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SB 423 Clean Firm Resources

See pdf uploaded below.

Additional submitted attachment is included below.

April 21, 2025

Comments Re.: Yee Yang, Chie Hong and Kristen Widdifield. December 2024. SB 423 Firm Zero-Carbon Resources Report. California Energy Commission. Publication Number: CEC-200-2024 012. Docket #: 21 ESR 01

Dear CEC Scientists,

Thank you for generating a report as required by SB 423 (chaptered 2022). This book-length treatise is loaded with valuable statistics.

It is more accurate to use the term firm clean energy. The manufacture and operation of any energy technology entails CO2 emissions. Let's consider the three Scopes of lifecycle emissions. Scope 1 includes inputs to the manufacturing process. This includes mining, transport, waste heat from inefficiency, utilities, fugitive emissions, manufacture of basic materials like cement and steel, and fabrication of finished equipment. Scope 2 is the energy used for all company operations. If grid energy is used, this is now approximately 53% dirty (carbonaceous) in CA. Scope 3 is emissions are from supply and value chain processes that require transportation, trash disposal, emissions by consumers using their products, storage, supplies, tools, utility use, and communications. Once the finished equipment is in service, it requires regular maintenance. This entails more transportation, utility use, use of tools and supplies, and communications. Each Scope and operation requires labor, which is a significant source of CO2 emissions. No energy technology has zero-carbon emissions over its lifecycle. In future reports and policies, please use the term firm clean energy.

Most of the firm technologies that you review have been used and studied for decades. To reach our climate and air quality targets in the least amount of time, we must select technologies with the highest efficiency. lowest cost per MW of output, and lowest toxic emissions, side effects, disadvantages, and risks. Only the best-performing technologies are to be used. We do not have infinite amounts of time and resources to achieve our objectives of resilience and decarbonization. It is most cost effective to be very selective and study new innovations to displace inferior technologies. Using "all of the above", i.e., anything that generates and stores energy, has many kinds of opportunity costs.These include higher amounts of toxic emissions, higher costs, higher income tax, higher electricity rates, fewer incentives for clean innovations, less resilience, higher rates of public health problems, more severe harms to EJ communities, and other facets of the Social Cost of Carbon (SCC). Through research, we have become more accurate at quantifying the high externalized costs (e.g., SCC) of fossil fuel energy. In like manner, we would be wise to objectively evaluate the performance characteristics of each energy technology that is at or near commercial readiness. However, those with unacceptable costs or side effects should not be studied unless all clean sources have been depleted.

THE IMPORTANCE OF COST AND TIME IN TECHNOLOGY SELECTION

Two popular energy technologies will be contrasted. See if you can guess what each is without viewing footnotes.

Let's consider the emissions mitigation impact of 2 kinds of energy generation. Technology A has a Levelized Cost of Energy (LCOE) of $86/MWh.[1] Utility-scale plants take 2 years to complete. Technology X has a LCOE of $182/MWh and utility-scale plants take 15 years to complete. This excludes cost of land and taxes If each is used to displace 11 GW of electricity from methane plants, the following shows the costs and duration to accomplish this. The completion date is : a) 2027 for Technology A and b) 2035 for Technology X plants. Technology A is completed and begins reduction of emissions from the retired methane plants 2 years after starting construction. Technology X is completed and begins reduction of emissions from the retired methane plants15 years after commencing construction. .

	Construction Cost (11GW capacity)	Years to Complete	% of CO2 mitigated 2027 - 2040	% CO2 miti. after 2040
A	$27B	2	100	100
X	$176B	15	zero	100

% is the percent of CO2 prevented by A and by X when methane power plants are displaced.

The construction cost of A is based upon 2023 prices[2] and includes a transmission interconnection line. Construction cost of X is based on actual cost of plant X, completed in 2024[3]. CO2 emissions from the 11 GWh of methane power plants displaced by each technology excludes fugitive emissions of methane from pipelines and storage tanks. The CO2 emissions rate from the plants is about 0.4 kg/kWh, 400/MWh, 400,000/GWh = 400 MT[4].

