

**SUPERIOR COURT OF THE DISTRICT OF COLUMBIA
CIVIL DIVISION**

Mark Z. Jacobson, Ph.D.,)	
)	
Plaintiff,)	
)	
v.)	2017 CA 006685 B
)	Judge Elizabeth Wingo
Christopher T.M. Clack, Ph.D.)	Next Court Date: None Scheduled
)	
and)	
)	
National Academy of Sciences,)	
)	
Defendants.)	
_____)	

DECLARATION OF DR. ANTHONY R. INGRAFFEA

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1. My name is Dr. Anthony R. Ingraffea. I am over the age of 18 and competent to make the following Declaration.
2. I currently am the Dwight C. Baum Professor of Engineering, Emeritus, at Cornell University.
3. I am author or co-author of over 250 peer-reviewed technical publications, including papers in the PNAS.
4. I have authored or co-authored papers related to the ongoing national energy transition, including papers co-authored by Dr. Jacobson.
5. I am aware of the litigation filed by Dr. Jacobson and certain claims related to papers entitled Jacobson MZ, Delucchi MA, Cameron MA, Frew BA (2015a) *Low-cost solution to the grid reliability problem with 100% penetration of intermittent wind, water, and solar for all purposes*, PNAS 112:15060–15065 and Jacobson MZ, Delucchi MA, Cameron MA, Frew BA (2015b) *Low-cost solution to the grid reliability problem with 100% penetration of intermittent wind, water, and solar for all purposes*, PNAS 112:15060–15065 (the “Jacobson papers”), and *Evaluation of a proposal for reliable low-cost grid power with 100% wind water and solar*, PNAS, doi:1073/pnas.1610381114, 2017 (the “Clack paper”). I am not a co-author of any of these papers, and am examining them as an independent scholar for the purposes of this declaration.
6. I was not named as a defendant in the litigation and have not participated in the litigation prior to submitting this Declaration.
7. The Clack paper claims that the Jacobson Papers “...do not show the technical, practical, or economic feasibility of a 100% wind, solar, and hydroelectric energy vision...” and contain “...modeling errors; incorrect, implausible, and/or inadequately supported assumptions; and the application of methods inappropriate to the task.” The purpose of my declaration is to refute three (3) of the most important claims of the Clack paper and their assertion that it is mere “scientific disagreement” that is the space between theirs and the Jacobson papers.
8. Claim #1: The Clack paper bases much of its allegations pertaining to unfeasibility, inaccuracy, and modeling errors on its incorrect assessment of Table 1 in the Jacobson paper (2015a). Clearly, Clack *et al.* incorrectly assessed the numbers in Table 1 as “maximum” values. They state:

“The maximum possible from table 1 of ref. 11 is given as 1,064.16 GW, whereas figure 3 of ref. 11 shows that flexible load (in green) used up to 1,944 GW (on day 912.6). Indeed, in all of the figures in ref. 11 that show flexible load, the restrictions enumerated in table 1 of ref. 11 are not satisfied.” (emphasis mine)

The Jacobson paper (2015a) clearly states, through a footnote citation to an earlier Jacobson paper (Jacobson *et al.* Energy and Environmental Sciences, 2015), that the numbers in Table 1 are not “maximum” values, but rather “average” annual values. This is not a matter of scientific disagreement. Rather, it is a matter of fact: the numbers in Table 1 are either maximum values, or they are average values. It is not a matter of scientific disagreement to state that, for example, two parties can look at the set of numbers, 5-6-7-8-9-10, and disagree on the point that their average is 7.5 while their maximum is 10. That would be a disagreement of fact, not opinion, scientific or otherwise. This is a crucial point, because subsequent incorrect allegations based on this error in fact percolate throughout the remainder of the Clack paper, as they themselves state:

“Indeed, in all of the figures in ref. 11 that show flexible load, the restrictions enumerated in table 1 of ref. 11 are not satisfied.”

9. Claim #2: Clack alleges that it is only “scientific disagreement” concerning the Jacobson paper use of Canadian hydropower in its calculations. Again, this is a matter of fact, not opinion: either it does or it does not include such imports. The Clack paper clearly errs in **fact** in asserting that hydroelectric output used in the Jacobson paper calculations is from U.S. facilities only:

“For example, the numbers given in the supporting information of ref. 11 imply that maximum output from hydroelectric facilities cannot exceed 145.26 GW (SI Appendix, section S1.1), about 50% more than exists in the United States today (15)...”

However, in a footnote to Table S2 of the Jacobson paper (2015a), there is clear reference to the same earlier Jacobson paper which clearly defined hydropower capacity used in Jacobson’s calculations as the sum of both U. S. supplies and imported Canadian supplies.

10. Claim #3: The Clack paper includes a distinct section entitled “Modeling Errors” implicating Jacobson’s LOADMATCH computer program as a source of such alleged errors. However, the Clack paper also includes a distinct section entitled “Implausible Assumptions”. I have led the development of many predictive computer programs, including highly successful commercial programs, and am very aware of the distinction between an alleged modeling error and an implausible assumption in the execution of a computer program. A modeling error is commonly known as a “bug” in the code: given correct input, it gives incorrect, or no, output. A code is not “buggy” if it is given incorrect input but correctly performs all its intended operations on that input; in this case, the incorrect input was based on incorrect or implausible assumptions. Therefore, I conclude that the Clack paper was asserting in its “Modeling Error” section the existence of a “bug” or “bugs” in LOADMATCH; else, why include a separate section called “Implausible Assumptions”?

11. Together, claims #1, #2, and #3 indicate to me a degree of carelessness in the Clack paper that should have been caught and corrected, pre-publication, by one or more of the 21 co-authors of the paper and/or by one or more of its PNAS reviewers.

I declare under penalty of perjury that the foregoing is true and correct. Executed on July 22, 2020.

A handwritten signature in black ink, appearing to read 'A. Ingraffea', with a long horizontal flourish extending to the right.

Anthony R. Ingraffea