March 10, 2025

Dear Colorado Senate Transportation & Energy Committee,

Please vote YES on (HB25-1040 – Adding Nuclear Energy as a Clean Energy Resource)

I am Tyler Linnebur, a volunteer with ACC Action and a Mineral & Energy Economics student at Colorado School of Mines. I submit this testimony in support of HB25-1040, which ensures that all carbon-free energy sources can contribute to Colorado's emissions reduction goals while strengthening grid reliability & economic growth.

With energy demand set to double, relying only on wind, solar, and battery storage leaves gaps in grid stability & affordability. Nuclear power provides 24/7 carbon-free electricity, making it a critical complement to renewables.

Beyond clean energy, this bill drives economic growth. Nuclear energy offers high-paying, long-term jobs. Small Modular Reactors (SMRs) can repurpose coal plant sites, preserving jobs while attracting federal funding and private investment. A single SMR project could create thousands of temporary & hundreds of permanent jobs.

Nuclear energy also strengthens national security by reducing reliance on foreign energy & ensuring a stable domestic supply. The U.S. has safely operated nuclear plants for 60+ years under strict NRC oversight, with modern reactors recycling 96% of spent fuel to minimize waste.

I urge the committee to support HB25-1040 to strengthen grid resilience & position Colorado as a leader in carbon-free energy innovation.

Sincerely,
Tyler Linnebur
tyler.linnebur@acc.eco
www.acc.eco

Testimony on HB25-1040: Concerning the Inclusion of Nuclear energy as a Source of Clean Energy

By William B. DeOreo, M.S., P.E., 3030 15th Street, Boulder, Colorado, 80304. wbdeoreo@gmail.com, 303-859-4997

Dear Members of the House Energy and Environment Committee,

I strongly support the inclusion of Nuclear Energy as a source of clean energy for determination of how retail utilities are meeting their clean energy targets for 2050 as proposed by this bill, and I urge you to pass the bill back to the full House with favorable recommendations. If you fail to allow nuclear energy to be considered for inclusion in the state's energy portfolio you will be tacitly deciding to limit our energy sources to effectively wind, solar and batteries. I believe this would be a major mistake from all perspectives, including the impacts it will have on the land, air and water of our State.

Under the current definition of clean energy, only wind, solar, geothermal, and small hydropower qualify as clean energy, and the energy source with the smallest output of emissions per KWHr, nuclear power, is specifically excluded! This places a severe handicap on nuclear energy since utilities choosing it do not get to include it as a clean energy source for meeting ther required clean energy targets. This means that companies with a nuclear power solution never have an opportunity to present these options, and nuclear energy is dismissed out of hand.

The environmentalist mindset often makes two errors in assessing the cleanliness of various energy sources: it ignores the ancillary waste and pollution caused by so-called "green" energy such as wind and solar, and it greatly over-estimates the amount of waste and pollution caused by nuclear power plants. Nuclear opponents frequently state categorically that the "waste problem" with nuclear reactors is unsolvable and hence invalidates nuclear energy as a source of clean energy.

The reality is that green energy projects create massive amounts of waste over their life cycles. The use of levelized cost accounting, which is the official way of comparing energy projects, is meant to include all costs for construction, financing and operation of competing energy sources over the lifetime of the projects, but the results can be misleading if not all costs are included or if the actual lifetimes are shorter than assumed. For example, many wind projects assume a 20 year life for the wind turbines, but experience has shown that actual lifetimes can be 10 years or less before "repowering" is required.[1] A study in Ireland showed that most of the

[1] For example, see: https://rclutz.com/2024/08/21/the-short-lives-of-wind-turbines/

heavy gearboxes used to increase the rotation speed from 15 RPM at the blades to 1800 RPM at the generator last only 7 years.[2]

It should also be pointed out that a major justification for the wind and solar system is that they emit no CO2 during normal operation, but the levelized cost analysis system does not include an analysis of the CO2 emitted as part of the construction or retirement of these facilities. So, to the degree that levelized cost analysis limits itself to just monetary parameters it is inherently incomplete.[3]

Wind and solar projects require backup power sources during periods when weather conditions do not allow for their operations.[4] These are normally planned as large lithium battery storage facilities. These facilities are dangerous. Figure 1 shows a fire that consumed approximately 80% of the batteries at the 400 MW [5]Moss Landing storage facility near Monterey, CA in January of 2025. This fire presumably started with a short circuit in one of the modules and quickly spread to the entire facility through thermal runaway. Lithium fires are very difficult to contain because Lithium burns when it comes into contact with water, which is a major complication for most fire departments. According to press reports, the strategy for fighting Moss Landing fire was to simply allow it to burn itself out.

The Moss Landing fire burned for several days, required evacuation of nearly 2000 persons and spread toxic emissions and heavy metals over hundreds of acres of prime agricultural land in the Salinas valley. What could be more environmentally friendly than this?

The current energy plan for Colorado includes construction of 24 GW of 4-hour battery complexes compared to our current inventory of 0.01 GW. The storage of 24GW of power in Colorado would require construction of the equivalent of 60 Moss Landing complexes across the state!

Furthermore, the Moss Landing project went into full operation in July of 2021, which means that it was a brand-new facility, which ran for only 3 ½ years before suffering a catastrophic failure. These are not good odds from a safety or pollution perspective. The United States nuclear power fleet has been in operation since the Shippingport plant was completed in 1957 and has never suffered anything close to the magnitude of the Moss Landing fire, Three Mile Island included.

---

[2] See: https://www.youtube.com/watch?v=LklUVkMPl8g

[3] For a description of the levelized cost of energy procedure see: https://corporatefinanceinstitute.com/resources/valuation/levelized-cost-of-energy-lcoe/

[4] In Colorado the average percent of time that a windmill is actually making power is 34%, so backup is required for the other 66% of the time when it is not.

[5] The Moss Landing plant has a capacity of 400 MW of power for a 4 hour duration, for 1600 MWHrs of energy output. According to NS Energy it was the largest biggest battery storage facilities in the world. (See https://www.nsenergybusiness.com/projects/moss-landing/)

Figure 1: Moss Creek Lithium Battery Complex burning in Monterey, CA (January 2025)

If Colorado chooses to limit its sources of clean energy to ones that require the construction of an equivalent of 60 Moss Landing battery storage facilities it must be aware that this choice has serious environmental implications and is not a simple and benign plan.

In addition to requiring massive amounts of battery storage systems (24 GW of 4 hour storage), the current "clean energy" plan requires the construction of 37 GW of new windmills (7.4 times our current capacity) and 56 GW of new solar panels (56 times our current capacity). Keep in mind that all of this construction is to supply an actual peak summer demand of only ~7 GW in the State of Colorado.[6] Each one of these components will require land, roads, and electrical transmission lines to implement.

A nuclear power system could be implemented on existing power plants (such as the Fort St. Vrain plant, which is already licensed as a nuclear facility) with little or no new transmission, land or roads required.

An environmental issue that is often overlooked with "green" energy is the waste that is left over during operations and retirement of the facilities. Figure 2 shows a site in Wyoming where derelict blades are being stored. According to the report, landfills in Wyoming will not accept these blades unless they are ground into small bits, which is very expensive, so the blades are simply accumulating above ground.[7]

[6] See Table 16 of the 2021 Colorado Electrical Resource Plan and Clean Energy Plan by Public Service Company of Colorado. (chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.xcelenergy.com/staticfiles/xe-responsive/Company/Rates%20&%20Regulations/PUBLIC%202021%20ERP%20&%20CEP_120-Day%20Report_FINAL.pdf)

[7] See: https://cowboystatedaily.com/2024/08/21/why-old-wind-turbine-blades-arent-being-buried-in-landfills-anymore/

Figure 2: Derelict windmill blades in Wyoming

If Colorado expands its windmill inventory by a factor of 7.4, as currently planned, the number of derelict blades and volume of worn-out turbine equipment is going to grow by at least the same factor.

The same holds true of solar panels, which have finite life spans. They are also vulnerable to damage from hail and wind storms. In order to meet the goal of having 56 GW of solar panels installed will require installation of literally millions of panels. If only 0.1% of them need to be disposed of every year we are talking about hundreds of thousands of waste panels in need of disposal[8]. Where are we going to put these things? You must ask yourself whether there are or will be economic ways of disposing of the waste from both wind and solar before you embark on this wind and solar energy future.

[8] 56,000 MW x 5000 200kw panels/MW x 0.1%/yr = 280,000 dead panels per year replacement

Figure 3: Field of destroyed solar panels after a hailstorm; not so resilient after-all.

In comparison, the major waste issue with nuclear power plants are the spent fuel rods that need to be sequestered once they are no longer useable for power generation. First, it should be pointed out that not every nuclear reactor design generates these items, and even when they are generated they represent a small volume of material that can easily be contained on-site, or eventually sent for reprocessing into new fuel, or sequestering in underground storage. Nuclear power plants are the only type of energy systems that can contain virtually all of their wastes on site or in storage in a condensed and hardened system.

The point that I am stressing is that as legislators and policy makers you cannot simply look CO2 emissions during operation as your criterium for gauging the cleanliness of a power plant. You have to look at the entire life cycle wastes, and include the nasty side stream for things like lithium battery storage system.

Issues with Nuclear Reactors

According to Dr. Alvin Weinberg, one of the founding fathers of nuclear reactor development there are over 2000 possible designs for nuclear reactors.[9] Unfortunately, the entire industry settled on the pressurized water cooled reactor used for the navy in its Nautilus submarine. This design worked fine for small reactors, like those in submarines, but as it is scaled up creates serious problems.

The main problems with nuclear reactors that are cited by opponents are:

- The need for Uranium fuel that requires mining,
- Uranium requires enrichment,

[9] Weinberg, Alvin M. “The First Nuclear Era”, American Institute of Physics, New York, (1994)

- Solid fuel pellets have a relatively short life-span due to buildup of xenon gas inside the pellets which inhibits the reaction,
- The U.S. must import virtually all of its enriched Uranium from foreign sources (e.g. Russia) and has only a miniscule capacity to make high assay fuel that is a preferred fuel for many of the new small reactors under development.
- Once the solid fuel pellets are exhausted, they must be removed from the reactor and either placed into on-site storage casks or taken for burial off site. Currently, there are no subterranean storage sites available.
- The alternative to storage of spent fuel is reprocessing, which involves separating out the fissile materials from the waste and then using it to manufacture fresh pellets. This has weapons proliferation implications which is largely why Presidents Carter and Clinton stopped reprocessing in the United States.

