Anthony R. Ingraffea, Ph.D., P. E.

Consulting Engineer

19 Hemlock Lane, Ithaca, NY 14850

Expert Report

by

Anthony R. Ingraffea, Ph.D., P.E.

In the matter of:

A Supplemental Environmental Impact Statement for the Cricket Valley Energy Center

Prepared for

Sussman and Associates

1 Railroad Avenue, Suite 3

Goshen, NY 10924

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1.0 Personal Background

I am the Dwight C. Baum Professor of Civil and Environmental Engineering, Emeritus, at Cornell University. I hold a PhD in Civil Engineering from the University of Colorado, Boulder, an MS in Civil Engineering from the New York University Polytechnic School of Engineering, and a BS in Aerospace Engineering from the University of Notre Dame. I am a licensed Professional Engineer in the states of Texas, Colorado, and New York.

I have expertise in rock mechanics, rock fracture, hydraulic fracturing for well stimulation, design of high-pressure gas pipelines, computational mechanics, methane emissions, oil/gas well drilling and cementing, and oil/gas well integrity. During the period from 1977-2004, I performed paid consultancy and sponsored research for the oil/gas industry and the federal government, including EXXON, Amoco, Schlumberger, the Gas Technology Institute, the New York Gas Group, and the U.S. Department of Energy.

I have published more than 315 technical journal articles, proceedings papers, and reports during my career. I have written 5 book chapters on computational and experimental geomechanics and hydraulic fracturing. Since 2006, I have been the Co-Editor-in-Chief of *Engineering Fracture Mechanics,* the premier journal in the field of fracture mechanics. I have won the highest American honor for fracture mechanics, the George Irwin Medal of the American Society for Testing and Materials:

> "The award, given by ASTM Committee E08 on Fatigue and Fracture, honors Ingraffea's pioneering and outstanding contributions to the advanced computational simulation of fatigue and fracture processes and the resulting improved understanding necessary for practical applications of fracture mechanics to the assessment of integrity in engineering structures."

I have also twice (1978, 1991) won the National Research Council/U.S. National Committee for Rock Mechanics award for outstanding research in rock mechanics, the latter specifically for research into hydraulic fracturing.

My professional résumé is attached as Appendix A.

2.0 Opinions

I have thoroughly reviewed the Draft Environmental Impact Statement (DEIS, 2011) and the Final Environmental Impact Statement (FEIS, 2012) submitted to the New York State Department of Environmental Conservation by the Cricket Valley Energy Center, LLC (CVEC).

To a reasonable degree of engineering certainty, I conclude that:

1. The CVEC devoted only 3 pages of its DEIS, and only 1 page of its FEIS, to GHG emissions from its proposed plant. This indicates that such emissions were not in 2011, and still are not in 2019, considered by CVEC to be of much importance.
2. The DEIS and FEIS contain serious errors and omissions. The most important error is CVEC's calculation of CO_{2e} emissions because it vastly underestimates the effect of both direct and indirect methane emissions on this calculation.
3. The DEIS, Table 4.2, claims this calculation to be 3,630,484 tpy (tons per year) CO_{2e}. This calculation is based on blatantly incorrect assumptions and is a gross underestimate.
4. Assumption 1 is that there will be only a "trace amount" of directly emitted methane from plant operations. Yet Lavoie *et al.* (2017) documented through direct measurement that natural gas fired power plants emit 21 to 120 times more methane than had been assumed and reported in their EIS's. CVEC could not have known this in 2011, but they have now known it for over a year and have not corrected its FEIS.
5. Assumption 2 is that indirect methane emissions do not include those from upstream production, storage, processing, and transporting via pipeline. By 2011, CVEC should have known that a significant percentage of methane from these upstream/midstream operations leaks, yet they chose to ignore this GHG source. The US EPA was then estimating that at least 1.8% of delivered methane leaks. We now know that that estimate is way too low, and a conservative value is about 2.9% of delivered-to-city-gate methane leaks today (Alvarez *et al.,* 2018). This means that CVEC is NOT INCLUDING 2.9% of its 170 million cubic feet per day as indirect methane emissions.
6. Assumption 3 is that, in 2011, CVEC used the lowest available global warming potential (GWP) for methane, 21 over a 100-year period of impact (GWP100), a value that had

been superseded in the IPCC AR4 of 2007 which cited a value of 25 for the 100-year period. So, in 2011, CVEC was underestimating the impact of both direct and indirect methane by 16%. That underestimate is even worse when seen from the time of the FEIS. We now know through IPCC AR5 (2014) that a more accurate value of methane GWP100 is 28, so today CVEC is underestimating 100-year methane impacts by 25%.

