DOCKETED	
Docket Number:	19-SB-100
Project Title:	SB 100 Joint Agency Report: Charting a path to a 100% Clean Energy Future
TN #:	230208
Document Title:	David BezansonPhD Comments - 19SB100 SB100 Joint Agency Report
Description:	N/A
Filer:	System
Organization:	David BezansonPhD
Submitter Role:	Public
Submission Date:	10/15/2019 5:50:18 PM
Docketed Date:	10/16/2019

Comment Received From: David BezansonPhD
Submitted On: 10/15/2019
Docket Number: 19-SB-100

19SB100 SB100 Joint Agency Report

see document (docx) attached

Additional submitted attachment is included below.

CA ENERGY COMMISSION: Docket #: 19SB100

author: David Bezanson, Ph.D.

Please use the following research and policy recommendations to guide CA toward targets set by SB100.

Forest Preservation to Increase Carbon Sequestration and Storage

The logging industry releases significant GHG emissions - primarily CO2 and methane. For 15 years after each harvest, the sequestration by tiny seedlings is less than the emissions from the disturbed land, decomposing leaves, and nitrogen-based synthetic fertilizers applied. Mining metals for its equipment is GHG-intensive. The timber harvest and milling process is becoming increasingly mechanized with off-road equipment that lacks effective emission controls. Transportation of logs, lumber, and paper generate additional emissions. Big trucks in CA have not been required to have smog checks, though a bill just passed that addresses the problem. The logging industry decreases the effectiveness of our best carbon-capture system, i.e., forests.

What ecosystem services (ES) are provided by our forests? What is their economic value? Following a synopsis that addresses these questions, policies that will preserve and increase these services and values in CA will be presented.

ES include watershed creation, decreased erosion, decreased siltation, decreased flooding, improvement of water quality, carbon sequestration and storage, decrease in many air pollutants, recreation; cooler air, water, and topsoil temperatures; habitat for biodiversity, attenuation of wind velocity (a major factor influencing wildfire damage), exudation of phytoncides which activate our immune cells, phytoremediation (extraction or breakdown of pollutants in soil), and soil enrichment. When combined, these decrease property damage, decrease water treatment costs for municipalities, improve public health, decrease medical costs paid by public programs (e.g., Medi Cal), and significantly diminish some causes of climate change as well as its effects (1) (2).

Forests significantly decrease atmospheric levels of CO2, more hazardous GHGs that are emitted from the combustion of fossil fuels, and co-pollutant toxins.

* nitrogen oxides, e.g., NO2, exacerbate and increase incidence of respiratory disorders, diabetes mellitus, and cardiovascular disorders

* ozone (O3) near ground level increases respiratory disorders and shortness of breath

* sulphur oxides (e.g. SO2) decrease longevity and induce wheezing

* carbon monoxide (CO) causes confusion, shortness of breath, and cognitive impairment

* particulate matter (especially PM<2.5um) causes congenital disorders, cancer, cardiovascular disorders, respiratory disorders, and chronic kidney disease

Established urban trees were studied for decreasing the 5 asterisked pollutants. Trees significantly decreased premature deaths and medical costs. In 2010 dollars, the economic value thereof totaled $389/hectare/year. The average value for each of the 86 cities studied was $173 million annually (3).

(This excluded the economic values of carbon sequestration, less intense heat islands, increased property values, subdued noise pollution and wind damage, and hedonic benefits.)

In 2018, 5976 million metric tons (MMT) of CO2 were emitted in the U.S. Per the EPA, this was merely 0.4% below the all-time high emitted in 2007. 2018 emissions exceeded 2017 levels in CA, U.S., and the world. According to the U.S. Forest Service, our forests sequester 16% of CO2 emissions - about 956 MMT in 2018 (4).

The social cost of carbon (SCC) is used by economists to estimate the externalized costs (not reflected in the price of carbon-intensive products) of carbon emissions. This includes property damage, premature death, medical costs, decreased GDP, compromised quality of natural resources, crop losses, and higher costs of food. However, it excludes the cost of extracting carbon from the atmosphere. A meta-analysis published in 2019 examined studies that have quantified this (5). The mean was $55/MT CO2e. Research published most recently and in peer-reviewed journals showed higher costs.

