Caiazza Comment on Retirement Input Assumptions

Summary

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.

These comments document the contents of the Integration Analysis and Draft Scoping Plan lifetime assumptions. The results of a brief literature search for expected lifetimes for wind, solar, and battery storage are presented. Then the resource estimates in the IA-Tech Supplement Annex 2 Emissions Key Drivers spreadsheet are used to estimate the effect of the indefinite lifetime assumptions.

Using an indefinite retirement date for wind, solar and battery storage resources underestimate the total builds needed for 2050. For land-based wind between 3,814 MW and 4,600 MW are not included and for offshore wind between 6,200 and 6,600 MW are not included. The amount of solar not included ranges between 22,639 MW and 19,983 MW. Finally, for battery storage between 10,713 MW and 12,207 MW of additional resources will be need to be developed to meet the 2050 projected value.

Another way to look at the exclusion of these resources is that land-based wind development costs could be up to 45% higher than the projections that don't include reasonable retirement dates simply because that much more needs to be developed. Off-shore wind costs could be up to 38% higher, solar costs could be up to 35% higher, and battery storage could be up to 64% higher than projections that exclude reasonable retirement dates.

I conclude that there are questions that the Climate Action Council needs to address. Why shouldn't reasonable retirement dates be included in the Final Scoping Plan. What would the revised costs be if retirements were included?

Integration Analysis Lifetime Assumptions

The spreadsheet IA-Tech-Supplement-Annex-1-Input-Assumptions has a tab named "Retirement" that "contains expected lifetime assumptions by resource category". The table listing the lifetimes is shown below.

Lifetime Assumptions by Resource Category

Lifetime Assumptions	
Resource Category	Lifetime (years)*
Hydro	Indefinite
Wind	Indefinite
Solar	Indefinite
Nuclear	60 / 80 **
Biomass	60
Storage	Indefinite
Fuel Oil Peaker***	60
Gas CCGT	60
Gas Peaker***	60

Table Notes:
* Resources with "indefinite" lifetimes are assumed to remain online throughout the study period.
** The license expiration of upstate nuclear units is determined as part of scenario definitions.
***Select units in NYISO zones J and K that are expected to retire as a result of the DEC NOx emissions rule are assumed offline by the start of 2025, based on the 2021 Gold Book.
Units that hit their 60 year lifetime threshold by 2025 but that have not yet announced retirement plans are kept online through model year 2025, due to the time it takes to complete retirement studies.
The 60-year retirement threshold is not enforced in downstate NY until 2035, to ensure local reliability is maintained in the near term. This analysis enforced LCRs in each capacity zone but did not study more detailed local reliability issues.

The reason for this comment is that the lifetime assumption for hydro, wind, solar, and storage are listed as indefinite. While that may be true for hydro it is an inappropriate assumption for wind, solar and energy storage. The question: Was that assumption incorporated into the cost projections?

Other Wind, Solar, and Energy Storage Expected Lifetimes
In this section I list the results of a quick internet search of wind, solar, and energy storage technologies.

According to TWI: A good quality, modern wind turbine will generally last for 20 years**,** although this can be extended to 25 years or longer depending on environmental factors and the correct maintenance procedures being followed. However, the maintenance costs will increase as the structure ages. The Electricity Markets & Policy group at Berkeley Lab claims: "Our interest was in better understanding how expectations for useful life have changed over time, as the wind industry has matured. We find that most wind project developers, sponsors and long-term owners have increased project-life assumptions, from a typical term of ~20 years in the early 2000s to ~25 years by the mid-2010s and ~30 years more recently. Current assumptions range from 25 to 40 years, with most respondents citing 30 years". However, there is a difference between design life and actual lifetimes. Energy Follower explains that "There is very little data on modern turbines reaching their life expectancy so it is largely unknown how long they will be operable. Modern wind turbines have over 8,000 parts (broken down into three major components) and blades as long as 262 feet, the same length as the wingspan of an Airbus. With higher efficiency modern turbines due to additional electronic components and a more powerful and massive design, there is a higher chance of something going wrong with more potential points of failure and overall added stress and load on the structure."

There is less information available for utility-scale photovoltaic systems. The Electricity Markets & Policy group at Berkeley Lab claims: "Solar project developers, sponsors, long-term owners, and consultants have increased project-life assumptions over time, from an average of ~21.5 years in 2007 to ~32.5 years in 2019. Current assumptions range from 25 years to more than 35 years depending on the organization; 17 out of 19 organizations from which data were obtained use 30 years or more." It is not clear to me why these expectations are so high when it known that photovoltaic cells degrade over time. The National Renewable Energy Lab concluded:

> A history of degradation rates using field tests reported in the literature during the last 40 years has been summarized. Nearly 2000 degradation rates, measured on individual modules or entire systems, have been assembled from the literature and show a mean degradation rate of 0·8%/year and a median value of 0·5%/year. The majority, 78% of all data, reported a degradation rate of <1% per year.

