little bit of H2 in with the CH4 and they will be happy and run along!

Latest Hydrogen Costings: If we assume the cost of wind power is Eu70/MWh, which is in line with the latest CfDs, the cost would be about Eu140/MWh. Either way, it is still much greater than the current gas price of Eu44.30. Finally it is worth noting that, according to S&P Platts, electrolyser stack refurbishment is required every nine years at 45% of capital cost.

NYISO 2021-2040 Resource Outlook

- As more wind, solar, and storage plants are added to the grid, Dispatchable Emission-Free Resources (DEFRs) must be developed and added to the system at scale to reliably serve demand when intermittent generation is unavailable.
- The lead time necessary for research, development, permitting, and construction of DEFRs will require action well in advance of 2040 if state policy mandates under the CLCPA are to be achieved.
- Fossil generation will likely need to be retained past the 2040 mandates to keep the system reliable if DEFR technology is not in operation.

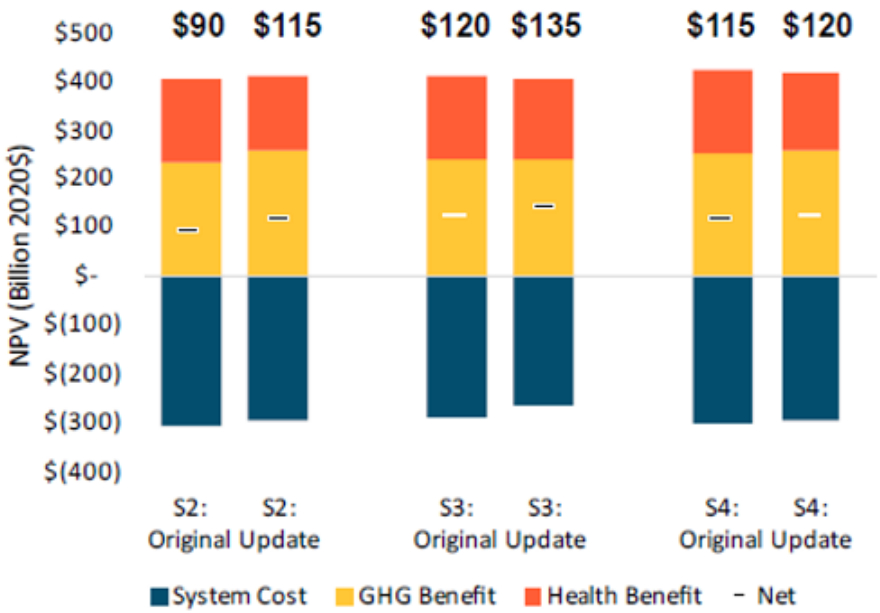
Resource Outlook Key Findings Datasheet

This sums up the reliability feasibility challenge of the Climate Act and NY policy

- DEFR is necessary for future reliability
- DEFR is not available so has to be developed, tested, and put on line well before 2040
- Until you have DEFR shutting down existing fossil generation is inappropriate
- Not mentioned are the costs of DEFR

Clearly conditional implementation dependent upon the availability of DEFR is a rational approach.

Cost of Inaction is more than cost of Action



Key Points

- Council claims that costs of inaction are greater than the cost of action
- Misleading and inaccurate
- Misleading because costs are given relative to the Reference Case and not a business-as-usual case per standard practice
- Reference case includes at least the cost of the "already implemented" electric vehicle mandate
- Inaccurate because the cost of the Plan counts the societal benefits of avoided greenhouse gas emissions multiple times
- They get $235 billion societal benefits but I estimate those benefits should only be $60 billion.
- If I lost 10 pounds five years ago, I cannot say I lost 50 pounds but that is what the plan says.
- I estimate that costs are at least $760 billion more than benefits

This graph is how the numbers were presented until May when I complained to the right person and they posted an update to Integration Analysis spreadsheets. No update with these numbers
According to the August 23 Meeting Presentation

- Cost of inaction greatly exceeds cost of action (by over $100 billion)
- System costs across all scenarios are in the same range given uncertainty
- The range of net benefits across the scenarios narrows (from $90-120B to $115-$135B)
- Therefore, it remains important to develop insights across multiple factors, including technology readiness and consumer acceptance

Affordability

- Integration Analysis does not list the costs and benefits of control strategies

- Draft Scoping Plan does not provide the total costs of the mitigation scenarios
- Costs are misleadingly presented "relative" to the reference case

This section is a summary of my **Electric System Comments** related to costs.