Multiplying 956 MMT CO2 x $55/MT CO2 = $52.6 billion. This is the annual cost of CO2 emissions borne by society, which is saved by forest sequestration. It excludes savings from reductions of co-pollutants and other GHGs and the value of hedonic benefits. For each 1% of net forestation (e.g. via acquisition), forests save us $526 million annually - *only if the new forest is of the same or a higher grade and added forests are of the same age or older than those eradicated by logging and development.*

To achieve net forestation, an equivalent added forest must have a sum of biomass that is at least equal to the biomass of logged forest. An acre of any grade of logged forest is not quickly replaced by planting an acre of seedlings. The baby trees need to grow for many years to reach the sum of biomass in the logged acre. In the case of logging an acre of 50 year old plantation, it would take 50 years of growth of new seedlings on an acre to reach an amount of biomass equal to that removed. Timber companies typically use a 40 year rotation schedule for each harvest.

In 2018, 1.66 million hectares of natural forest were destroyed (by logging, wildfire, development, etc.) in the USA (6). Sequestration rates by US forests are projected to decrease due to land use changes and human population growth (7).

There is a delay between decreasing levels of GHG emissions in the atmosphere and change in air temperature. The duration of this "climate lag" is on average 38 years according to renowned climate scientist James Hansen. The delay of ocean temperature change longer. The sooner we implement effective policies, the sooner we will solve climate change. The U.N. I.P.C.C. report released in Oct. 2018 was authored by 91 scientists who reviewed over 6,000 studies on climate change. It indicates that we only have a decade to begin making substantive annual emissions decreases to avoid the most severe impacts of climate change (8).

Extractive resource operations, including livestock grazing, as well as construction of new roads are to be prohibited in public forests. Incentives are to be offered to private forest owners. One example is an annual tax credit for maintaining a conservation easement or harvest deferral. Protection and expansion of our forest treasures may also be accomplished via government acquisition of private forest lands.

Measures to increase soil carbon storage are well-known and are to be incentivized in forestry, agriculture, landscaping, and other land uses. The right of private forest owners to export logs is to be

terminated. (Exporting is more profitable than selling it domestically.) Withdrawal of the export profit option would increase the appeal of conservation tax credits.

Protecting healthy forests is of greater ES benefit than afforestation or reforestation. Protecting primary (old-growth) forests has more ES benefit than protecting forests degraded by logging, insect infestation, fire, etc. Funding priorities and regulation are to reflect these greater ES values.

1. https://www.srs.fs.usda.gov/pubs/gtr/gtr_srs226.pdf

2. https://www.fs.fed.us/pnw/sciencef/scifi208._pdf

3. https://www.fs.fed.us/nrs/pubs/jrnl/2018/nrs_2018_nowak_001.pdf

4.https://www.fs.fed.us/climatechange/advisor/scorecard/Carbon_Infographic_Final.pdf

5.https://www.sciencedirect.com/science/article/pii/S0959652618334589?via%3Dihub

6.https://www.globalforestwatch.org/dashboards/country/USA?gladAlerts=eyJsYXRlc3REYXRlIjoiMjAxOSOwOSOxNiJ9&map=eyJkYXRhc2VOcyI6W3siZGFOYXNldCI6ImZkYzhkYzFiLTI3MjgtNGE3OS1iMjNmLWIwOTQ4NTA1MmI4ZCIsImxheWVycyI6WyI2ZjY3OThlNiOzOWVjLTQxNjMtOTc5ZSOxODJhNzRjYTY1ZWUiLCJjNWQxZTAxMCOzODNhLTQ3MTMtOWFhYSOONGY3MjhjMDU3MWMiXSwib3BhY2l0eSI6MSwidmlzaWJpbGl0eSI6dHJ1ZX0seyJkYXRhc2VOIjoiODk3ZWNjNzYtMjMwOC00YzUxLWFlYjMtNDk1ZGUwYmRjYTc5IiwibGF5ZXJzIjpbImMzMDc1YzVhLTU1NjctNGIwOS1iYzBkLTk2ZWQxNjczZjhiNiJdLCJvcGFjaXR5IjoxLCJ2aXNpYmlsaXR5IjpOcnVlLCJOaW1lbGluZVBhcmFtcyI6eyJzdGFydERhdGUiOiIyMDAxLTAxLTAxIiwiZW5kRGFOZSI6IjIwMTgtMTItMzEiLCJOcmltRW5kRGFOZSI6IjIwMTgtMTItMzEifSwicGFyYW1zIjp7InRocmVzaCI6MzAsInZpc2liaWxpdHkiOnRydWV9fVOsImNlbnRlciI6eyJsYXQiOjI3LCJsbmciOjEyfSwiYmVhcmluZyI6MCwicGlOY2giOjAsInpvb20iOjIsImNhbkJvdW5kIjpmYWxzZSwiYmJveCI6W119

