The Air We Breathe, Part 2

By John Benson

December 2022

1. Introduction

"The debate is over around climate change. Just come to the state of California. Observe it with your own eyes."

> *- California Governor Gavin Newsom in September 2020 after surveying the devastation caused by catastrophic wildfires*

The impacts of climate change are no longer a distant threat on the horizon—they are right here, right now, with a growing intensity that is adversely affecting our communities and our environment, here in California and across the globe. The science that, decades ago, predicted the impacts we are currently experiencing is even stronger today and unambiguously tells us what we must do to limit irreversible damage: we must act with renewed commitment and focus to do more and do it sooner…[1]

I wrote the first part of this series, described and linked below, not knowing there would be a second part, much less a third part. But in mid-November I came across a just-released scoping plan by the subject of the first part (the California Air Resources Control Board or CARB) which was very good and thorough. It also clearly defined how CARB will lead us (California) to Carbon Neutrality by 2045. As I got well into the source document (and this paper) I looked at my word-count and saw I was well over my preferred length, and not near covering all of the plan that I needed to, thus this paper is now parts 2-and 3.

The Air We Breathe: *I have said in the past that energy and water are tightly linked. Energy is required to process water, pump water and otherwise make it suitable for use. Also, guess which sector is the largest user of water? The power sector.*

But this post is not about water, it is about an even more important resource for energy, as well as every living thing on our planet. The title of this post might help you guess what this resource is.

The governmental body that defines the rules to remedy our air quality issues is the California Air Resources Control Board (CARB), and this post is about this body.

https://energycentral.com/c/cp/air-we-breathe

This paper is a summary of CARB's Scoping Plan. Part 2 of this paper describes:

- High level goals of California's greenhouse gas (GHG) reduction efforts, and methods we intend to use to achieve these goals
- The severity of climate change impacts
- Innovative steps we intend to take to control GHG

Part 3 of this paper describes:

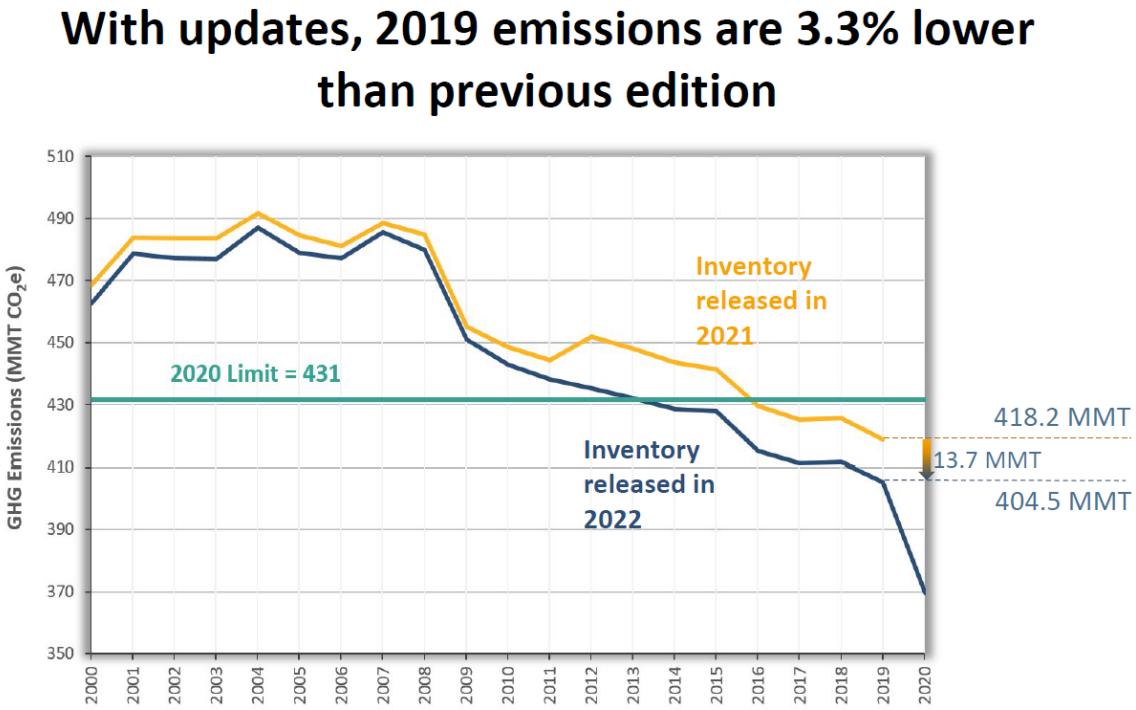
- Scenarios used to develop this plan

[1] California Air Resources Control Board, 2022 Scoping Plan for Achieving Carbon Neutrality, November 16, 2022, https://ww2.arb.ca.gov/sites/default/files/2022-11/2022-sp.pdf

