ERM

200 Charles Ewing Blvd.
Suite 160
Ewing, NJ
08628

Telephone: +1 609.895.0050
Fax: +1 609.359.8664

www.erm.com

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Board Secretary, Aida Camacho-Welch
Board of Public Utilities
44 South Clinton Avenue, 9th Floor
P.O. Box 350, Trenton, NJ 08625-0350
Zec.Comments@bpu.nj.gov

Testimony for Toby Hanna, ERM

Public Comments for: The Application of PSEG Nuclear, LLC and Exelon Generation Company, LLC for the Zero Emission Certificate Program

BPU Docket Nos.: ER20080557, ER20080558, & ER20080559

My name is Toby Hanna. I am a Partner at ERM, where I lead ERM's Air Quality and Climate Change practice. I have 30 years of experience as a licensed professional engineer helping companies manage air pollutant and greenhouse emissions. I am testifying today to provide my endorsement that retaining nuclear generation of electricity is presently one of the most significant and economical options for avoiding greenhouse gas emissions and preventing worsening ozone air pollution.

Last summer, I led a team of engineers and scientists that conducted research on the greenhouse gas and air pollution impacts that would occur if one or more of PSEG's three nuclear reactors in New Jersey were to stop generating electricity. Our two reports found that:

1. The operation of PSEG Nuclear's units have resulted, and are projected to continue to result, in significantly lower levels of greenhouse emissions than the levels that would be emitted if these nuclear reactors were not operating.

2. Ozone pollution, the primary component of smog, will increase if these nuclear reactors stop generating electricity.

I will provide further detail on these two areas.

With respect to greenhouse gases, we used data from market models to calculate the greenhouse gas emissions that would be emitted by the units that would generate the electricity that ordinarily would have been provided by PSEG's nuclear units. This electricity deficit would be supplied by a mix of coal, natural gas, other nuclear units, solar, wind, and a small number of oil and renewable electricity generating units. Most of those units are located in other states, meaning no economic or jobs benefits for New Jersey, just more pollution. That range of generating units emits varying amounts of greenhouse gases. Coal units emit the most greenhouse gas per unit of electricity output and the nuclear, solar, and wind units are essentially zero emitting. The combination of hundreds of generating units that would be dispatched to replace the 3 PSEG nuclear reactors emit significantly more greenhouse gases than the 3 nuclear units would emit for the same electricity supplied. We did this analysis as a 10 year look back (2010 – 2019) and a 6 year look forward (2020 – 2025). Our research demonstrated that operation of PSEG's three nuclear reactors resulted in 10 to 20 million metric tons **fewer** greenhouse gases (CO_{2e}) emitted per year

between 2010 and 2019. Further, even considering lower emitting generating units coming on line in the future, there will be 10 to 12 million metric tons **fewer** greenhouse gases (CO_{2e}) emitted each year when these nuclear units operate between 2020 to 2025. These greenhouse gas impacts are massive, considering that New Jersey's historical Electricity Generation Sector greenhouse emissions averaged about 18 million metric tons per year over the last decade (2010-2019). In other words, if these nuclear reactors were to shut down, New Jersey's electricity sector's annual greenhouse gas emissions would increase 60-100% over the 16-year review period, making it much harder to meet New Jersey's greenhouse gas reduction commitments under the Global Warming Response Act.