7. https://www.fs.usda.gov/treesearch/pubs/53212

8. https://www.ipcc.ch/sr15/

Renewable Energy Subsidies

Due to the long-term emission of methane from dams, increasing periods of drought, scarcity of suitable sites for new dams, and massive amounts of high-GHG concrete used to construct dams, hydroelectric power is not to be classified as renewable.

Many of the reasons why nuclear energy is neither renewable nor viable in an era of rapid climate change are explained in the World Nuclear Institute Oct. 2019 report. A lifecycle analysis of nuclear reactor energy shows that significant amounts of GHGs are emitted. Uranium mining emits fluorocarbons. Each reactor requires thousands of tons of cement, steel, and copper. Production of

these materials entails high amounts of heat produced primarily from combustion of fossil fuels. There are numerous hazards and costs of nuclear energy that not shared by lower carbon renewables. Utility-scale reactor construction typically takes a decade. There is no proven method of safely storing fissile waste. During heat waves, which are increasing with climate change, it is difficult to maintain a safe temperature of fuel rods and reactors are temporarily taken off line. Globally, there is a shortage of high-potency uranium (>3%) that has not been mined. Low-potency uranium is useful for reactors only if it is enriched in centrifuges - requiring high inputs of electricity generated primarily from fossil fuel sources. Ionizing radiation continues to be mutagenic for decades and its long-term impacts on humans and other biota are unknown.

The Energy Policy Act was last revised in 2005 and is due for a major overhaul to render it climate-friendly. It allocates $5.7 billion in annual subsidies for fossil fuel production, $4.3 billion for nuclear energy, and only $2.7 billion for renewables. By transferring subsidies for fossil fuel and nuclear energy to development and innovation in renewables, we will provide more local jobs in all states and build electric energy capacity that is more economical per kW. The cost per kW of nuclear electricity is about double that of photovoltaic solar and about quadruple that of onshore wind (12). Implement policies in CA that a) offset federal subsidies to fossil fuel production and nuclear energy, b) provide more incentives for renewables. Collaborate with other states to call for a progressive revision of the EP Act.

https://www.worldnuclearreport.org/The-World-Nuclear-Industry-Status-Report-2019-HTML.html

Carbon Pricing Legislation

Carbon pricing is becoming more popular as indicated by 7 bills that have been introduced in Congress in 2019. While some provide incentives for carbon capture technologies (CCT), none provide incentives for carbon sequestration by forests. CCT are unproven outside of small laboratory experiments, extract CO2 but not other GHGs, and would be very costly to develop on a global scale. Their production, installation, and maintenance would entail massive GHG emissions. Forests have none of these disadvantages, are globally scaleable, grow and maintain themselves, and provide a cornucopia of ES that are not provided CCT. Afforestation alone is estimated to be capable of decreasing carbon levels in the atmosphere by 67% (13). Legislation is recommended to provide incentives for forest preservation and net forestation that improves quality while increasing quantity. This may be incorporated into amendments of carbon pricing legislation or established via separate legislation. Incentivizing forest protection instead of CCT is advised.

Carbon pricing legislation is most likely to achieve deep decarbonization of our economy if it includes the following provisions.

Include a tax as well as an emissions cap with progressive annual targets for each announced 10 years in advance. E.g., the tax would rise by 7%/yr. while the cap would fall by 7%/yr. This is more likely to improve climate health than either alone. A cap, unlike a tax, directly targets emissions. It is more important to cap than to increase tax revenue. Companies exceeding the cap would be fined.

