DOCKETED	
Docket Number:	21-ESR-01
Project Title:	Energy System Reliability
TN #:	248829
Document Title:	Climate Action California Comments on Distributed Clean Energy Sources should not be nuclear
Description:	N/A
Filer:	System
Organization:	Climate Action California
Submitter Role:	Public
Submission Date:	2/16/2023 5:15:25 PM
Docketed Date:	2/16/2023

Comment Received From: Climate Action California
Submitted On: 2/16/2023
Docket Number: 21-ESR-01

Distributed Clean Energy Sources should not be nuclear

Additional submitted attachment is included below.

February 15, 2023

California Energy Commission

Docket Unit, MS-4

Docket No. 21-ESR-01

715 P Street

Sacramento, California 95814

Dear Staff,

Thank you for your efforts to help CA transition to a clean energy economy. Your webinar focused on the Diablo Canyon reactor explores the challenges of demand forecasting, scaling clean energy generation and storage, resilience, and reliability in the context of climate change, all issues covered in detail in your Integrated Energy Plan Report. There is widespread consensus among stakeholders that the above issues require more attention than we have been dedicating to them.

We wish to make three comments and suggestions for CEC policy regarding extension of Diablo Canyon and the deployment of distributed clean energy resources v. nuclear.

1. FOCUS FUTURE PLANNING ON LOCAL DER. As we know, energy transmission over short distances is efficient and less costly than long-distance transmission. Fortunately, clean energy resources (solar and wind) don't need to take up a vast amount of land, and can be developed almost everywhere in our state. While your planning addresses 24/7 demand and supply, we recommend that future research, CEC quantifies California's clean energy supply and demand on a *county* basis: In other words, please review the amount of available clean energy that is *not* dependent on transmission of energy from other counties, in each county of CA. Consider setting an objective for each county to meet its energy supply needs from clean energy distributed resources, including rooftop solar, community microgrids, and utility-owned clean generation resources such as utility-scale solar, wind, and offshore wind generation.

2. NUCLEAR ENERGY SHOULD BE A LAST RESORT. We recommend that your future evaluation of reliability focus on energy sources with the lowest 3-Scope lifecycle GHG intensity, the lowest toxic emissions, the highest benefit to cost ratio, greatest efficiency, and best likelihood of swiftly replacing fossil energy. Benefit to cost estimates should include all of the variables listed in Appendix A of your IEPR, Dec. 2022. In addition, the latest estimates of Social Cost of Carbon (CO_2, CH_4, and N_2O) from the EPA should be used with a discount rate of 1 percent. In addition, factors pertinent to reactors from the appendix of this document should be estimated.

   Regarding nuclear reactor permitting decisions, we believe future webinars should focus on issues that are unique to reactors and which provide positive benefit to cost ratios. This will inform more strategic decisions about energy policy.

   Furthermore, future estimates of clean energy supply needs should be increased in accord with the precautionary principle. It would be prudent to set clean generation targets annually that conform to your modeling and are then multiplied by at least 1.1. If we generate and store more clean energy than CA can use during a given year, we can export it.

3. BE REALISTIC ABOUT THE HIGH COST OF NUCLEAR ENERGY

   Clean energy outperforms nuclear reactors by a wide array of criteria. Most clean energy technologies generate energy at significantly lower cost than nuclear. The cost of electricity from reactors increases with their age, as maintenance costs rise. Reactors have poor efficiency because they continuously release heat into the atmosphere and our water resources. They contaminate more water resources during their operation than clean energy sources. Unlike clean energy, reactors emit toxics continuously, i.e., ionizing radiation with multi-millenia half lives. Corruption, which has infected parts of the nuclear industry also has costs. As we know, high-magnitude cost-overruns and delays are the norm for building and renovating reactors. The entire civilian nuclear power system could not exist were it not for the backstop liability insurance provided by the U.S. government, as private insurers are not willing to provide liability coverage for the largest possible accident.

See Appendix for a detailed overview of reactors and emissions.

In summary, CEC has recommended extension of Diablo Canyon until “viable alternatives” are “clearly established.” We believe that this goal has been achieved—by the weight of scientific research as well as by proof of efficacy from domestic and international utilization of diverse clean energy resources.