Ozone, which is regulated for its health impacts such as asthma and other respiratory and heart conditions, is measured as a concentration in ambient air. USEPA and NJDEP consider a safe level to protect public health and welfare to be 70 parts per billion on an 8-hour average basis, which is the National Ambient Air Quality Standard or NAAQS. New Jersey's air persistently exceeds this standard, particularly in urban areas where disproportionate health impacts can be greater for low income and minority citizens. New Jersey has been fighting for years to bring down its ozone levels across the state and has made significant improvements, but the 70 ppb standard is still not attained. We are close, but the remaining challenges have few available solutions. Reductions of even fractions of a ppb are very hard to come by, and New Jersey cannot afford to allow increases when decreases are nearly impossible. In addition to the health impacts of not meeting the ozone NAAQS, there are also penalties and sanctions that New Jersey will incur if it cannot attain the standard. Our ozone air quality study assessed the ozone impact from the anticipated power generation shift from nuclear power plants owned by PSEG Nuclear to fossil-fuel based and other generating sources in the Eastern U.S. This assessment involved an air quality modeling analysis for ground level ozone, which is formed due to photochemical reactions involving many compounds, principally oxides of nitrogen (NOx) and volatile organic compounds (VOCs), which are regulated by the USEPA as ozone precursor air pollutants. That is, direct emissions of NOx and VOCs from sources such as fossil fuel-fired power plants photochemically react in the atmosphere to produce ground-level ozone. Similar to our greenhouse gas analysis, we used the market model predictions to determine which generating units will "fill the void" and supply the electricity that would not be provided by PSEG's nuclear units if they were to shut down. This allowed projection of the increases in NOx and VOC emissions, which were in turn modeled with a photochemical atmospheric air quality model that is commonly used by air pollution control agencies to predict ozone concentrations. Through our ozone impact analysis, we concluded that shutting down the three PSEG nuclear reactors would increase maximum 8-hour ozone concentrations by 0.11 ppb in New Jersey. This increment of ozone pollution will be extremely challenging for New Jersey to overcome and the resulting health impact, particularly in urban communities, is a clear priority for improvement.

As a licensed professional engineer, I recognize the necessity of balancing economic and environmental factors when considering emission reduction choices. For greenhouse gas emission reductions, on the order of 10 million metric tons, it is hard to beat the economics of the ZEC program for nuclear electricity generators.

The tool that is commonly used to evaluate this balance of economic feasibility is a simple cost benefit analysis. There are a number of benefits associated with the preservation of New Jersey's

nuclear reactors: affordable energy, jobs, better air quality, and lower greenhouse gas (or carbon) emissions.

If we look at benchmarks for acceptable cost benefit values for carbon mitigation options, we will find values backed by credible scientific and accounting principles that range from $23 to $175 per metric ton of CO_2e for the 2020 to 2030 timeframe. In fact, the study performed by the United States Interagency Working Group on the Social Cost of Carbon, expressly identified in ZEC Act findings as support for the law, for 2020, calculated an average value for the social cost of carbon as $59.75 per metric ton of carbon.

These cost benefit figures are commonly known as the social cost of carbon. They represent the value to society of avoiding the adverse impacts associated with higher levels of greenhouse gases in the atmosphere, which largely relate to climate change. As a coastal state, New Jersey could be particularly susceptible to the impacts of climate change and associated rise in sea levels it could bring.

In the case of New Jersey's nuclear electricity generation fleet, which presently consists of PSEG's three nuclear reactors, we can calculate a cost of avoided carbon across the entire PJM grid by assuming that all of the $10/MWh ZEC goes solely to avoiding the carbon associated with 1 MWh of electricity generation. To understand the full greenhouse gas reduction benefit that these nuclear units provide, our analysis included all of the electric generation that these nuclear units effectively replace, regardless of the state that they are located in. It would provide an incomplete picture to only look at the New Jersey-based greenhouse gas emissions that are offset by the nuclear units. In 2019, the PJM marginal CO2 emission rate was 1,216 lbs/MWh. Using this factor the cost of avoided carbon within PJM is $18 per metric ton. This is in comparison to a cost of avoided carbon from solar and offshore wind of approximately $105 and $400 per metric ton, respectively. Note that this entails the conservative assumption that no other added benefits result from that ZEC, when arguably other incremental benefits such as avoidance of other air pollutants, reliable/resilient energy, overall lower cost for energy, and the retention of high quality jobs are also funded by each ZEC. Discounting for those benefits when calculating the cost of avoided carbon would reduce the cost of avoided carbon to a lower level, but to simplify the analysis we can put aside that discount. Even with the conservative assumption that all of the ZEC price goes solely to preventing increased carbon emissions, this is below the documented social cost of carbon values in the most widely accepted scientific studies, making the preservation of PSEG's three nuclear reactors both a good environmental choice and a good economic choice.

This concludes my comments. Please feel free to contact me if you have any questions.

Sincerely,

William M. Hanna, P. E.
Partner