Continue EPA regulation at least until SB100 targets have been reached. Several bills suspend emissions regulation for up to 12 years. This would severely weaken The Clean Air Act. There is no research that proves the efficacy of carbon pricing alone (without regulation) for emissions reduction. In

contrast, decades of research has proven the efficacy of regulation. Carbon-intensive industries have consistently failed to self-regulate.

Instead of paying out carbon dividends to citizens directly, which is a provision of several bills, invest the revenue in publically-owned renewable energy development and a Forest Carbon Reserve. If paid to citizens, dividends may be spent on anything and a significant amount would likely be spent on carbon-intensive products and services (e.g., beef and travel). Dividends may be invested without restriction and it is likely that a significant percent would be invested (directly or indirectly) in stocks of carbon-intensive corporations.

Exemption of carbon-intensive companies from liabilities of causing climate change is a provision of several bills. This burdens all taxpayers with remediation, litigation, and other externalized social costs (SCC) that are rising annually. Globally, 7 million of deaths are attributed to Greenhouse Gas (GHG) emissions and co-pollutants each year. Thus, no change in current law, which permits litigation against carbon-intensive industries, is advised.

Carbon sequestration credits (as in cap and trade policies) are to be earned only if emissions are decreased, there is additionality, and leakage is averted. This requires raising the price of offset credits to the SCC ($55/MT) or higher and increasing the amount annually.

https://www.theguardian.com/environment/2019/jul/04/planting-billions-trees-best-tackle-climate-crisis-scientists-canopy-emissions

Burning Biomass for Energy and Fuel

Using biomass for electricity generation emits a quantity of GHGs (including hazardous copollutants) that is 50% greater than the amount emitted from using coal. Biomass electricity generation releases 350% more GHGs than natural gas (97% methane) (1, 2) The combustion of biofuels, e.g., for transportation, also immediately releases GHG emissions.

Globally we are harvesting more trees and fallen biomass than we are planting or growing by deferred logging. In the USA, we harvest twice the amount that is added by new growth each year. Harvesting biomass contributes to this deforestation (3) and decreases the ES of forests. Forests sequester more atmospheric carbon than any other terrestrial habitat. Natural forests (where there is no active management, logging, or removal of other biomass) retain more carbon than tree plantations.

Economics favors solar and wind over biomass energy production. Government subsidies can only prop up biomass energy transiently. Market forces will lead consumers including utility companies, to use solar or wind. The efficiency (energy output to input) is higher and the cost per kW is lower for solar and wind than it is for biomass energy. And the cost of renewables is decreasing. Solar and wind have been more thoroughly researched and widely used than biomass electricity generation. We have a large year-round surplus of untapped wind and sunlight. Most biomass facilities lack state-of-the-art emissions controls and efficiency technologies. Biomass energy subsidies are to be discontinued and permits for new construction denied.

There are many profitable alternate uses for biomass other than biofuel and electricity production, e.g., paper, wood, compost, and mulch. Increased use of the latter 2 in crop farming and landscaping would

decrease use of synthetic, ammonia-bound nitrogen fertilizers (which pollute our land, air, and waterways) while providing a wide range of additional ecologic benefits.

If biomass energy generation is to continue, it is best to use only non-forest sources of biomass, e.g., food scraps or landscape trimmings. And emission control technologies are needed. This minimizes environmental impact from CA burners, which are on average 3 decades old. Non-wood plants (e.g., cane, bamboo, rice straw, hemp) are more eco-friendly materials for paper production than timber. PCR paper production is to be incentivized.

About 30% of our food supply is wasted: Using this, instead of fallen leaves and branches, is more forest-friendly and climate-friendly.

1. www.pfpi.net

2. Smith, P. et. al. (2014) Agriculture, forestry and other land use. In *Climate Change 2014* NY: Cambridge University Press.

