I’m a rural Democrat from HD57 who supports this study. We realize that our current energy usage depends on gas and oil and renewable energy (wind and solar) will only be able to replace 24% of our energy needs. We must be able to understand and make energy choices to meet our climate goals and help our rural communities thrive.

INDIVISIBLE COLORADO

Testimony in opposition of HB1080
March 28th, 2023

Esteemed Chair and Committee Members,

We strongly oppose funding a study on the feasibility of Small Modular Reactors because SMRs are nuclear reactors and they bring with them most of the old challenges associated with nuclear energy. We base our position on research from the Union of Concerned Scientists who are concerned about SMRs. We encourage you to reference their publications at UCS.org. The UCS have dedicated a number of reports, articles and podcasts to this subject because they see SMRs as a false solution.

Like all nuclear reactors, SMRs have four major unresolved problems: safety, waste, proliferation and costs. In fact, when accounting for subsidies, nuclear power costs 4-5 times more than solar power costs right now. A report published by the Union of Concerned Scientists, entitled "The Cost of Nuclear Power, Cheap Dreams Expensive Realities", warns us that these risks and costs keep private sector financing out of the equation and result in the need for significant and perpetual government subsidies for nuclear power plants. We strongly believe our public dollars would be far better spent on developing Colorado's abundant solar and wind resources, and on the increasing number of promising storage technologies - all of which, it should be noted, do not produce toxic radioactive waste.

HB1080 is a gateway to a future that would not be cheap, would not be safe, is not desired by front line communities like Pueblo, and just as importantly, does not effectively combat climate change. Because under the most optimistic scenario – putting costs, safety, waste, proliferation aside – a nuclear reactor in Colorado would only begin to generate energy in 8 to 10 years, but unfortunately would begin to draw on our funds right now, with the passage of this bill.

It is sobering to imagine how much our climate, our environment, and our economic well being will likely have changed in the next 10 years as a result of climate impacts. We ARE running out of time to address the crisis, and this bill wastes valuable resources exploring a risky, unnecessary technology that would deliver questionable benefits. We urge you to reject it.

Sincerely,

Elizabeta Stacishin, Climate Liaison
Indivisible Colorado

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

House Bill 23-1080

March 29, 2023

Members of the Energy and Transportation Committee. I appreciate the opportunity to testify to you in support of House Bill 23-1080. I am a civil engineer with over 40 years of experience in the areas of water and energy, and I am convinced that the only way that Colorado can successfully reduce its dependence on fossil fuels, while also maintaining an advanced economy is by adopting nuclear power into its energy supply system.

Nuclear power can supply a safe, clean and reliable source of energy for electricity, transportation and industry. If we turn our backs on nuclear power we will find ourselves in the same position as is Germany today, where they are resorting to lignite burning in order to replace the energy produced from nuclear plants they have shut down. We must not allow ourselves to follow their example.

HB1080 is focused on a study of the laws, economics, safety and jobs impacts of the use of small modular nuclear reactors to replace the existing coal fired generation plants that are to be retired as part of the Clean Energy Plan. This is a good thing and I hope you will support it. But I believe the bill would be improved with a couple of amendments:

1. Rather than studying just a single type of nuclear reactor, the small modular reactor I suggest that the study include a survey of all of the existing and advanced nuclear technologies either on the market now, or which are anticipated to be available over the next 10 years. These include:
    a. currently licensed and known high capacity systems such as the Westinghouse AP-1000 plants, which produces in the 1000 MW range of power,
    b. SMR systems that have been licensed for design such as the NuScale system
    c. SMR designs that are in the process of licensing like the Integrated Molten Salt Reactor from Terrestrial Energy; the Natrium system from Terra Power, one of which is currently being built in Kemmerer Wyoming.
    d. One thing to keep in mind is that all the above reactors require enriched Uranium and the SMR reactors require a fuel called HALEU, which is higher level of enrichment. There are presently no plants in the U.S. to make either standard or high assay enriched Uranium (HALEU), and we have been buying this from Russia. Fuel requirement need to be carefully considered. A system that can run on locally available sources such as either natural Uranium or Thorium should be favored.
    e. Breeder reactors are not practical for weapons production, but the technology of Uranium enrichment is exactly the process used for weapons production.
    f. More advanced systems that can run either on natural Uranium, such as the CANDU reactors from Canada or breeder reactors that can use either natural

Uranium or Thorium as fuel. The Thorium breeder reactor has been described as the holy grail of nuclear power by Dr. Alvin Weinberg, the inventor of the light water reactor, but it is receiving little or no government support.