The nuclear industry has developed designs, such as the Westinghouse [10]AP1000 which do a good job minimizing the problems associated with nuclear reactors. If given a choice between the current "green" energy plan and one relying on reactors such as the AP1000 I would recommend adopting the nuclear power option. The entire 7 GW peak summer demand could be met on a 24/7/365 basis with 7 or 8 plants. I would certainly prefer to live near an AP1000 than one of the 60 lithium battery facilities envisioned in the current plan (See Figure 1).

I believe that any of the current slate of new nuclear power reactors such as the AP1000 or the various small modular reactors would be preferable to the current green energy plan, and that all of the issues I listed above can be addressed fairly easily. Having said this, I would like to point out that we have other options for nuclear power that totally side-step these problems or reduce them to trivial proportions. I am referring to the liquid fluoride thorium reactor, which was pioneered and put into test operation for over 5 years at the Oak Ridge national lab in the 1960s and 70s.

Here are some brief explanations of why I believe that the liquid fluoride thorium reactor (LFTR) is superior to the standard designs and why I believe it is the best hope for an energy supply that is economic, virtually limitless, safe and the cleanest power supply on the planet.

Advantages of the LFTR

Once a LFTR is started up it does not use Uranium fuel; it uses Thorium, which is a non-fissile but fertile element that converts to fissile U233 when exposed to neutrons in the reactor. Thorium is a byproduct of rare earth mining and there are proven deposits of rare earth minerals in Utah and western Colorado.[11] There is also a rare earth processing facility in Wheat Ridge, Colorado, so this technology is not foreign to our State.[12]

[10] The AP 1000 reactor is currently fully licensed for construction in the U.S. and was the last reactor built here at the Vogtle site in Georgia. The lessoned learned there will make construction of the next reactor much simpler and less expensive than were seen in Georgia.

[11] See: https://kslnewsradio.com/science-technology/rare-earth-minerals-found-in-utah-colorado-are-critical-for-cleaner-energy-sources/2105465/

[12] See: https://www.nationaldefensemagazine.org/articles/2020/7/16/rare-earth-processing-plant-opens-in-colorado

Because all thorium is fertile it does not require any enrichment and can be used directly in the reactor. This virtually eliminates the enrichment problem.

In a LFTR the fuel is dissolved in a molten salt solution so no solid fuel is required. The use of liquid fuel eliminates the time and expense required for fabrication of solid fuel elements, which is a major savings and greatly simplifies the entire operation.

Reaction wastes, that create such a problem for solid fuel systems, can be continuously purified in a liquid fuel system. Xenon gas can be continuously purged from the system and the various fission byproducts can be removed through physical/chemical processes, so they never build up in the system. Many of these isotopes have valuable medical and industrial uses which can create an additional income stream for the plants.

All of the high level fissile material in the LFTR remains in the reactor until it is consumed, so this eliminates the need to store high level wastes or to reprocess them. This is a massive advantage the does not receive enough attention.

The use of Thorium fuel eliminates the need to import or enrich Uranium fuels. The entire system can be run with Colorado/North American materials derived as byproducts of rare earth mining.

A final advantage of the LFTR is that it does not require water for cooling, and the salts that carry the fuel have very high melting and boiling points which allow the reactor to operate at high temperatures and low, near atmospheric, pressures. This eliminates the need for massive containment structures and makes the melt down of the core impossible, since it is in a liquid state during normal operations.

The conclusion here is that the LFTR avoids all of the safety and environmental problems that opponents of nuclear power rightly point out as issues with nuclear power. As long as Colorado will not include nuclear power as a clean energy source, however, it is unlikely that this technology will ever see the light of day here. Therefore, I urge the members of you committee to pass this bill back to the full House with favorable recommendations.

Sincerely,

William B. DeOreo, M.S., P.E.

Nuclear energy is far from clean if you widen the boundary to include extraction and disposal.

Extraction:
This sign says it all:

Calamity Camp is just southeast of Gateway, Colorado in the Dominguez-Escalante National Conservation Area. The watershed in this area flows south to the Delores River.

Disposal:
Current disposal techniques for spent nuclear fuel is burying in deep rock and dry cask storage in-cased in concrete or bitumin. Both of which are heavy users of fossil carbon. This brings in the cascading impacts of fossil fuel toxicity from extraction, transportation, refinement, and burn.

When you narrow the boundary to just power generation, nuclear seems relatively safe with current technologies and this technique is used by proponents to simplify and bolster their arguments. Wide boundary vision to include destructive upstream and downstream externalities is not simple. It requires courage, but it's so necessary to our future.

https://www.hometownsource.com/monticello_times/column-nuclear-reactors-killing-americans-at-accelerating-rate/article_7cb060d2-eef6-11ef-836b-8349ae8997a8.html

Column: Nuclear reactors killing Americans at accelerating rate

John LaForge Guest columnist
Feb 27, 2025

John LaForge

A new analysis of public health data from the Centers for Disease Control and Prevention (CDC) reveals alarming evidence that cancer deaths are rising in communities surrounding America's oldest nuclear power plants.

Epidemiologist Joseph Mangano, executive director for the Radiation and Public Health Project in New York, has conducted a study showing a disturbing correlation between prolonged exposure to nuclear radiation and increased cancer mortality in affected counties.

According to Mangano's research, which examines county-by-county cancer mortality data over three distinct time periods, radiation routinely released from nuclear reactors is directly impacting public health.

His findings indicate that cancer deaths in counties hosting 15 of the nation's 16 oldest nuclear facilities have significantly increased over time, reinforcing longstanding concerns about the safety of prolonged nuclear plant operations.

"There is no safe dose of radiation," Mangano states, citing the National Academy of Sciences' BEIR VII report, which confirms that every exposure to ionizing radiation has the potential to trigger cancer.

As nuclear reactors age and continue to release radioactive gases such as helium, xenon and krypton into the atmosphere, residents in nearby communities are at increasing risk of developing cancer due to prolonged exposure.

The data further illustrates the impact of these radiation releases varies based on geographical factors, including wind patterns and local topography.

For example, in Wisconsin, excess cancer deaths were significantly lower near the Point Beach nuclear facility than in counties downwind of the Palisades and DC Cook plants on Lake Michigan's eastern shore.

These findings suggest that radiation exposure is not uniform and that some communities bear a greater burden than others.

The implications of Mangano's research are particularly concerning for residents of Wright and Sherburne counties in Minnesota, home to the Monticello Nuclear Generating Plant.

Since the plant began operating in 1971, the once-lower-than-average cancer mortality rate in these counties has risen sharply. Projections estimate that between 2031 and 2050, as many as 1,662 excess cancer deaths could occur if Monticello's operating license is extended through 2051.

"These findings should serve as a wake-up call," said Kelly Lundeen, a staff member at the Wisconsin-based environmental and nuclear watchdog Nukewatch. "We are urging local, state, and federal officials to take immediate action to phase out commercial nuclear power before more lives are lost."

Despite growing concerns, the U.S. Nuclear Regulatory Commission (NRC) has already approved license extensions for several aging reactors, allowing some to operate for up to 80 years.

Given the demonstrated public health risks, advocates are calling for an immediate halt to these extensions and a transition toward safer, renewable energy sources.

The Coalition for a Nuclear-Free Mississippi River was planning to rally outside of the Minnesota Public Utilities Commission hearing earlier this month to maintain the current shutdown date of the Monticello reactor.

The Radiation and Public Health Project, the organization behind Mangano's analysis, is pushing for greater transparency in radiation monitoring, stricter regulations on radioactive emissions, and a comprehensive plan to phase out aging nuclear plants.

John LaForge serves as the co-director of Nukewatch, a Wisconsin-based environmental and peace action watchdog group.

Senate Transportation & Energy

03/10/2025 01:30 PM

HB25-1040 Adding Nuclear Energy as a Clean Energy Resource

Typed Text of Testimony Submitted

Name, Position, Representing	Typed Text of Testimony
Angie Gridley Against themself	My name is Angie Gridley. I've lived in Pueblo West, Colorado for over 25 years. I'm strongly opposed to nuclear energy and urge you to vote NO on HB25-1040. Nuclear is much more costly than beneficial and is NOT clean energy. I fear that in the "flashy" headlines, catch phrases and enticing claims being made by proponents and supporters of the nuclear industry, facts are being ignored, unseen, unheard. When the coal plant (the largest industrial polluter in the state) closes in 2031, Pueblo does not want it to be replaced with an energy source that produces toxic waste that lasts for hundreds of years! I implore you to please hear, see and consider the facts about nuclear and vote NO on HB25-1040. Please examine the following statements made in HB25-1040 and consider the information refuting those statements: HB25-1040: [12-14d] Advanced nuclear energy can produce higher quantities of clean energy with a smaller land footprint than other clean energy sources HB25-1040: [8-9II] Does not produce carbon dioxide, thus offsetting carbon emissions A 2008 analysis conducted by Virginia Tech and University of Singapore professor Benjamin Sovacool concluded that "nuclear power is responsible for about six times the carbon emissions of wind power, and 2-3 times the carbon emissions of various types of solar power technologies—and the renewables' carbon footprint drops as the technology becomes more efficient. At such a disparity in carbon emissions, nuclear power should not qualify as a "clean energy" technology even based only on carbon releases, much less other pollutants. https://www.nirs.org/wp-content/uploads/factsheets/nuclearenergyisdirtyenergy2014.pdf According to a briefing by the Nuclear Information And Resource Service: "defining nuclear power as clean leads to three fundamental misconceptions: "1) that carbon dioxide is the only pollutant that matters when defining 'clean energy;' 2) that because radiation is invisible and odorless, it is not a toxic pollutant; 3) that nuclear power is carbon-free. None of these are true... To call nuclear power 'clean' is an affront to science and common sense." Naming nuclear energy "clean" is meant to infer that it's carbon-free and non-polluting. But, as Vandana Shiva, who was a nuclear physicist, explains in "Don't Nuke the Climate," "It is the most polluting energy when you think in terms of radiation damage, and when you think of nuclear waste. https://www.sierraclub.org/oregon/blog/2023/11/nuclear-energy-clean