3. Liao, C. et. al. (2010) Ecosystem carbon stock influenced by plantation practices *PLoS One* 5 (5), e1086.

Methane (M)

Amounts of this GHG are increasing in our atmosphere. In its initial 20 years in the atmosphere it traps 85 times more heat than CO2. The foremost anthropogenic source, contributing 40%, is raising cattle. This exceeds the amount from the sum of oil and gas operations plus landfill decomposition plus biomass energy generation. When soil is left undisturbed, M is absorbed and stored. When soil is disturbed, e.g. by clearing land for livestock pasture, logging, or tilling acreage for crops, M is released. Thus, preventing of conversion of forests to pasture and replacing till with no-till agriculture is recommended. Replacing internal combustion off-road equipment with electric would decrease emissions.

Trees emit and absorb M. Those in tropical forests and wetland areas emit the most while those in boreal and temperate regions (especially drier climates) emit less. The latter regions are most suitable for preservation and afforestation from a perspective of CO2 : M. Trees remove significantly more CO2 than the amount of M they emit.

Most M persists in the atmosphere for about 10 ten years. A major mechanism of its decrease is natural conversion into CO2 and H2O. The latter is not a problem because it contributes to the hydrologic cycle. CO2 is sequestered by trees.

Upgrade residential, government, and business new building codes to ban natural gas (over 97% M).

Gasoline-powered Landscape Equipment (GLE)

Research has shown that the economic sector emitting the greatest quantity of GHGs in CA is ground transportation. CARB has estimated that the GHG emissions from all GLE will equal the GHG emissions

from all motor vehicles by 2020. In future years, CARB projects that emissions from GLE will exceed that of motor vehicles by an increasing margin.

A statewide ban on GLE is recommended. Gas leaf blowers have been banned in over 200 cities in Canada and the USA, including many in CA. Local incentives for replacing GLE with ELE (electric landscape equipment) are listed on the California Air Resources Board website (CARB) and the Bay Area Air Quality Management District (BAAQMD) website, but there are no statewide incentives. A statewide ban on all kinds of GLE provides more benefits to CA than bans on only some kinds of GLE enacted by a minority of local governments. A statewide GLE ban would improve public health, environmental quality, productivity, and increase tax revenues while decreasing costs of food, medical care, stress management, antisocial behavior, and environmental protection and remediation. Furthermore, a ban would curtail the ravages of climate change including wildfires, drought, coastal flooding, property damage, insect-transmitted infectious diseases, and depletion of marine and terrestrial wildlife populations.

Gaseous and airborne GLE emissions include carbon monoxide, carbon dioxide, aldehyde, volatile organic compounds, methane, particulate matter (PM), nitrogen oxides (NO), sulphur oxides (SO),benzene, formaldehyde,and heavy metals. Many of these pollutants increase ground-level ozone.The combination of these significantly lowers air quality. Most GLE have inefficient 2-stroke engines, which emit more toxins than 4-stroke engines,and lack emission controls and mufflers.

Gas emissions from GLE have been proven to decrease longevity, induce shortness of breath, exacerbate chronic respiratory disorders, increase risk of cardiovascular disorders (e.g., heart attack), trigger allergic reactions, decrease lung function, increase upper respiratory infections, diminish cognitive function, decrease alertness,and lower endurance.The combination of GLE gases impairs heart,liver, and lung capacities to expel toxins.

Heavy metals, toxic and fatal in sufficient doses, increase oxidant damage, cancer, cardiovascular disease, organ damage,and neurodegenerative disorders (e.g., Parkinson's and Alzheimer's).

Benzene induces birth defects, leukemia, anemia, bone marrow damage, cancer, drowsiness, and immune impairment.

Nitrogen oxides cause chronic respiratory disorders (e.g., cancer),cardiovascular disease, and diabetes mellitus.

Sulphur oxides induce shortness of breath and decrease longevity.

Carbon dioxide exposure may temporarily cause headache, dizziness,shortness of breath, and fatigue; chronic impairment of visual acuity, cognitive function, and kidney function; and cancer and brain damage.

Carbon monoxide , fatal in high doses, causes confusion, shortness of breath, diminished endurance, impaired cognitive function, and brain damage.

Formaldehyde temporarily induces wheezing and fatigue; causes cancer, birth defects, and asthma.

Aldehyde causes cancer, liver damage, and cilia impairment.