- Action Plans for each Sector in the Scoping Plan Scenario
- Carbon Removal and Sequestration Methods and Roles

This Scoping Plan lays out the sector-by-sector roadmap for California, the world's fifth largest economy,[2] to achieve carbon neutrality by 2045 or earlier, outlining a technically feasible, cost-effective, and equity-focused path to achieve the state's climate target. This is a challenging but necessary goal to minimize the impacts of climate change. There have been three previous Scoping Plans. Previous plans have focused on specific greenhouse gas (GHG) reduction targets for our industrial, energy, and transportation sectors—first to meet 1990 levels by 2020, then to meet the more aggressive target of 40 percent below 1990 levels by 2030. This plan, addressing recent legislation and direction from Governor Newsom, extends and expands upon these earlier plans with a target of reducing anthropogenic emissions to 85 percent below 1990 levels by 2045. This plan also takes the unprecedented step of adding carbon neutrality as a science-based guide and touchstone for California's climate work. The plan outlines how carbon neutrality can be achieved by taking bold steps to reduce GHGs to meet the anthropogenic emissions target and by expanding actions to capture and store carbon through the state's natural and working lands and using a variety of approaches…

Author's comment: See a recent graphic from a CARB presentation below vs. the above summary: [3]



[2] According to Bloomberg, California is poised to overtake Germany as the world's 4th largest economy, continuing to outperform the nation and other countries in GDP growth, companies' market value, renewable energy and more. https://www.gov.ca.gov/2022/10/24/icymi-california-poised-to-become-worlds-4th-biggest-economy/

[3] CARB Presentation, "2000-2020 GHG Inventory (2022 Edition), Oct 26, 2022," slide 17 https://ww2.arb.ca.gov/sites/default/files/classic/cc/inventory/ghg_inventory_webinar_slides.pdf

Per the above updated chart we crossed 1990 levels in 2013, and were 13.8% below 1990 GHG Emissions levels in 2020. Our goal is to be 40% below 1990 levels by 2030.

The major element of this unprecedented transformation is the aggressive reduction of fossil fuels wherever they are currently used in California, building on and accelerating carbon reduction programs that have been in place for a decade and a half. That means rapidly moving to zero-emission transportation; electrifying the cars, buses, trains, and trucks that now constitute California's single largest source of planet-warming pollution. It also means phasing out the use of fossil gas used for heating our homes and buildings. It means clamping down on chemicals and refrigerants that are thousands of times more powerful at trapping heat than carbon dioxide (CO_2). It means providing our communities with sustainable options for walking, biking, and public transit to reduce reliance on cars and their associated expenses. It means continuing to build out the solar arrays, wind turbine capacity, and other resources that provide clean, renewable energy to displace fossil-fuel fired electrical generation. It also means scaling up new options such as renewable hydrogen for hard-to-electrify end uses and biomethane where needed. Successfully achieving the outcomes called for in this Scoping Plan would reduce demand for liquid petroleum by 94 percent and total fossil fuel by 86 percent in 2045 relative to 2022.2 Despite these world-leading efforts, some amount of residual emissions will remain from hard-to-abate industries such as cement, internal combustion vehicles still on the road, and other sources of GHGs, including high global warming chemicals used as refrigerants.

The plan addresses these remaining emissions by re-envisioning our natural and working lands—forests, shrublands/chaparral, croplands, wetlands, and other lands—to ensure they play as robust a role as possible in incorporating and storing more carbon in the trees, plants, soil, and wetlands that cover 90 percent of the state's 105 million acres while also thriving as a healthy ecosystem. Modeling indicates that natural and working lands will not, on their own, provide enough sequestration and storage to address the residual emissions. For that reason, it is necessary to research, develop, and deploy additional methods of capturing CO_2 that include pulling it from the smokestacks of facilities, or drawing it out of the atmosphere itself and then safely and permanently utilizing and storing it, as called for in recent legislation. Carbon removal also will be necessary to achieve net negative emissions to address historical GHGs already in the atmosphere.