I estimated the costs for the projected generating capacity described in the Draft Scoping Plan Integration Analysis. My estimate of the overnight cost to develop the resources needed to transition to a zero-emissions electric system in 2040 are generally consistent with the Appendix G Figure 48 net present value of system expenditures. I estimate that the Reference Case capital costs are only $82.5 billion and that the mitigation scenarios range from $220 billion to $400 billion. There are variances that I address to the extent possible.

The Draft Scoping Plan does not provide sufficient documentation to reconcile all the differences. My estimates only include the capital costs for the projected generating resources and do not include transmission ancillary services that must be included for a true estimate of the total costs to go to zero-emissions generation.

I submitted other comments that explained that the New York Independent System Operator (NYISO) is currently updating its System and Resource Outlook. I projected costs for their capacity projections and found that their cost numbers are 30% higher. I strongly recommend that the Climate Action Council reconcile the differences between the projections.

The Integration Analysis that provides the numbers used in the Draft Scoping Plan misleads readers with its definition of the Reference Case. Policy modeling like this compares projections for future mitigation scenarios against a business-as-usual case future projection. The definition used in the Integration Analysis "includes a business-as-usual forecast plus implemented policies". The Climate Act mandates "9 gigawatts (GW) of offshore wind electric generation by 2035". In my benefits are greater than costs comment I showed that after correcting for this mis-leading approach net-zero transition costs are between $295 billion and $316 greater than the benefits but these cost numbers show that the costs are increased to between $363 and $372 greater than the benefits.

I quantified costs associated with some particular issues with the Integration Analysis cost projections. The Integration Analysis does not consider the effect of end-of-life retirements for wind, solar, and energy storage. I showed that in 2040 incorporating retirements would increase costs by at least 6%. However, costs jump considerably when costs to 2050 are considered. For example, my projected cost for Scenario 4 in 2040 is $399,530 million but the cost to replace all the equipment that ages out between 2020 and 2050 is $304,428 million. I also showed that the biomass and wind capacity factors are biased high. The observed statewide average wind capacity is trending down since 2015 and that effect is not addressed in the Draft Scoping Plan.

Note that my comments made specific recommendations to address all the issues described and there is no evidence whatsoever that anyone on the Climate Action Council saw much less considered my recommendations.

Cumulative Environmental Impacts

- Last cumulative environmental impact statement in 2020 before Integration Analysis
- Assuming Onshore wind 3.3 MW turbines, offshore wind 15 MW turbines, and 9.3 acres of equipment area per MW for solar installations

Increase above FEIS	Onshore Turbines	Offshore Turbines	Solar sq miles
Scenario 1	631	594	629
Scenario 2	497	493	660
Scenario 3	712	685	602
Scenario 4	984	621	669

Caiazza Comment Overlooked Impacts

Comparison of Integrated Analysis Projected Capacity and Cumulative Environmental Impact Statements (MW)

	Onshore Wind	Offshore Wind	Total Solar	Battery Storage	Zero-Carbon Firm Resource
Prior EIS	5,905	4,200	9,865		
2020 FSGEIS	7,805	9,000	19,200		
Integration Analysis					
Reference Case	3,787	9,000	19,956	8,225	0
Scenario 1	9,888	17,912	62,463	22,869	22,869
Scenario 2	9,445	16,393	64,621	21,465	21,465
Scenario 3	10,154	19,278	60,604	19,212	19,212
Scenario 4	11,052	18,310	65,210	22,956	22,956

There is no question that the integrated analysis renewable resources should be addressed in another environmental impact statement. Considering the number of turbines and area covered by solar panels environmental impacts that may be acceptable for a limited number of facilities clearly could be issues with the larger numbers projected. Assuming onshore wind uses 3.3 MW turbines (average turbine size in the Article Ten queue in 2020), offshore wind uses 15 MW turbines per Empire Wind website, and that solar projects in the Article Ten queue in 2020 averaged 9.3 acres of equipment area per MW I calculated the quantity of turbines and area covered for the FEIS and Draft Scoping Plan in Table 2. The Draft Scoping Plan calls for at least 497 more onshore wind turbines, 493 more offshore wind turbines and 602 more square miles covered with solar equipment.