Additionally,

Proponents claim that nuclear energy is clean because it emits no carbon dioxide, the main gas that is causing climate change. However, the mining of uranium for fuel is polluting and reactor construction is extremely energy intensive…Claims that nuclear is clean energy also ignore the risks of highly radioactive waste that remains lethal for hundreds of thousands of years, which is generated and stored on-site at every nuclear facility in the country. Despite years of research and debate, no viable, secure method for long-term storage for radioactive nuclear waste has been found.

https://truthaboutvogtle.com/wp-content/uploads/2024/06/Truth-about-Vogtle-report.pdf

HB25-1040: [20-22d] utilizing nuclear energy as a source of clean energy will help Colorado prevent future blackouts and brownouts

“In the last decade (2010-2019), nearly 4000 weather-related outages have occurred in nuclear power plants, mainly related to warm cooling water.” This past year was the warmest year ever recorded and is predicted to only get warmer. In the US alone, the Nuclear Regulatory Commission reported that “external environment factors were the second largest common cause for the failure of nuclear reactors between 2006 and 2020.”

https://www.sciencedirect.com/science/article/pii/S2211467X24000725

HB25-1040: [12-15b; 23-25e] Colorado can continue to spearhead energy innovations that align with the state’s goals of keeping energy affordable

Nuclear energy can be utilized in conjunction with existing clean energy sources to lower energy costs for Coloradans and maintain a reliable source of electricity

Referring to the Vogtle nuclear plant in Georgia, residents saw a 23.7% rate increase in their bills, in stark contrast to claims made in 2016 by Georgia Power that completing the Vogtle nuclear plant would put “downward pressure on rates.”:

https://truthaboutvogtle.com/wp-content/uploads/2024/06/Truth-about-Vogtle-report.pdf

Only two power reactors have actually gotten built in the U.S. in recent years and they were billions over budget and way behind schedule. "The ultimate cost was more than twice the original estimate and the time it took to bring the reactors into service was twice as long as originally projected," says Edwin Lyman, who tracks the industry for the Union of Concerned Scientists.

In fact, that's why Three Mile Island had to close in the first place. "Power prices started declining, and nuclear plants, which are intensive operations to run, became uneconomical," Hanson says. "We owed it to our shareholders to make that difficult decision."

https://www.npr.org/2024/12/09/nx-s1-5171063/artificial-intelligence-wants-to-go-nuclear-will-it-work

While some SMRs might bring additional power down the road, the reality is that solar and geothermal plants are being built for less money and faster than even the most optimistic SMR designs…Clean, cost-effective power options are available today

	for big tech and additional electricity needs. Utilities, developers, and large power users need to focus there and stop betting on expensive, unproven nuclear technologies that will not generate meaningful amounts of power for years to come. https://ieefa.org/articles/nuclear-hype-ignores-high-cost-long-timelines Colorado does not want nuclear! We want money, time and resources spent on proven, reliable, efficient, affordable, effective and truly CLEAN energy sources like wind and solar. Let's listen to and learn from the voices that have experienced the real outcomes and consequences of nuclear, not the false notions given by those who will profit the most. Let's keep our focus on what works and not on what is still developing, unproven and unclean. Thank you, Angie Gridley 858 S. Greenway Ave, Pueblo West, CO 81007
Deborah Segaloff Against themself	Dear Senators: Please vote NO on HB25-1040. I live in Boulder County, and I am a retired PhD biomedical research scientist who was Professor of Physiology and Biophysics at the Carver College of Medicine in Iowa and a faculty member of our medical center's cancer center. I am currently serving on the Board of Directors of PSR Colorado, the Colorado chapter of Physicians for Social Responsibility. I worked with radioactive compounds for all my scientific career and I'm in no way phobic of radioactivity. I am, however, knowledgeable in the area. Although the nuclear-powered production of electricity is carbon free, nuclear energy is by no means a clean energy. The mining of uranium and the deposition of spent nuclear fuel are as dirty as they get and pose very significant health risks to the public. Colorado has previously had several sites of mining for uranium mining and milling. Through a series of decay processes, uranium decays to radium-226, which decays to radon-22 gas, a known cause of lung cancer. Due to the extremely long half-life of radium-226, the radon-22 is continuously produced. In subsequent years millions of dollars were spent to clean up areas where homes were dangerously contaminated with radium-226. Bringing back mining for the uranium needed for nuclear energy will bring back the myriad of problems resulting in ensuing contamination. Finally, and most importantly, there remains the question of where and how the highly radioactive spent nuclear fuel, which will remain radioactive for tens of thousands of years, will be stored. As the Supreme Court is currently weighing a case related to how the US is to store its nuclear waste, it is clear there are no adequate long-term solutions. Please don't be swayed by the argument that nuclear energy represents a clean energy. It is far from it. I and PSR Colorado ask that you vote NO on HB25-1040. Sincerely, Deborah L. Segaloff, Ph.D. 7180 Longview Drive

	Niwot, CO 80503
Susan Luenser For themself	If Colorado's elected representatives are serious about reducing carbon emissions from vehicles and electricity generators, then their support of reliable, affordable sources of "clean energy" is essential to maintaining our state residents' quality of life. I request that HB25-1040, Concerning the Inclusion of Nuclear Energy as a Source of Clean Energy, be approved by the Transportation and Energy Committee so that all Colorado elected representatives can vote on this important bill. Electricity generation from a nuclear source is independent of the weather or time of day, benefiting both grid reliability and user energy costs. Wind and solar are not only dependent upon air movement and sunshine, but are also vulnerable to weather events that produce snow/ice deposits and high wind/hail damage. Colorado can learn from Texas' tragedy of relying too heavily on intermittent "clean" energy sources. The power blackout from the Texas ice storm of February 2021 caused at least 246 deaths (Texas Department of State Health Services). Cold kills. Lack of reliable power kills. Electricity from nuclear generation reliably powers supporting infrastructure for health and survivability. Operational costs from existing reactors are already competitive, as utilities that operate nuclear power plants can attest. Use of modular nuclear power units can streamline future regulatory and production costs. Current subsidies for wind and solar mask the actual product life-cycle costs of these "clean" sources, including costs for mining of materials, over-building needed to compensate for intermittent capacity, land-use/environmental operational impact, operational life, and decommissioning/disposal. Colorado would benefit from the comparably smaller footprint of a nuclear power unit that would free up thousands of acres of land that otherwise would be devoted to wind and solar electricity generation. United States nuclear operators have an excellent safety record. Spent nuclear fuel is successfully contained and secured with dry cask storage. The problem of long-term, safe storage has been solved at Yucca Mountain in Nevada, Only political issues prevent its implementation. I encourage you to balance the real benefits of nuclear electricity generation against political fear. If you are sincere in facilitating development of "clean" energy sources, please approve HB25-1040 through the Transportation and Energy Committee.
Daniel Butler For themself	I'm a student at the University of Colorado school of public health, and I'm here today in strong support of HB25-1040. If you spoke with residents of our state 100 years ago, folks working in coal mines and living in cities powered by coal and wood, and explained to them that we will have magic rocks that boil water with no air pollution, but this source of energy was

	not considered clean, they would have looked at you through bloodshot eyes soot covered faces and called you nuts. Nuclear power is clean, reliable, efficient and, contrary to popular belief, remarkably safe. Nuclear power plants operate at over a 90% capacity factor, far exceeding intermittent sources like wind and solar. It can support Colorado's future energy needs and provide long-term jobs for skilled workers in our state. While concerns about nuclear waste are understandable, modern technology and secure long-term storage solutions are continually improving, making this a manageable issue. Furthermore, the long term implications of the waste from fossil fuels are significantly more impactful to all of us every day through air pollution and its health impacts. Exposure to airborne pollutants is strongly linked to childhood asthma, and fossil fuels specifically increase the ozone burden we face in the Front Range. Fossil fuel combustion releases nitrogen oxides and volatile organic compounds, key ingredients in ground-level ozone. Ozone mitigation efforts have been a focus of this legislative body in the past, with SB24-229 and SB24-095. This bill will further these efforts and take the burden of pollution mitigation away from our poorest residents. Colorado is an energy powerhouse and a model of diversified electricity generation for the country. This bill furthers our goals as a state, diving us toward an clean, powerful, and sustainable future. Thank you for your time.
Simone Colburn Against Mi Familia en Accion	Thank you Madame Chair and members of the Committee. My name is Simone Colburn, I am a student at Colorado College in Senator Exum's district, and I work with Mi Familia en Accion to promote the health, safety, and prosperity of Latino communities in Colorado. I am speaking to you today to urge you to vote no on HB25-1040 as a young person who began advocating for the transition away from fossil fuels at fifteen years old. I know addressing the climate crisis is not only a top priority for me, but also for many members of the committee voting on the bill today. Colorado committed to 100% net-zero emissions by 2050 and is falling behind. I understand the temptation to give in to Big Tech companies offering to fund the construction of Nuclear Power Plants. However, I urge you to remember why this bill failed past two years; we know that nuclear energy is not clean energy. Nuclear costs eight times more than wind and solar, takes 10 to 15 years to construct, uses millions of gallons of water every day, contributes to the ninety thousand metric tons of highly-radioactive fuel waste already stored across the country, and poses a threat to local communities. While climate change is fast approaching and I would love nothing more than an easy way out of this global crisis, now is not the time to give in. If you are considering voting for this bill in an effort to address environmental degradation, I urge you to consider who is arguing for and against the bill. Big Tech, which is now a top carbon emitter, is lobbying for your support on projects that are opposed by local communities. Meanwhile, I, as your constituent, along with dozens of grassroots environmental organizations, who I assure you are willing to try almost anything to protect the health of this state and our futures on a livable planet, understand that