2. The study should include a survey of all of the fossil fuel plants slated for retirement, with an analysis of which nuclear systems would be most compatible with the existing sites. Some sites may be good for small systems and others would be better for large, utility scale systems. Reserve judgement.
3. We need an objective and arm's length comparison of the economic, operational, and environmental factors, including the effects on land and wildlife, involved with nuclear, wind and solar with analysis of the required energy storage to give wind and solar similar capacity factors as nuclear.
4. This study should be based on historical data from the current wind and solar systems currently supplying Colorado with power and should exclude the impacts of tax subsidies. We know that 1, 1000 MW nuclear reactor would replace approximately 2000 typical 1.5 MW wind turbines, each of which requires large amounts of materials including concrete, steel, plastic, electronics and rare earth materials.
5. We need to consider the gaps between the actual energy produced by our renewable components and the electric demand. The graph below[1] shows the actual output from 230 GW of windmills (the dashed line) and the demand for electricity. Notice that the actual output never comes close to the faceplate capacity of the wind turbines, and there is always a large gap between the demand and supply from wind. This must be filled with either coal or natural gas, which we are wanting to reduce.

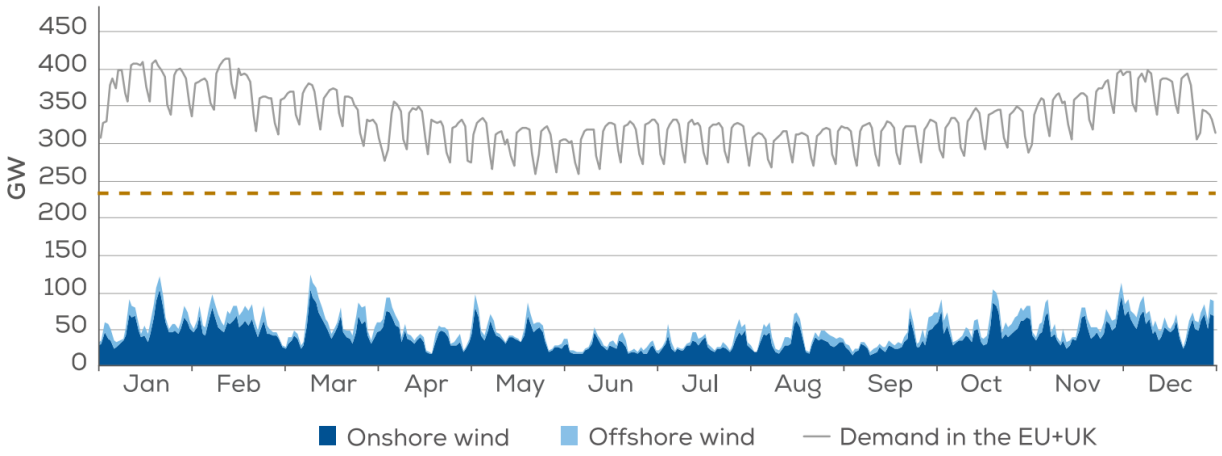


Figure 1: Inherent inability of wind energy to meet demands

6. Energy from wind is inherently unstable because the wind velocities are always changing and the energy output from a wind turbine varies as the third power of the wind velocity. This means if the velocity falls by half the output from the turbine

[1] "The Inadequacy of Wind Power", Wade Allison, The global warming policy foundation (Figure 1)

falls not by half but by a factor of 8! The unit probably becomes ineffective when this happens. Just as bad, if the velocity doubles the output would increase by a factor of 8 and the unit probably must be taken off-line to prevent an overload. A turbine designed for 100% output at 20 mph will only produce at 12.5% at 10 mph.

