Southern Oregon Climate Action Now

SOCAN

Confronting Climate Change

https://socan.eco

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Reference HB2215

Chair Marsh and members of the House Committee on Climate, Energy and Environment:

I write as cofacilitator of Southern Oregon Climate Action Now (SOCAN), an organization of over 2,000 rural Southern Oregonians who are concerned about the climate crisis and support legislative action to address it. The Mission of SOCAN is to promote awareness and understanding of the science of global warming and its climate change consequences and stimulate individual and collective action to address it. Oregonians, some well-intentioned, who have succumbed to the campaign of self-promotion by the nuclear industry might infer that SOCAN should, therefore, support the nuclear option. We do not! Indeed, among the position statement SOCAN has developed, we have a position on nuclear power (SOCAN 2022) which states:

> "SOCAN acknowledges the role that nuclear energy now contributes to the U.S. energy mix, but rejects claims by the nuclear industry and nuclear proponents that genuinely clean renewable energy cannot supply our global current and future energy demand. SOCAN recognizes the benefit of retaining existing nuclear plants, including aging and unprofitable ones that meet stringent safety and transparency conditions, until such time that safer, more economical and sustainable alternative renewables and efficiencies are available. Meanwhile, SOCAN recognizes that nuclear energy is inferior to solar and wind in: taking up to four times longer and costing much more to bring online than wind; producing much more carbon dioxide equivalent per unit of energy generated than solar or wind; and risking promotion of weapons proliferation, meltdown, waste, mining hazards, and further radioactive contamination of humans and the environment. SOCAN also urges (demands) that before any consideration be given to expanding nuclear generation, the 1957 Federal Price Anderson Nuclear Industries Indemnity Act, extended in 2005 through 2025, is repealed. This Act results in taxpayers indemnifying (bearing the cost of covering nuclear accidents for) damages from an incident at a nuclear facility that exceed about $15 billion. **Board approved 12/04/2021** For an explanatory background on this position, visit **Background to SOCAN's Position Statement on the Nuclear Option**."

I will not include the entire 43-page explanation (Journet 2023) here, but will extract a few salient ideas.

p. 21 “Over the years of our awareness of the developing climate crisis, there have been repeated efforts to promote nuclear energy as a solution, or a major contributor to the solution. Some of these efforts have been clearly promoted by the nuclear industry itself apparently trying to regain or increase its share of the energy market. Other efforts have been orchestrated by well-meaning individuals who genuinely see nuclear generation of electricity as having a substantial and beneficial role to play in fighting the climate crisis. Some have even interpreted the evidence to suggest it is essential if we are to succeed because we cannot achieve our global energy needs on renewable sources and storage alone.

p. 22 “Not surprisingly, the nuclear issue is not as clean as many proponents and opponents would have us believe. Claims that we should promote nuclear energy seem to be based on several premises that deserve evaluation.

“The three main premises discussed here are as follows:
1) Clean renewable energy sources are inadequate to provide our energy needs.
2) Nuclear energy generation is free of greenhouse gas emissions.
3) Nuclear energy is safe.

“Evaluating these claims reveals a complex morass of sometimes conflicting evidence. This discussion will try to summarize the evidence as of December 2022.

“**1) Clean renewable energy sources are inadequate to provide our energy needs**

“In a recent report, Jacobson *et al.* (2022) analyzed the potential for genuine clean renewable energy – defined as energy: “that is both clean (emits zero health and climate affecting air pollutants when produced or consumed) and renewable (has a source that continuously replenishes the supply).” These energy sources mainly comprise Wind, Water and Solar energy with storage but include limited geothermal where available (see, for example, Solutions Project 2022). They do not include “fossil energy, bioenergy, non-hydrogen synthetic fuels, blue hydrogen, carbon capture, direct air capture, or nuclear energy, since each may result in a greater risk of air pollution, climate damage, and/or energy insecurity.” The only form of Hydrogen they considered was Green Hydrogen, that is Hydrogen produced by electrolysis using Wind, Water, or Solar (WWS) energy sources.