There is even less information available for utility-scale energy storage systems. Another National Renewable Energy Lab analysis did an example scenario:

> An example scenario was simulated wherein an integrated battery-PV system was controlled in self-consumption mode, attempting to minimize energy exchanged with the grid. For this application, battery lifetimes ranging from 7-10 years may be expected. Without active thermal management, 7 years lifetime is possible provided the battery is cycled within a restricted 47% DOD operating range. With active thermal management, 10 years lifetime is possible provided the battery is cycled within a restricted 54% operating range.

I found one other reference that claimed that listed different types of chemical battery lifetimes between 5 and 15 years.

Integration Analysis Implications

I searched the Draft Scoping Plan for the term "retirement" and could not find any documentation for the rationale used to assume that wind, solar, and energy storage have indefinite lifetimes. I recommend that the Final Scoping Plan incorporate documentation explain the retirement rationale because as I show below there are implications for the cost projections.

I have attached my annotated version of the Draft Scoping Plan description in the section "Carbon-Free Electric Supply" in Appendix G Section I that starts at page 42. The only annotation addition is an extracted copy of the actual data in the figures that list capacity (MW) and generation (GWh) in that section that are based on data in the IA-Tech Supplement Annex 2 Emissions Key Drivers spreadsheet.

The following tables list the capacities for the Integration Analysis fuel mix categories for the Reference Case (Table 1), Scenario 2: Strategic Use of Low-Carbon Fuels (Table 2), Scenario 3: Accelerated Transition Away from Combustion (Table 3), and Scenario 4: Beyond 85% Reduction.

Table 1: Reference Case Summary Fuel Mix Capacity (MW)

Reference Case	2020	2025	2030	2035	2040	2045	2050
Nuclear	4,860	3,355	2,135	1,287	1,287	1,287	-
Gas & FO	26,388	25,775	20,756	15,352	16,319	17,822	18,639
Zero-Carbon Firm Resource	-	-	-	-	-	-	-
Biomass	327	327	327	327	327	275	178
In-State Hydro	4,269	4,269	4,610	4,610	4,610	4,610	4,610
Hydro Imports (Existing)	1,485	1,485	1,485	1,485	1,485	1,485	1,485
Hydro Imports (New)	-	-	1,250	1,250	1,250	1,250	1,250
Wind	1,917	3,292	3,787	3,787	3,787	3,787	3,787
Wind Imports	-	-	-	-	-	-	-
Wind_Offshore	-	1,826	6,200	9,000	9,000	9,000	9,000
Solar	2,592	8,201	13,644	14,387	14,661	14,942	19,956
Battery Storage	750	1,500	3,000	4,655	4,872	5,123	8,225
Pumped Storage	1,435	1,435	1,435	1,435	1,435	1,435	1,435
Total	44,023	51,467	58,629	57,576	59,033	61,017	68,565

Table 2: Scenario 2 Summary Fuel Mix Capacity (MW)

Scenario 2	2020	2025	2030	2035	2040	2045	2050
Nuclear	4,860	3,355	3,355	3,355	3,355	3,355	2,135
Gas & FO	26,388	25,775	21,579	18,078	-	-	-
Zero-Carbon Firm Resource	-	-	-	-	21,015	21,576	21,290
Biomass	327	327	327	327	327	275	178
In-State Hydro	4,269	4,269	4,610	4,610	4,613	4,613	4,613
Hydro Imports (Existing)	1,485	1,485	1,485	1,485	1,485	1,485	1,485
Hydro Imports (New)	-	-	1,250	1,250	1,250	1,250	1,250
Wind	1,917	3,292	3,814	4,263	5,845	7,781	9,445
Wind Imports	-	-	1,760	5,796	6,397	6,397	6,397
Wind_Offshore	-	1,826	6,200	9,906	14,364	16,393	16,393
Solar	2,592	8,201	18,852	28,994	43,432	53,089	64,621
Battery Storage	750	1,500	3,000	5,791	10,713	17,046	21,465
Pumped Storage	1,435	1,435	1,435	1,435	1,435	1,435	1,435
Total	44,023	51,467	67,667	85,292	114,232	134,694	150,707

Table 3: Scenario 3 Summary Fuel Mix Capacity (MW)

Scenario 3	2020	2025	2030	2035	2040	2045	2050
Nuclear	4,860	3,355	3,355	3,355	3,355	3,355	2,135
Gas & FO	26,388	25,775	22,398	14,292	-	-	-
Zero-Carbon Firm Resource	-	-	-	5,489	23,522	25,230	25,359
Biomass	327	327	327	327	327	275	178
In-State Hydro	4,269	4,269	4,610	4,613	4,613	4,613	4,613
Hydro Imports (Existing)	1,485	1,485	1,485	1,485	1,485	1,485	1,485
Hydro Imports (New)	-	-	1,250	1,250	1,250	1,250	1,250
Wind	1,917	3,292	4,600	5,220	6,126	8,250	10,154
Wind Imports	-	-	2,421	5,448	6,397	6,593	6,593
Wind_Offshore	-	1,826	6,600	10,423	16,756	19,278	19,278
Solar	2,592	8,201	16,762	28,625	41,420	49,042	60,604
Battery Storage	750	1,500	3,000	8,090	12,207	16,383	19,212
Pumped Storage	1,435	1,435	1,435	1,435	1,435	1,435	1,435
Total	44,023	51,467	68,244	90,054	118,894	137,190	152,297

