The Energy Advocate

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Scientific American Sokalized

John Kasch, M.D. of Sacramento sent me an article by Mark Z. Jacobson and Mark A. Delucchi in the November 2009 issue of *Scientific American* called "A Path to Sustainable Energy." My first impression was, "These guys must be joking." My second impression was, "Yes, they *are* joking, and the joke is on *Scientific American*." Jacobson and Delucchi wrote a spoof to show what tomfoolery can be published in *Scientific American*, rather like Alan Sokal's spoof of post-modernist jargon in *Social Text* (TEA December 2007). They did manage to squeeze in some calculations that detail what is really involved in a carbon-free economy, but avoided all precautionary words, lest the editors reject the manuscript. It's a laugh a minute.

The authors have humorously gone way beyond Al Gore's challenge to "to repower America with 100 percent carbon-free electricity within 10 years." They have a plan "to determine how 100 percent of the world's energy, for *all* purposes, could be supplied by wind, water and solar [WWS] resources, by as early as 2030."

I suppose that if the authors had suggested power lines directly from wind farms to C-5A air transport planes, the editors of *Scientific American* would have caught on, but the ever-practical Jacobson (civil engineering professor at Stanford) and Delucchi (transportation expert at the University of California-Davis) used a more subtle approach.

For example, their analysis concluded that nuclear power was a poorer option than wind, solar, geothermal, tidal, and hydroelectric power because some CO_2 is produced when the plant is built and when the fuel is refined. Just think of all the CO_2 released when they make concrete for the containment building (and forget the concrete used in making thousands of concrete bases for wind towers required to get the same power). While we're at it, we can forget about the manufacture of all the support towers and concentrate on the steel used in the 10-meter reactor vessel. See, this kind of stuff just slips past the editors.

On that topic, there is a lot of CO_2 released when uranium is refined; gosh, that electricity comes from coal-fired power plants. It will never occur to the editors that the electricity could come from nukes instead, so Jacobson and Delucchi (J&D) could slip that right under their noses without fear that the editors would detect the spoof.

I have no idea how J&D got one patently absurd thought past the *Scientific American* editors, but it must have worried them that the spoof would be discovered. They not only used some ridiculous words, but demonstrated their idea with a totally preposterous chart. It all has to do with average downtime for annual maintenance. Coal plants are down on average for 46 days a year, whereas wind and photovoltaics only have 7 days of downtime. This is indicated in the article by a chart with 365 dots, some colored to represent coal, wind, and PV. They say,

> The average U.S. coal plant is offline 12.5 percent of the year for scheduled and unscheduled maintenance. Modern wind turbines have a down time of less than 2 percent on land and less than 5 percent at sea. Photovoltaic systems are also at less than 2 percent.

A savvy editor would ask how much *uptime* they have. As a matter of fact, a savvy editor would *know* that the annual capacity factor of a coal plant is almost 3 times that of wind and more than 5 times that of PV. But that only shows that J&D are excellent spoofers, who recognize the abysmal educational level of the *Scientific American* editors.

The spoof continues. Their mix of sources contains 1.7 billion rooftop solar photovoltaic systems, each of 3 kilowatts. They note that less than 1% of these are in place. True enough. If they were serious, they would have used a much smaller number. "Less than 1%" covers a lot of territory. Less than 1% of all men are 2.0155 meters tall with one green eye and one brown eye, yellow hair, a gray beard, a broken ankle, and only their four wisdom teeth in their mouths.

Let's see. The world population is 6.7 billion. Likely, there are 5 people per household, making about 1.3 billion homes, *some* of which are single-family homes with good sunlight. (The US and Europe have anomalously low family size.) So, precisely where might these 1.7 billion sun-baked rooftops with southern exposure come from? J&G slipped another one past the number-challenged editors.

Perhaps the strongest clue that J&D wrote a spoof is that the hallmark of good engineering is overweening practicality. Given their fantastic credentials in California universities, one would expect an article by the authors to be intellectually brilliant, solidly analytical, and exquisitely practical. As their *Scientific American* article is none of the above, it was obviously intended to show that you can publish anything in *Scientific American* so long as it is fashionable nonsense.

I am sure that Alan Sokal is proud of their effort.

But Wait! There's More!

So pro-renewable are the *Scientific American* editors that they missed a few other things, like the fact that the sun doesn't shine at night, and the wind never blows steadily. They accept J&D's child-like explanation and a very smooth graph shown in Fig. 1.

> "Intermittency problems can be mitigated by a smart balance of sources, such as generating a base supply from

steady geothermal or tidal power, relying on wind at night when it is often plentiful, using solar by day and turning to a reliable source such as hydroelectric that can be turned on and off quickly to smooth out supply or meet peak demand."