7. One can combine the fault indicated in item 6, not including upstream/midstream methane emissions, with assumption 3, use of a very out-of-date methane GWP100. If one calculates the CO_{2e} value of 2.9% of 170 million cubic feet per day consumed using a GWP100 of 28, one gets about 140 million cubic feet per day of CO_{2e} from methane. That is about 880,000 tpy of neglected CO_{2e}. This means that the value claimed in Table 4.2 (see Item 3, above), should be at least 4,500,000 tpy, about 25% higher because of neglected indirect methane emissions. It should be higher still because of the underestimation of CO_{2e} from direct emissions.
8. Moreover, something else has changed since 2011: one should no longer focus on GWP100. The IPCC Special Report on 1.5 ºC (2018) emphasizes that one must now be focused on GWP20, or even GWP10 values for methane. Figure 1 shows why this is correct; we have run out of time to wait for drastic reductions in GHG emissions because as the data since 2011 (the red dots in this figure) show, we are already perilously close to that 1.5 degree C danger threshold, and global warming projections (purple solid colored line in this figure) are, unfortunately, very accurate.
9. If one uses the IPCC 5 methane GWP20 of 86, and redo the calculation shown in item 7, one gets an additional 2,700,000 tpy of CO_{2e}. Therefore, the value in Table 4.2 should then be at least 6,300,000 tpy CO_{2e}, a value at least 75% higher than shown in the DEIS. Again, it should be even higher because of the underestimation of CO_{2e} from direct emissions.
10. Because of these faulty assumptions and errors, CVEC must be required to submit to the DEC a Supplemental Environmental Impact Statement that accurately reflects what is now well-known about methane emissions, both direct and indirect, and their impact on climate change.

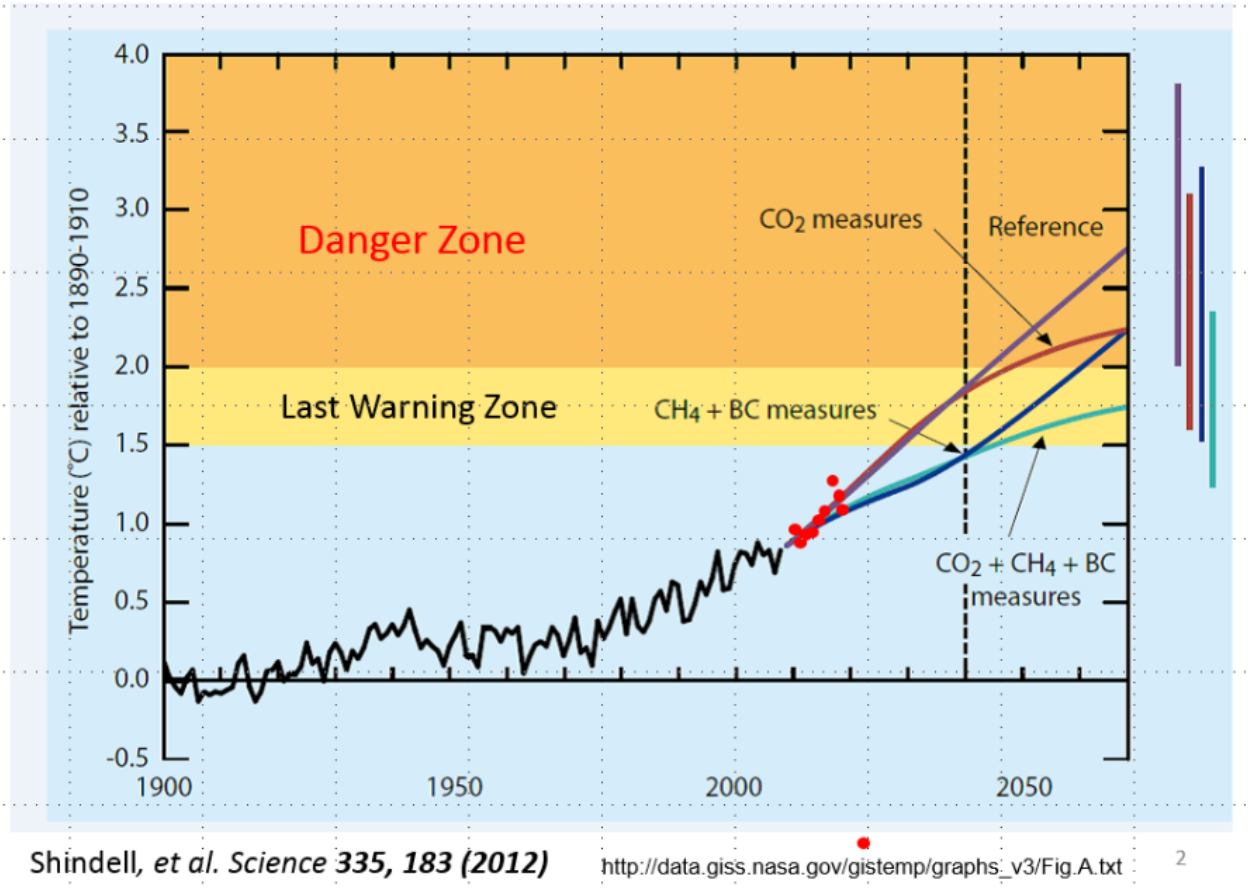

Figure 1. History and forecast of global warming. Black line is history to 2009. Solid colored lines are forecasts for different future scenarios, beginning in 2010. Purple line is the reference, business-as-usual scenario. Red dots are additional data points for years 2011-2018. Vertical colored lines are 95% confidence intervals for the respective scenario forecasts.

3.0 REFERENCES

Alvarez R, *et al.* Assessment of methane emissions from the U.S. oil and gas supply chain. *Science*, 2018, Vol. 361, Issue 6398, pp. 186-188, DOI: 10.1126/science.aar7204

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APPENDIX A

Professional Résumé of Anthony R. Ingraffea