Table 4: Scenario 4: Summary Fuel Mix Capacity (MW)

Scenario 4	2020	2025	2030	2035	2040	2045	2050
Nuclear	4,860	3,355	3,355	3,355	3,355	3,355	2,135
Gas & FO	26,388	25,775	21,579	20,326	-	-	-
Zero-Carbon Firm Resource	-	-	-	-	23,676	24,333	24,048
Biomass	327	327	327	327	327	275	178
In-State Hydro	4,269	4,269	4,610	4,613	4,613	4,613	4,613
Hydro Imports (Existing)	1,485	1,485	1,485	1,485	1,485	1,485	1,485
Hydro Imports (New)	-	-	1,250	1,250	1,250	1,250	1,250
Wind	1,917	3,292	3,859	4,491	6,282	8,305	11,052
Wind Imports	-	-	2,649	5,970	6,397	6,397	6,397
Wind_Offshore	-	1,826	6,600	9,967	15,875	18,066	18,310
Solar	2,592	8,201	18,060	29,841	41,623	53,450	65,210
Battery Storage	750	1,500	3,000	6,311	11,576	18,973	22,956
Pumped Storage	1,435	1,435	1,435	1,435	1,435	1,435	1,435
Total	44,023	51,467	68,210	89,373	117,896	141,938	159,070

The Integration Analysis spreadsheet states that "Resources with 'indefinite' lifetimes are assumed to remain online throughout the study period." I assume that means that the 2020 wind capacity of 1.917 MW in 2020 is not replaced in the total capacity in 2040, 20 years later. Table 5 shows that assumption under-estimates the resource builds in the wind, solar, and energy storage resource categories significantly. If those resource builds are not included then the costs are underestimated too.

Table 5: Additional Capacity Installed for replacement at expected lifetime

Scenario 2	Lifetime	2025	2030	2035	2040	2045	2050	Total
Wind	20				1,917	1,376	522	3,814
Wind_Offshore	20				-	1,826	4,374	6,200
Solar	25				14,438	2,592	5,610	22,639
Battery Storage	10		750	750	1,500	2,791	4,922	10,713

Scenario 3	Lifetime	2025	2030	2035	2040	2045	2050	Total
Wind	20				1,917	1,376	1,308	4,600
Wind_Offshore	20				-	1,826	4,774	6,600
Solar	25				12,795	2,592	5,610	20,996
Battery Storage	10		750	750	1,500	5,090	4,117	12,207

Scenario 4	Lifetime	2025	2030	2035	2040	2045	2050	Total
Wind	20				1,917	1,376	567	3,859
Wind_Offshore	20				-	1,826	4,774	6,600
Solar	25				11,782	2,592	5,610	19,983
Battery Storage	10		750	750	1,500	3,311	5,266	11,576

Reference Case	Lifetime	2025	2030	2035	2040	2045	2050	Total
Wind	20				1,917	1,376	494	3,787
Wind_Offshore	20				-	1,826	4,374	6,200
Solar	25				274	2,592	5,610	8,475
Battery Storage	10		750	750	1,500	1,655	217	4,872

Using an indefinite retirement date for these resources underestimates the total builds needed for 2050. For land-based wind between 3,814 MW and 4,600 MW are not included and for offshore wind between 6,200 and 6,600 MW are not included. The amount of solar not included ranges between 22,639 MW and 19,983 MW. Finally, for battery storage between 10,713 MW and 12,207 MW of additional resources will be need to be developed to meet the 2050 projected value.

Another way to look at the exclusion of these resources is that land-based wind development costs could be up to 45% higher than the projections that don't include reasonable retirement dates because that much more of the resource needs to be developed. Off-shore wind costs could be up to 38% higher, solar costs could be up to 35% higher, and battery storage could be up to 64% higher than projections that exclude reasonable retirement dates.

I have questions for the Climate Action Council. Why shouldn't reasonable retirement dates be included in the Final Scoping Plan. What would the revised costs be if retirements were included? The operational characteristics of battery storage affect expected lifetimes. What did the Integration Analysis assume for thermal management and discharge characteristics? Were those factors included in the estimates of the projected capacity resources?

I prepared this comment because I could not believe that the Integration Analysis authors would apparently ignore all the information that indicates that the lifetimes of wind, solar and battery storage are much less than other generating resources. I have written extensively on implementation of the Climate Act because I believe the ambitions for a zero-emissions economy outstrip available renewable technology such that it will adversely affect reliability and affordability, risk safety, affect lifestyles, will have worse impacts on the environment than the purported effects of climate change in New York, and cannot measurably affect global warming when implemented. The opinions expressed in this document do not reflect the position of any of my previous employers or any other company I have been associated with, these comments are mine alone.

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