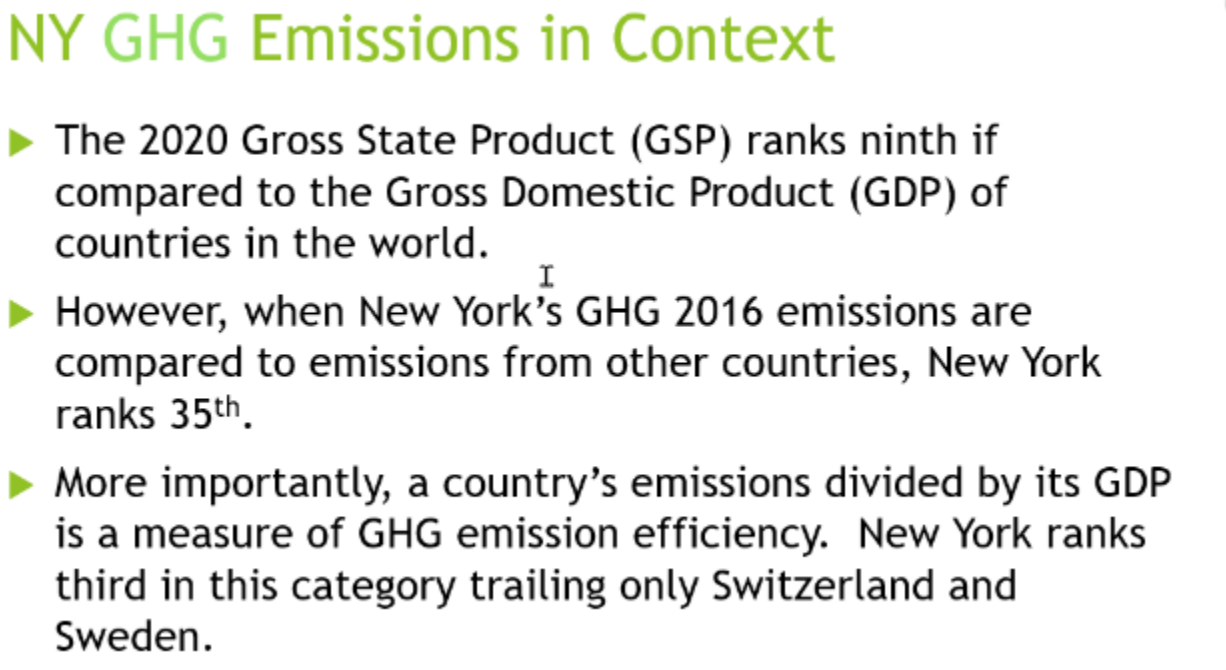
Difference between number of wind turbines and areal extent of solar facilities in the cumulative environmental impact statements and the Integration Analysis

	Onshore Turbines	Offshore Turbines	Solar sq miles
Prior EIS	1,789	280	143
2020 FSGEIS	2,365	600	279
Reference Case	1,147	600	290
Scenario 1	2,996	1,194	908
Scenario 2	2,862	1,093	939
Scenario 3	3,077	1,285	881
Scenario 4	3,349	1,221	948

Increase above FEIS	Onshore Turbines	Offshore Turbines	Solar sq miles
Scenario 1	631	594	629
Scenario 2	497	493	660
Scenario 3	712	685	602
Scenario 4	984	621	669

I have considered the avian impact of the Bluestone Wind Project in Broome County New York to show impacts for a single facility. It will have up to 33 turbines and have a capability of up to 124 MW covering 5,652 acres. The "Cumulative Impacts Assessment" Appendix UU, which is document #752 on the NYSDPS-DMM-Matter Master website case #16-F-0559 in the Article 10 application for the facility provides data on eagle impacts. Over the 30-year expected lifetime of the facility the analysis estimates that 85 Bald Eagles and 21 federally protected Eastern Golden Eagles will be killed. A first-order approximation[1] is to scale those numbers to the total capacity projected for the Draft Scoping Plan. Table 3 shows that this approximation suggests that at least 216 Bald Eagles could be killed every year when there are 9,445 MW of on-shore wind. There were 426 occupied bald eagle nest sites in New York in 2017. I am not a wildlife biologist but those numbers indicate to me that there will be major threats to the survivability of Bald Eagles in New York. The Final Scoping Plan must include proposed thresholds for unacceptable environmental impacts like this.