	the benefits of Nuclear Power would not go to our communities while the environmental harms would disproportionately impact us. We have the technology with solar and wind power to cut emissions without using dirty, costly, dangerous nuclear power. I am incredibly grateful for all the work you each have done and are continuing to do to help move toward Colorado's clean energy targets. I hope you will continue the fight by voting no on HB25-1040. Thank you for your time.
Katherine Merlin Against WildEarth Guardians	Members of the Committee, my name is Katherine Merlin and I represent WildEarth Guardians. I am an attorney who has spent over a decade working in Colorado to achieve a just, sustainable, and equitable transition to clean energy, and to reduce the negative impacts of oil and gas production in the state. I am here to testify against House Bill 25-1040, on which I ask you to vote "no." Thank you for your time in considering the following comments. I would like to start with the places where we agree. Demand for new sources of electricity is increasing in Colorado as a result of multiple factors including the transition away from fossil fuels. The transition away from fossil fuels is urgently needed in Colorado, as our state faces disproportionate risks from climate change. The current path to eliminating GHG emissions in Colorado does rely on a transition to solar and wind energy along with energy storage. The pace of technological development in energy generation, storage, delivery systems, and "smart" meters and appliances requires a responsive regulatory environment. The legislative declaration states that "providing more options for generating electricity in Colorado will lead to a less expensive and a more reliable path to eliminating greenhouse gas emissions." However, nuclear energy is the most expensive kilowatt hour available today. The most recently completed nuclear facility in the U.S. is the Votgle plant in Georgia (specifically reactor 4). This project had a construction cost of $15,000 per kilowatt of capacity built and took 11 years to build, according to the US Dept. of Energy. The levelized cost of electricity (LCOE) – an estimate of the lifetime costs of a power plant expressed in cents per unit of electricity produced (kilowatt-hours, kWh) – accounts for the construction costs, construction time, financing, fixed and variable operations and maintenance, and fuel costs. Votgle had an LCOE of 22.3 cents/kWh, compared to the LCOE of gas fired electricity between 4.1 and 5.6 cents/kWH (depending on gas prices). In 2022, the global weighted average LCOE for newly commissioned onshore wind projects was $0.033/kWh. In 2023, the global average cost of electricity from utility-scale solar PV fell to $0.044 kWh. Solar and wind are by far the cheapest energy sources to build and operate, full stop. The next three paragraphs in the legislative declaration relate to "advanced nuclear," "small modular reactors" (SMRs), and "new designs for advanced nuclear reactors." This is extremely important, because all of the projects in Colorado which have been discussed publicly involve these "next gen" promises – for example in Pueblo or Aurora or Craig and Hayden, all of which have explicitly proposed SMR design. But the actual text of this bill does not limit the proposed changes to SMRs or next gen design. It just says that "nuclear is clean." With one hand this industry is promising new, smaller, safer, and cleaner technology is just around the corner. But with the other, it's not making any promises. Georgia's Votgle facility covers 3,200 acres –

almost ten times larger than the Suncor facility. That is not a small footprint. “Small modular reactors” have never been built in the US. While the US Nuclear Regulatory Commission approved the first SMR model for the US market in 2022, whether these “advanced” or “small” designs are truly safe is still very much a matter of debate. But that point is entirely swallowed by the fact that this bill doesn’t actually require “clean nuclear" plants to be small or new or next gen in the first place. If Colorado intends to lay the regulatory groundwork to approve only these “new designs” which will be ready in the 2030s, this bill is not the path forward. There is ample time for future legislation to be proposed, vetted and debated to shape the regulatory environment for future next gen nuclear facilities.

A related point to these paragraphs is where projects have already been proposed. Four communities: Pueblo, Aurora, Craig, and Hayden. I’m sure you will hear from Puebloans about this, so I’ll let them speak for themselves. Aurora is suburb of Denver and by itself is our third largest city – is this really where we want to put a new nuclear facility, whether it’s big and old or small and very, very new? On the other side of our state in Craig and Hayden – the Yampa River runs through both of these communities, before flowing into the Green River and then the Colorado River. In 2015 we just saw the Gold King Mine disaster, where a relatively small amount of water contaminated with mining waste spilled into the Animas River, affecting water in four states and putting Silverton on the US Superfund list. That mine only operated from 1887 to 1907 and it didn’t have anything to do with uranium. In 2025, are we really going to put new uranium fission reactors at the headwaters of the Colorado River?

I will end with water. Nuclear power requires vast amounts of water for cooling that Colorado cannot afford to use in this way, particularly when there are other ways of generating power that require dramatically less water. Notably, the water demands of solar energy and wind energy are orders of magnitude less than what nuclear power requires. Estimates of relative water consumption between energy sources is difficult to find, and numbers are hard to compare because not all water use is “consumptive”. Hydroelectric energy “uses” the most water, but that use is essentially entirely non-consumptive. However, a 2019 study called “Water use of electricity technologies: A global meta-analysis” published in Renewable and Sustainable Energy Reviews shows that “In the U.S., operational water consumption for nuclear power plants with closed-loop cooling could be more than 3000 L/MWh with a minimum of 1408 L/MWh.” These compare in the same analysis with American PV solar energy at less than 50 L/MWh and wind at essentially zero.

We agree that we need more clean energy, but nuclear power is not the answer. Wind and solar are by far the cheapest sources and also have the least environmental impact, which could be even lower if we built more into our existing built environment and on brownfield sites instead of undeveloped land. We need more secure, resilient electrical grids hardened against natural disasters and manmade threats. We need to phase out fossil fuel development and transition to an economy for the future, not the past. But "new" nuclear energy is an old false solution repackaged and sold to us as a revolution. We need to stop asking poor and majority-minority communities to bear the burdens of environmental harm and health risk as sacrifice zones.

Please vote “no” on HB 25-1040.

Kyle Jensen Against themself	Hello and good afternoon. I am here as a concerned citizen with some slight inside knowledge on how nuclear energy is disposed of. My father used to work closely with the rocky flats facility and for a while, I believed that the room that they had could safely contain nuclear waste. This was until that an audit by the FBI was brought to my attention that the room that my dad had talked about fills very quickly and they have to dispose of it over in Yuka mountain. This proved as a testament to me that we don't really have safe means of storage let alone cleanup for nuclear waste. Defining nuclear energy as clean energy brings in a major concern in that light for me because that will increase our output of waste for something we already are lacking the means of proper and safe containment and disposal for. If our solution is just to shove it in an area that's less populated, how soon will that disposal exceed the capacity to store it and work it's way into populated areas. This is already known to be a public health concern in many parts of Colorado and this is something we cannot afford to be careless with. I urge this bill to be put off until we have the adequate knowledge to handle the safety and waste to something that is potentially a health crisis if not handled properly. I understand that we need to meet energy demands but this is cutting corners at the expense of public health and safety.

Senate Transportation and Energy Hearing on HB25-1040
3/10/25
Jamie Valdez
In opposition

Hi everyone. My name is Jamie Valdez and I'm a native of Pueblo and a proud parent and grandparent with little ones growing up in the community. I'm the founder and Director of a local organization called Roots to Resilience as well as a founding member of the Nuclear-Free Colorado statewide coalition and a GreenLatinos member.

Pueblo is already one of the most disproportionately impacted communities in Colorado according to data from the state health department and this would perpetuate that paradigm. Nuclear power produces waste that remains radioactive for tens of thousands of years, uranium must be constantly extracted and processed, and enormous amounts of precious water resources are needed to cool reactors, threatening our delicate river systems. This bill represents an attempt to take advantage of a technicality in the state's definition of "clean energy", which only requires that a technology be carbon free and completely overlooks other hazardous types of waste and pollution undermining truly clean technologies like wind, solar, and battery technologies.

A nuclear power plant in Pueblo County would expose our community to extreme risks in both the near and distant future because of the presence of nuclear fuel and the storage of spent fuel which must be replaced at least every 24 months. The spent fuel remains radioactive and must be isolated for thousands of years. The vessels in which the nuclear waste is stored can corrode and leak over a much shorter time, potentially contaminating water. The US currently has no solution for dealing with nuclear waste. The plan for creating such a solution involves the shameful exploitation of low-income communities. Historically, no community has consented to having such storage of nuclear waste. Domestic mining and milling, which occurred at sites such as the Cotter Mill site in Cañon City from 1959 to 2009, create additional exposure to hazardous radiation and even more ongoing disposal problems. Nuclear is not clean and no amount of speculation on how many jobs these as yet unproven technologies might provide can make it so. We want *clean*, *safe*, family-sustaining jobs.

While construction of data centers may employ many people, the number of permanent jobs is not very high. In fact, employment per million dollars invested is among the very lowest of all business investments. Furthermore, the need for data centers, especially as justified by the development of AI, is volatile, as shown by the recent shock of DeepSeek. The power sector's data center mania just got a dose of reality. Building electricity generation for an anticipated data center may lead to stranded electrical generation assets.

If passed, this handout to the nuclear-industrial complex would divert important funds and resources away from the renewable energy and storage technologies that are already proving they can power our energy future and advancing at much faster rates than nuclear power technologies. For the safety and public health of my community and that of all Coloradans, I ask you to consider the precautionary principle and vote "no" on this bill.

My name is Thomas Bearden. I live in Weld County.

I am a retired engineer with over 30 years of energy, federal contractor, and nuclear design experience. Most recently, I worked on the licensing and design of the Mitsubishi US-APWR and the B&W mPower Small Modular Reactor (SMR).

I strongly support HB25-1040 because it puts nuclear power in CO on a "level playing field" with other forms of low carbon energy.

Currently, nuclear supplies about 20% of America's needs. This percentage is expected to grow in the coming years. Unlike renewables, nuclear provides CONTINUOUS 24/7 "base load" power to the grid, similar to fossil fuels. However, it does so with ZERO carbon emissions.

Here in the US, there is currently a "revival" of interest in nuclear. Other speakers will discuss nuclear expansion and extension projects in progress, including an exciting one here in the Mountain West, where a new SMR is being constructed at the former coal site near Kemmerer, WY. This project is being managed by TerraPower, a company founded by Bill Gates.

The US DOE has identified former coal plant sites as IDEAL for new nuclear construction. This is because the necessary civil and electrical infrastructure already exists at these sites. DOE estimates that there are cost savings of up to 35% for these kinds of projects. CO has several former coal plant sites that are suitable for new nuclear.

Many of you are aware that the Ft. St. Vrain nuclear plant operated in Weld Co. for about 20 years before being decommissioned in the early 1990's. This site was converted to natural gas and is still active. Ft. St. Vrain is another good location for new nuclear.

I would be happy to respond to any written questions from the Com. I work closely with the CO Nuclear Alliance, so consider us as a "technical resource" for any Com. questions.

Please contact me anytime. Email: tebearden@me.com Cell: 303-956-6816. Thank you.