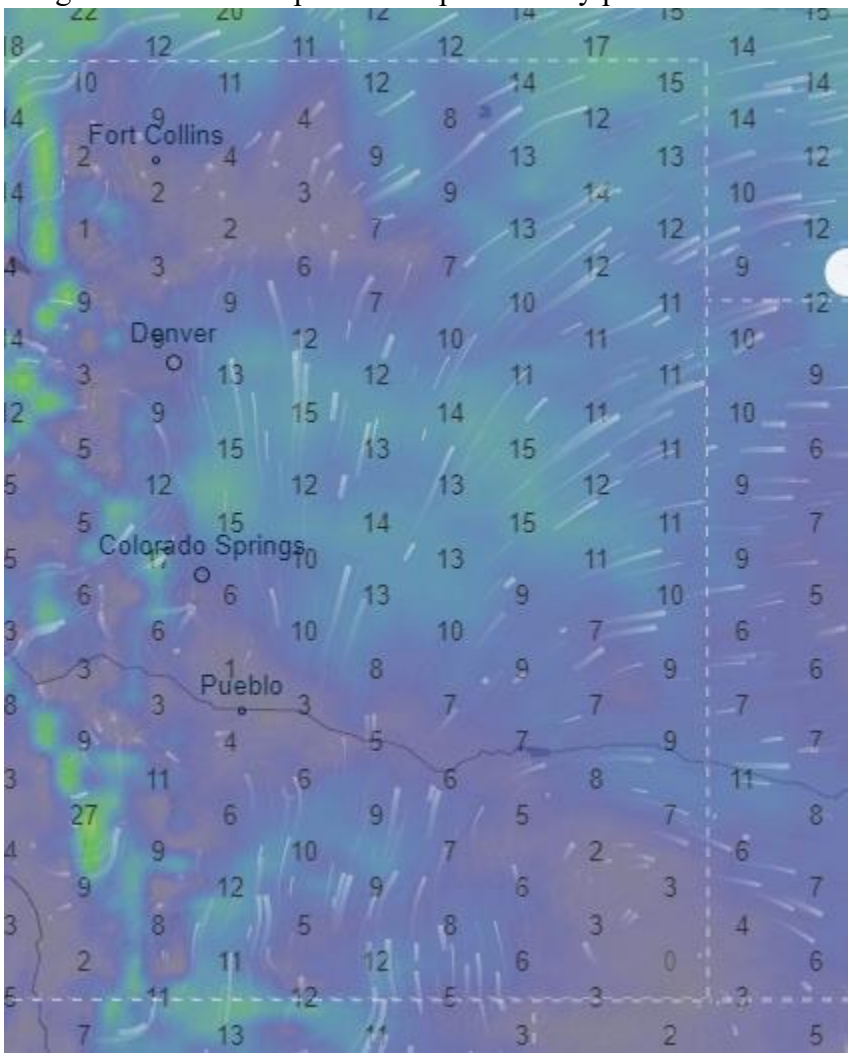


Figure 2: Variability of wind in Colorado on 3/28/23 (Ventusky.com)

7. A fleet of nuclear power plants, especially ones that can use natural Uranium or Thorium, can supply all of the energy demands of our State without needing any back up. They would make the use of windmills and solar panels unnecessary, except in specialized cases. One nuclear plant such as the AP1000 can replace over 2000 wind mills and their required storage system.

Conclusion

Thank you for the opportunity to testify to you today. My name is William DeOreo, and I am a PE with over 40 years of experience. I recommend that the Energy committee pass HB23-1080 because it will fund needed research into the nuclear engineering.

This study, however, should not limit itself to just small modular reactors because there is no guarantee that this is the technology we want to invest in for a multi-decade commitment. It should be amended to broaden its scope.

Small modular reactors require a form of fuel (high assay low enriched Uranium [HALEU], which we used to get from Russia. The department of energy is now asking congress for $1billion to build enrichment plants to make HALEU domestically. Producing HALEU requires the same enrichment technology used for weapons production. So relying on SMRs is locking ourselves into the same nuclear weapons trap from which we have been trying to escape for decades.

We need to include more advanced nuclear designs for plants that can use either natural Uranium (such as the CANDU plant from Canada), or those that can breed their own fuel on site from either natural Uranium or, better, Thorium.

Even though Colorado has excellent wind resources we must realize that any weather based energy system is inherently unable to be a reliable source of base load power. This means they will always need redundant supplies from batteries, thermal storage, coal or natural gas. Nuclear power stations can provide all of our energy requirements without the need for expensive and environmentally destructive weather based systems, but we don’t want to make the wrong choice at the start.

I urge you to pass HB23-1080 and send it on to the general assembly and Governor, with amendments to broaden its scope.

Thank you.

Hello,

I hope to persuade you in voting in agreeance with bill HB23-1080. Nuclear energy is our most reliable clean energy source, a feasibility study for the use of small modular reactors for carbon-free energy will illuminate how we can deeply decarbonize our energy/electricity sectors with minimal environmental impacts.

Nuclear energy has done some amazing things in the ~70 years it has been around.