Not included in Presentation



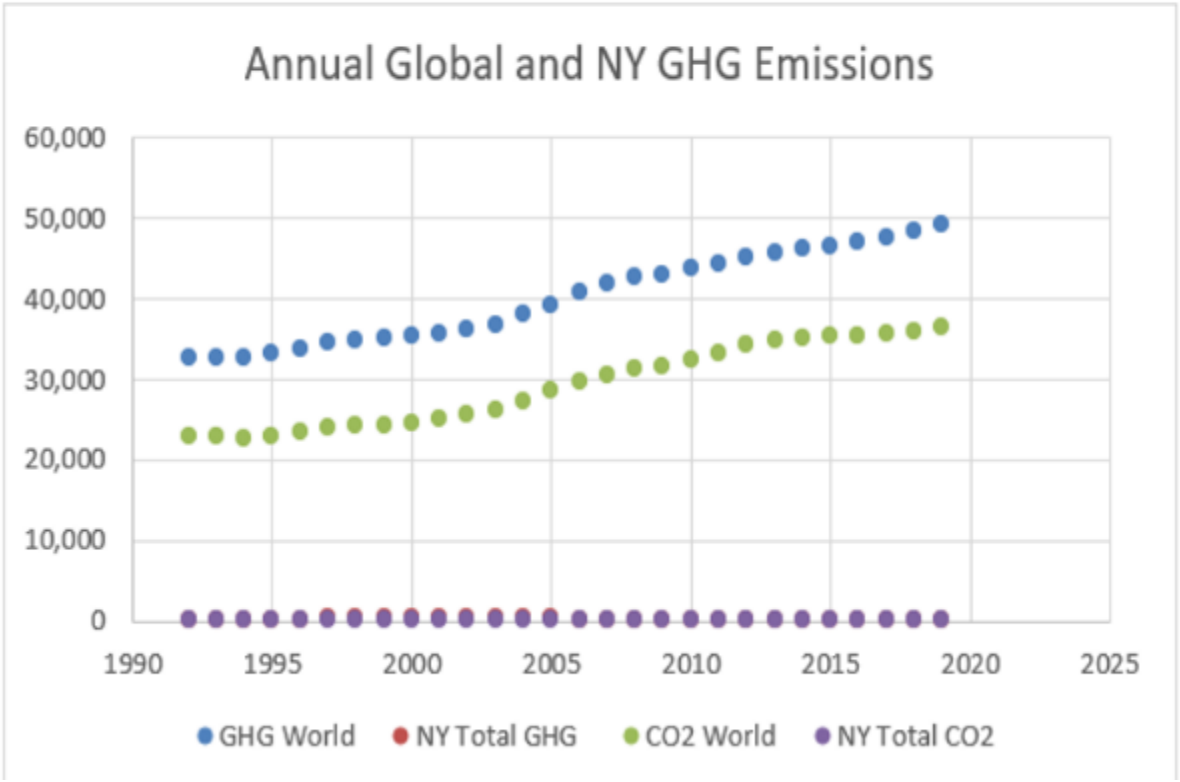
Climate Act advocates frequently argue that New York needs to take action because our economy is large. I analyzed that claim recently and summarized the data here. The 2020 Gross State Product (GSP) ranks ninth if compared to the Gross Domestic Product (GDP) of countries in the world. However, when New York's GHG 2016 emissions are compared to emissions from other countries, New York ranks 35th. More importantly, a country's emissions divided by its GDP is a measure of GHG emission efficiency. New York ranks third in this category trailing only Switzerland and Sweden.

Despite the fact that the ostensible rationale for GHG emission reduction policies is to reduce global warming impacts, the Draft Scoping Plan continues an unbroken string of not reporting the effects of a policy proposal on global warming. The reason is simple. The change to global warming from eliminating New York GHG emissions are simply too small to be measured much less have an effect on any of the purported damages of greenhouse gas emissions. I have calculated the expected impact on global warming as only 0.01°C by the year 2100 if New York's GHG emissions are eliminated.