Testimony Opposing HB 25-1040
Presented to the House Transportation & Energy Committee
March 10, 2025

Dear Chair and Members of the Committee,

My name is Kristen Autret, I am an environmental and occupational public health scholar and advocate for environmental and human health. I write today to strongly oppose House Bill 25-1040, which seeks to redefine nuclear energy as a "clean energy resource." While I recognize the urgent need for reliable energy solutions in Colorado, I urge this committee not to be misled—nuclear power is neither clean nor sustainable.

First, **radioactive waste is an unresolved, long-term environmental hazard.** Unlike wind and solar, which produce no lasting pollutants, nuclear power generates waste that remains dangerous for tens of thousands of years. Colorado has no viable plan for the long-term storage of this toxic material, yet this bill would falsely classify nuclear as a "clean energy resource." How can an energy source be clean when the land surrounding its waste storage sites is uninhabitable and hazardous to human health?

Second, **this bill ignores the full environmental impact of nuclear energy, including uranium mining.** The mining and milling of uranium, a necessary step for nuclear fuel, devastates ecosystems, contaminates groundwater, and disproportionately harms Indigenous communities in the Southwest. Colorado should not ignore the well-documented environmental injustices associated with nuclear fuel production.

Third, **nuclear power plants pose serious occupational health risks.** Workers at nuclear facilities face prolonged exposure to radiation, increasing their likelihood of developing cancer and other serious illnesses. The same communities that once relied on coal jobs should not be subjected to the health hazards of nuclear employment. If this legislature truly cares about worker health and safety, it should prioritize expanding wind and solar energy jobs—industries that do not expose workers to radiation.

Fourth, **the economic argument for nuclear power is deeply flawed.** The cost of nuclear energy has continued to rise, while the costs of wind, solar, and battery storage have plummeted. Nuclear reactors take decades to build and often run over budget. Additionally, this bill fails to account for the impact of tariffs on uranium imports from Canada, which will significantly increase the cost of these operations. Why should Coloradoans foot the bill for an outdated, dangerous energy source when cheaper, safer alternatives exist?

Lastly, **nuclear energy does not belong in the same category as wind and solar.** While nuclear plants do not emit carbon dioxide during operation, their full life cycle—from uranium mining to waste disposal—leaves a lasting environmental footprint. A clean energy resource should not leave behind toxic waste, nor should it come with the threat of catastrophic failure from human error, natural disasters, or aging infrastructure.

Colorado has the opportunity to be a national leader in truly clean energy. We should be investing in technologies that do not create new environmental and public health risks. For these reasons, I urge you to vote NO on HB 25-1040. Thank you for your time, and I welcome any questions.

Respectfully, s

Kristen Autret, MPHc

Board Member Physicians for Social Responsibility (PSR) Colorado

Kristen.autret@cuanschutz.edu | 303-519-7874

Why the State of Colorado Should Include the Thorium Molten-Salt Reactor in its Energy Future

William B. DeOreo, M.S., P.E..
wbdeoreo@gmail.com,
December 2023

Introduction

This paper argues that most of the reactor designs being proposed to serve as replacements for weather-based energy sources (wind and solar) suffer from major problems: they rely on enriched uranium fuels, use only a small fraction of the energy contained in the fuel, and they continue to confront us with high level waste problems that require either reprocessing or long-term storage.

In the 1960's a team at the Oak Ridge National Laboratory headed by Alvin Weinberg and H.G. MacPherson came up with a reactor design that minimized these problems, it was the thorium molten-salt reactor. We argue here that this design is more relevant than ever and should be included in the upcoming study of alternative energy authorized by the joint resolution of the Colorado legislature in its 2023 session.

The current electrical energy plan in the State of Colorado[1] recognizes that the total base generation demand for the system is 12.6 gigawatts (GW). To satisfy this demand, the plan is to construct 118 GW of "renewable" energy sources, consisting of the following, all before 2040:

1. 37 GW of new windmills (compared to actual construction of 5 GW between 2004 and 2021.)
2. 56 GW of new solar panels, (compared to actual construction of 1 GW of solar panels between 2004 and 2021.)
3. 24 GW of 4-hour battery packs (compared to 0.01 GW of batteries between 2004 and 2021.
4. The total new faceplate capacity is 118 GW, which is ~9 times the actual demand.

This is equivalent to needing a car when all the cars available only have an 11% chance of starting on a given day, so you need to buy 9 cars (at full price) so that you will have a reliable transportation source. The only thing that makes our legislators and energy executives believe this huge amount of over-building can be accomplished is that they expect the costs to be borne by the U.S. taxpayer, Government borrowing, and the consumers of electricity. As the U.S. treasury and the consumers go bankrupt the folly of this approach will become obvious, even to its most ardent proponents.

---

[1] These figures are from "Colorado's Energy Future: The High Cost of 100% Renewable Electricity of 2040" Jake Fogleman, Isaac Orr and Mitch Rolling. IndependenceInstitute.org, Page 11, (May 2023)

The Current Plan

A key element of the current plan, which has been endorsed by Governor Polis, is that it specifically excludes the largest single source of carbon-free energy from its definition of "renewable" energy, which is nuclear energy. Without further explanation it states that "fossil and nuclear fuels and their derivatives are not eligible energy sources." Only solar, wind, geothermal, biomass and small-scale hydropower are deemed worthy sources of energy.[2] This means that the Polis Plan relies on just these sources to power the State of Colorado and all of the existing coal and natural gas are to be retired no later than January 1, 2040, 17 years from now!

Another major flaw in the Polis Plan is that is assumes that electrical energy demands will remain constant at their 2022 levels through 2050. This, despite the fact that the plan anticipates mass implementation of electric vehicles and conversion of home space and water heating, cooking and even lawn mowing to electricity.

The impact of this plan on energy costs is already being felt in Colorado. For example, consumers are now being switched to smart meters which allow the utility to charge for electricity on a time-of-day basis. Under this system the cost for peak period electrical use will rise from 9 cents to 21 cents per kW-hr. This is an admission of the fact that the renewable energy system is not able to meet peak demands. Things will only get worse in the form of rotating blackouts and extremely high costs for energy.

To summarize, according to the Independence Institute report, "To meet the Governor's goal of 100% renewable energy by 2040, all utility companies operating in the state will be required to replace electricity currently generated with coal, natural gas, and petroleum with qualifying renewable energy resources such as windmills, solar panels and battery storage facilities by 2040." Keep in mind that nuclear power is not currently listed as a qualifying source of renewable energy.

The Nuclear Option

Instead of engaging in the amazing over-building of the current plan, the Independence Institute report suggest that a nuclear option be considered that will replace both fossil fuels and the existing "renewable" inventory of power systems. The types of reactors they suggest are a combination of large, pressurized water reactors (PWR) at 1400 MW each and small modular reactors (SMR) used primarily for meeting peak demands. Because this plan will include sufficient dispatchable power from the new fleet of nuclear plants the use of windmills and large scale solar is not deemed necessary.

Under the nuclear option suggested by the Independence Institute, the state's electrical energy demands would be supplied a combination of large PWR reactors (71%), small modular reactors (24%), existing hydropower sources (2%), existing solar (2%) and existing wind (1%) a

[2] Ibid, pg 4

tiny fraction would come from battery storage used mainly to stabilize the grid. Assuming a total electricity demand of 12.6 GW dispatchable power the required power outputs from each source are as shown in Table 1.

Table 1: Required nuclear power capacity from each source

Generation Source	Required Capacity (GW) at 90% CF	Number of Units (rounded up)
Large PWR nuclear	10	8 @ 1.4 GW each,
SMRs	4	12 @ 0.35 GW each
Total new nuclear	14	20

Proponents of the nuclear option contend that if all the costs of the renewables, including land, transmission, back-ups and replacement costs are included nuclear power would prove cost-effective. This seems reasonable, but disputing costs is not the purpose of this paper. The issue we wish to discuss concerns the fuel requirements of a new fleet of 20 large and small reactors. Our contention is that the need for enriched uranium fuels, both low level LEU and high assay HALEU presents a problem given the present state of enrichment facilities in the United States.

There are reactor designs that can operate with natural uranium, such as the CANDU reactor, and there are those that use the thorium fuel cycle, such as the LFTR design. The ability to operate a reactor without the need for enriched fuels is a major advantage, and we believe the State of Colorado should include these designs in their analysis of alternative energy sources in Colorado.

How Much Enriched Fuel is Needed for the Nuclear Option?

Using various public sources, the following are estimates of the enriched fuel requirements for the two types of reactor being considered: pressurized water reactors (PWRs) and small modular reactors (SMRs). There are two categories of fuel demand: the amount needed to fuel the reactor at start-up and the amount needed to refuel it on an annual basis.

LEU Required For PWR's

The annual fuel requirements for PWRs are estimated to be 24.7 MT[3] of 4.4% enriched fuel per GWe-yr[4] of energy production[5]. So, to supply the annual fuel needs for 10 GW of electricity generation at a 90% capacity factor for 1 year would require approximately 250 MT of LEU fuel per year.

[3] MT=metric tons=1000 kg
[4] GWe-yr= 1 gigawatt of electrical power produced continuously for 1 year
[5] https://www.world-nuclear.org/information-library/nuclear-fuel-cycle/introduction/nuclear-fuel-cycle-overview.aspx

Since the annual burn-up represents approximately 22% of the total fuel load of the PWR reactor [6], the start-up load for 10 GW of PWRs would be approximately 250/0.22 = 1136 MT of low enriched Uranium LEU). Over a 20 year operating period, this would amount to a total of 6136 MT of LEU for Colorado, or an average of 307 MT/year,.

HALEU Required for SMRs

The annual fuel demands for SMRs using HALEU are approximately 5.2 MT per GWe-yr of electricity production. The start-up demands for a small fast reactor, such as the Natrium Sodium Fast reactor is approximately 60 MT/GWe-yr [7].

Using these factors, we calculate that the fuel requirement for 4 GW of reactors of this type would be 21 MT per year plus 240 MT at start-up. Over a twenty-year period, this would amount to 660 MT of HALEU or an average of 33 MT/year.