Let's consider the fuels used by each technology. Technology A does not require production, processing, consumption, storage, or shipping of fuels. Instead, it harnesses natural energies that are delivered by natural forces. Technology X requires mining of elements that are processed using high amounts of energy input. Significant transportation emissions are emitted during the mining and processing phases and during refueling. Between one and three times a year, fuel that is depleted in an X plant is replaced with new fuel.

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[1] https://www.lazard.com/media/xemfey0k/lazards-lcoeplus-june-2024-_vf.pdf

[2] https://www.eia.gov/analysis/studies/powerplants/capitalcost/pdf/capital_cost_AEO2025.pdf

[3] https://www.powermag.com/what-was-learned-from-building-new-nuclear-reactors/

[4] https://www.eia.gov/tools/faqs/faq.php?id=74&t=11

Another significant difference between A and X is in the reverse logistics phase of deconstruction, remediation, recycling, and storage. Technology A does not spew toxics into air, lands, and waterways. So, remediation is not required. Many of the materials used to build A can be recycled and used in future A plants and other applications. Technology A does not contain any HazMat that requires long-term secured storage. However, some chemicals in A contain toxics that require disposal in electronics waste sites. Being near these toxics is not harmful - only ingestion or contact with skin may be harmful. In contrast, Technology X fuel continuously spews invisible toxics into the air, waterways, and land whether the fuel is inside or outside a power plant. Toxics are emitted inside power plants whether the plant is shut down or operating. Any amount of exposure is harmful, even if one does not touch the fuel. Remediation of the site where an X plant has been in operation is warranted. However, no effective site clean up procedures have been discovered other than removal and replacement of land, etc. No effective solution for cleaning up this HazMat from air, water, land, botanicals, and animals (including people) has been found.

Plant X fuels cannot be recycled for reuse in X plants. Depleted fuels require storage for hundreds of millenia because the fuels continue to be toxic for that long. Current costs of storing this HazMat range from $6B to $13B annually in the US and all analysts project annual increases [5],[6]. The cost of storage of the depleted toxic fuel range from $300,000 to $8million annually at each X plant [7].This is for security services because HazMat (freshly processed or depleted) can fetch a high price on the Black Market. Animals, including people, and botanicals may be harmed by HazMat exposure. Corporations that own reactors do not pay storage fees. (They may have done so initially, but are reimbursed by the federal government.) Storage costs are paid via federal taxes by each taxpayer.

After X plants close, no electricity is generated, yet, storage of HazMat is required. Let's see how storage costs accumulate, without factoring in projected increases in storage and inflation.

Sum of Annual Storage Costs During Each Period

Years	1	10	100	1000	10,000	100,000
Cost	$10B	$100B	$1T	$10T	$100T	$Qd

Qd is quadrillion

[5] https://sustainability.stanford.edu/news/steep-costs-nuclear-waste-us

[6] http://large.stanford.edu/courses/2024/ph241/cranmer2/

[7] https://www.latimes.com/business/la-fi-radioactive-nuclear-waste-storage-20190614-story.html

It is unlikely that the corporation or its owners will still exist 100 years after a reactor closes. Yet, storage costs persist like an interminable cancer. Above a trivial amount, the federal government pays for all liabilities of X plants.

Labor is required each day to provide remote surveillance and on-site security services for storage. This generates CO2e emissions from energy use and transportation. Each X plant has 80 security guards and 20 guards work a shift [8]. Because most are in isolated locations, commuting probably requires driving an automobile. Each X plant typically employs 500 - 800 workers [9]. Most of these are off-site. Let's assume that each drives to work, uses an ICE vehicle that achieves 30 mpg, and has a round-trip commute of ten miles. As each gallon of gasoline is consumed, 8.6 kilograms of CO2 are emitted. A round-trip commute uses 0.33 gal, emitting 2.8 kg of CO2. Assuming that each worker commutes 20 times per month, the total CO2 emitted is 56 kg. Annually, this totals 672 kg per employee. Multiplying this by 700 workers is 470,400 kg. This equals 470.4 metric tons.