More information: Climate Act Emission Reductions in Context

NY GHG Emissions in Context

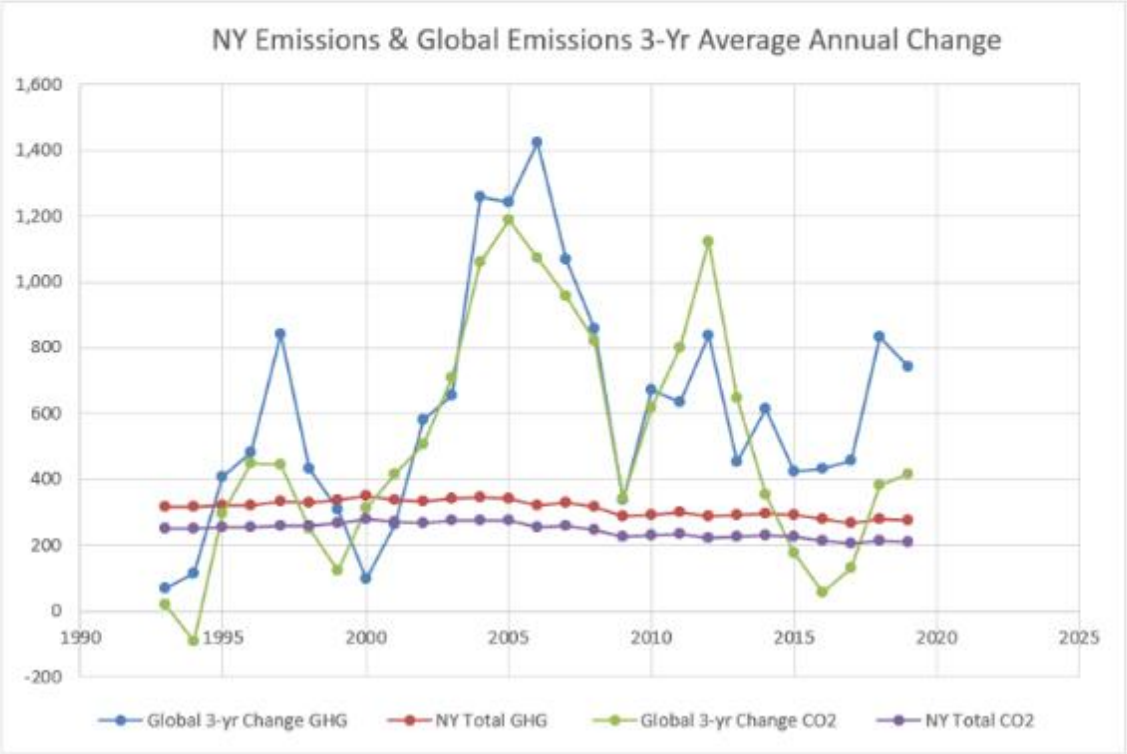
- New York and Global GHG Annual Emissions 1990-2019



This graph and the following graph illustrate compare New York GHG emissions and global emissions. I used CO2 and GHG emissions data for the world's countries and consolidated the data in this spreadsheet. I used the New York State GHG data set CO2e AR4 100 year global warming potential GHG values for consistency.

NY GHG Emissions in Context

- New York GHG Emissions Relative to Global Emissions Increases



These data are documented in the same spreadsheet as the previous figure. The trend results indicate that the year-to-year trend in GHG emissions was positive 21 of 26 years and for CO2 emissions was positive 24 of 30 years. In order to show this information graphically I calculated the rolling 3-year average change in emissions by year. New York's emissions are only 0.45% of global emissions and the average change in three-year rolling average emissions is greater than 1%. In other words, whatever New York does to reduce emissions will be supplanted by global emissions increases in less than a year.

More information at: Climate Act Emission Reductions in Context and Climate Act Emissions in Graphical Context

Not included in Presentation

Climate Act Effect of Global Warming

- What is the effect of global warming If NYS GHG emissions are eliminated?
- EPA Model for the Assessment of Greenhouse-gas Induced Climate Change
- Predicts a reduction, or a "savings," of between approximately 0.0097°C and 0.0081°C by the year 2100.
- Temperature decreases three (3) degrees Fahrenheit for every 1,000-foot increase in elevation above sea level. The projected temperature difference for all the greenhouse gases is the same as a 39-inch change.
- The general rule is that temperature changes three (3) degrees Fahrenheit for every 300-mile change in latitude at an elevation of sea level. The projected temperature change is the same as a change in latitude of less than a mile.
-

Reasons for my skepticism

- Attempting to get to zero emissions is an extraordinary challenge that is downplayed by the Climate Act, the Council and the Draft Scoping Plan
- Need DEFR but it has to be developed for New York in less than a decade
- No reason to expect that the costs won't be huge despite the Hochul Administration's cover up of costs and benefits
- The cumulative impacts of the required renewable developments have not been evaluated and could be unacceptable
- There is no plan for implementation so there are problems
- Finally what is going to happen when we have electrified everything and there is an ice storm

Over-riding Risk

Extreme weather events can have extreme consequences on a more fragile wind and solar electricity network. I am particularly worried about ice storms. On a local level it is not clear how the public will be able to survive a multi-day power outage caused by an ice storm when the CLCPA mandates electric heat and electric vehicles but the bigger reliability concern is that fact that ice storms can take out transmission lines. For example, consider, the January 1998 North American ice storm:

The North American Ice Storm of 1998 (also known as Great Ice Storm of 1998) was a massive combination of five smaller successive ice storms in January 1998 that struck a relatively narrow swath of land from eastern Ontario to southern Quebec, New Brunswick and Nova Scotia in Canada, and bordering areas from northern New York to central Maine in the United States. It caused massive damage to trees and electrical infrastructure all over the area, leading to widespread long-term power outages. Millions were left in the dark for periods varying from days to several weeks, and in some instances, months. It led to 34 fatalities, a shutdown of activities in large cities like Montreal and Ottawa, and an unprecedented effort in reconstruction of the power grid. The ice storm led to the largest deployment of Canadian military personnel since the Korean War, with over 16,000 Canadian Forces personnel deployed, 12,000 in Quebec and 4,000 in Ontario at the height of the crisis.