Four-fifths of voters polled in the US prefer clean energy to dirty nuclear and fossil energy. Still, federal funding is available to extend the lives of aging reactors, but there is little consensus on whether it is enough to rehabilitate Diablo Canyon. It is also questionable whether the maintenance required to extend the facility's life is safe or suitable, as the primary coolant loop cannot be serviced at all. The pipes in this system are subject to high levels of ionizing radiation and neutrons and are thus subject to highly corrosive conditions and embrittlement. If a leak occurs in this system, a high pressure steam explosion in or near the core may occur, potentially spreading radioactive material over a wide area. The Inflation Reduction Act provides much more funding for development of many new clean energy resources and products. CEC has the responsibility of receiving and disbursing clean energy funds for CA. **Please use the funds received exclusively for clean energy.**

The Warren-Alquist Act criteria for new reactors in CA should also apply to permits for extensions of reactor life. See pages beginning with 110 in the link above..

Thank you for considering these comments. If staff would like to discuss our ideas, we would welcome the conversation. Please contact David Bezanson; we look forward to speaking with you.

Sincerely,

David Bezanson, PhD. David Bezanson
Steve Rosenblum, PhD.
For Climate Action California

APPENDIX

DO NUCLEAR REACTORS GENERATE ZERO-CARBON ENERGY ?

The nuclear industry has declared that reactors are “zero-carbon” or “carbon-free.” Lobbying has led to regulatory and legislative capture that echoes this claim. Is it corroborated by scientific research?

Hundreds of studies have calculated carbon emissions over the lifecycle of nuclear reactors. There is a wide range of estimates of gCO2/kWh. Research factors in mining, construction, dismantling, and the beginning of fissile trash storage. There is no consensus on how to estimate C emissions from dismantling and long-term storage. Furthermore, C emissions from the operating phase (after construction but prior to dismantling), including transportation, were not factored in (1, 2, 3, 4, 5, 6, 7).

LIFECYCLE ANALYSES OF REACTORS

Most lifecycle research concludes that reactors have C emissions comparable to that of renewables like PV solar and wind. Future research is likely to find the C emissions of reactors to be significantly higher for the following reasons. The vast majority of research was done in 2017 or earlier. During that time, the efficiency of wind and solar were significantly lower than in 2021. For example, the efficiency of PV solar was in the range of 15 to 19% prior to 2018. Currently, flat-panel PV solar efficiency is 20 – 23% and is projected to rise to 30%. Bifacial design can capture 8% more energy. Thus, 38% is a feasible efficiency using existing technologies. Increased efficiency will drive down the price and lifecycle C emissions per kW.

Pre-2018 research was based primarily on the use of moderate grade uranium ore. Unmined deposits of this grade are becoming scarce worldwide. Low grade uranium is now the norm for use in reactors. This requires a significantly higher input of electricity to activate the fission reaction, i.e., enrich the uranium. Worldwide, about 65% of electricity is fossil fuel or biomass sourced – each having high GHG and toxic emissions. A popular technology for enrichment is uranium gas centrifuges, which are rotated at high RPM using mostly fossil-fuel-sourced electricity.

The reactor industry is unsustainable due to the diminishing global supply of moderate grade uranium. Eventually, the lifecycle carbon emissions of reactors will exceed that of fossil fuel power plants. Estimates for the likely date of parity, at the current global output of reactors, vary from 2070 to 2145 (1). This depends upon the magnitude of other uses of uranium, e.g., nuclear weapons and medical diagnostics; as well as the commercial use of other elements, e.g., thorium.

Most uranium used in US reactors is imported. Per the Energy Information Association, the largest suppliers were Canada, Kazakhstan, Australia, and Russia in 2019. Cargo transport over such long distances emits significant quantities of C. In contrast, nearly all of the materials used to manufacture US solar and wind equipment is US-sourced, which entails lower amounts of toxic and C transport emissions. And there is no need to import solar and wind energy because we have plentiful resources in the US. 33% of uranium fuel rods require replacement with fresh enriched uranium every 18 to 24 months. All rods are replaced within 5 to 6 years. This periodic mining, enrichment, and replacement process entails significant amounts of mining, transportation, and GHG emissions – throughout the operating phase.

Reactors are typically refurbished every 40 years. This takes 2 to 4 years, during which time there is no electricity output. Restarting is done gradually over a period of several months at a low power output.

Water vapor, especially when combined with heat, is a GHG. Each reactor emits enough heat and water vapor to equal 4.4 gCO2e/kWh. In contrast, solar and wind decrease heat and water vapor enough to remove 2.2 gCO2e/kWh (7). Jacobson constructed a table contrasting the emissions of many energy technologies over 100 years (7).