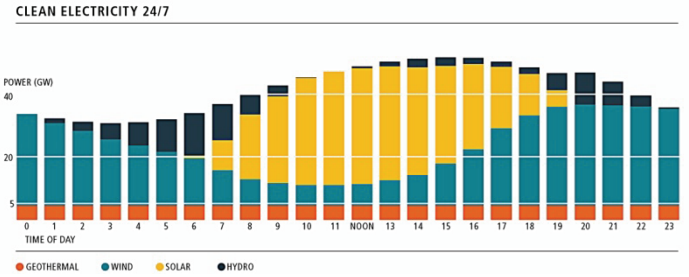

Figure 1: "Clean Electricity 24/7" from Jacobson and Delucci. Geothermal is on the bottom, wind is next up, and solar is the splotch in the middle. A little bit of hydro smoothes everything out. Right.

Anybody who knows anything about wind power would know that wind power is proportional to the cube of wind speed and that the wind speed varies all over the map. Figure 2 shows power data from a real wind farm, and it bears no resemblance to the J&D cartoon shown in Fig. 1. Fluctuations like those seen in Fig. 2 occur on all time scales.

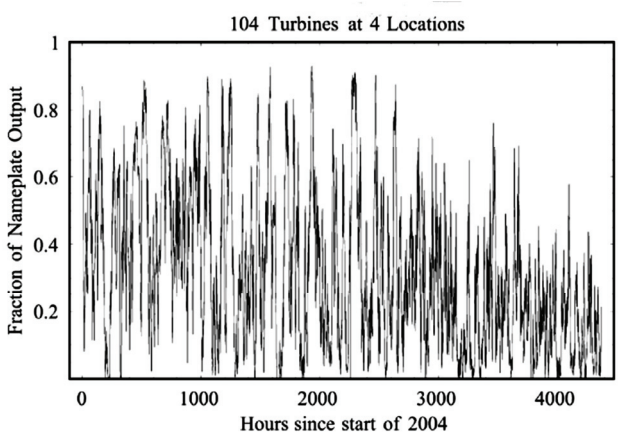

Figure 2: Power output from a 104-turbine wind farm, in relative units, versus time for about a half of a year.

So taken were *Scientific American*'s editors by the erudition[1] of the J&D article that they use the headline: "Wind, water, and solar technologies can provide 100 percent of the world's energy, eliminating all fossil fuels." J&D must have told the editors that their calculator said so.[2] If you know what they're doing, *these guys are funny!*

It is extremely easy to solve problems if there are no constraints. A good example is in an ancient joke. "How do you get four elephants into a VW?" "Easy. Two in the front, two in the back."

J&D joke: "How do you get all of the world's energy from wind, water and solar?" "Easy. 490,000 tidal turbines, 5,350 geothermal plants, 900 hydroelectric plants, 3,800,000 5-MW wind turbines, 720,000 wave converters, 1,700,000,000 3-kW rooftop solar PV systems, 49,000 concentrated solar power plants, and 40,000 300-MW solar PV power plants."

Those numbers could have been presented in such a way as to sober up the troops, but J&D obviously knew that the editors would not publish anything short of blissful paeans to renewable energy. Instead, they just did their calculation, and presented their guesses with pretended 1-percent precision just to look serious to the editors.

The J&D musings were, we recall, going to tell us "how 100 percent of the world's energy, for all purposes, could be supplied by wind, water and solar [WWS] resources, by as early as 2030." A crucial word in the Jacobson/Delucchi sentence is *how*.

In this regard, there is a stunning inattention to detail that escaped the attention of the *Scientific American*'s editors. All they have is calculations of how much energy *could* be generated *if* they put windmills, hydropower stations, wave machines, and solar collectors all over the planet, some in the front seat, some in the back. Never mind the velocity-cubed dependence of wind power and its devastating effects on grid stability. Never mind that the sun doesn't shine at night. Never mind the brutality of the ocean toward machinery. Never mind that all ways of generating and distributing energy are regularly opposed by environmentalists (sometimes with good reason).

The irrational exuberance about low costs of renewable energy was yet another thing to slip by the editors. J&D present laughable costs (in 2020, expressed in 2007 dollars) of wind energy, and wave energy and hydroelectric energy (4 cents per kWh); concentrated solar energy, coal and nuclear (8 cents per kWh); and Solar PV (only 10 cents per kWh). Another beautiful zinger!

All in all, I have to compliment Jacobson and Delucchi for their beautiful spoof, and for having the courage to show that *Scientific American* has no standards whatsoever. I am anxiously awaiting their confession.

More topics …

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[1] From Ambrose Bierce's *Devil's Dictionary*…"Erudition: Dust shaken from a book into an empty skull."

[2] It is not uncommon for students in elementary physics or chemistry classes to calculate the mass of a sodium atom and get something like 15.229387543821 kilograms, a quantity ridiculous for its size and its unwarranted precision. The usual defense is, "But that's what my calculator said!"