“The authors noted that as of December 2021, 15 U.S. states, districts or territories had already established a 100% renewable energy goal (California, Connecticut, Hawaii, Maine, Nevada, New Jersey, New Mexico, New York, Oregon, Puerto Rico, Rhode Island, Virginia, Washington D.C., Washington State, and Wisconsin). If the nation were converted to 100% WWS energy by 2050/2051 some 4.7 million more long-term full-time jobs would be created than following a Business-as-Usual scenario involving accelerating fossil fuel use and consequent accelerating greenhouse gas emissions. The land area required for this system would be 0.84% of the current national land surface, a figure which compares favorably with the current 1.3% of U.S. land surface utilized by the fossil fuel industry. Indeed, this represents but 65% of the current land area allocated to energy production.

“A report by Bond *et al.* (2021) for Carbon Tracker concluded “With current technology and in a subset of available locations we can capture at least 6,700 PWh per annum (Picawatt (PWh) = [p. 23] 1015 watts) from solar and wind, which is more than 100 times global energy demand. This opportunity presents itself because the cost of renewable energy has dropped. They also concluded that providing energy from solar alone would occupy only 0.3% of the land surface and that pricing will mean that: “fossil fuels will be pushed out of the electricity sector by the mid-2030s and out of total energy supply by 2050.”

“Jacobson’s (2020) book, based on his Stanford University course, offers evidence that the world can be powered 100% on “clean, renewable wind-water-solar (WWS) energy and storage for everything.” He also argued that “The main obstacles appear to be social and political.”

“In a study funded by the German Federal Environmental Foundation, Ram *et al.* (2019) concluded “A global transition to 100% renewable energy across all sectors – power, heat, transport and desalination before 2050 is feasible.” Furthermore, they indicated this is possible with “…Existing renewable energy potential and technologies, including storage.” They further conclude that a “sustainable energy system is more efficient and cost effective than the existing system, which is based primarily on fossil fuels and nuclear.” In assessing some proposed options, they state their proposed route “…achieves a cost decline without the reliance on high-risk technologies such as nuclear power and carbon capture and [storage] sequestration (CCS). A full energy transition to 100% renewable energy is not only feasible, but also cheaper than the current global energy system.” The obstacle, they suggest, is neither technological feasibility nor economic viability, but political will.

“The evidence that wind, water and solar can provide our energy needs has been offered for several years (e.g., Jacobson *et al.* 2015). Although that paper received some criticism (Clack *et al.* 2017) the authors responded effectively (Jacobson 2017, Jacobson *et al.* 2017). Indeed, Jacobson (2017) also pointed out that “most of [the authors of the critique] have a history of advocacy, employment, research or consulting in nuclear power, fossil fuels or carbon capture. Through The Solutions Project (2022), Jacobson and his team have developed road maps for achieving 100% clean renewable energy economies in all 50 states and the nation as a whole as well as most other nations across the globe.

“In a review of our energy future, energy and environment economist Mark Cooper (2021) argues that there is no benefit to continuing to subsidize and promote nuclear energy since the ‘nuclear renaissance’ has failed for multiple reasons. Amory Lovins (2021a) from RMI (formerly Rocky Mountain Institute) argued that proponents of nuclear power frame the issue incorrectly by focusing only on carbon and ignoring the issue of cost. Because clean renewables are cheaper, he argues, they displace less carbon per dollar than nuclear energy. Additionally, Lovins points out that most of the carbon emissions reductions in the U.S. to date have resulted from increased energy use efficiency and the increasing role of clean renewable energy with nuclear playing a very minor role. Meanwhile, in a different discussion (Lovins 2021b), he addresses twelve myths that include some promoted by nuclear proponents. Notably, he points out, in response to the criticism that solar and wind electricity are intermittent, that the grid doesn't result in one generation source providing one user. Rather there is an array of generators covering a wide array of locations. Although it is [p.24] certainly true that the sun sets and thus compromises solar generation overnight, as Torchinsky (2022) noted, a recent development in the technology shows promise of solar cells that can generate electricity at night by generating "electricity from the small difference in temperature between the ambient air and the solar cell itself." Meanwhile, a lull in wind turbine generation in one location can be compensated by generation elsewhere. Furthermore, the battery storage technology is advancing rapidly and, compensating for intermittence, involves more options than just batteries.