It has allowed successful deep-decarbonization campaigns in France (Nuclear: ~70% of electricity generation), Ukraine (55%), Slovakia (52.3%), among others (https://www.nei.org/resources/statistics/top-15-nuclear-generating-countries). This is because nuclear is one of, if not THE, lowest CO2 emitting energy sources we have (https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/statistical-review/bp-stats-review-2019-full-report.pdf).

It has produced such LITTLE waste when compared to fossil fuels that a comparison is almost not necessary. Nuclear in the US generates ~2,000 tons a year while providing 50% of our clean electricity and ~20% of total electricity. Coal alone produced ~130 million tons of coal ash in 2014 (https://www.epa.gov/coalash/coal-ash-basics). Additionally, coal ash exposes the public to more radiation that nuclear energy ever has.

This one may surprise you: nuclear energy is the 2nd safest form of energy, and it has been around for almost 70 years. It is second, only by a very slight difference, to Solar photovoltaic (https://ourworldindata.org/nuclear-energy).

The list of pros also includes: lowest land requirements of any source, cheap and abundant fuel, most reliable energy source (92.7% capacity factor in US), etc.

The list of cons has historically included: radiation hazards, managing radioactive wastes, nuclear weapons proliferation, high costs, and long construction times.

Radiation hazards, radioactive waste management, and proliferation issues have all basically been put to rest by either sound international policy (proliferation), or through the rigorous process we call science (radiation hazards and waste management). Solutions or arguments are scientifically known in regard to radiation hazards and waste management, but politics and/or public opinion is still lagging behind the science.

Cost and time to construct are still legitimate issues, although there is reason to believe that they are issues for 2 main reasons: Unnecessary and non-science-backed safety regulations (NRC) and the fact that the US has only built a single operating nuclear reactor since 2000 (we are not good at it, currently). South Korea has been able to build nuclear plants on budget and in ~4 years and 8 months on average, they demonstrate what having an experienced workforce

and scientifically based regulation can result in. But, to sidestep those two potential reasons, there is another solution to the issues of cost and time to construct.

Building small modular reactors would allow for the mass production of reactor parts/modules in factories, whereas current reactors are so big, everything is basically made on site, adding substantially to costs and time. Small modular reactors could be made in a factory, and parts could be made in parallel, increasing efficiency, which would drive down costs and time to construct.

Additional benefits of small modular reactors include: more possibilities for implementation due to smaller energy production capacities, even smaller land footprint, even less waste produced, less water requirements for cooling, etc.

In summary, small modular reactors have the potential to solve the final two “problems” that many say are the reason why we should not pursue more nuclear. They are right in a way: if it costs too much and takes too long, it may not be the best idea. Small modular reactors can solve these problems and allow us to continue to bring the most reliable source of clean energy to the grid. Renewables are great, but they can’t replace fossil fuels because they are not reliable, and they are not very energy dense (it takes A LOT of materials to produce not that much energy). Nuclear has done a great job, even with a decades long lull, and it can do even more in the future if we decide to invest in the best clean energy source we have. I hope you vote in agreeance with this bill and invest in a reliable and clean energy future for Colorado.

Matthew James Randall

Testimony for House subcommittee hearing HB23-1080 on SMR study

Madam Chair Kipp, Committee members, thank you for the opportunity to testify today. My name is Dr. Mike Fox. I am a retired Emeritus Professor of Environmental and Radiological Health Sciences at CSU, but I am representing myself, not CSU. I wrote a book about nuclear power and the environment and I strongly believe that nuclear power is a critical component of a clean energy portfolio. I urge you to approve this bill to study the use of Small Modular Reactors to help meet Colorado energy needs.

I am also a strong proponent of solar and wind energy, and have a grid-tie solar system on my house, a stand-alone solar system on my cabin, and will soon have a 3 MW wind turbine on my wife's farm property in Kansas. However, wind and solar energy have limitations that ensure they cannot meet all of our needs for clean energy. They are highly variable throughout the day, from day to day, and from season to season. Thus, it is necessary to have power available when they are not producing electricity effectively. Currently, that backup energy often comes from fossil fuels.

