I was motivated to submit these comments when I read some of the comments submitted for the April 20, 2017 stakeholder meeting. In particular, I want there to be at least one comment on the record that disputes the idea that the Synapse Energy Economics report entitled *"The RGGI Opportunity 2.0, RGGI as the Electric Sector Compliance Tool to Achieve 2030 State Climate Targets"* (hereinafter the "Synapse Study") makes a compelling case that a RGGI cap that declines by 5% per year from 2020 to 2030 can be achieved easily.

I have been involved in the RGGI program process since its inception. In the final years before my retirement I analyzed air quality regulations that could affect electric generating company operations. The opinions expressed in this post 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. I believe the majority of the stakeholder opinions expressed at meetings and in submitted comments are, in my opinion, very naïve relative to the actual burden implementing their preferred alternatives, overly optimistic about the potential value of continued RGGI reductions and ignore the potential for serious consequences if things don't work out as planned.

In the current program review process many environmental organizations advocate continued reductions based on reductions made to date and cite a report prepared by Synapse Study that outlines a plan that "achieves a 40 percent CO2 emission reduction in the nine states by 2030 by lowering the RGGI cap on electric sector emissions from 78 million short tons in 2020 to 39 million short tons in 2030, and adding a new emission reduction measures in the transportation, buildings, and industrial sectors". For example, in the April 20, 2017 stakeholder comments there was a submittal Joint Comments (38 Environment and Health Organizations) that cited the Synapse report. This study was commissioned by the Sierra Club, Pace Energy and Climate Center and Chesapeake Climate Action Network. The introduction to the Synapse report states that it "…builds upon Synapse's prior analysis of emission reductions in the electric and transportation sectors by additionally analyzing emission reductions in the building sector to create a robust least-cost buildout of compliance with RGGI states' 2030 climate goals."

Synapse Report Rebuttal

I do not believe that the Synapse makes a compelling case supporting a 5% reduction per year after 2020 to the RGGI cap. I did not try to rebut every proposed aspect of the multi-sector analysis. Instead I evaluated four components and have shown that they are overly optimistic. The Synapse study text for these points is shown in italics; my comments in regular text.

Half of Emission Reductions Come from the Electric Sector (p. 7, Synapse Study)

> *Electric-sector efficiency and renewables are responsible for nearly half of the additional required reductions in 2030. Figure 5 presents emission reductions in the electric sector for the baseline and 40 percent emission reduction policy scenarios. In the 40 percent emission reduction scenario, Northeast states' electric sector emissions are capped at 39 million short tons in 2030 compared to the currently mandated RGGI cap of 78 million short tons in 2020.*

The latest EIA data indicates that 2014 electric sector emissions (Table 1) were 86.1 million tons compared to the 78 million ton current cap. Note that coal and residual oil made up 34.6 million tons of the total sector emissions and that natural gas emissions were 51.5 million tons. Since 1990 most of the electric sector emission reductions have been as the result of coal and residual oil reductions primarily due to retirements and changes in operations driven by economics and not necessarily RGGI. Natural gas went up as it displaced the other two fuels.

Table 1: EIA CO2 Emissions from RGGI States
https://www.eia.gov/environment/emissions/state/

	Million metric tons		Million tons	
	1990	2014	1990	2014
All-Sector Emissions	469.6	391.5	517.6	431.6
Electric Power Sector				
Coal	68.3	27.9	75.3	30.8
Petroleum Products	55.6	3.5	61.3	3.9
Natural Gas	18.8	46.7	20.7	51.5
Total	142.7	78.1	157.3	86.1

These data suggest that future reductions necessary to meet the current 2020 cap of 78 million tons is close enough to be achievable. However, an additional 39 million ton reduction is necessary to meet the proposed 2030 cap. The Environmental Energy Alliance of New York (EEANY) White Paper submitted last year determined bounds for the CO2 reductions that could be attributed to RGGI investments to date. The upper bound is an econometric model that estimates that emissions would have been 24 percent higher (31.9 million tons) without the program. RGGI estimates that emissions would have been 17% higher (22.6 million tons) than without a program. If you assume that all the savings in fossil fuel use earned by RGGI investments only displaced natural gas rather than historical use as the RGGI estimate did, then emissions would have been only 5% higher (4.2 million tons). My point is that future reductions will have to come as the result of RGGI and state programs not fuel economics and depending on how you calculate the impact of RGGI programs to date this could be relatively easy or not. Given that future reductions will mostly be from displacing natural gas I believe that it is more difficult than the Synapse study presumes.