Table 2: Summary of demands for enriched Uranium fuel for standard reactors

Reactor Type	Net Power Output GW	Annual Required MT	Startup Required MT	Total MT Required over 20 Yrs.
PWR	10	250 LEU	1136 LEU	6136
SMR	4	21 HALEU	240 HALEU	660
Total Fuel Demand		271 combined	1376 combined	6796 Total, or 340 MT/year

The important thing about the estimates of enriched uranium fuel shown in Table 2 is not the precise value of the total but in the scale of the demand. One might argue that these demands are high or low, but one cannot argue that if we elect to pursue a future of standard uranium-burning nuclear reactors we are going to need a very large amount of enriched uranium for fuel. Not only that, but the estimate of 340 MT/yr of enriched uranium fuel shown in Table 2 is for just a single state, Colorado. If the entire county pursued this path the demands for enrichment would be orders of magnitude greater than this.

Current Sources of Enriched Fuel

Uranium Oxide

Uranium oxide is the first step in production of enriched uranium. It is first converted to gaseous uranium hexafluoride and then run through centrifuges to enrich it to around 5% for low enriched fuel (LEU) or between 5% and 20% for high assay enriched uranium fuel used for many small modular reactors.

According to the US Energy Information Agency the United State imports most of the uranium it uses for fuel.[8] As shown in Figure 1 from the cited EIA report, domestic uranium

---

[6] Approximately 1/3 of the fuel rods need to be replaced every 18 months= 22% per year.
[7] TerraPower public presentation to the National Academies in 2021 .
[8] https://www.eia.gov/energyexplained/nuclear/where-our-uranium-comes-from.php

concentrate production (the bottom/blue line on the graph) fell to near zero in 2020 and *virtually all of the uranium purchased for civilian power production comes from imports*. This is an alarming situation, especially when we consider that the countries we are relying on are not necessarily friendly to the U.S., and even more so, when contemplating massive increases in nuclear power production. While domestic production has increased since 2020 we still rely on foreign sources for most of our civilian uranium.

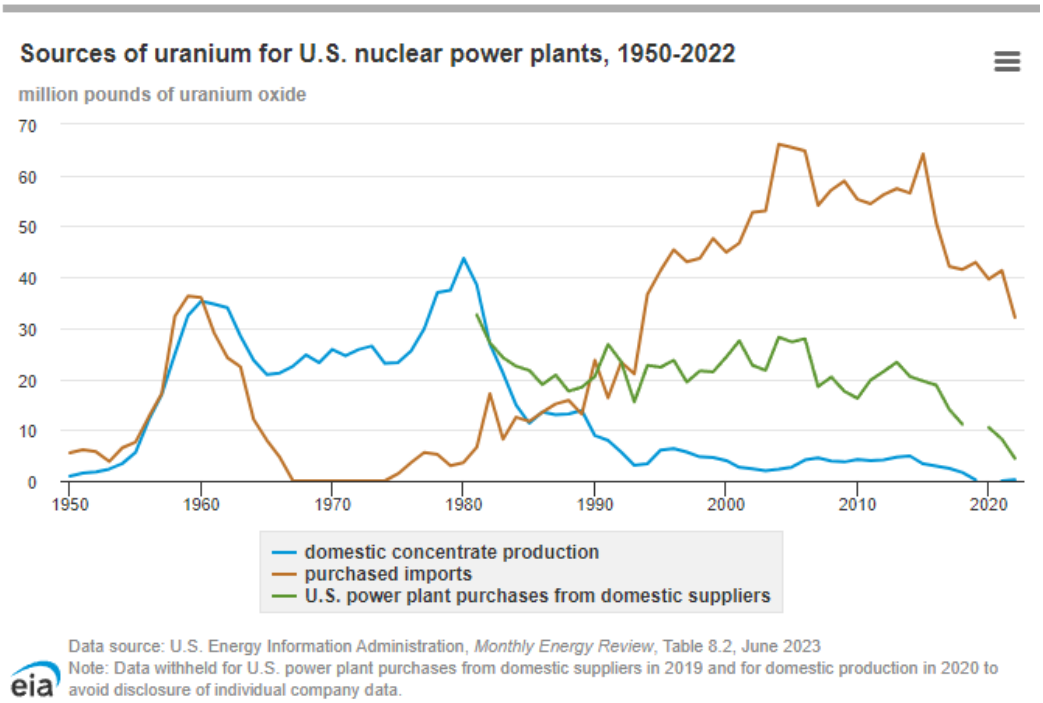


Figure 1: Sources of Uranium oxide in the United States

HALEU Production

The only current supplier of HALEU in the United States is Centrus Energy's enrichment plant in Piketon, Ohio.[9] According to Centrus, at full scale operation this plant would produce 6 MT of HALEU per year, and it would take nearly 4 years to ramp up to this level.[10] This means that to build the 4 GW of SMRs envisioned in the Independence Institute report for Colorado, requiring 261 MT for start-up and one year of operation (see Table 2) would require over 43 years of production from the Piketon plant. [11] The costs to develop this material will have to be born by the new projects using it, or by the taxpayers in the form of subsidies.

[9] https://energynews.us/2023/10/23/as-nuclear-fuel-plant-opens-in-ohio-can-small-reactors-compete/
[10] "Centrus on Track for HALEU Demonstration by Year End", World Nuclear News, (Feb 2023).
[11] Assuming they all are fueled by HALEU

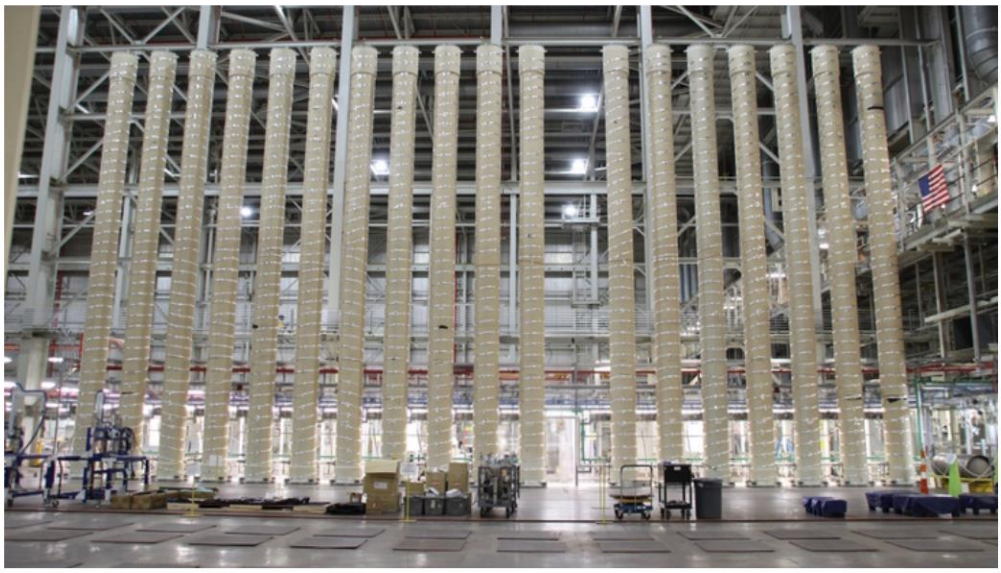


Figure 2: HALEU plant at Piketon.

Other Issues with Standard Reactors

Standard pressurized water reactors and small modular reactors that use solid fuel pellets have two other issues to consider in addition to their demand for enriched uranium. First is that the solid pellets become depleted in enriched uranium fuel as well as poisoned with fission products after approximately 4-5 years of operation and must be removed from the reactor. This occurs when approximately 90% of the fissionable material (primarily uranium-238) is still in the pellets. Fissionable materials are high level wastes that require either storage for thousands of years in geologically safe conditions or must be reprocessed, which entail proliferation issues.

Conventional (aqueous) reprocessing is a problem because the last reprocessing plant in the United States was shut down during the Ford administration in 1976 over fears of fissile diversion to weapons proliferation. Reprocessing continued to be discouraged by all U.S. administrations through that of Obama.[12] This leaves only geological storage of high-level wastes as an option. We have been storing these wastes on-site at the existing fleet of reactors and this is already a pressing issue, but if we triple the size of the fleet, as recommended by the Department of Energy, this approach becomes utterly untenable.[13] Chemical processing is being considered but the conventional, aqueous approach would take a large investment in time and money and would entail security risks.

Given the problems with enrichment, high level wastes, and the need for reprocessing or long-term storage, wouldn't it be great if there was a technology that would allow us to harness

---

[12] https://www.powermag.com/u-s-spent-nuclear-fuel-reprocessing-may-be-making-a-comeback-heres-why/

[13] Op Cit, Energy News pg 6

nuclear energy using naturally occurring fuels that do not require enrichment? Actually, there are at least three options for reactors that do not require enrichment.

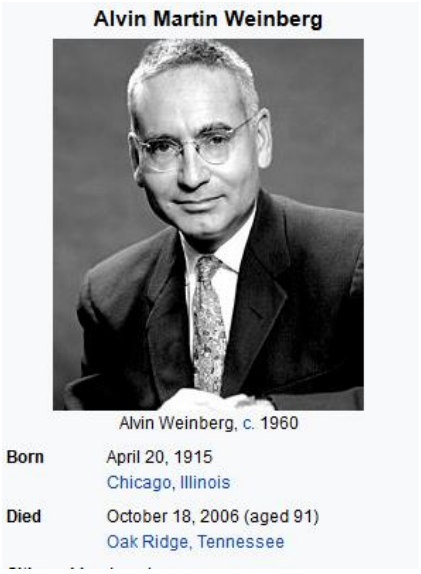
Some Current Contenders

The CANDU reactor, developed in Canada, uses heavy water for the moderator and natural uranium as its fuel. This reactor is a solid-fuel reactor, so it has the problem of refueling every 6 to 24 months and the need to deal with high-level waste, but it does not require enriched fuel.[14] We believe that Colorado should be aware of this design and include information about it in the upcoming study of alternative energy sources.

Terra Power is working on three reactor designs: the Natrium sodium cooled reactor, the fast chloride molten salt reactor, and the travelling wave breeder reactor. The Natrium system uses HALEU fuel as does the molten chloride reactor. The Travelling Wave system also requires HALEU or plutonium for its startup, but it is a breeder reactor that claims to thereafter transform natural uranium to plutonium, eliminating the need for enrichment. It is designed to operate without chemical reprocessing but this comes at the cost of material breakthroughs that have proven unachievable. This is why TerraPower transferred their ambitions from the traveling-wave reactor to the Natrium design.

