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Senator Bill Reineke, Chair
Members of the Senate Energy & Public Utilities Committee
Ohio Statehouse

Via e-mail

RE: HB 308 Making nuclear energy and natural gas from oil and gas wells green, Interested party

Dear Chairman Reineke and members of this Committee:

My name is Dr. Julie Weatherington-Rice. I am an Earth Scientist. I started out as an Earth Science teacher because that's all girls could do in the 1960s. I'm coming before you again, wearing my teacher's hat to explain why the Natural Laws of the Universe make it impossible to declare nuclear energy and natural gas from oil and gas wells as "Green" energy. If you harken back to 5th grade Physical Geography, Jr. High science classes and high school chemistry, you already know the reasons. Nuclear energy comes from the decay of Thorium and Uranium and natural gas, which typically comes from oil and gas wells, is very old carbon that is liberated into the atmosphere when burned.

If you think back to 5th grade Physical Geography, you will remember that the earth is a bit more than 4.5 billion years old. Almost all of the Thorium and Uranium, the parent sources for nuclear energy came to us as star dust as the planet coalesced. Because they are radioactive metals, they decay. The half-life of Thorium is about 14 billion years and the half-life of Uranium-238, the most common form of Uranium is a bit over 4.4 billion years. That means we have about 80% +/- of all the Thorium we started out with and something less than 50% of all the Uranium. Being radioactive at the core of our planet is a good thing, it keeps our planet hot and moves those plates around renewing our earth's surface. Without that hot core, we would be a cold, dark planet. We know all of this, thanks to the Curies and their work on radioactive metals more than a century ago. Since then, scientists have filled in the missing sections of the Periodic Table of Elements and their isotopes. Here we are looking at the rows 7 and 6 down to radioactive lead. I am attaching a link to my favorite version of the table on the web, <https://ptable.com/?lang=en#Isotopes/Count>. If you look at the isotopes for Uranium, you will see that there are 26 of them. We are most interested in Uranium-238, the most common source and Uranium-235, the source that is enriched to make nuclear fuel rods.

Nuclear energy fuel rods don't just show up at the nuclear power plant enriched with Uranium-235. There is a whole long process that has to be undertaken to create those fuel rods. That process is clearly explained by the US Energy Information Administration on their web page,

<https://www.eia.gov/energyexplained/nuclear/the-nuclear-fuel-cycle.php>. I encourage you to go to this web page and read it. When you do, you will discover that the Uranium first has to be mined from the earth like coal or extracted from the earth like oil and gas. Both processes require a large amount of energy from fossil fuels. They also create great volumes of waste materials that are filled with all of the naturally occurring transuranic elements from all the Thorium and all the Uranium isotopes down to radioactive lead. Most of them stay with the discarded ores and waste streams but radium is water soluble and radon is a noble gas.

Once the raw ore is gathered up, it must then be refined and enriched. Again, another huge undertaking that generates significant volumes of hazardous, toxic and radioactive waste streams and requires a great deal of energy which is often generated by fossil fuels. By this point we have released huge volumes of carbon, usually ancient carbon and we have great volumes of high-level radioactive waste that we have to do something with. Just the waste stream of Uranium-238 has a half-life of almost the same time that the earth has been here. How many half-lives would it have to decay to get to the radium-226 and -228 combined levels of 5 picocuries/Liter, the Federal Safe Drinking Water MCL for radium, combined radium-226 and -228 USEPA brownfields and Ohio EPA solid waste levels of 5 picocuries/gram or the US EPA limit of 4 picocuries/Liter of combined radon in air which is a health-based limit to prevent lung cancer? Even if you used the Federal and Ohio release limit into the environment of 60 picocuries/Liter for radium-226 and 60 picocuries/Liter of Uranium-228, we are talking hundreds to thousand and perhaps even more half-lives. We have absolutely no real concept of how long this waste stream has to be stored and no place on earth to put it.

Ok, now we have fuel rods that are enriched with Uranium-235 that we can take to the nuclear power plant. These are high-level radioactive rods and just the Uranium-235 has a half-life of 700 million years. To help us understand what that means in human terms, 700 million years ago was the Precambrian geologic age and the only life on earth was unicellular, floating around in oceans. Ohio was submerged in one of those oceans. One of the life forms from that period is the blue-green algae that fills up Lake Erie each summer. So again, we have a product for which there is no safe place on earth to store it. For more information on these decay processes, I recommend reading the US EPA web page on Radioactive Decay, <https://www.epa.gov/radiation/radioactive-decay#:~:text=The%20series%20of%20decay%20products,the%20%22decay%20series.%22>. If you want to know more about the decay of the refined Uranium-235, I recommend this power point from the Nevada Site Specific Advisory Board, which highlights the decay chain of Uranium-235, <https://nss.gov/wp-content/uploads/2023/04/989FY15-Radiactivity-and-Radioactive-Decay-Wegst-FINAL-3-25-15.pdf>. The short answer to all of this is that once you have liberated the radioactive genie from the bottle, there is no way, like Pandora's box, to put it back in again.

Once the rods have done their job, they are considered spent fuel rods. But that does not mean that they are "safe". They are still high-level radioactive waste. The Nuclear Regulatory Commission tells us that the half-life of these spent fuel rods are about 24,000 years and that it will take between 10 and 20 half-lives before they are at a safe level to release to the earth's

surface. Meanwhile they are stored in wet pools and then in dry casks on site. Why are they left on site? Because there is no safe place on earth to store them. Here is a direct quote from the US Energy Information Agency web site at the end of the web page:

“Within a few years, the spent fuel cools in the pool and may be moved to a dry cask storage container at the power plant site. Many reactor operators store their older, spent fuel in these special air-conditioned concrete or steel containers.

“The final step in the nuclear fuel cycle is to collect the spent fuel assemblies from the interim storage sites for final disposition in a permanent underground repository. **The United States currently has no permanent underground repository for high-level nuclear waste.**”

Why do we have no permanent place to store them? Because the best place we have found so far, Yucca Mountain in Nevada, leaks! What happens if we leave those spent fuel rods at Davis Bessie and Perry? Remember, they have to stay there for 240,000 to 480,000 years, almost 1/2 a million years. Well, 24,000 years ago, only one half-life, Davis Bessie and Perry were under 1-2 miles of continental glacial ice and humankind was back to the Stone Age (30,000 to 3,000 years BCE).

So, when viewed in the long run, for a moment of electric light, we have generated a waste stream that has to be protected basically until the sun burns out in about another 5 billion years. Even if you encapsulate the wastes in a borosilicate glass, as proposed last week, you still have to find a place to store that glass where it will not be broken and degraded. There is no such place. We have been searching the earth for such a site since at least the Manhattan Project and have yet to find a location. We have literally generated a waste stream that will be toxic, hazardous, radioactive and long outlive human kind on this earth. We are wishing this deadly waste stream on the whales, crows and cockroaches and their kin that take over long after humankind are gone from the face of the earth. I doubt that they will be thanking us any time soon. Just how could anyone call that GREEN energy? Maybe the proponents of this bill were hoping you would forget the science you learned in grade school and high school. It's up to you to tell them that you have not. I am open to any questions.

Respectfully submitted,



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For identification purposes only

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Board Member &/or Scientific Advisor to a number of local and Statewide Agencies and NGOs