Author's comments: The GHG reduction techniques described in the above paragraph are commonly called negative emissions technologies (NET). I have posted many papers on this. Go to the papers directory linked below, to the Table of Contents, section 2 (Climate Change Impacts & Mitigation) and look for any paper with "NET" or "NETWORKS" in its title. Click on the TOC-entry for this paper and you will be taken to a brief description and link to the paper. I believe there are 6 or 7 of these papers.

https://energycentral.com/c/ec/papers-directory-third-quarter-2022-update

…Specifically, this plan:

- *Identifies a path to keep California on track to meet its SB 32 GHG reduction target of at least 40 percent below 1990 emissions by 2030.*

- *Identifies a technologically feasible, cost-effective path to achieve carbon neutrality by 2045 and a reduction in anthropogenic emissions by 85 percent below 1990 levels.*

- *Focuses on strategies for reducing California's dependency on petroleum to provide consumers with clean energy options that address climate change, improve air quality, and support economic growth and clean sector jobs.*

- *Integrates equity and protecting California's most impacted communities as driving principles throughout the document.*

- *Incorporates the contribution of natural and working lands (NWL) to the state's GHG emissions, as well as their role in achieving carbon neutrality.*

- *Relies on the most up-to-date science, including the need to deploy all viable tools to address the existential threat that climate change presents, including carbon capture and sequestration, as well as direct air capture…*

2. Severity of Climate Change Impacts

The impacts we thought we would see in the decades to come are happening now. These include:

2.1. Wildfires

Of the twenty largest wildfires ever recorded in California, nine occurred in 2020 and 2021. The worst wildfire season in California's recorded history was in 2018, with over 24,226 structures damaged or destroyed and over 100 lives lost. The largest wildfire season ever recorded in state history was in 2020, where more than 4.3 million acres burned, albeit at different intensity and with varying ecological impacts, and over 112 million metric tons of carbon dioxide (CO_2) emitted into the atmosphere.[4] The economic damage of these fires was estimated to be over $10 billion in property damage and over $2 billion in fire suppression costs. The Camp Fire, which destroyed much of Paradise, California, was the world's costliest natural disaster in 2018, with overall damages of $16.5 billion. It was also the deadliest fire in California history, with 85 civilian fatalities. Wildfires have always been part of California's natural ecology and will continue to be. However, changes to the state's climate and precipitation expands the footprint of wildfire threat, severity, and intensity, with one quarter of California—more than 25 million acres—now classified as being under very high or extreme fire threat.

The impacts of wildfire smoke have been linked to respiratory infections, cardiac arrests, low birth weight, mental health conditions, and exacerbated asthma and chronic obstructive pulmonary disease…

Catastrophic wildfire damages extend beyond human health and the economy. The Castle Fire in 2020 and the KNP Complex and Windy Fires in 2021 led to the loss of an unprecedented number of giant sequoias: an estimated 13 to 19 percent of the giant

[4] CARB. 2020. Public Comment Draft Greenhouse Gas Emissions of Contemporary Wildfire, Prescribed Fire, and Forest Management Activities. https://ww3.arb.ca.gov/cc/inventory/pubs/ca_ghg_wildfire_forestmanagement.pdf

sequoia population in the Sierra Nevada. An iconic species, giant sequoias are the largest trees on earth, with exceptional longevity outside of climate extremes.

It is clear that we must take drastic measures to prepare for future wildfires, which is why California invested $2.7 billion in wildfire resilience from fiscal years 2020 to 2023. The exponential increase in funding launched more than 552 wildfire resilience projects in less than a year, and CAL FIRE met its 2025 goal of treating 100,000 acres a full three years ahead of schedule. Since Fiscal Year 2019–20, treatment work has significantly increased, and CAL FIRE has averaged 100,000 acres treated each fiscal year.

Although we are making progress, we have a lot more work to do in order to achieve our goal of treating one million acres annually by 2025. The Governor's Wildfire and Forest Resilience Strategy details 99 actions needed to address the key drivers of catastrophic wildfires, ramp up the pace and scale of forest management, and make threatened communities more resilient to catastrophic fires. It is also important to note that natural wildfire cycles are a part of a sustainable forest ecosystem and will continue to play a role in a healthy forests' future. We should not expect wildfires to cease, but we must manage our lands to address catastrophic wildfires that result from buildup of carbon stocks due to our interventions to suppress wildfires and from climate change resulting from fossil fuel combustion.

2.2. Drought

Drought is a recurring feature of the California climate that has been intensified by increasingly warmer average temperatures. Anthropogenic climate trends have exacerbated drought conditions; human-caused climate change accounts for 19 percent of drought severity and 42 percent of the soil moisture deficit in this region since 2000. The governor declared a drought state of emergency in October 2021, and as of September 2022, 94 percent of California was in severe drought, and 99.8 percent of the state was in at least moderate drought. The first three months of 2022 were the driest January, February, and March on record in California. The harsh drought conditions affecting California are part of a larger megadrought—a drought lasting more than two decades—that has been ongoing in the Southwestern region of North America since 2000. The past 22 years have been the region's driest period since at least 800 CE.[5]

While large urban water districts with diversified sources of water supply have maintained water deliveries to customers through the drought, hundreds of individual well owners and some small water systems have suffered disruption. The state is providing funding for water system consolidation and modernization projects in small communities, emergency repairs and replacements for dry wells, and bottled and hauled water deliveries. A 2021 law requires small suppliers to create drought contingency plans. During the drought of the last three years the state has delivered emergency drinking water assistance to nearly 10,000 households and 150 water systems.