The Thorium Molten-Salt Reactor Option

The thorium molten-salt reactor was described by Dr. Alvin Weinberg (1915-2006) as the Holy Grail of nuclear power. Weinberg was the director of the Oak Ridge National Laboratory, and he played a key role in its development. He was a towering figure in early nuclear reactor development and his opinion needs to be taken seriously.



There are many advantages of the thorium molten-salt reactor (TMSR) and reasons why Colorado should thoroughly study the system for use as part of the energy grid.

In my opinion, the two most important features of the TMSR are, first, its use of liquid fuel and second that it uses the thorium-uranium 233 fuel cycle rather than the uranium 238-plutonium 239 cycle used in conventional reactors. Ironically, these features also represent the biggest problem for adoption of the thorium economy, since they are so foreign to the historical pattern of nuclear reactors in use today.

The thorium fuel cycle is inherently safer and less subject to subversion for illegal weapons manufacture than is the uranium-plutonium system. When uranium 238, which makes

[14] https://energyeducation.ca/encyclopedia/CANDU_reactor

up the bulk of standard fuel, is irradiated it is transformed into plutonium 239, which is the gold standard for weapons production. The thorium cycle can very nearly eliminate the production of more plutonium. This makes thorium a natural for civilian power.

The thorium molten-salt reactor is a liquid fuel system using a lithium-fluoride,beryllium-fluoride salt (FLiBe) as its medium. Liquid fuels can be continuously treated to remove fission wastes and poisons such as xenon gas. New fuel can also be continuously added to the system without having to shut the reactor down for refueling. In a liquid fuel system one never has to remove "spent" fuel rods and the fissionable material all stays in the reactor until consumed. This means that the only "wastes" that need to be handled are the short-lived fission byproducts, which require sequestration for hundreds of years, rather than high level wastes, which require thousands of years of isolation. In addition, many of the fission byproducts are valuable for medical and industrial purposes making them a source of revenue rather than a burden.

Next on the list of advantages of the thorium breeder, in my opinion, is that it is a thermal reactor rather than a fast reactor. This means that the neutrons are slowed down using a graphite moderator to enhance the rate at which neutrons are captured in the fuel system, and thus sustain the reaction. This greatly reduces the amount of fissionable material needed in the reactor. The fast breeder using the plutonium cycle contains many times the fissile inventory (per unit power) of plutonium, which slows ultimate deployment and increases costs.

Once started, the only fuel that needs to be added to a thorium breeder is thorium itself, as it comes out of the ground, with no enrichment required. Inside the reactor the thorium is converted into uranium 233, which can be chemically separated and placed back into the reaction chamber. The amount of U233 which the reactor produces is the same as is needed to sustain the reaction. This means that there is no excess fissionable material for diversion to illicit activities. Any attempt to divert fuel would lead to a shutdown of the reaction, which makes it a self-regulating system.

A simple diagram of a thorium breeder reactor is shown in Figure 3. Note that there are two separate liquid streams: one containing the active fission products and the graphite reaction core, and another containing a blanket of thorium that absorbs neutrons from the nuclear reaction chamber and allows the thorium to uranium 233 transformation to occur. Fluid from this system is fed into a chemical separator so that the U233 can be isolated and returned to the reaction chamber.

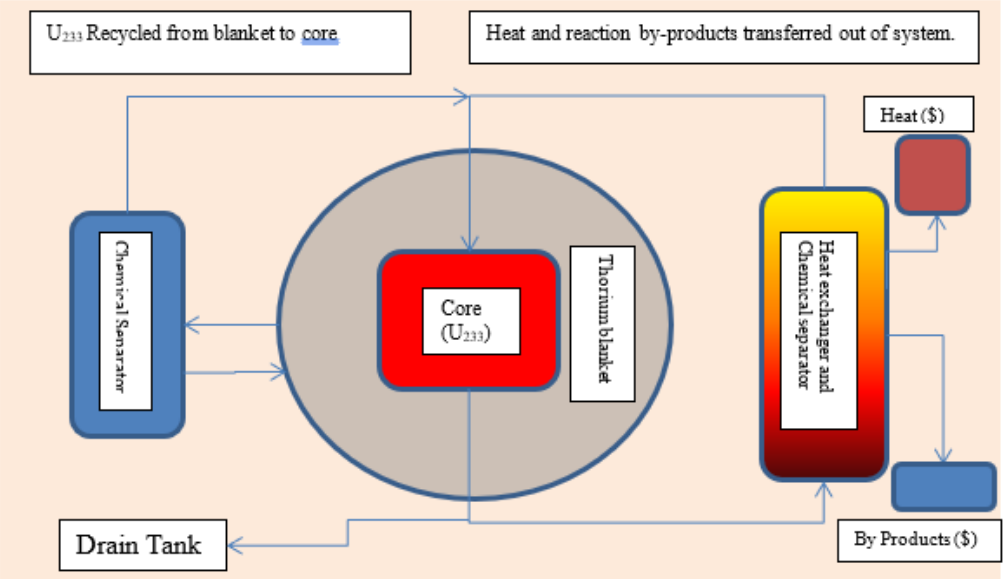


Figure 3: Schematic of a Thorium breeder reactor

Cost Considerations

There has been recent news about increased cost estimates for the NuScale project in Idaho leading to its cancellation. The cost estimate for that project increased from $50/MW-hr to $98/MW-hr for a number of reasons. This contributed to a lack of subscriptions from local utilities. It should be pointed out that the NuScale reactors use pressurized water for cooling and they operate at high pressures. They are essentially scaled down versions of the existing pressurized water reactors with which we are familiar. Cost certainly was not the only issue with the decision to terminate the project since a cost of $0.10/kW-hr is not unreasonable.

There is little comparison between these reactors and the LFTR we are discussing here. The LFTR uses a molten salt for its coolant and fuel transport. Since salt melts at a high temperature the reactor can achieve high temperatures at low pressures. This requires far less material and controls, which greatly simplifies the reactor.

There are other key factors that reduce the costs for thorium versus uranium reactors. The amount of material that must be handled over time for thorium reactors is a fraction of that required for uranium reactors. All things being equal, reactors running on solid uranium fuels will require all the costs be paid up-front to start the reactor. These include heavy mining, enrichment, fuel fabrication, transport, etc *before making a profit*. While liquid core, thorium-based systems begin with a very modest cost and they process the fuel on an as-you-go basis. Thus, income generally follows expenditures and avoids paying interest on a fully financed, prolonged loan. Two other radical cost efficiencies are the uranium solid fuel systems have an end-of-life cost that is huge due to waste disposal while the LFTR avoids these. It is

worth repeating that LFTR gets the added benefit of potential resale of the separated elements coming from the processing stream. Again, the small, slow cleaning of the liquid fuel has all the advantages coming from a plentiful thorium supply.

The conclusion is that it would be incorrect to dismiss all advanced reactors based on cost estimates for one version. It is far too early to make decisions about what reactors to investigate based on cost alone. It is far more important to understand the underlying features and advantages of each design and defer cost considerations at least to the preliminary design phase.

Summary

The use of modern nuclear reactors for provision of safe and reliable civilian energy is a very good idea. Nuclear power can provide on-demand energy with a fraction of the land and materials costs for any other system, including wind and solar which both require huge amounts of land and materials while providing only weather based and intermittent energy.

One of the major obstacles of nuclear power is the desire to simply take the existing technologies of pressurized water and solid fuels and shrink them down to scale. We have shown that the amount of enriched fuels required to do this just in Colorado would overwhelm the existing domestic enrichment system, especially that of high assay uranium fuels.

The LFTR is a cleaner and safer nuclear reactor. It requires neither enrichment nor conventional reprocessing. Its fuel system is vastly simpler and generates less waste than any solid fuel system and the thorium fuel cycle is an inherently better system for civilian power generation. Its main drawback is that it represents a rethinking of the nuclear power designs. Once a thorium breeder reactor is started it should be able to run continuously for the life of the reactor. Colorado has a chance to be a leader in developing this technology and should definitely use the alternative energy study authorized by the joint legislature in 23-0918.01 as a way to explore what could be a true revolution in energy.[15]

Acknowledgement

Thanks to Joe Bonometti. Kurt Harris and Kirk Sorenson, of FLIBE Energy, for reviewing this paper and for the work that Jake Fogelman did in the analysis of the state's current energy plan (aka the Polis Plan).

[15] For more information: https://flibe.com/. The author of this paper has no financial or commercial interest in Flibe Energy.

THIRD WAY

March 7th, 2025

Colorado General Assembly
Colorado Senate Transportation and Energy Committee
200 E. Colfax Avenue
Denver, CO 80203

Written Testimony from Third Way in Support for HB25-1040, "Adding Nuclear Energy as a Clean Energy Resource"

Chair Priola, Vice Chair Cutter, and Esteemed Members of the Committee,

My name is Alan Ahn, Deputy Director for the Climate and Energy Program at Third Way. Third Way[1] is a national think tank based in Washington, DC that champions modern center-left ideas and policies. I am submitting this written testimony on behalf of Third Way in support of HB25-1040, "Adding Nuclear Energy as a Clean Energy Resource."

One of the fundamental positions of Third Way's Climate and Energy Program is that we will need a diverse set of clean energy technologies and solutions to reach our climate goals, and Third Way has been at the forefront of highlighting nuclear energy as an increasingly indispensable part of our climate toolkit.[2] Nuclear energy had historically been a partisan issue in Washington, but working closely with Democratic allies and champions, Third Way has played a central role in building the overwhelming bipartisan support for nuclear energy at the federal level over the last decade. This bipartisan support has resulted in the passage of legislation supporting nuclear energy deployment and licensing, and billions of dollars in federal investments towards nuclear R&D, advanced reactor demonstrations, and nuclear-eligible grants and incentives.

Third Way was a pioneer in creating awareness[3] among policymakers about a growing ecosystem of private developers in the US that were commercializing next-generation advanced reactors—innovative technologies that address many of the traditional objections to nuclear energy through enhanced passive safety profiles, smaller footprints, reduced construction and project risks, and more sustainable fuel cycles, including some that have the ability to use recycled nuclear waste as fuel.[4] Thanks to unprecedented bipartisan support that has led to significant federal investments, we are now on track to building our first commercial advanced reactor projects in the US within the next several years.