Efficiency, Wind, and Solar Drive Down Electric-Sector Emissions (p. 8, Synapse Study)

> *Under the 40 percent emission reduction scenario new, lower RGGI caps drive deeper, more wide-spread changes in the RGGI states' electric system. Figure 6 reports the impact of these measures in terms of generation by resource. Coal, oil, and natural gas-fired generation are replaced by efficiency and renewables. Note that electric sector generation is lower in the 40 percent emission reduction scenario than in the RGGI baseline even though substantial generation is needed to power electric vehicles and heat pumps: savings from energy efficiency outweigh additional electricity sold to owners of electric vehicles and heat pumps.*

> *Renewables supply one-half of the RGGI region's electric generation in 2030 (p. iv, Synapse Study). Adding 50,000 gigawatt-hours of new wind and solar in the 40 percent emission reduction scenario results in a future where half of all electricity generation comes from renewable resources in 2030, compared to just 30 percent in the baseline RGGI scenario.*

The Synapse study neglects a major aspect of the electric system in their assumptions that renewables can replace coal, oil, and natural gas to the extent proposed. The electric power system is very complex and must operate within narrow parameters while balancing loads and resources and supporting synchronism. In countries like Germany, it has only been possible to develop an aggressive level of renewable generation in their power system because Germany is able to rely on neighboring country's conventional facilities in the grid for load support. Synapse has presumed that renewables in the RGGI system can provide the necessary ancillary support but has not shown that it can provide all the important parameters provided by central power stations. For example:

> Conventional rotating machinery such as coal, nuclear, and gas plants as well as hydro generation provide a lot of support to the system. This includes reactive power (vars), inertia, regulation of the system frequency and the capability to ramping up and down as the load varies. Most renewable resources lack these important capabilities and are only intermittently available (e.g., not dispatchable). Unlike conventional generators that rotate at constant speed, wind turbines must rotate at variable speeds so that their rotational energy offers no support to the system.
>
> Some, but not all of the disadvantages of solar and wind energy can be mitigated at extra costs through electronic and mechanical means. When these resources make up only a small percentage of the generation on the system, overall system stability is not adversely impacted in a significant way. Stated another way, when the overall system is robust enough, utilities can allow a small percentage of solar "lean" on the system and still provide a stable source of electricity. As the penetration of solar and wind energy increases the system robustness will degrade and reliability will be compromised without costly improvements.

Such additional costs are not generally applied to the evaluation of renewable resources at this time, and it certainly appears that the Synapse study has failed to take any of these types of costs and issues into account. As noted above, the German grid relies on its neighbors to provide a wide range of support services. It may not be possible for the RGGI electrical systems to support the Synapse study's presumed high penetration of renewable power and the provision of those services are not incorporated in their costs projections. In order for the Synapse projections to work in a real-world scenario the RGGI grid operators will also end up relying on neighboring power systems to provide this support and that could cause "emissions leakage".

Energy Efficiency Savings Are One-Third of Total Emission Reductions (p. 9, Synapse Study)

> *Efficiency measures will continue to lower consumers' bills. Applying Massachusetts' expected electric energy efficiency savings in terms of percent of sales—based on their current three-year plan—to all RGGI states lowers electric sales by 11 percent by 2030. These efficiency savings have been determined to be cost effective in Massachusetts.*

This presumption does not account for the current state of energy efficiency in other RGGI states. If a state is presently more efficient than Massachusetts then it is inappropriate to assume that the same rate of efficiency savings is possible simply because easier energy efficiency targets have already been implemented in the states that are already more efficient.

Wallet Hub analyzed state energy efficiency using data from the U.S. Census Bureau, the National Climatic Data Center, the U.S. Energy Information Administration and the Federal Highway Administration. Their conclusions are highlighted below:

> "To identify the most energy-efficient states, WalletHub analyzed data for 48 states based on two key dimensions, including "home-energy efficiency" and "car-energy efficiency." We obtained the former by calculating the ratio between the total residential energy consumption and annual degree days. For the latter, we divided the annual vehicle miles driven by gallons of gasoline consumed. Each dimension was weighted proportionally to reflect national consumption patterns.
>
> In order to obtain the final ranking, we attributed a score between 0 and 100 to correspond with the value of each dimension. We then calculated the weighted sum of the scores and used the overall score to rank the states. Together, the points attributed to the two major categories add up to 100 points.
>
> Home-Energy Efficiency – Total Points: 55
> Home-Energy Efficiency = Total Residential Energy Consumption per Capita / Degree-Days
> Car-Energy Efficiency – Total Points: 45
> Car-Energy Efficiency = Annual Vehicle Miles Driven / Gallons of Gasoline Consumed

The Wallet Hub 2015 Energy Efficiency RGGI State Rankings are listed in Table 2. Four states are more efficient than Massachusetts and New York and Vermont are markedly more efficient than Massachusetts. Therefore, the presumption that New York and Vermont will be able to reduce emissions by 11% or the same as the Massachusetts expected electrical energy efficiency savings level is difficult to justify and appears to be unfounded.