Volatile organic compounds induce fatigue and shortness of breath;

Cause respiratory disorders, cancer, cardiovascular disorders, liver dysfunction, kidney dysfunction, cognitive impairment, and dementia.

Methane temporarily induces shortness of breath, weakness, and drowsiness; increases ground-level ozone (which kills 1 million people annually worldwide)

Sulphur oxides induce wheezing, impaired breathing, and decreased longevity.

Particulate Matter

Fine particulate matter (<PM2.5um) pollution is from engine emissions as well as debris that is dispersed from the ground into the air: This may be carried long distances by wind. Decomposing PM launched into the air commonly contains pathogenic microbes, pollen, pesticides, fertilizers, and herbicides. PM causes preterm birth disorders and mortality, cancer, mutagenesis, cardiovascular disease, chronic kidney disease, exacerbation of respiratory disorders, and increases risk of Alzheimer's Disease.

https://ww3.arb.ca.gov/msprog/offroad/sore/sm_en_fs.pdf?_ga=2.150141302.135515834.1560738325-1460984516.1553896319

https://www.fairwarning.org/2017/09/leaf-blower/

https://www.npr.org/2017/02/28/517576431/california-weighs-tougher-emissions-rules-for-gas-powered-garden-equipment

https://ww2.arb.ca.gov/index.php/our-work/programs/zero-emission-landscaping-equipment/about

http://www.baaqmd.gov/funding-and-incentives/public-agencies/lawn-and-garden

https://www.epa.gov/sites/production/files/2015-09/documents/banks.pdf

https://www.edmunds.com/about/press/leaf-blowers-emissions-dirtier-than-high-performance-pick-up-trucks-says-edmunds-insidelinecom.html

https://www.agza.net/services

https://grist.org/article/it-was-a-bad-year-for-carbon-emissions-even-in-california/

https://sor.senate.ca.gov/sites/sor.senate.ca.gov/files/Policy%20Matters%20SCC%20Final.pdf

See separate list of research references.

According to a study conducted by all 15 European Union nations in 1999, the costs of all-source noise pollution totaled 2% of Gross Domestic Product (Los Angeles Times 3/27/1999).

California Air Resources Board (CARB)estimated that the damage to health, crops, and buildings from gas leaf blower emissions alone was several $billion in CA in 2010.The Environmental Protection Agency and CARB recommend that they not be used.

Wolfe et.al.(2019) estimated the decrease in medical costs from preventing e ach ton of 3 kinds of GLE exhaust emissions a) PM particulate matter, b) SO sulpher oxides,and c) NO nitrogen oxides in the USA.

PM only - residential $590,000/ton commercial $630,000/ton

SO only - " $200,000/ton " $170,000/ton

NO only - " $4,500/ton " $4,800/ton

Researchers estimated the number of tons of each emission from GLE in 2025 as:

PM only - residential 6,000 commercial 20,000

SO only - " 89 " 150

NO only - " 20,000 " 54,000

The estimates do not include the costs due to other GLE exhaust emissions, noise pollution, property damage, diminished quality of natural resources, and costs of reducing GHG levels in the atmosphere.

Per CARB, total emissions from GLE are projected to match total emissions from cars and trucks in CA by 2020. In 2016 CARB and EPA calculated the sum of car and truck emissions in CA to be 155 MMT CO_2e (million metric tons of CO_2 equivalent). Ground transport emissions increased in 2018 in CA, USA, and globally, per preliminary data.

The social cost of carbon (SCC) includes premature deaths, medical costs, degradation of natural resources, decreased GDP; property damage from climate-induced floods, windstorms, and wildfires; and increased cost of food. It excludes extraction of GHG emissions from the atmosphere. A 2019 meta-analysis by Wang et.al. found the mean SCC to be $55/MT CO_2e ($200/MT of carbon). Estimates from more recent peer-reviewed journals exceeded this mean. The total annual SCC from GLE emissions in CA is at least 155 MMT CO_2e x $55/MT CO_2e = $8,525,000,000 ($8.525 billion). This excludes the social cost of other emissions, noise, and climate remediation.

After the effective date of the ban, a fine for each infraction is to be imposed.