"In addition, there are other techniques available for storing energy: already in use is the water storage system where water is pumped to a high elevation reservoir when energy is abundant, and then runs back down generating energy when the intermittent source is unavailable (e.g., EERE Undated a, EERE Undated b). An alternative, where local topography is not conducive to the water storage approach, energy can be used to raise a unit of mass (soil or rocks) which then can be lowered to emit the potential energy locked into the elevated mass (e.g., Moore 2021).

"In an analysis of forecasts about the energy transition, Way *et al.* (2021) argued: "Most energy-economy models have historically underestimated deployment rates for renewable energy technologies and overestimated their costs." They concluded that: "compared to continuing with a fossil-fuel-based system, a rapid green energy transition will likely result in overall net savings of many trillions of dollars - even without accounting for climate damages or co-benefits of climate policy." Furthermore, they argue that because of the rapid decrease in renewable energy costs and their rapidly increasing deployment an energy future that relies on solar photovoltaics, wind, batteries and hydrogen electrolyzers is preferable because, "In contrast, a slower transition (which involves deployment growth trends that are lower than current rates) is more expensive and a nuclear driven transition is far more expensive." Again, we see evidence that clean renewable resources are expanding rapidly and offer a more cost-effective approach than promoting nuclear energy.

"Premise 1 Inference: There seems abundant evidence, from many independent sources, that this premise for nuclear power, probably the most critical of all, is false. Rather, there is sufficient clean renewable energy to supply our needs. Since Premise 1 is the main premise underlying the argument that we need nuclear energy, its falsification constitutes a substantial blow to the entire argument that nuclear energy is necessary.

"2) Nuclear energy generation is free of greenhouse gas emissions.

"When we undertake assessments of the climate impact of our activities, we must do more than examine day-to-day operations. We must examine the full life cycle emissions of that activity. In the case of solar and wind energy, this means examining the emissions that result from the extraction of materials and construction of the solar panels and wind turbines, plus emissions resulting from their transport, installation and maintenance, and finally those resulting from their end-of-life removal and disposal. Fortunately, operation of these renewable generation sources is emissions-free. In the case of nuclear energy, this also means we must include the emissions resulting from the construction, operation, and decommissioning / disposal of the power plant, plus the emissions resulting from the [p. 25] extraction, processing and final disposal of the nuclear fuel. Fossil fuel-powered generation facilities are subject to the same assessment as the nuclear generator. Only when we are armed with these data are we able to make a legitimate comparison.

"Over the years, several reports have been issued presenting life cycle emissions of various energy sources. These generally report emissions in grams (g) of carbon dioxide equivalent (CO2e) emitted per kilowatt hour (kwh) of electricity generated. Carbon dioxide equivalent is a measure of the warming impact of all gases assessed in terms of their equivalence to that of carbon dioxide – designated as 1. All analyses reveal that fossil fuels result in huge emissions in the many hundreds to thousands of g CO_2e/ kwh. When Carbon Capture and Storage technology (CCS) is included, the emissions only drop slightly. This is not surprising, especially when one considers that CCS only addresses combustion emissions so upstream (extraction processing and distribution) emissions are untouched), as are those resulting from willful / unintended emissions from incomplete or inoperative flaring of methane. Given that substantial CO_2e emissions from natural gas usage result from methane leakage upstream, or emissions resulting from unintended / willful incomplete or inoperative flaring, CCS can do little to reduce the climate pollution caused by this fuel. A National Energy Technology Laboratory report (Skone *et al.* 2015), for example, indicated that in the Appalachian Basin, 77% of the CO_2e footprint of natural gas comprised methane with the majority of this resulting from distribution, transmission, and well completion. Presumably because the majority of CO_2e emissions in the coal cycle result from combustion, imposing 90% carbon capture reduces coal-fired electricity emissions much more than it reduces gas-fired electricity generation emissions. Interestingly, this analysis reports the emissions from nuclear, hydroelectric, wind and solar in the range of 20 – 40 g CO_2e/ kwh, while, at 250, geothermal is 6 to 10 times greater. Meanwhile, without CCS, coal is assessed at 1,205 g CO2e/ kwh, Petroleum at 1180 g CO2e/ kwh, and natural gas at 523 g CO_2e/ kwh.