California agriculture is responsible for more than half of all U.S. domestic fruit and vegetable production, and in 2021 drought resulted in the fallowing of nearly 400,000

[5] Williams, A. P., B. I. Cook, and J. E. Smerdon. 2022. "Rapid Intensification of The Emerging Southwestern North American Megadrought in 2020–2021." Nature Climate Change, https://doi.org/10.1038/s41558-022-01290-z Note access is limited.

acres of fields.[6] Direct crop revenue losses were approximately $962 million, and total economic impacts were more than $1.7 billion, with over 14,000 full- and part-time job losses…

Though native California species are adapted to drought, human engineering has altered most streams and wetlands in the state, making drought increasingly stressful to fish and wildlife. The state has conducted hundreds of fish and amphibian rescues in this drought to move creatures from diminished habitat, upgraded hatcheries, and boosted hatchery production, and has hauled millions of young hatchery salmon to San Francisco Bay to avoid adverse river conditions. State biologists monitor dozens of streams statewide and have negotiated voluntary agreements with landowners and water users to improve stream flows and temperatures.

California has started to implement major policies to build resilience to combat drought—such as the Sustainable Groundwater Management Act of 2014, the governor's Water Resilience Portfolio (2020), the governor's Water and Supply Strategy (August 2022), and new standards for indoor, outdoor, and industrial water use. However, it is crucial that we take further actions to minimize the impacts of drought in the years to come.

2.3. Extreme Heat

California's hottest summer on record was 2021. Death Valley recorded the world's highest reliably measured temperature (130°F) in July 2021, breaking its own record (129°F) from summer 2020.[7] Meanwhile, Fresno also broke one of its own records, with 64 days over 100°F in 2021. This is part of a trend: the daily maximum average temperature, an indicator of extreme temperature shifts, is expected to rise 4.4°F–5.8°F by 2050 and 5.6°F–8.8°F by 2100. Heat waves that result in public health impacts are also projected to worsen throughout the state. By 2050, these heat-related health events are projected to last two weeks longer in the Central Valley and occur four to ten times more often in the Northern Sierra region.

Heat ranks among the deadliest of all climate hazards in California, and heat waves in cities are projected to cause two to three times more heat-related deaths by mid-century.[8] Climate vulnerable communities will experience the worst of these effects, as heat risk is associated and correlated with physical, social, political, and economic factors. Aging populations, infants and children, pregnant people, and people with chronic illness are especially sensitive to heat exposure… Rising temperatures will also speed up smog-forming chemical reactions, leading to worse asthma, reduced lung function, cardiac arrest, and cognitive decline…

In addition to the dangers to public health, California's September 2022 heat wave is particularly illustrative of how more frequent extreme heat strains the state's infrastructure we depend on to adapt to a changing climate. For example, as all-time

[6] Medellín-Azuara, J. 2022. Economic Impacts of the 2021 Drought on California Agriculture. University of California Merced. https://wsm.ucmerced.edu/wp-content/uploads/2022/02/2021-Drought-Impact-Assessment_20210224.pdf

[7] Masters, J. 2021. Death Valley, California, breaks the all-time world heat record for the second year in a row. Yale Climate Connections. https://yaleclimateconnections.org/2021/07/death-valley-california-breaks-the-all-time-world-heat-record-for-the-second-year-in-a-row/

[8] Ostro, B., S. Rauch, and S. Green. 2011. "Quantifying the health impacts of future changes in temperature in California." National Library of Medicine. https://pubmed.ncbi.nlm.nih.gov/21975126/

high temperature records were broken in Sacramento, San Jose, Santa Rosa and Fairfield, electricity demand for air conditioning threatened to overwhelm the state power supply.

Author's comment: add Livermore (where I live) to the above. Both Sacramento and Livermore both hit 116°, Livermore on Sep 5 and Sacramento on Sep 6.