Table 2: 2015 Energy Efficiency RGGI State Rankings
https://wallethub.com/edu/most-and-least-energy-efficient-states/7354/#main-findings

Overall Rank	State	Total Score	'Home-Energy Efficiency' Rank	'Car-Energy Efficiency' Rank
1	New York	93.36	4	4
2	Vermont	89.71	5	7
6	Rhode Island	78.9	11	10
9	Connecticut	72.75	20	11
11	Massachusetts	71.06	15	21
12	New Hampshire	70.81	6	36
14	Maine	69.77	3	42
18	Delaware	65.76	31	6
29	Maryland	55.13	32	27

1.3 Million Electric Heat Pumps Replace Oil Heaters (p. 11, Synapse Study)

> *In 2015, over 4 million families in the RGGI region were still heating their homes with oil. By 2030, this number is expected to shrink to 3 million households in the RGGI baseline scenario as households move to more efficient forms of heating. These oil furnaces and boilers would release 20.4 million short tons of CO2 into the atmosphere in 2030.*
>
> *The 40 percent emission reduction scenario shifts 1.3 million of the remaining 3 million households from oil to air-source heat pumps by 2030 (see Figure 9). Heat pumps are appliances that use electricity to absorb heat energy in cold areas (i.e., outside) and transfer it to indoor areas. Heat pumps have the advantage of being able to work in reverse—not only can they provide heating in winter months, but they take the place of a central air conditioning systems in the summer months. Heat pump technology has existed for decades, and these units are commonplace in Europe and Asia, but high-performing systems that function well in cold-weather climates as in many of the Northeast states have just recently begun to make inroads in the United States. By shifting heating consumption from inefficient, high-emitting oil boilers and furnaces to highly efficient heat pumps, 9 million short tons of CO2 are avoided.*

Despite the Synapse disclaimer heat pumps are at a disadvantage in cold climates like New York and other RGGI states there are physical issues: "An air-source heat pump works well as long as temperatures are above freezing. Below that temperature, less heat is available, and the pump may have to rely on its supplemental heating coil to warm your home. This coil uses electricity to heat and will increase heating costs." Traditionally, heat pumps have not enjoyed a wide level of penetration in housing markets because consumers are primarily interested in cost of ongoing operation. Furthermore, there does not appear to be any in-place incentives that would lead to a wide-scale shift from conventional oil- and gas-fired boilers to heat pumps. Absent some regulatory requirement or financial incentive program, the Synapse study assumption that one million conventional furnaces will be replaced with heat pumps over a fifteen year period has no basis in fact and appears to be a highly unlikely scenario.

Ten Million Electric Vehicles Offset 28 Million Short Tons of CO2 (p. 12, Synapse Study)

> *The 40 percent emission reduction scenario adds 10 million battery electric vehicles in the nine RGGI states by 2030, above what is currently in place and expected in the baseline forecast (see Figure 10).9 The stock of electric vehicles in the RGGI baseline is based on the Energy Information Administration's 2015 projections and reaches 46,000 vehicles in the RGGI region in 2030. In contrast, Synapse's 40 percent emission reduction scenario assumes that one-third of the RGGI region's light-duty vehicles run on electricity by 2030 based on the Federal Highway Administration's projection of the potential for electric vehicle adoption. These new electric vehicles reduce total RGGI state emissions by 28 million short tons of CO2 in 2030.*

The Energy Information Administration's Annual Energy Outlook 2016 includes tables with projections of future vehicle stocks. The vehicular data are categorized by region not state so it was not possible to reproduce the Synapse Study numbers. Table 40. Light-Duty Vehicle Stock by Technology Type notes that, nationwide, in the reference case there are 340,481 conventional light duty cars in the 100 mile electric vehicle and 200 mile electric vehicle classes in 2016 and in 2030 predicts there will be 3,534,097 vehicles in the reference case and 3,542,276 vehicles in the reference case without the Clean Power plan.

In New York there are about nine million light duty vehicles registered. The Synapse study claims that it is possible to replace one third of the 8.7 million gas powered vehicles with electric vehicles, which equates to 2.9 million electric vehicles in New York by 2030. That would be 82% of the EIA projected total for 2030 for the entire United States. In order to reach the projected total in the Synapse study presumption, over 190,000 per year would have to be sold. At the current time, there are no regulatory structures and likely insufficient financial incentives in place to support this massive level of electric vehicle penetration.