"Jacobson (2020) also assessed the life cycle emissions of various fuels and concluded that nuclear power emits between 9 and 37 times more greenhouse gases (measured as CO_2e) than wind power.

"In an early literature review Sovacool (2008) summarized complete life cycle assessments of greenhouse gas emissions measured in g CO_2e per kwh electricity generated. With numbers rounded, that report wind (onshore and offshore respectively) at 9 and 10, solar thermal energy at 13 with photovoltaic solar at 32. Various nuclear reactor types averaged out at 66. At that time, the evidence suggests, nuclear was not assessed as equivalent to clean renewable energy sources in terms of emissions. These values compared with biomass (14 – 31) natural gas (443), diesel and oil (998) and coal (960, 1050) revealing how appalling all fossil fuels are by comparison. Additionally, since then, the warming impact of methane has been [p. 26] reevaluated time and again, and each time seems to be revealed as worse than previously thought. It's worth noting, also, that some of these assessments date from before the fugitive emissions (leakage) of methane in the extraction, processing, and transmission of natural gas were fully assessed and reported. These analyses have consistently demonstrated that natural gas is comparable to other fossil fuels in life cycle greenhouse gas emissions. Alvarez *et al.* (2018) reported that fugitive methane emissions produced a global warming impact equivalent to the combustion carbon dioxide emissions of the gas – negating the saving gas is often argued to exhibit because when we only consider combustion emissions, we find that emissions per unit of energy generated are lower for methane than for coal and oil. This would likely nearly double the natural gas impact reported above by Sovacool (2008). Indeed, Howarth (2015), a pioneer in the arena of life cycle assessment of the greenhouse gas emissions from natural gas, suggested that a main result of the inclusion of fugitive emissions is to reveal both shale-fracked and conventional natural gas produce a greater number of grams of carbon dioxide equivalent per mega Joule of energy generated than either coal or oil. Natural gas (methane) is not 'the clean fossil fuel!'

"Chapter 7 of the Intergovernmental Panel on Climate Change evaluation of various energy sources (Bruckner *et al.* 2014) reported lifecycle assessments in a range of 675–1689 g CO_2e/kWh electricity for coal. Corresponding ranges for oil and gas were 510–1170 g CO_2e/kWh and 290–930 g CO_2e/kWh14. They identified the ranges for lifecycle greenhouse gas emissions as 18–180 g CO_2e/kWh for Photovoltaic panels, (Kim *et al*., 2012; Hsu *et al.,* 2012), with 9–63 g CO2e/kWh for Concentrated Solar Power (Burkhardt et al., 2012), and 4– 110 gCO2e/kWh for nuclear power (Warner and Heath, 2012). Wind generation was graphed in the range of solar and nuclear, but the actual value was not reported.

"Evans (2017) reported on CO_2e emissions in a Carbon Briefs report from a publication by Pehl *et al.* (2017) using the same units (i.e., g CO_2e per kwh electricity generated) as employed by Sovacool (2008) above and others, below. This assessment identified wind at 4, solar at 6 and nuclear at 4 g CO_2e per kwh. Meanwhile, coal with Carbon Capture and Storage (109), natural gas with Carbon Capture and Storage (78), Hydro (97) and bioenergy (98) are all over an order of magnitude worse in terms of emissions.

"The National Renewable Energy Laboratory (NREL 2021) reported life cycle assessments also measured in terms of g CO_2e/kWh, though some were from much earlier studies dating from as far back as 2005 – presumably when no more recent study has been performed. Wind and nuclear tied at 13 g CO_2e per kwh with concentrating solar power at 28 and photovoltaic panels at 43. Meanwhile, natural gas, oil, and coal respectively scored 486, 840, and 1001 g CO_2e per kwh.

"Jacobson (2019) further reported the 100 year life cycle assessment in terms of g CO_2e/kWh as follows: rooftop solar 0.8 – 15.8, solar photovoltaic utility 7.85 – 26.9, concentrated solar power 8.43 – 25.2, onshore wind 4.8 – 8.6, offshore wind 6.8 – 14.8, hydroelectric 61-109, wave 26 – 38, tidal 14-36, nuclear 78 to 178 g, biomass 86 – 1,788, natural gas with CCUS at 230 – 481, and coal with CCUS 282-1,011 CCS where U represents Carbon Capture and Storage with Utilization. Unfortunately, the main utilization in CCUS of the gas is to promote further [p.27] extraction of fossil fuels and thus generates further greenhouse gas emissions, which rather defeats the purpose.