Supplemental Information not included in the presentation

Summary of Caiazza Draft Scoping Plan comments submitted

Caiazza Comment Summary for Climate Action Council **July 1, 2022**
This comment is an executive summary of the comments I submitted that highlights the most important points that I think the members of the Climate Action Council should know about the Draft Plan.

Caiazza Comment Cost Methods Overview **July 1, 2022**
This comment reviews information made available in May describing the cost methodologies. I have made the point in many of my comments that I believe the Integration Analysis documentation should describe all the control measures proposed, provide references for the assumptions used, supply the expected costs for those measures and list the expected emission reductions for the Reference Case, the Advisory Panel scenario and the three mitigation scenarios.

Caiazza Comment on the Alleged Climate Crisis **July 1, 2022**
I recommend that the Final Scoping Plan include a conditional schedule that considers the availability of necessary technology and potential impacts to reliability and affordability before implementing certain control measures. I explained that there is an ever expanding body of knowledge that there isn't a climate crisis so we can afford wait.

Caiazza Comment Renewable Energy Systems and the Second Law of Thermodynamics **July 1, 2022**
The Integration Analysis and the Draft Scoping Plan zero-emissions electric grid transition plan depend on a long-duration, dispatchable, and emission-free resource that does not exist. This comment explains why there are reasons to believe that a commercially viable and affordable resource like this may never be developed.

Caiazza Comment on Draft Scoping Plan Scenarios **June 30, 2022**
There is a specific request for feedback on the components of the three mitigation scenarios as well as an implicit request for a recommendation for the appropriate scenario going forward. This comment presented my response.

Caiazza Electric System Comments **June 30, 2022**
These comments address a few Draft Scoping Plan electric system issues. The ultimate problem is that the Climate Act presumed that converting the electric grid from its current reliance on fossil fuels to provide reliable electricity when needed most was just a matter of political will. The presentation addressed many of the comments included in this submittal.

Caiazza Comment Overlooked Impacts and Life Cycle Analysis ***June 30, 2022***
In this comment I address the environmental and life cycle costs and benefits discussion in the Draft Scoping Plan. In general, the Plan over-estimates benefits and under-estimates costs throughout the document and associated documentation. This extends beyond financial costs and includes environmental impacts, upstream emissions, and life-cycle emissions.

Caiazza Draft Scoping Plan Transportation Scenario Incremental Cost Comment **June 25, 2022**

This is a technical comment on a trivial problem and has no major bearing on Climate Act implementation. However, it raises a pervasive issue that needs to be addressed. Note, however, there has been no indication how this type of comment will be addressed in the Final Scoping Plan.

Climate Act Mandates that must be Considered in the Scoping Plan June 24, 2022
There are four Climate Leadership and Community Protection Act (Climate Act) mandates for the Climate Action Council that have been overlooked to this point. In brief those mandates are related to expertise, an implementation safety valve, costs and benefits documentation, and consideration of the experiences of other jurisdictions. Instead of focusing on specific technical issues, the Council should be considering how to address those mandates in their review of the Draft Scoping Plan.

There are members of the Climate Action Council that believe there are no conditions relative to meeting the zero-emissions electricity targets. However, New York Public Service Law § 66-p. "Establishment of a renewable energy program" has safety valve conditions for affordability and reliability. I am very disappointed that the leadership of the Climate Action Council has not addressed the safety valve provisions. The existence of those conditions has not even been mentioned despite the apparent safety-valve nature of this mandate.

Caiazza Comment on Hydrogen as a Zero-Carbon Firm Resource June 23, 2022
This comment addresses the use of hydrogen in some form or other as the Draft Scoping Plan placeholder technology for the Zero-Carbon Firm Resource or Dispatchable Emissions-Free Resource (DEFR) generally accepted as a complementary requirement when intermittent resources like wind and solar make up a significant portion of the electric grid resource mix.