Colorado, along with much of the west, has not been supportive of nuclear power in the past, with only a few western states having nuclear power. As a result, western states generally have higher per capita carbon dioxide emissions than states with nuclear reactors. In the past decade, major advances have been made in new types of nuclear reactors to make them more flexible and able to meet the needs of various communities. These are Small Modular Reactors (SMRs), which are defined by the Nuclear Regulatory Commission (NRC) as having electrical capacity of 300 MWe or less, though this is an outdated definition. A variety of SMRs are being designed and tested in the US and in many other countries. The only one currently certified by the NRC is by NuScale, which has 77 MW modules that can be grouped in 4, 6, or 12 units to meet various needs. The minimum configuration has 308 MWe and the 6-module has 462 MWe capacity. I would suggest that the committee amend the bill to consider SMRs that have 500 MWe or less, so as not to exclude many possible options in the future.

Small modular reactors have many features that make them desirable. They can be manufactured in a factory and shipped to the site, greatly improving the potential for cost savings and reliability as more units are built. They are intrinsically safe by design. For example, the NuScale reactor is cooled by natural convection without the need for pumps that can fail. In case of a loss of electricity, it cannot melt down. All types of SMRs have similar safety features. They are modular, hence scalable, so they can meet various needs of small to large cities. A major advantage is that they have a very small footprint and can readily replace a coal-fired or gas-fired power plant, using the same transmission lines and source of cooling water. They can be used to back up wind and solar power, such as the Terra-Power Natrium reactor being planned to replace a coal-fired power plant in Kemmerer, WY. They are designed to last for many decades – the NuScale reactor is designed for 60 years, 2-3 times as long as wind and solar power plants.

Many people worry about the safety of nuclear reactors and have concerns about radiation. As a scientist who has spent a career studying radiation and its biological effects, I can attest that these fears of radiation are greatly overstated. (My book, *Why We Need Nuclear Power, the Environmental Case,* gives a detailed explanation of this topic). With an average of over 100 reactors operating in the US

since the 1990s, there has only been one major accident, Three Mile Island in 1979, and no one was killed or injured from that accident. Thus, nuclear power in the US has a very good safety record, and new generation reactors are intrinsically even safer by design.

I urge the Committee to approve this bill to study the feasibility of Small Modular Reactors in Colorado. This is a rapidly developing field with a variety of future options that can provide safe, flexible, carbon-free energy to back up wind and solar without the need for fossil fuels, ensuring that all Coloradans will have a stable, dependable, clean source of electricity to power their homes, cars, and businesses.

Respectfully submitted,

Dr. Mike Fox

February 21, 2023

Dear Rep Winter,

I am Bob Blackburn, a resident of Sedalia, and I am researching Colorado House bill HB23-1080 Reliable Alternative Energy Sources for a bipartisan climate change organization that is agnostic on technology.

The Energy and Environment committee brief Understanding Nuclear Energy's Role in An Energy Portfolio uses a reference that is not designed for long-term planning in the framework of Colorado's Clean Energy Standards.

The "US EIA outlook" referenced in the brief is the Annual Energy Outlook 2022 from US Energy Information Agency. It predicts that US electrical generation sources in 2050 will be 34% from natural gas, 10% coal, 44% renewables, and 12% nuclear. (Page 48). **This projection is not in line with the CO Clean Energy Standard and any reference to it in the committee brief is misleading.**

"U.S. EIA outlook estimates that nuclear energy will become a smaller part of the U.S. energy portfolio in the future, and will fall to 13 percent in 2050 due to: low natural gas prices, limited growth in electricity demand, retiring nuclear power plants, and increasing competition from other renewable energy sources."

The Annual Energy Outlook is the authoritative source for short-term energy information in the US. However, it is not an adequate tool for long-term planning in Colorado, where we aspire to cut statewide CO2 emissions by 90% in 2050.

Two authoritative US government energy models use the Annual Energy Outlook as a starting point. They add adjustments to energy generation and consumption along four pathways, with a multitude of variables:

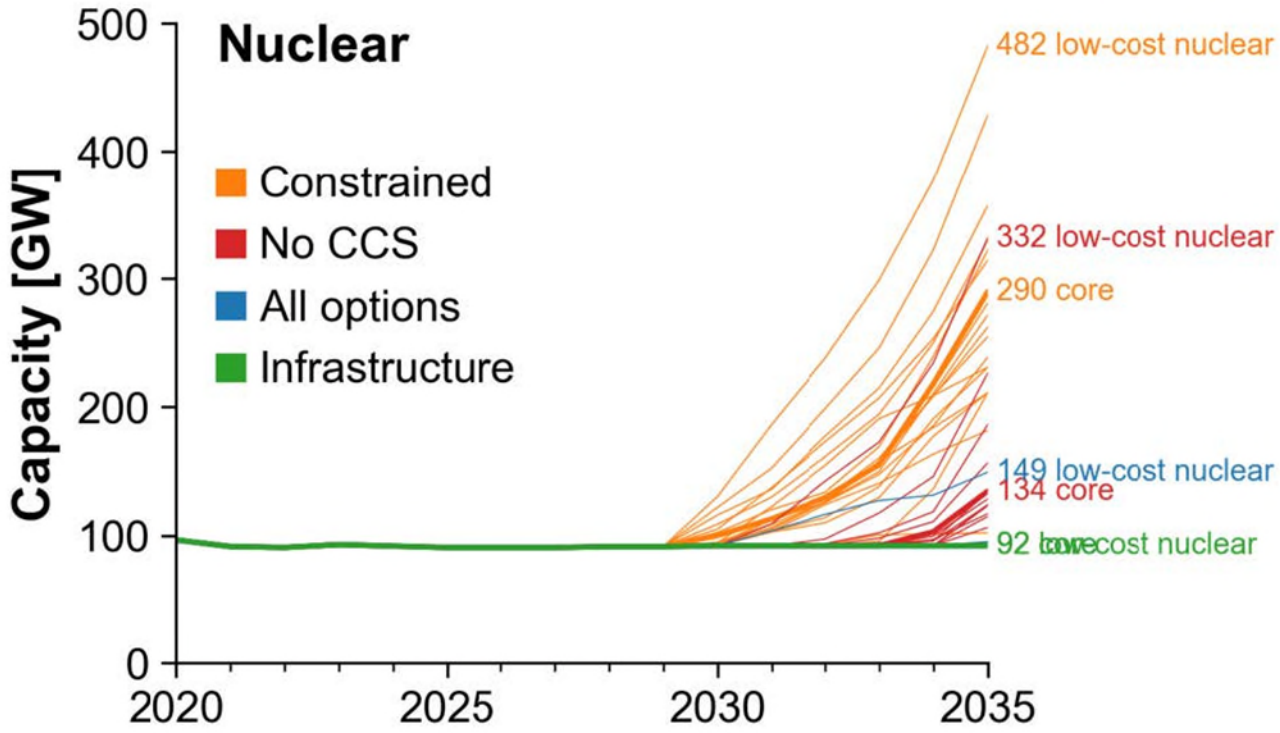
· Examining Supply-Side Options to Achieve 100% Clean Electricity by 2035 by Goldens own NREL, the National Renewable Energy Laboratory. This model is designed to generate 4 pathways to a net-zero electric grid by 2035.

· Long-Term Strategy of the US: Pathways to Net-Zero GHG Emissions by 2050, the official energy planning model of the Biden Administration, using the GCAM model produced by the Pacific Northwest National Laboratory.

On the next page is a graph showing the projected use of nuclear power from NRELs Examining Supply-Side Options to Achieve 100% Clean Electricity by 2035 page 31.

This graph models the projected nuclear energy generation needed through 2035, an aspirational goal for Colorado and our energy utilities.

NOTE: Decarbonizing the grid is just the beginning. Cleaning carbon emissions from the transportation and industrial sectors is a much larger task.



The graph demonstrated the complexity and uncertainty in long-term energy planning and the need for an up-to-date model:

· All scenarios assume a reasonable retail electricity cost to the consumer.

· 499 GW of nuclear-generated electricity would be required with relatively low-cost ($4,500/kW) nuclear electricity and NIMBY resistance to the build-out of transmission lines.

· 332 GW would be required with low-cost nuclear electricity and an unsuccessful deployment of large-scale carbon-capture and sequestration. (CCS)

· 290 GW of nuclear electricity would be needed if nuclear electricity cost as expected and there was NIMBY resistance to transmission line build-out.

· 149 GW if nuclear electricity was low-cost, CCS was successful, and transmission lines were built out.

· 134 GW if the nuclear cost was as expected and CCS was unsuccessful.

· 134 GW would be needed if nuclear was at a moderate cost and CCS was unsuccessful.

· 92 with low-cost nuclear and an optimal Direct Current transmission line build-out.

Decarbonizing Colorado is an enormous task. Recognizing the uncertainty and the high stakes, I ask that the committee look at the best available sources to make an informed decision as to whether or not to study the deployment of Small Modular Nuclear Reactors.

Bob Blackburn

Sedalia, CO

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