“Jacobson (2020) departed from the pattern of reporting nuclear generation as similar to solar and wind in terms of emissions per unit of energy generated. Rather, that author identified nuclear generation as producing between 9 and 37 times more CO_2e and pollution than wind generation. The above data reveal that the range for solar means that nuclear could compare even less favorably.

“While substantial differences exist among the studies, presumably based on slightly different methodologies, comparisons within studies reveal that nuclear generation, while consistently much lower than fossil fuels, is never a zero emissions process. It is not entirely clear if all life cycle assessments of the nuclear technology include decommissioning and waste storage, though they should. A study by Koltun *et al.* (2018) of a so-called fourth generation reactor (gas turbine technology with modular helium reactor GT-MHR) specifically included both decommissioning and waste treatment and revealed g CO_2e/kWh of 15, well in line with the data reported above suggesting maybe these components are included.

Premise 2 Inference: While there seems little doubt that nuclear generation is a substantial improvement over coal, oil, and natural gas, at best, it appears to be right in line with the genuinely clean renewable sources of solar and wind. At worst, it simply may not achieve their low emissions so is no improvement over clean renewable sources. Furthermore, investment in nuclear energy would compete with investment in genuinely clean energy sources; every dollar spent on promoting nuclear energy is effectively a dollar subtracted from promoting renewable energy / storage. Meanwhile, as Matthews 2022 point out, the cost per megawatt hour of electricity generated (in 2021 dollars) is as follows: Solar $36.49, Geothermal $29.82, Onshore wind $40.23 while hydro is $64.27, ultra-supercritical coal is $82.61, advanced nuclear is $88.24, and biomass is $90.17. The cost of nuclear power alone renders it noncompetitive.

“3) Nuclear energy is safe

“There exist two basic concerns regarding health and safety: one deals with the day-to-day operations (including waste production), the other with unpredictable events (whether human-induced or natural).

“The Health and Safety Concern

“That nuclear fission poses potential health and safety risks is well known. As discussed above (Health Effects of Radioactive Isotopes), the problem with nuclear radiation from unstable isotopes is its proclivity for inducing cancer in exposed organisms. Exposure to the high energy radiation disrupts DNA in the nuclear chromosomes of the cells of exposed individuals, often causing cancerous hard or soft tumors.

p. 28 “As also discussed in Journet (2023), the risk posed by these isotopes depends largely on their half-lives: isotopes with short half-lives tend to emit intense radiation, while those with longer half-lives emit less intense radiation, but obviously do so over a much longer period.

“It seems that the normal activity of a nuclear power plant will generally pose little threat to the environment though the heated water discharged from a plant may well disrupt local aquatic species. Problems arise, however, when normal activity is undermined – whether by human error, natural catastrophe (such as earthquakes and tsunamis), or terrorist/military assault.

“However, it is worth remembering, as stated by NRDC (2022): “Current radiation protection standards are based on the premise that any exposure to radiation carries some risk, and that that risk increases directly with dose of exposure.” In a significant analysis of the literature, the National Academy of Sciences (NAS 2006) offered: “Epidemiologic studies … show that exposure to low… radiation can lead to the age- and time dependent development of a wide range of tumor types that, in general, are not distinguishable from those arising in non-irradiated populations.”

“Richard Clapp, a retired professor from Boston University’s School of Public Health offered in a guest editorial in Environmental Health Perspectives (Clapp 2005) “Given the availability of alternative carbon-free and low-carbon options and the potential to develop more efficient renewable technologies, it seems evident that public health would be better served in the long term by these alternatives than by increasing the number of nuclear power plants in the United States and the rest of the world.”