In contrast, Technology A requires only 20 employees for routine maintenance [10]. Additional workers may be contracted for cleaning periodically.

Excluding long-term storage and other externalized costs, the construction cost per GW capacity of Technology X is more than six times higher than that of Technology A. If our budget is large enough to afford X, but we choose only A, we can achieve the same amount of decarbonization using one sixth of our energy build-out budget. Remaining funds may be used for more A to achieve a six-fold rate of capacity increase and decarbonization. In either case, decarbonization begins 2 years after planning by using A, instead of waiting 15 years for X to be built. The cumulative emissions reduction of X per GWh capacity can never match or exceed that of A. In addition, the LCOE of A is less than half that of X. There is widespread agreement among scientists and policy analysts that lowering the cost of electricity will catalyze decarbonization. The following table shows the effect of replacing methane-generated electricity with each technology. The cost figures are not dollars, but show the ratio or cost relative to the other technology. This excludes externalized costs.

Technology	Construction Cost/GWh capacity	CO2 Reduction/GWh	LCOE per GWh
A	1	400 Mton	< 1
X	6	400 Mton	2

Most research on the lifecycle carbon intensity of Technology X estimates that the CO2 emissions of X are about equal to those of Technology A. However, most research fails to consider the externalized costs of X. Many of these costs have a high price tag, whereas the

[8] https://time.com/archive/6673157/are-these-towers-safe/

[9] https://www.nei.org/advantages/jobs

[10] https://www.nrel.gov/docs/fy21osti/76957.pdf

externalized costs of clean energy are negligible. Only Technology X requires periodic fuel mining and processing, security guards 24/7, and long-term storage - all of which have a high carbon intensity. Only Technology X HazMat causes medical damages from routine “safe” operations. It continuously emits invisible pollution that causes radiolysis and oxidant reactions. Technology X has far more employees per plant than Technology A. Technology X has a much higher rate of industrial accidents that may harm those in the surrounding neighborhood, city, county, or neighboring nations. More accurate research is called for.

Knowing the above, why would anyone select X over A? Without quantitative cost to benefit comparisons like the above, energy generation and storage consumers face a challenging barrage of unsubstantiated claims from purveyors of energy technologies. Please conduct many such technology comparisons in future reports and dockets.

A is not a hypothetical. It is a combination of utility-scale clean generation and storage that has been in commercial use for many years. It is a 50 : 50 mix of onshore wind turbine plus Li battery storage combined with PV bifacial solar plus Li battery storage. In practice, the ratio may be optimized depending on the amount of sunny days annually and the amount of wind. Costs of each pair, after factoring in tax incentives, are the Levelized Cost of Energy (LCOE) calculated by Lazard Investment Bank. The LCOE of wind&storage is $66/MWh. The LCOE of solar&storage is $105/MWh . A significantly lower LCOE could be achieved by increasing the ratio of solar to battery capacity or the ratio of wind to battery capacity. These adjustments may diminish resilience of the grid if there are ineffective energy policies or a scarcity of DER in a locale[11].

Likewise, Technology X is not a hypothetical. It is a fleet of nuclear reactors[12]. The LCOE is $182/MWh for nuclear electricity[13]. This probably does not include the cost of long-term HazMat storage.

FIRM CLEAN ENERGY

The most important way to improve this report and future reports is to limit the definition of firm clean energy technologies to the best that are currently available, have robust performance metrics, and have low SCC and other side effects. A definition of clean is important in order to fulfill the SB 423 mandate as well as to plan policies. Using the lifecycle carbon intensity of utility-scale solar or wind is the best metric because these resources are plentiful, do not emit toxics during operation, and the cost of such technologies is plummeting. In contrast, your report

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[11] https://www.eia.gov/analysis/studies/powerplants/capitalcost/pdf/capital_cost_AEO2025.pdf

[12] https://www.powermag.com/what-was-learned-from-building-new-nuclear-reactors/

[13] https://www.lazard.com/media/xemfey0k/lazards-lcoeplus-june-2024-_vf.pdf

included technologies with a wide range of lifecycle carbon intensities, including the dirtiest one in widespread commercial use in CA.