Transportation of uranium, in non-operating phases, is factored into most research. However, not even a single study was located that estimated the C emissions from transportation of workers (or uranium) during the operating phase of the lifecycle. According to an industry association, Nuclear Energy Institute, each utility scale reactor requires 500 to 1000 workers throughout the operating phase as of 2021. Let's consider the C emissions from transport of 500 workers. If the average round-trip commute is 12 miles and the average m.p.g. of vehicles is 12 (in commuter traffic), then one gallon of gasoline is burned. This emits 19 pounds of CO2 per E.P.A. 19# x 500 workers = 9500# of CO2/day. This equals 4.31 MT of CO2e. If commuters work 240 days annually, the total is 1034 MT/yr. (Multiplying this by 95 reactors in the US has a product of 98,230 MT/yr.) Maintenance and security staff are required continuously and emissions from transport of workers are important to add. Factoring these into lifecycle analysis research would generate more accurate estimates of gCO2/kWh.

As reactors age, they become less efficient. The ratio of energy output to input decreases while hours of maintenance rise annually. These factors increase C emissions per kWh (4).

Long term storage costs are frequently mentioned in the literature, but lifecycle research excludes estimates of emissions from this final stage. Due to the prolonged half-life of spent uranium fuel, safe storage is required for millenia. For the initial decades after reactor closure, the fissile refuse is stored on the reactor site inside metal containers in a pool of water. After cooling, these multi-ton cylindrical coffins are oft set upon a concrete foundation surrounded by fencing. Manufacture of metals and concrete entails high energy inputs and C emissions. Storage requires on-site security workers to be present, or monitoring from a remote location, continuously. This entails transportation emissions for millenia even if a permanent national repository is approved. For decades in the US, plans to transport the coffins to a permanent underground crypt have been proposed. No site has been approved because voters in each target state have rejected the dumping of radioactive garbage in their backyard. Transportation to a final resting place poses risks of accidents and spills. In addition, moving the heavy cargo is energy intensive, emitting copious amounts of C. Storage is very controversial and many MT of CO2e are emitted annually due to the labors of policy makers, regulators, and NPOs to address this issue. The most ambitious storage plans are being executed in Sweden. Excavation of tunnels 200 to 500 meters deep has begun, but none have been completed. This subterranean process is also energy and C intensive. There is no guarantee of the geologic stability of these subterranean vaults for thousands of millenia. Until there are sound estimates of the C emissions from the storage phase, estimates of lifecycle emissions will be too low to allow accurate comparison with other energy technologies.

CLIMATE CHANGE

Nuclear reactors are a poor choice of energy technology during a period of accelerating climate change based on lifecycle CO2e criteria. In addition, they are dirty, slow, and expensive. In contrast, renewables are cleaner (free of ionizing radiation emissions), can be built at utility scale within a few years (instead of 10 to 19 years for reactors), and generate electricity for as little as one-fourth the cost of reactors. The NRC requires reactors to shut down when the ambient temperature is at least 100 F. Renewables can operate at temperatures well above 100 F. Reactors require huge volumes of water for cooling. In contrast, renewables do not require water for cooling or operation. Reactors have the only energy technology that presents risks of theft of fissile materials, proliferation of nuclear weapons, and being used as a dirty bomb by organized crime and hostile nations. Like other forms of dirty utility-scale energy generation, the lifecycle of reactors violates environmental justice. E.g., the mining, construction, operation, and demolition phases expose workers and proximal residents to many toxins including ionizing radiation. Though reactor failures are uncommon, a single failure can imperil public health, crops, and wildlife within a radius of hundreds of kilometers for decades (2, 5, 7, 8, 9, 10, 11, 12, 13, 14).

To decelerate climate change, construction of new reactors has been proposed. The above considerations reveal that renewables are more effective and economic for rapid and safe scaling up of electricity generation and storage.

Others, some of whom object to new reactors, favor extending the lifespan of existing reactors. This should only be considered for reactors situated on sites that are distant from sources of new or existing renewable generation plants or suitable plant sites. If a reactor is in a microclimate that lacks sunlight, wind, geothermal sources, and ocean tides; extension is worthy of consideration. Replacing existing reactors with fossil fuel plants would accelerate climate change. So renewables, rather than fossil fuel generation, are the best replacement for reactor energy.

Site-specific hazards are critical to consider. Existing reactors on risky sites should be decommissioned promptly. These risks include tsunamis, flooding, sea level rise, a climate with many days annually that exceed 100F, landslides, proximity to airports, proximity to seismic fault lines, subduction zones, and locations on the shores of fresh-water bodies that are receding due to recurrent drought.

CONCLUSION

Because the terms “carbon-free” and “zero-carbon” do not apply to reactors, It’s use should be discontinued – especially by scientists, government, and mass media. If the term “low carbon” is used for reactors, a 3-Scope comparison with other energy sources is required for this to be meaningful. Reactors do have low CO_2e emissions relative to fossil fuel energy sources. However, lifecycle reactor emissions are higher than the emissions from renewables.

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