The emergence of advanced nuclear technologies could not have come at a better time, with soaring energy demand across the economy through the revitalization of the US industrial sector, which has created opportunities for economic growth and new, well-paying jobs. Without consistent, reliable, and emissions-free energy sources like nuclear that can operate around the

[1] For more information, please visit https://www.thirdway.org/.
[2] Jackie Toth and Jackie Kempfer, "How Advanced Nuclear Got on the Map," Third Way, April 8, 2021, available at: https://www.thirdway.org/memo/how-advanced-nuclear-got-on-the-map.
[3] Todd Allen, Ryan Fitzpatrick, and John Milko, "The Advanced Nuclear Industry: 2016 Update," Third Way, December 12, 2016, available at: https://www.thirdway.org/infographic/the-advanced-nuclear-industry-2016-update.
[4] "Advanced Nuclear Energy," 20x35.org, available at: https://www.20x35.org/advanced-nuclear-energy.

clock and does not fluctuate with weather conditions,[5] decarbonizing growing industrial and manufacturing activity will be virtually impossible—an assertion that bears out in Third Way's analyses on energy systems and pathways to net zero, both home[6] and abroad.[7]

We cannot allow outdated assumptions and preconceived notions of nuclear technology to impede the advancement and deployment of this crucial energy source. Today's challenges are immense—as we try to meet escalating power needs, fall behind and play catch-up on climate action,[8] and ensure equitable access to clean air and energy,[9] nuclear energy will become even more important. And with the new era[10] in nuclear technology that is currently unfolding, we will now have the solutions to meet these challenges.

Respectfully,

Alan Ahn
Deputy Director for Nuclear
Climate and Energy Program
Third Way
aahn@thirdway.org

[5] Alan Ahn, "Nuclear energy in places such as Iowa supports the green transition we need," Des Moines Register, February 16, 2025, available at: https://www.desmoinesregister.com/story/opinion/columnists/2025/02/16/iowa-energy-future-nuclear-power-duane-arnold-palo/78481572007/.
[6] Decarb America Research Initiative, see more at: https://decarbamerica.org/.
[7] Carbon-Free Europe, see more at: https://www.carbonfreeeurope.org/.
[8] Alan Ahn et al., "The Increasing Value of Nuclear to Catch Up on Climate," Third Way, April 23, 2024, available at: https://www.thirdway.org/blog/the-increasing-value-of-nuclear-to-catch-up-on-climate.
[9] Alan Ahn, "Importance of Preserving Existing Nuclear," Third Way, September 10, 2021, available at: https://www.thirdway.org/memo/importance-of-preserving-existing-nuclear.
[10] Alan Ahn, "Dawn of a Nuclear Era," Third Way, October 18, 2024, available at: https://www.thirdway.org/blog/dawn-of-a-nuclear-era.

Dear Senate Transportation and Energy Committee members,

We, the undersigned organizations, community leaders, and elected officials in Colorado, call on you to **oppose HB25-1040: Adding Nuclear Energy as a Clean Energy Resource** when it comes up for a vote in the Senate Transportation and Energy Committee. The future of energy production is one of the most important and challenging issues we face as a state, a nation, and a global community. The need to rapidly decarbonize our economy and transition to a clean energy source is a deeply urgent matter, and nuclear energy is a false solution that will divert urgently needed funds from renewable energy solutions.

In recent years, there has been a rapid resurgence of pro-nuclear industry lobbying which touts nuclear energy as a "clean" and "carbon free" energy source that will transition our economy out of the era of fossil fuels. There are already proposals in Pueblo, Craig, and Hayden Colorado to transition coal plant infrastructure into nuclear energy infrastructure. While we agree with the need to transition away from fossil fuel-based energy as quickly as possible, we also believe that a transition to nuclear power would be a grave mistake with consequences that will echo for hundreds of future generations.

The idea that nuclear power is a clean energy source could not be further from the truth. Nuclear power is the only energy resource that generates dangerous waste that will remain radioactive for thousands of years. There is no known method or technology to process this waste effectively, and thus, it must be stored as long as it remains radioactive. There is a strong possibility the waste would need to be stored onsite, as transporting radioactive waste carries severe risks. Our state's ongoing challenges with the nuclear waste stored at the former Fort St. Vrain plant should be enough to dissuade Colorado Legislators from pursuing this radioactive energy option. Nuclear meltdowns such as Chernobyl or Fukushima, while exceedingly rare, should also dissuade Legislators from pursuing nuclear power. The unfortunate reality is that climate change will lead to an increase in natural disasters in our state, from floods to fires, which have the potential to create an exponentially more terrifying catastrophe if radioactive material is present.

Nuclear power is not "carbon-free." In reality, mining and enriching uranium, producing and transporting cement, constructing nuclear reactors, and processing and transporting waste all contribute to the upstream carbon costs of nuclear energy. The carbon footprint of nuclear energy development is significantly larger than the carbon costs associated with wind and solar energy production. By including nuclear energy under the legal definition of "clean energy," and thus grouping it alongside wind, solar, and other renewable energy sources, the Colorado Legislature risks diverting much-needed energy transition funds away from proven renewable energy technologies, and towards a risky, expensive, and unsustainable technology.

Nuclear power also relies on the exploitation of resources that our communities cannot afford, including water and uranium. Nuclear reactors are by far the most water-intensive way to produce energy. A single 300 megawatt small modular reactor operating at 90% capacity would withdraw between 160 million and 390 million gallons of water daily. Colorado is experiencing a water crisis, and our state cannot afford this level of fresh water usage.

Nuclear power plants also require uranium which must be mined and enriched. Marginalized communities bear a disproportionate burden of the environmental and health impacts of uranium mining and enriching. During the Cold War, over 500 uranium mines were established on Navajo land, and, due to lasting contamination in the land, air, and water from these mines, the communities that surround them still experience high rates of lung and bone cancer, kidney failure, birth defects, among other health impacts from uranium exposure.

The bottom line is that nuclear energy corporations and major utility companies would reap all the profits, while Colorado's frontline communities would absorb all the risks, health impacts, and environmental contamination. Given the rapidly diminishing costs in renewable technologies which have shown great promise in tackling the climate crisis, a transition to nuclear power would be a ludicrous waste of time, money, and energy for our state. **Please vote NO on HB25-1040.**

Sincerely,

350 Colorado
Arvadans for Progressive Action
Brown and Black Parents United Foundation
Clean Energy Action
Colorado Coalition for a Livable Climate (Representing 53 Colorado organizations)
Colorado Renewable Energy Society
Conservation Colorado
Equinox Consultancy LLC
GreenFaith Boulder County
GreenLatinos
Mi Familia Vota
Naropa University and the Joanna Macy Center for Resilience and Regeneration
Our Sacred Earth
Physicians for Social Responsibility Colorado
Pueblo's Energy Future
Renée Millard Chacon, Commerce City Council Member
Renewable Energy Owners Coalition of America
Rocky Mountain NAACP CO-MT-WY State Conference
Rocky Mountain Peace and Justice Center
Roots to Resilience
Sierra Club Colorado
Snake River Alliance
Sunrise Movement COS
Womxn From The Mountain

I have a desperate plea for you. I hope you think of this plea with any legislation that passes your desk, especially anything with the word "nuclear". I beg you, to consider YOUR role in thrusting humanity into dystopia, and to Vote NO on HB25-1040: Adding Nuclear as a Clean Energy Resource

I need you to broaden your perspective, and I need you broaden your responsibility. Indigenous cultures who stewarded this land for millennia, specific to this land the Cheyenne, Ute and Arapahoe people, did so with a perspective of deep time. When faced with a significant choice, they considered seven generations past and seven generations forward; considering what in the last seven generations led to this moment, what is the full context of the choice we are faced with today, and what are the potential impacts for the next seven generations, what is the full weight of our choice today?

This technology we are discussing today has been around for hardly a generation and was initially created as a weapon of mass destruction, that's the (very abridged yet most pertinent to my point) context of where we are coming from, and looking forward? The Energy Information Administration tells us "A major concern related to nuclear power is the creation of radioactive wastes such as uranium mill tailings, spent (used) reactor fuel, and other radioactive wastes. These materials can remain radioactive and dangerous to human health for thousands of years." There may not be carbon emissions, but I'd hardly call this a "clean" energy.

In its hearing in the House, I heard the waste point addressed with promising research and ideas - specifically referring to the recycling plant in France, and how that could be a solution to our waste problem. How the current solutions of storage facilities at Yucca mountain (an environmental justice monstrosity) and nearly "indestructible" storage containers (for how long? "High-level nuclear waste has such a concentration of radionuclides that thermal generation during storage and disposal must be considered. This type of waste is obtained mainly from the treatment and conditioning of spent fuel. These residues can be active for thousands of years." nuclear-energy.net) are sufficient. We have "best practices", we have ideas for what MIGHT work for thousands of years (maybe putting the nuclear waste miles under the surface of the earth in Ice caps or in a deep geological repository has consequences we haven't yet had exposure to - seeing as we are working with a geologic timeframe on only decades of research). Yet the simple fact that keeps getting skirted around is we do NOT have an answer for waste yet that can guarantee safety for future generations. That's not even considering the risks of more dire emergencies and mistakes.

When hearing the "facts" of how safe Nuclear energy is, I hope you'll consider this:

"A fact is an agreed upon reality. What happens when facts are accepted as true is that there is a cutting off of realities that are unknown- even if they are postulated about, they are relegated to the realm of the unknowable. This does not make the unknowable any less true. This only makes the unknowable unaccounted for as influences on your life and the collective lives of people around the world. But we are propelled by the unknowable. It is in these liminal spaces of the unknown where destiny is formed" (Joy Kmt, in Black Quantum Futurism)

To pass this bill is to speed up the development of a technology that may very well be our greatest sin as a species - something that in an instant, can harm hundreds of generations to come. Hundreds of your children's children WILL suffer from this current nuclear paradigm. I need you to broaden your perspective, and I need you to broaden your responsibility. I am your great great grandmother begging you to hear my wisdom and move slow. If there's a plan for recycling the waste, if we need more research, pass that legislation first! I am your great great great grandchild, BEGGING you to think of me and protect me.

Vote no on HB25-1040. Give humanity more time to do this right.

Madison Cartaya