“Responding to an article promoting nuclear power in the energy mix, Larsen (2020) wrote: “the proponents of nuclear power…are overlooking the significant risks inherent in the technology and the fact that scaling up nuclear power would take too long and is too costly to be an effective climate solution.” During the Russian invasion of Ukraine, invading forces took over the Ukrainian Chernobyl nuclear disaster site and apparently unwittingly exposed themselves to radioactive hazards. The invading Russian forces then targeted the largest nuclear power plant in Europe, in Zaporizhzhia, with shells and missiles before commandeering it. These events should be enough to alert everyone that nuclear facilities are sitting ducks for ignorant military or terrorist behavior and thereby pose an ongoing threat to citizens within many miles of the facility.

“In responding to the claim of operational safety, frankly, it seems that no argument is really necessary except the single word: ‘Zaporizhzhia.’ It has long been suggested that a major threat posed by nuclear power plants is their exposure to terrorist action. Now, with the Russian invasion of Ukraine we have the perfect example of that threat as Putin’s forces attacked the largest nuclear power plant in Europe and with its bombardment risked an outcome potentially equal to Fukushima. Given the number of unsettled regions around the globe, where civil unrest is possibly simmering just below the surface, the expansion of [p. 29] nuclear power, with its capacity to provide fuel to allow nuclear weapons proliferation, seems unwise at best. And if we acknowledge that this energy source is unnecessary, the notion of promoting nuclear power seems downright foolhardy.

"It should be acknowledged, however, that maybe the Zaporizhzhia incident, emerging as a result of the Russian invasion of Ukraine is as strong an argument against a large, centralized power generation grid system as it is an argument against the energy resource used in that generation facility. The fact that the Ukrainian power plant is a nuclear facility simply compounds the risk."

An important consideration in relation to nuclear generation is the Price Anderson Act by which taxpayers subsidize by indemnifying the nuclear industry:

p. 20 "**The Price Anderson Act**
"This Act, initially passed by Congress in 1957 and since renewed, provides the nuclear industry with a substantial subsidy that tilts the energy economic playing field in its favor. As described by Holt (2018) the Price Anderson Nuclear Industries Indemnity Act authorizes the Nuclear Regulatory Commission to limit the liability of nuclear licensees from radiation damage to the public. This authority has been extended by Congress four times; it currently remains in effect until 2025. The Act requires nuclear generator owners (1) to carry insurance liability up to the current commercially available maximum, ($450 million as of January 1, 2017), (2) for owners of 100-megawatt-and-above power reactors to contribute to an industry-wide fund which cover damages above $450 million through a contribution by each nuclear reactor owner up to $121.3 million. As a result of the number of reactors liable for this payment, the total in this fund caps at $12.4 billion but it is variable depending on the number of liable reactors. Damages above this amount would require Congressional action to be funded, but there is no source for any such funds, so these would come from general revenue (i.e., the U.S. taxpayer).

"It's worth being reminded that restoration of damage from the Fukushima incident is anticipated to cost over $200 billion. Thus, if a Fukushima-like incident were to happen in the U.S. taxpayers would be responsible for over $190 billion.

p. 21 "Holt (2018) also notes: "The Price-Anderson Act's limits on liability were crucial in establishing the commercial nuclear power industry in the 1950s. The nuclear power industry still considers them to be a prerequisite for any future U.S. reactor construction." We live in a society where individuals and businesses are, in many cases, required to carry insurance to cover damages should they be responsible for an accident. Surely, by the same token, an industry that claims to be safe should be required to negotiate insurance from private insurers. If that industry cannot persuade insurers to provide coverage, or afford the premiums levied, the message about safety of operations at nuclear reactors should be clear.

"Polonsky & Eskelsen (2021) report that the Nuclear Regulatory Commission sought no changes in the liability plan when the Price Anderson Act was considered by Congress that year.

“In 2021, the Department of Energy initiated a public comment period preparatory to a review of the act (Fork and Fowler 2021). These authors noted that the Price-Anderson Act is critical to nuclear suppliers’ ability to manage their risk. In its report on recommendations regarding re-authorization, the Nuclear Regulatory Commission authors (USNRC 2021) pointed out that the maximum coverage available per incident from this Act is $13.4 billion. Since this total is based on the per reactor allocation to the fund, if the number of reactors decreases from the total (94 as of October 2020) the total funds available would decrease since each reactor contributes $137.609 million to the fund. Despite the cost of the Fukushima incident estimation of over $200 billion, this report relies only on the U.S. history of claims and the Three Mile Island example to conclude that the total available from the fund is sufficient to meet needs. This conclusion is offered despite the recognition that with nuclear plant retirements, this total number of reactors will likely drop, as will the amount in the fund. The key point not mentioned is that any accident cost beyond the fund that stands at a little over 1/10th the Fukushima cost will be covered by the U.S. taxpayer. In reviewing the NRC report, Lewis (2021) summarized it as follows: “The NRC … does not recommend repealing or modifying any specific provisions, though it does make a few minor recommendations relating to the treatment of nonprofit operators and international coverage.” The modifications include recommending a 10-year rather than a 20-year extension based on the anticipated deployment of advanced reactor designs.