Let’s peruse a table of the technologies that have the best performance, are most cost effective, and have the least risks. A 1 - 5 scale could be used to rate each characteristic. 5 is the most favorable. Cost includes construction duration, construction costs, and generating costs per MWh. Emissions of GHGs should be calculated over the entire lifecycle. These simplistic ratings help readers to focus on the technologies to study in depth. Please compute and publish something like this annually.

The Best Firm Clean Energy Sources

Technology	Performance	Cost	Risks/Side Effects	GHGs	toxics
Flow batteries					
Zinc batteries					
Iron Air batteries					
Lithium batteries					
Compressed air storage					
Pumped hydro					
Run of the river hydro					
Large and small hydro					
Geothermal energy					
DER system 1					
DER system 2					
DER system 3					
Concentrated Solar Power					
Flywheels					
Gravity Storage (solid and liquid)					

Ground-source Pumped HVAC
(a.k.a. Geothermal district heating)

Thermal and Thermo-Chemical Batteries

Ocean Waves and Currents

DER systems are combinations of storage and generation. Technologies below DER systems perform storage, generation, or both.

Instead of limiting your search to stand-alone baseload power sources, study the performance of DER combinations of 2 or more kinds of generation, plus 2 or more kinds of storage, plus performance and efficiency upgrades to the grid, plus energy management policies and software, e.g., demand-response options for VPPs, and fast-track interconnection to the grid for clean resources. One combination of generation sources that has been shown to increase resilience is wind plus solar. The clean energy revolution is evolving in these directions instead of scaling up utility-scale baseload generation. DER provides superior resilience, requires fewer miles of transmission wires, and avoids the 10% power loss of transmission. Use something like the above table to contrast permutations of DER components and systems.

For each of the best technologies, present a table displaying these variables:
- Duration to construct
- Cost to construct
- MT of CO_2e reduction/MWh (by replacing methane-generated electricity)
- cost/GW of electricity generation
- Opportunity costs/MWh
- Externalized costs/MWh[14] (including the Social Cost of Radiation)

The precautionary principle points to time, cost of generation, opportunity costs, and externalized costs as crucial to our success in decelerating climate change and meeting targets mandated by CA legislation (e.g., SB-1020). More effective policy and technology selection would be expedited by using these variables in analyses.

TECHNOLOGIES THAT ARE TO BE DISQUALIFIED AS FIRM CLEAN ENERGY

REACTORS INCLUDING SMR Performance measures show high waste heat, low efficiency, and moderate capacity factor. For decades, industry has promised superior safety, lower cost, and quick manufacture. None have materialized. Industry has assured us that factory-assembly of many components will make SMRs cost-competitive. This assembly process has been used

[14] Synthesis of evidence yields high social cost of carbon due to structural model variation and uncertainties | PNAS

for decades with utility-scale reactors. Nevertheless, the costs and cost estimates for utility-scale and SMR reactors continue to rise, while the costs of wind, solar, and storage continue to fall [15]. HazMat fissile trash from SMRs has the same lethality and lifespan of trash from utility-scale reactors [16], [17],[18].

Cost - Construction and generation costs per MW are the highest of any commercially available generation technology. These require far more years to construct than any other generation technology. Globally, the average construction duration is 15 years, with longer averages in recent decades in the US[19]. In contrast,clean technologies start generating MW more quickly (commonly 2 years from start of construction), preventing emissions from dirty generation plants which they displace. The cost of long-term storage and requisite security services for fissile trash is many $billions annually in the US. Construction costs of SMRs is the same as that of traditional utility-scale reactors per nameplate MW capacity[20]. The most recently completed reactor in the US, the Vogtle pair in GA, cost $36billion for 2.2 GW capacity. Plans for SMRs have been submitted in the US. However, none are close to approval by the NRC. Natrium brand SMR has an estimated construction cost of $10billion for 0.345 GW capacity. This construction cost is $28million/MW[21]. In the US and most other nations, actual construction costs and durations are double the estimated amounts.