Presuming for a moment that it would be possible to effect such a significant change in the driving habits of New Yorkers for example, the Synapse study has not taken into consideration that there are significant infrastructure requirements for the 2.9 million electric vehicles projected. One of the greatest impediments to the further development of electric vehicle market is that charging stations in public places have not yet been implemented on a widespread basis nor has a satisfactory cost model been developed on how to finance such a massive infrastructure build-out. Clearly, if one in every third car parked on a New York City street is to be an electric vehicle, significant costly changes to the existing electrical systems must come about. The Synapse study has not taken those costs into account in its presumption that an unprecedented change in the vehicle market will lead to the emission reductions proposed.

Summary

I looked at four components of the Synapse study: electric sector, energy efficiency, home heating and electric vehicles. Synapse claims 103 million ton CO_2 emission reductions when these recommendations are implemented. In the following I offer alternative estimates of the tons saved based on the aforementioned evaluation.

In the Synapse electric sector analysis (section 2.4, p. 7) half of the emission reductions or 39 million tons come from the electric sector. The big unknown is how much renewable will displace the natural gas usage and it was argued above that as little as 4.3 million tons of reductions occurred because of RGGI itself. Synapse assumes that the state renewable portfolio standards will be implemented but does not explain how. For example, they note that:

> For New York, in addition to modeling the existing RPS (approximately 24 percent of retail electric sales by 2015), we modeled an additional 3,000 MW of utility-scale photovoltaic (PV) solar added by 2023 and an additional 1,600 MW of wind added by 2029, in line with the New York State Energy Research and Development Authority's (NYSERDA) projections for capacity that will come online as a result of the *NY-Sun* and *Large-Scale Renewables* programs

The missing piece is how much generation will that presumed additional capacity generate and how much will it displace natural gas generation. It is not enough to assume that it is a straight ratio because the ancillary services provided by traditional power plants would not be included. Synapse did not account for electric system reliability issues in its projected penetration of renewables into the RGGI states power system. For an upper bound estimate of potential reductions I used the 2014 EIA data and assume that petroleum products are already at their de minimus level, coal goes to zero, and that natural gas stays the same assuming that the replacement of coal by natural gas equals the reduction by renewables. Using those assumptions there are only 22.6 million tons of savings.

The energy efficiency Synapse projection (section 2.6, p. 9) accounts for one third of total emission reductions or 27 million tons. Their analysis presumes that the Massachusetts rate of energy efficiency improvement can be applied to four states that have better efficiency but that is inappropriate. I assumed that the expected energy improvement of 11% in those four states would only be half of that, scaled the reductions as a function of residential and commercial end use and determined that instead of 17 million tons of electric energy efficiency there would only by 12.1 million tons. The remaining 10 million tons of Synapse energy efficiency comes from gas energy. They simply assumed without much justification that it could be improved by 1% per year but I accept their guess even though Synapse overestimated the amount of emissions savings that are available from energy efficiency programs absent additional policy and/or regulatory structures.

For home heating (section 2.7, p. 11) Synapse projects that 1.3 million heat pumps will replace of the 3 million home heating furnaces still on oil saving 9 million tons of CO_2. Their analysis does not address the physical constraints of heat pumps in freezing weather. Synapse has not provided a plausible structure that will bring about its projected transition to electrically-powered heat pumps. Rather than their high bound assumption that 43% of the furnaces will be converted to heat pumps I think a realistic number for conversion is 10% so the CO2 savings could be 2.1 million tons.

The Synapse electric vehicle scenario (section 2.8, p. 12) projects that there will be 10 million electric cars in RGGI by 2030 and also notes that EIA projects only 46,000 electric vehicles by 2030. That equates to some kind of incentive program to get RGGI drivers to buy 9,954,000 electric vehicles and even if the incentive is only $1,000 that is over $9 billion dollars. Synapse failed to appreciate the complexities and costs associated with a massive conversion of driving preferences to electric vehicles. In the real world a more realistic estimate would be RGGI incentivizes an order of magnitude more electric vehicles (460,000) and the CO2 savings would be 1.3 million tons.

Synapse claims 103 million ton CO2 emission reductions when their recommendations for these four components are implemented. However, based on my evaluation I expect that a reasonable lower bound to future reductions is only 51.6 million tons from these four components.

Final Note

As a retiree on a fixed income I would like to make one last point in response to the April 20, 2017 stakeholder comment in this submittal Joint Comments (38 Environment and Health Organizations). They state: "we see tremendous opportunity to achieve climate, public health and economic benefits by committing to a more ambitious RGGI program". I believe that it is incumbent on RGGI to quantify the expected changes that could occur as a result of the proposed reductions after 2020 so that those of us on fixed or low incomes can be assured that the proposed costs have tangible benefits.