“It is not clear what Congressional action has occurred in relation to the proposed reauthorization.”

A particularly popular nuclear option in Oregon is the Small Scale Modular Reactor (SMR) probably because manufacturer Nu Scale is based in the state. Buy there are serious drawbacks to this technology:

p. 12 “According to the U.S. Energy Information Agency (EIA 2022), these are about a third of the size of currently operational nuclear power plants while those currently under construction are simple and compact in design and can be assembled in a factory and transported to the site. It is suggested that these features may allow more rapid nuclear power plant construction. Whereas large conventional nuclear reactors produce 700 or more Megawatts (MW) of energy, SMRs operate at 300 MW, while the even smaller version Microreactors operate at up to 10 MW Lou 2021). The same source suggests that SMRs require less fuel and also more infrequent refueling than conventional reactors. However, as of 2021 [p. 13] the International Atomic Energy Agency (Liou 2021) states “their economic competitiveness is still to be proven in practice …”

“According to the IAEA’s Liou (2021), SMRs are small reactors with a capacity to generate up to 300 MW per unit (about a third the capacity of traditional nuclear power plants) and produce low carbon electricity. The modular aspect refers to the fact that they are prefabricated offsite and then transported as a unit to the site. Because of their small footprint (area requirement), they can be sited where large conventional nuclear reactors are not possible. Because of their reduced cost in construction, they can be installed incrementally as energy (electricity) demand increases.

"Liou (2021) also pointed out that: "The IAEA expects to publish a Safety Report on the applicability of IAEA safety standards to SMR technologies in 2022." According to Donavan and Vives (2022) as of April 2022, the IAEA had completed its review of safety standards that would be applicable internationally and was expected to publish a report later in 2022. Liou (2022) then reported that IAEA's Nuclear Harmonization and Standardization Initiative, charged with developing such standards, with a focus on SMRs first met in June. Since SMR development is occurring in many nations, the discussions involved 133 participants from 33 nations. It is not clear when the necessary codes and standards will appear.

"Nakhle C. (2022) indicates that not only does it take on average eight years to build a nuclear power plant, more importantly the time between the decision and the commissioning can vary between 10 to 19 years. On the positive side, Nakhle (2022) argues, SMRs are not suitable for producing weapons-grade materials since uranium enrichment tends to be limited to 20 percent or less, so it is easier for them to comply with nonproliferation regulations. Furthermore, SMRs have reduced fuel requirements. She reports that the International Atomic Energy Agency (IAEA) stated that power plants based on SMRs may require refueling every three to seven years, compared to every one to two years for conventional plants. Some SMRs are designed to operate for up to 30 years without refueling. The positive implication is that less frequent refueling decreases the risks inherent in transporting radioactive matter.

"However, Nakhle (2022) acknowledged that at this stage, SMRs remain mostly a concept and that their economic competitiveness and general viability remain to be tested. She suggests [p. 14] that it is currently difficult to find reliable data demonstrating the commercial potential of this technology. As a result, it's difficult to offer a forecast.

An important measure of the merit of a technology is the levelized cost of energy (LCOE) of various sources of electricity. This metric incorporates the lifetime, capital cost, operations and maintenance expenses, fuel expenditures and energy production of a technology. Nakhle (2022) reports that one study found that SMRs are in fact the costliest option.