Risks/Side Effects - Global inventories of uranium are falling. The inaccessibility, scarcity, and cost of mining high-grade ore require higher fuel acquisition and processing emissions. It is estimated that the inventory of unmined moderate to high-grade uranium will fall to a negligible quantity by about 2115[22]. This assumes that it will be used to fuel utility-scale reactors for electricity and not for medical, industrial, or nuclear weapons manufacture. Nuclear weapons budgets have continued to mushroom in blue and red federal administrations.

Fissile waste cannot be used to power reactors, though it may be used to manufacture dirty bombs and tritium and plutonium for nuclear bombs).

Fissile waste, whether left on the surface of the earth or in a subterranean storage cavern continues to emit ionizing radiation for hundreds of millenia. There is widespread consensus

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[15] https://www.latimes.com/opinion/story/2025-04-18/small-modular-reactors-cost-california

[16] https://blog.ucs.org/edwin-lyman/five-things-the-nuclear-bros-dont-want-you-to-know-abou

[17] https://sppga.ubc.ca/news/why-nuclear-energy-is-not-the-solution-to-the-climate-crisis/
[18] 24-01-MZJ-TestimonyV2

[19] https://www.worldnuclearreport.org/IMG/pdf/wnisr2024-v2.pdf

[20] https://www.latimes.com/opinion/story/2025-04-18/small-modular-reactors-cost-california

[21] https://www.worldnuclearreport.org/IMG/pdf/wnisr2024-v2.pdf

[22] https://world-nuclear.org/information-library/nuclear-fuel-cycle/uranium-resources/supply-of-uranium

among scientists that no known storage technology is available that will guarantee prevention of fugitive emissions in response to geologic and anthropogenic influences. Only one long-term storage facility has been built on the planet. Completed in 2024, it is under the Baltic Sea, operated in part by robots, and has begun to store fissile trash [23]. Though reactors have a lengthy anticipated useful life, the risk of radiation emissions increases annually. Many scientists recommend that reactors be decommissioned after 40 years.

The capacity factor is likely to deteriorate as climate change accelerates. The NRA requires reactors to shut down at ambient temperatures above 99 F. During extended droughts, there may be insufficient water available for safety and cooling. Reactors are usually located adjacent to fresh or ocean water resources. Less frequently (but with increasing severity) flooding, *tsunamis*, typhoons or other storms may disable a reactor. This occurred in Fukushima in 2011, forcing the reactor to close [24].

There is little evidence that reactors have been built to replace fossil energy. Policies to prohibit permitting of new fossil energy plants while requiring replacement of fossil fuel plants with clean energy (instead of dirty nuclear) are needed. Globally, fossil energy generation continues to grow annually. Since 2006 there has been little or no growth of generation from reactors[25].

Nuclear fuels continuously emit ionizing radiation into the air, land, and water resources. No means of halting fission reactions have been discovered. Via bioaccumulation, it is passed up the food chain [26]. The lowest amounts of radiation are stored in herbivores, moderate amounts in omnivores, and the highest amounts in carnivores. We are assured by industry that the amount is inconsequential. Even mild measurable exposure may cause measurable harm. This may manifest as various cancers and other chronic ills that entail excessive free radicals and

[23] https://www.worldnuclearreport.org/IMG/pdf/wnisr2024-v2.pdf

[24] https://caneurope.org/myth-buster-nuclear-energy/

[25] Wnisr2024-v2.pdf

[26] https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3406943

oxidants. Incidence of the footnoted medical disorders is higher in those exposed to nuclear ionizing radiation [27],[28],[29],[30],[31],[32],[33],[34],[35], [36].