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Caiazza Comment on Draft Scoping Plan Benefits June 22, 2022
The Climate Leadership and Community Protection Act Scoping Plan claims that "The cost of inaction exceeds the cost of action by more than $90 billion". However, the benefit claims are poorly documented, misleading and the largest benefit is dependent upon an incorrect application of the value of carbon. These comments address the Scoping Plan benefit claims and explain how the value of carbon is used incorrectly.

Caiazza Comment on Retirement Input Assumptions June 16, 2022
In what appears to be a egregious attempt to reduce the published costs of wind, solar, and battery storage the Integration Analysis assumes that the expected lifetimes of those technologies is indefinite. As a result, units are assumed to remain online throughout the study period and no costs for replacements between now and 2050 are included. However. that is a poor assumption because it is totally unreasonable to expect that, for example, the existing land-based resources will still be in operation in 2050.

Caiazza Comment on Economy Wide Strategies June 9, 2022
Economy wide strategies refers to policies to pay for implementation. Unfortunately the Draft Scoping Plan discussion was written to address specific issues raised by the Climate Action Council. As a result, it gets bogged down into details about specific issues raised by council members rather than looking at the big picture. In theory, a price on carbon is a great idea. The Council has not considered the theory relative to their perceptions.

Reconcile NYISO and Integration Analysis Capacity Projections Comment June 6, 2022

This comment addressed the differences between the NYISO Resource Outlook and the Integration Analysis that were discussed in the presentation.

Caiazza Personal Comment Electric Vehicles June 3, 2022
I prepared this comment because I found that the Integration Analysis is simply making assumptions about future zero-emissions transportation implementation strategies without providing adequate referenced documentation. There are numerous recommendations for additional documentation in these comments so that New Yorkers can understand what will be expected and how much it will cost. The Integration Analysis projections for electric vehicle costs start in 2020. The observed data is not consistent with the projections.

Caiazza Personal Comments on Section 2.1 Scientific Evidence of Our Changing Climate 2 June 2022
I submitted these comments so that the Council could not say that no one questioned the necessity of greenhouse gas emission reduction action inherent in the Climate Act. In the comments I refuted many of the claims made in Section 2.1 of the Draft Scoping Plan. I argued that if documentation is not included that explicitly supports the claims made and contradicts my comments and the attachment, then I think those claims should be removed from the final Draft Scoping Plan.

Caiazza Personal Comments on Benefits of Climate Action May 31, 2022
The Draft Scoping Plan asserts that there will be benefits from the implementation of the Climate Act but provides no documentation to support that claim. These comments highlight the claims that must either be substantiated by analysis and documentation or removed from the final Scoping Plan.

Caiazza Personal Comment on the Benefits Greater than Costs Claim May 30, 2022
The scoping plan claims that "The cost of inaction exceeds the cost of action by more than $90 billion". In my verbal comments at the Syracuse Climate Act public hearing I said that statement is inaccurate and misleading. This comment explains why that the Draft Scoping Plan must address this issue and makes recommendations for changes to language to clarify the caveats associated with the claim.

Caiazza Comment Electric Service and Distribution System Upgrades Needed for Electric Heating 15 May 2022
These comments are based on the work of Kip Hansen. He estimated costs associated with the distribution network for upgraded residential electric service; electrical distribution system improvements so that all homes can heat with electricity and use the "**more usual and affordable" overnight electric vehicle chargers; and disconnecting natural gas** supplies. I applied his reference information to New York and found that these costs range from $16.8 to $43.1 billion. These costs don't include "the costs to homeowners, who must pay for the service upgrade, service entrance wires, and circuit breaker panel box. And, of course, does not include the purchase new appliances or the installation of EV chargers." This cost estimate also does not include disconnection costs for fuel oil or propane heated homes. Finally, these estimates only apply to single family homes and not the 4.2 million housing units that are in multi-family buildings.

Documentation for Caiazza Comments at Public Hearing in Syracuse on April 26, 2022
This summarizes the verbal comments I submitted on April 22 to the Council. I don't think the Council, much less the public, appreciates the Draft Scoping Plan's claimed benefits, costs, threats to reliability, or effect of the proposed reductions on global climate change.

Caiazza Comment on Astoria Repowering Application and the Draft Scoping Plan **16 March 2022**
This submittal references comments I submitted on the New York State Department of Environmental Conservation (DEC) decision to deny the NRG Astoria Gas Turbine Power Replacement Project Title V Permit Application. In my comments I argued that the Climate Act has the obligation to not impede the provision of safe and adequate electric service. DEC's denial of the Astoria Gas Turbine Title V application because it: "Does not demonstrate compliance with the requirements of the Climate Leadership and Community Protection Act" is at odds with that mandate and the NYISO Resource Outlook finding that existing fossil fuel resources cannot be shut down until DEFR is in place.