Farmer (2022) pointed out that despite their potential for use where conventional nuclear reactors are not possible, most current plans are to construct very small capacity SMRs on site alongside current reactors. Farmer (2022) also noted that Oregon's NuScale SMR company plans to develop SMRs in Poland and build a plant in Idaho starting operations in 2029. However, NuScale has attracted critique from the Institute for Energy Economics and Financial Analysis think tank. The institute (IEEFA 2022) reported that the NuScale design was "too late and too expensive, too risky and too uncertain" compared to modern solar and wind renewables. NuScale claims its SMR have a generating cost of $58/MWh, through to 2040 with a construction cost of $3,000/kW. Meanwhile, the IEEFA (2022) cost analysis (Figure 1) reports that the comparable cost for solar and wind energy will be much lower by then.

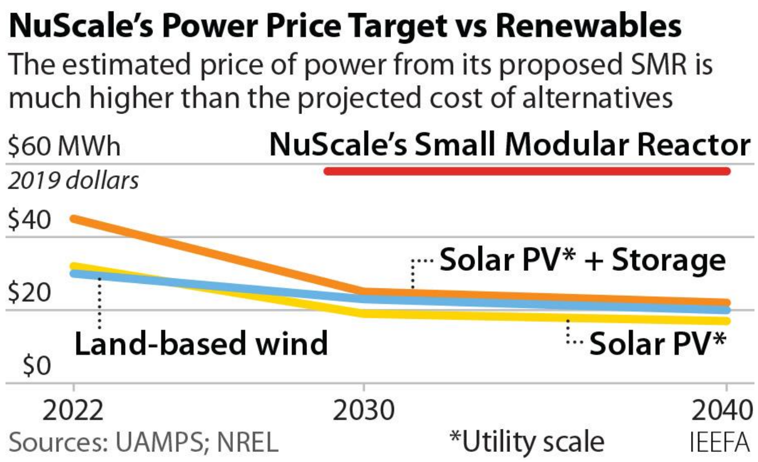

Figure 1. Cost estimates for Small Modular Reactor energy versus renewable energy. (IEEFA 2022)

> Additionally, in reviewing the waste production from SMRs, Krall *et al.* (2022) concluded that in comparison to existing PWRs (Pressurized Water Reactors), SMRs will increase the volume and complexity of LILW (Low and Intermediate Level Waste) and Spent Nuclear Fuel. This increase of volume and chemical complexity will be an additional burden on waste storage, packaging, and geologic disposal.
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> "The discrepancy regarding nuclear proliferation risk may be explained as Virgili (2020) indicates by the fact that some SMRs operate on < 20% enriched uranium, while some use > 20% enriched uranium.
>
> "They conclude that of three distinct SMR designs they assessed, that relative to a gigawatt-scale PWR reactor, these reactors "will increase the energy-equivalent volumes of Spent Nuclear Fuel., long-lived LILW, and short-lived LILW by factors of up to 5.5, 30, and 35, respectively."
>
> p. 15. "Small Modular Reactors seem to offer some advantages over the conventional nuclear reactor, but many questions remain. The evidence presented above suggests that there is little likelihood that SMRs will provide a satisfactory climate remedy."

Assessments have been undertaken on how a nuclear power generation emphasis nationally affects greenhouse gas emissions:

> p. 31 "If nuclear generation were to contribute substantially to lowering a nation's emissions, this should be reflected in the relationship between nuclear emphasis among nations and the greenhouse gas emissions of those nations. Sovacool (2021) reported on this relationship and concluded that, in fact, greater emissions are associated with those nations that have more nuclear generation than those with less, a result contrary to the expectation if nuclear generation were to reduce emissions. Meanwhile, Sovacool (2021) also points out, nations with a greater emphasis on renewable generation exhibit lower GHG emissions than those utilizing nuclear generation. Rather than promoting emissions reductions, a nuclear emphasis seems merely to compete with and replace renewables. Maybe promoting nuclear energy psychologically encourages a 'business as usual' attitude among users that results in excessive energy utilization and undermines the encouragement of energy use efficiency and conservation. Since we know that there exists no totally benign energy source, actions that promote false solutions and create

the impression continued massive energy use is now acceptable are more dangerous than they might initially appear.

In summary, it is our judgment that there exists no justification for the legislature to countermand the expressed will of the people regarding nuclear power. Thus, SOCAN opposes HB2215 and all other proposals attempting to introduce nuclear energy into the Oregon power mix.

Respectfully Submitted

Alan Journet

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