The history of radiation leaks from reactors is incomplete. Publicly-available reports are merely the tip of the iceberg. Research on casualties, medical disorders, and whether local food and water were safe is compromised by the accuracy and scope of data that could be accessed. Some nations do not require leaks to be reported to the public. Though it is commonly thought that Chernobyl had the world's first significant leak, the first large leaks were from Mayak[37], a 5-reactor facility, in the 1950s. Multiple leaks occurred until 1998. Governments have failed to conduct thorough assessments of reactor leaks and sequelae. This is due to several factors. In the 1940s and 1950s, many above-ground tests of nuclear weapons were conducted. Radiation from these has invaded freshwater resources, oceans, and land worldwide. This will continue to be harmful to plants, crops, and animals including people for hundreds of millenia. Leaks from many reactors have also polluted our environment. Currents and winds carry the radiation afar. The source cannot be traced. Unless local measures of radiation levels are taken prior to an accident, it is difficult to prove that a recent leak was the sole cause. Governments in most nations are the liability insurance of last resort for reactors. To avoid equitable payouts to victims, governments have withheld information from the public. The duration between radiation exposure and detection of medical damages is often decades, making it difficult to verify whether a particular leak was the only cause.

Potential class-action or legislation-mandated liabilities include a) medical disorders [38], b) long-term storage liabilities, e.g., contamination of natural resources or harms to wildlife, c)

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[27] https://www.sciencedirect.com/science/article/pii/S2468294222000557

[28] https://www.tandfonline.com/doi/abs/10.1080/09553002.2021.1876955
David Bezanson - Radioactivity in Food

[29] https://www.mdpi.com/1648-9144/60/4/653

[30] https://www.bmj.com/content/380/bmj-2022-072924.abstract

[31] https://www.mdpi.com/2073-4409/10/12/3570

[32] https://academic.oup.com/ije/article/52/4/1015/7186891

[33] https://www.mdpi.com/2076-3425/12/8/984

[34]
https://meridian.allenpress.com/radiation-research/article/199/5/490/491672/Exposure-to-Ionizing-Radiation-and-Risk-of

[35] https://www.bmj.com/content/382/bmj-2022-074520.abstract

[36] https://psr.org/issues/nuclear-weapons-abolition/disarmament-public-health/

[37] https://en.wikipedia.org/wiki/Mayak

[38] https://www.congress.gov/bill/119th-congress/senate-bill/243/cosponsors

shifting costs of long-term storage from taxpayers to nuclear industry corporations and trade associations.

The civilian-owned reactor industry is a necessary foundation of nuclear weapons manufacture. It is a mechanism for shifting the costs of weapons production from the military to the domestic energy budget (the peaceful atom). This avoids escalation of the nuclear weapons budget to levels that may be politically unacceptable. The most recent US annual nuclear weapons budget is $110B[39]. The global nuclear arms race is headed toward “mutually assured destruction” (MAD). Global abolition of nuclear weapons is probably the most effective preventive medicine for averting MAD [40],[41]. The implementation of abolition would pay a massive peace dividend to nations who currently have nuclear arsenals and would provide a wide array of benefits to all nations. This windfall would be enough to fund many kinds of effective CO2 emissions mitigation policies.

FUSION

Tiny-scale laboratory experiments have not proven this to be sustainable for more than 2 minutes. It has numerous technologic problems. Science has not discovered ways of overcoming these obstacles.

SMOKESTACK CARBON CAPTURE

This does not generate or store energy. Thus, it is not a form of firm clean energy. In fact, CCS on fossil or biomass power plants increases the amount of energy required to generate each MW of electricity by about 25%.Thus, it significantly increases the cost of electricity. In turn, this decreases the rate of electrification of our energy sector. Generous tax incentives available for CCS installation add to the cost of electricity for taxpayers. CCS equipment does not diminish the amount of toxic co-pollutants emitted from smokestacks nor does it capture previously-emitted CO2 from the atmosphere. Many toxics have GHG effects[42]. CCS promotes mitigation deterrence, retarding our efforts to mitigate GHG emissions. Though industry claims boast of a 90% capture rate, scientific publications reveal that the actual rate is 10 to 70 %. Nearly 90% of CCS is used for EOR. Long-term subterranean storage of CO2 has not been proven effective and there are numerous unresolved problems with storage vaults and