In the absence of such an analysis to date I have adapted data for RGGI emissions in Table 3 from the analysis in Analysis of US and State-By-State Carbon Dioxide Emissions and Potential "Savings" In Future Global Temperature and Global Sea Level Rise. The original analysis of U.S. and state by state carbon dioxide 2010 emissions relative to global emissions quantifies the relative numbers and the potential "savings" in future global temperature and global sea level rise from a complete cessation of all CO2 emissions in the RGGI region as well as the activist's call for a further 39 million ton reduction. If further reduction are proposed then RGGI should provide their own projection on the impact to global temperature and global sea level rise.

My analysis shows current growth rate in CO2 emissions from other countries of the world will quickly subsume any reductions in RGGI CO2 emissions. According to data from the U.S. Energy Information Administration (EIA) and based on trends in CO2 emissions growth over the past decade, global growth will completely replace an elimination of all 2010 CO2 emissions from RGGI states in 190 days. For the emissions reductions proposed consistent with a 5% year reduction in the cap in the draft energy plan (2030 cap of 39 million tons), global growth will completely replace the expected reductions in 16days.

Furthermore, using assumptions based on the Intergovernmental Panel on Climate Change (IPCC) Assessment Reports we can estimate the actual impact to global warming for a change to the cap. If the RGGI 2030 cap is set at 39 million tons for an additional reduction of 39 million tons the ultimate impact on projected global temperature rise would be a reduction, or a "savings," of approximately 0.00052°C by the year 2050 and 0.00108°C by the year 2100.

Clearly, if the effects of the expected emissions reductions on global temperature rise are so small that they cannot be reasonably expected to be measured, then the potential effect on the purported environmental impacts of climate change in RGGI will similarly be too small to measure. If RGGI has a different assessment of the potential impacts of this plan then it should be provided.

RGGI has been a success inasmuch as it has successfully demonstrated how a cap and auction program can be run, has contributed to the observed CO2 reductions and has provided worthwhile investments in energy efficiency and energy conservation. I recommend that the post 2020 RGGI cap only be adjusted as a function of the emission containment reserve. If RGGI investments reduce CO2 emissions then the price will come down and the emission containment reserve can be set up to reduce the cap based on actual reductions. Post 2020 the auction proceeds can continue to be invested to facilitate further reductions and minimize impacts to those least able to pay for additional energy costs. However, it appears that including climate benefits as the result of lowering the cap post 2020 as a specific policy objective is nothing more than a feel good gesture.

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Table 3: Analysis of Carbon Dioxide Emissions and Potential "Savings" in Future Global Temperature and Global Sea Level Rise from a Complete Cessation of All CO2 Emissions in the RGGI States and the United States in Addition to the RGGI Observed Reductions and a 39 million ton 2030 Cap

http://scienceandpublicpolicy.org/images/stories/papers/originals/state_by_state.pdf

Scenario	CO_2 Emissions Million Metric Tons	Percentage of Global Total	Time Until Total Emissions Subsumed by Global Growth		Temperature "Savings" Deg C		Sea-Level "Savings" (cm)	
			Global Growth	China Growth	2050	2100	2050	2100
CT	36.9	0.12	17	26	0.0005	0.0011	0.0039	0.0118
DE	11.7	0.04	5	8	0.0002	0.0004	0.0012	0.0037
ME	18.5	0.06	8	13	0.0003	0.0006	0.0020	0.0059
MD	70.5	0.22	32	50	0.0010	0.0022	0.0075	0.0225
MA	73	0.23	33	51	0.0011	0.0022	0.0078	0.0233
NH	17	0.05	8	12	0.0003	0.0005	0.0018	0.0054
NY	172.8	0.55	79	121	0.0025	0.0053	0.0184	0.0552
RI	11	0.03	5	8	0.0002	0.0003	0.0012	0.0035
VT	6	0.02	3	4	0.0001	0.0002	0.0006	0.0019
RGGI Total	417.4	1.33%	190.0	293.1	0.0062	0.0127	0.0445	0.1334
US Total	5631.3	17.88%	2,563	3,954	0.083	0.172	0.6	1.8
RGGI Impacts								
RGGI Reductions to 2020	44.5	0.14%	20.2	31.2	0.00066	0.00136	0.00474	0.01421
RGGI 2030 Cap 39 million tons	35.4	0.11%	16.1	24.8	0.00052	0.00108	0.00377	0.01131