2 and 4 stroke $500 (the fine in D.C.)

Banning GLE could be expedited by collecting an environmental impact tax on their purchase and rental. Some of these funds could be used as incentives to replace GLE with ELE.

A rebate program to replace GLE with ELE (similar to the one recently used by Bay Area Air Quality Management District - BAAQMD) would have maximum impact if it were available for individuals, businesses, and government.

Plans to Phase Out Fossil Fuel Production and Consumption

A study by CalEPA was completed in Sep. 2019 that considers policy options to achieve this. Reports and webinars will be available on their website. As of 14 Oct., none were available.

Each of the policies outlined in my public comment would expedite this objective. Stationary source emission limits have failed to spur innovation or decreased production. Success is more probable if emission limits are decreased annually, e.g., by 10%. Apply this to all carbon-intensive industries, e.g., steel, cement, biomass energy, logging, oil & gas, raising livestock, etc. All kinds of GHG emissions are to be targeted including sulpher oxides, nitrogen oxides, halocarbons, CO_2, and methane.

Of current O&G extraction technologies, the greatest health hazards are from hydraulic fracturing. Place a moratorium on new fracking sites until SB100 targets have been achieved. Deny permit requests for any form of O&G extraction on new sites - public or private. Require O&G operators to pay an annual user fee for sale of public resources. Set the fee at >1% of revenue and increase it annually. Offer incentives to O&G to join us or exit gracefully. E.g., offer tax credits for replacing fossil production with renewable production. If they achieve 100% renewable production, offer an additional annual bonus.

Impose a gas-guzzler tax on the purchase of any size of internal-combustion passenger vehicle or small truck, new or used. This would begin at 30 mpg and increase by 1% for each lower mpg rating. Increase diesel and gasoline taxes by double the rate of inflation annually.

Continue to offer incentives for purchase of electric vehicles, including trucks. Collaborate with charging station companies to increase the network of charging stations, especially in existing and new multi-family buildings. Replace internal combustion public buses with electric (this has been done in some large cities in PRC).

https://www.psr.org/blog/resource/compendium-of-scientific-medical-and-media-findings-demonstrating-risks-and-harms-of-fracking/

Community Choice Aggregates

Publically-owned CCAs are becoming more popular in CA. Offer incentives for them to provide annual increases in the percent of their sources that meet Renewable Portfolio Standards. This would allow them to pass on savings to their customer base that would align the interests of CCAs and the public they serve. E.g., government incentives could reward increasing the percent of power that is renewable and CCAs could provide lower rates/kW for higher % renewable deciles. Taxes could be imposed on the lowest deciles, which would raise rates/kW. (Similar incentives for utility corporations would increase the development of renewables.) Enable CCAs to use existing power lines owned by utility corporations. Offer incentives to utilities and CCAs for exceeding the Renewable Portfolio Standard.

https://cal-cca.org/about/

Smart Grid for Load-balancing

Power supply in one part of CA may be insufficient while supply in other parts is ample. A smart grid enables prompt distribution to areas with temporary deficiencies. Such a grid is necessary to maximize the development of renewable electricity. Renewable energy production sites are dispersed and mostly small-scale. In some areas, utility-scale battery storage of electricity may be a useful add-on to a smart grid. Incentivizing innovation in battery efficiency would increase demand for renewable energy. Because CA is in one time zone, greater redistribution benefits would be realized by integrating the CA grid with a national grid spanning 4 time zones.

Divestment and Reinvestment

Require all levels of government and state employee pension funds to divest from carbon-intensive industries and reinvest in renewable energy and efficiency sectors. University of CA has a 5 year plan to accomplish this. Gov. Newsom's Executive Order, signed last month, calls for this policy.

CONCLUSION

The above policy recommendations are based on empirical research and the precautionary principle that is well-established in sciences (e.g., climate science), regulation (e.g., EPA emission standards), and public health policy. Future research will enable us to refine policies. Setting progressive annual targets, announced years in advance, for implementing policies will enable our economy to innovate with minimal disruption. Join with other states to advance Congressional legislation to expedite reaching a carbon-neutral economy, e.g. 100% Clean Economy Act of 2019.