California has taken major steps to protect communities from the impacts of extreme heat. Our recent budgets invest $800 million to cool our schools and neighborhoods, including projects to reduce urban overheating. The Extreme Heat Action Plan, released in April 2022, outlines the all-of-government approach California is taking to reduce urgent risks and build long-term resilience to the impacts of extreme heat. In September 2022, Governor Newsom signed multiple bills addressing extreme heat, including AB 2238 (Rivas, Chapter 264, Statutes of 2022), which will create the nation's first extreme heat advance warning and ranking system to better prepare communities ahead of heat waves. The Administration is committed to addressing extreme heat, but we still have a lot of work to do.

Wildfires, drought, and extreme heat are some of the most pronounced climate impacts California is experiencing, but they are not the only ones. Sea level rise, rising ocean temperatures, ocean acidification, and inland flooding are also already having devastating impacts on our communities, ecosystems, and economy, and will continue to do so in the years and decades to come. The decisions and actions that we take today will determine how strongly we will feel the impacts of climate change in the future.

3. Supporting Innovation

Reaching our ambitious, deep decarbonization goals will require continued technological innovation. Investment in research, development, and deployment of clean technologies has never been more critical. Sending clear and sustained market and policy signals will encourage large and small companies alike to pursue innovation that can be scaled up and deployed here and beyond our borders. The full suite of AB 32 policies has touched nearly every sector of California's economy and spurred technology innovation in the state, including the growth of technology developers, manufacturers, processors, and assemblers in many areas. Specifically, AB 32 policies and programs support both the supply side and the demand side to build new markets in California. On the supply side, AB 32 policies support businesses to demonstrate and refine technologies, and to help establish critical supply chains. On the demand side, AB 32 policies and programs provide outreach, education, and incentives—as well as disincentives—to motivate everyone from consumers to institutional purchasers to utility planners to adopt new, climate smart technologies. Innovations resulting directly from the state's climate policies include the following:

3.1. Heavy-Duty Zero-Emission Vehicles

In the past 10 years, a growing market for heavy-duty zero-emission vehicles (HD ZEVs) was established in California, and this market now represents the largest single share of North American supply and demand for HD ZEVs. Vehicle and component manufacturers are making long-term investments to develop and produce HD ZEVs within California.

3.2. Renewable Diesel Fuel

Total consumption of renewable diesel in the California low-carbon fuel standard (LCFS) market has skyrocketed from approximately 1.8 million gallons in 2011 to nearly 589 million gallons in 2020. The LCFS is a key driver of market development for renewable diesel and its coproducts. While the federal renewable fuel standard (RFS) and blenders tax credit also benefit producers, an analysis of their respective contributions to market development, and interviews with industry representatives and independent experts, point to LCFS as a more important factor in market development, at least in recent years.

3.3. Small-Scale Energy Storage

In the past five years, a market for small-scale energy storage in California was created where none previously existed. As of 2020, 185 megawatts (MW) of small-scale energy storage projects have been interconnected to the grid. The significant increase in deployment in the last five years is a result of the Self-Generation Incentive Program (SGIP), which significantly reduces the upfront costs to purchase and install small-scale energy storage devices, and of growing customer interest in disaster resiliency in the face of increasing risk from wildfire and related utility outages…

About a year ago I posted a paper that covered small-scale energy storage products in detail. This is described and linked below.

The Future of Microgrids: *I responded to a question from one of my colleagues at Energy Central, which caused me to think about the subject of this post. This brought up some interesting possibilities.*

The California Electric Utility Culture has decided that microgrids will be very useful to prevent transmission lines that feed small isolated communities from starting wildfires.

This post expands on the possibilities for microgrids to expand into other segments once the wildfire mitigation market starts to saturate.

https://energycentral.com/c/ec/future-microgrids

Also, in the post briefly described and linked below, the CPUC is pushing future solar projects to incorporate small-scale energy storage units. Many of these storage units incorporate power controllers that allow them to interact with generation, the utility grid and various loads.

Even as I was writing parts 1 and 2 of this series, and thus reviewing the original ruling (issued about a year ago), there was no doubt in my mind that the chances of this ruling standing intact were slim to none. This perception was mainly because the solar industry felt that this ruling was highly unfair to them and was likely to seriously hurt future rooftop solar energy deployments. Also, the solar industry is strongly viewed as a positive environmental influence in our state, is financially very powerful, and thus strongly influences many political leaders. Thus, this decision was set aside last summer, and the CPUC (on Nov 10) issued a new proposed decision.

On December 15, the CPUC approved the proposed decision that the above review is based on, but with mark-ups. I downloaded the decision, and skimmed through it, and although nothing looks like a major change, there are significant changes. This paper is a detailed review of the approved decision.

https://energycentral.com/c/cp/rooftop-solar-energy-tug-war-part-4-final-resolution

3.4. Overview

See the graphic below:

Figure 1-3: Comprehensive California climate change investments