Caiazza Personal Comment on Renewable Energy Resource Availability **11 March 2022**
This comment explains why an accurate and detailed evaluation of renewable energy resource availability is crucial to determine the generation and energy storage requirements of the future New York electrical system. I describe the history of blackouts in New York and specific lessons from Texas that must be incorporated into New York planning to prevent a similar problem in New York. I explain that in order to ensure electric system reliability for an energy system that depends on renewable generators and energy storage, the resources available during periods of low wind and solar energy production must be known.

Draft Scoping Plan Residential Heating Electrification Estimates **15 February 2022**
In my opinion, home electrification is a primary concern for New Yorkers given the importance of affordability and the impact to every household. Accordingly, I spent a lot of time trying to replicate the costs to retrofit existing furnaces with heat pumps as documented in these comments. I found that the existing documentation is too incomplete to be able to reproduce the cost projections.

Caiazza Comment Calling for a Moratorium on Utility-Scale Solar Development **18 March 2022**
I recommended that the Climate Action Council impose a moratorium on the development of utility-scale solar projects until permitting requirements have been established for responsible solar siting and protection of prime farmlands. Although the New York State Department of Agriculture and Markets (Ag & Market/Department) has policies on solar energy projects, the Article Ten Trelina Solar Project application to build and operate an 80-megawatt solar farm in the Town of Waterloo, Seneca County was approved despite the fact that it did not adhere to that policy. At a minimum all utility-scale projects should adhere to those policies.

Caiazza Comment on the Scoping Plan Social Cost of Carbon Benefit Calculation **18 March 2022**
This comment addresses two issues with the Draft Scoping Plan Social Cost of Carbon Benefit calculations. I explain that the methodology is flawed and that I cannot reproduce the values in the Scoping Plan.

New York's Irrational War on Methane

In order to support the elimination of natural gas the authors of the Climate Act included specific language that increases the alleged impacts of methane. However, their justification is wrong.

William Happer:

To understand why methane regulation will be irrelevant to climate, it is necessary to discuss a few numbers. This is not customary in climate discussions, which are usually more based in emotion than in fact.

Like water vapor (H_2O), carbon dioxide (CO_2), and nitrous oxide (N_2O), methane is a naturally occurring greenhouse gas. Together with clouds, greenhouse gases control how heat added to the Earth by sunlight is returned as thermal infrared radiation to space. Greenhouse gases impede the flow of heat from Earth's surface to space. The details of how this happens are considerably more complicated than described by the adjective "heat-trapping." Much of the heat transfer near the surface is due to convection of moist air and has little to do with greenhouse gases. And how the temperature varies with altitude at various locations on Earth's surface is as important as the concentration of greenhouse gases.

Few realize that large increases in the concentrations of greenhouse gases cause very small changes in the heat balance of the atmosphere. Doubling the concentration of methane – a 100% increase, which would take about 200 years at the current growth rates – would reduce the heat flow to space by only 0.3%, leading to an average global temperature change of only 0.2 °C. This is less than one-quarter of the change in temperature observed over the past 150 years.

Most of the predicted catastrophic warming from greenhouse gas emissions is due to positive feedbacks that are highly speculative, at best. In accordance with Le Chatelier's principle, most feedbacks of natural systems are negative, not positive. So, even if regulations on U.S. methane emissions could completely stop the increase of atmospheric methane (they can't), they would likely only lower the average global temperature in the year 2222 by about 0.2 °C, a completely trivial amount given that humans have adapted to a much larger change over the past century while reducing climate deaths by over 98%. And U.S. regulations will have little influence on global emissions, where producers are unlikely to be as easily cowed.

New York's Irrational and Unsupportable Methane Obsession

Viewed through a pragmatic lens, the New York obsession with eliminating natural gas is irrational. Increased use of natural gas has been responsible for the majority of electric generation emission reductions observed in the state. Natural gas provides efficient, resilient, and safe energy to homes and businesses. Not so long ago the idea that natural gas could also be used a bridge fuel until the aspirational "green" generating resources and energy storage technologies could be tested at the scale needed, perform like a natural gas fired generating unit, and provide power at a similar cost, was generally accepted as a rational approach. Unfortunately, the Climate Act does not allow this approach.

Risk Assessment