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[39] Opinion | Tell Congress to Stop Spending Your Tax Dollars on Nuclear Weapons | Common Dreams

[40] https://www.icanw.org/signature_and_ratification_status

[41] https://psr.org/issues/nuclear-weapons-abolition/disarmament-public-health/

[42] https://cacondor.substack.com/p/not-just-hot-air

https://cacondor.substack.com/p/the-biomass-boondoggle

CO_2 pipelines. The first subterranean storage site in CA was completed in 2024. There were fugitive emissions from these wells within a few months. Research estimates that at least 40% of the CO_2 stored in any subterranean pore space will eventually leak into our atmosphere. For decarbonization, reduction of toxic emissions, decreasing the SCC, cost-effectiveness, and accelerating the clean energy revolution; it is more effective to replace dirty energy facilities with clean energy than to add CCS equipment.

COLORS OF HYDROGEN THAT ARE NOT GREEN

H_2 produced with dirty technologies does not expedite decarbonization of our economy. In contrast, green H_2 (produced with electrolysis and clean, continuous, proximal, dedicated energy) may enable decarbonization. All kinds of H_2 production and conversion to electricity have poor efficiency. Green H_2 is not currently cost-competitive with other commercially-available clean energy technologies and its use should be reserved for applications that are difficult to decarbonize. One example is long-distance marine transport, which could be powered by a combination of sails and green H_2 fuel cells. H_2 produced with fossil fuels and CCS equipment is hardly carbon neutral. CCS equipment captures only a part of the CO_2 emissions while increasing energy use and accompanying emissions.

RENEWABLE NG (METHANE)

Whether sourced from recently harvested biomass, biologic wastes, or wells, NG has a high CH_4 content. The CH_4 percentage varies from 70 to 95. To obtain energy from NG, combustion is used. This emits CH_4, CO_2, ozone, and a broad array of Toxic Air Contaminants. Being highly flammable, it is hazardous to store, transport, or ignite inside buildings.

Lifecycle emissions of NG energy are the same or higher than that of coal energy. This is due to a high rate of fugitive emissions[43] [44],[45],[46],[47].

The primary reason SB 423 was written was to reveal the viability of energy sources that could replace CO_2 emissions-intensive biomass and fossil fuels - avoiding their high carbon intensity, externalized SCC, numerous opportunity costs, high rates of fugitive emissions, and low

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[43] New Data Show U.S. Oil & Gas Methane Emissions Over Four Times Higher than EPA Estimates, Eight Times Greater than Industry Target

[44] Methane emissions from major U.S. oil and gas operations higher than government predictions | Stanford Report

[45] New Data Show U.S. Oil & Gas Methane Emissions Over Four Times Higher than EPA Estimates, Eight Times Greater than Industry Target

[46] Evaluating net life-cycle greenhouse gas emissions intensities from gas and coal at varying methane leakage rates - IOPscience

[47] https://scijournals.onlinelibrary.wiley.com/doi/10.1002/ese3.1934

efficiency. RNG has all the problems of fossil NG. RNG and fossil NG have the same carbon intensity when combusted. There are disadvantages of using RNG instead of fossil NG. If non-waste feedstocks are used, RNG decreases carbon sequestration by botanicals, may divert land use from agriculture to energy, and depletes soils of nutrients. Like fossil NG, RNG is far from carbon neutral. Claims to the contrary are refuted by research showing that the carbon intensity of crop biofuels is equal or greater than that of gasoline [48]. A higher and better use of waste biomass is for mulch and or aerobic compost.

[Growing crops for fuel is not a climate solution. Sustainable agricultural practices aren't going to change that. - Earthjustice]

Please keep the above in mind when drafting this year's IEPR.

Thanks for Your Research,

David Bezanson

David Bezanson, Ph.D.
CA voter and resident

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[48] Growing crops for fuel is not a climate solution. Sustainable agricultural practices aren't going to change that. - Earthjustice