THE SKY'S LIMIT CALIFORNIA:

WHY THE PARIS CLIMATE GOALS DEMAND THAT CALIFORNIA LEAD IN A MANAGED DECLINE OF OIL EXTRACTION

MAY 2018

OILCHANGE INTERNATIONAL

In collaboration with

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This report was written and researched by Kelly Trout of Oil Change International, with additional research by Kyle Ferrar of FracTracker Alliance and David Hughes of Global Sustainability Research. It includes additional writing and research contributions from Janet Redman, Greg Muttitt, Hannah McKinnon, and David Turnbull, all of Oil Change International, Roger Lin of The Center on Race, Poverty & the Environment, and José López of Communities for a Better Environment. It was edited by Collin Rees of Oil Change International. Design adjustments by Matt Maiorana of Oil Change International.

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Oil Change International
714 G Street SE, Suite 202
Washington, DC 20003 USA
www.priceofoil.org

Phillips 66 refinery in Rodeo, California. Thomas Hawk (CC BY-NC 2.0).

“YOU CAN’T DO TOO MUCH TO SOUND THE ALARM BECAUSE SO FAR THE RESPONSE IS NOT ADEQUATE TO THE CHALLENGE.”

GOVERNOR JERRY BROWN, JULY 5, 2017

“LET’S LEAD THE WHOLE WORLD TO REALIZE THIS IS NOT YOUR NORMAL POLITICAL CHALLENGE. THIS IS MUCH BIGGER. THIS IS LIFE ITSELF. IT REQUIRES COURAGE AND IMAGINATION.”

GOVERNOR JERRY BROWN ADDRESSING GERMAN LAWMAKERS IN STUTTGART, NOVEMBER 8, 2017

“THE FOSSIL FUEL ERA IS ENDING, AND CALIFORNIA IS NOT INTERESTED IN THE BOOM-OR-BUST OIL ECONOMY.”

LIEUTENANT GOVERNOR GAVIN NEWSOM AND THE CALIFORNIA STATE LANDS COMMISSION RESPONDING TO TRUMP ADMINISTRATION PLANS TO LEASE NEW AREAS FOR OIL DRILLING OFF CALIFORNIA’S COAST, FEBRUARY 7, 2018

IF YOU'RE IN A HOLE, STOP DIGGING.

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ABSTRACT

California's leaders have been vocal supporters of the Paris Agreement, which commits to keeping global warming to well below 2 degrees Celsius, and striving to limit it to 1.5 degrees Celsius. Despite this, California presently has no plan to phase out its oil and gas production in line with Paris-compliant carbon budgets.

This analysis examines the carbon emissions enabled through continued permitting of new oil and gas wells. It further quantifies the impact of a managed phase-out of existing wells, beginning with a 2,500-foot buffer zone around sensitive areas. Finally, we discuss the need for an ambitious just transition plan that protects workers and communities in the shift to a climate-safe economy.

As a wealthy oil producer, California is well positioned to take more ambitious action to proactively phase out its fossil fuel production and has a responsibility to do so in order to fulfill its commitment to climate leadership.

We recommend that the state take the following actions:

- Cease issuing permits for new oil and gas extraction wells;
- Implement a 2,500-foot health buffer zone around homes, schools, and hospitals where production must phase out;
- Develop a plan for the managed decline of California's entire fossil fuel sector to maximize the effectiveness of the state's climate policies; and
- Develop a transition plan that protects people whose livelihoods are affected by the economic shift, including raising dedicated funds via a Just Transition Fee on oil production.

Oil rig operating next to a walk and bike way in the Signal Hill area of Los Angeles. Sarah Craig/Faces of Fracking (CC BY-NC-ND 2.0)

KEY FINDINGS AND RECOMMENDATIONS

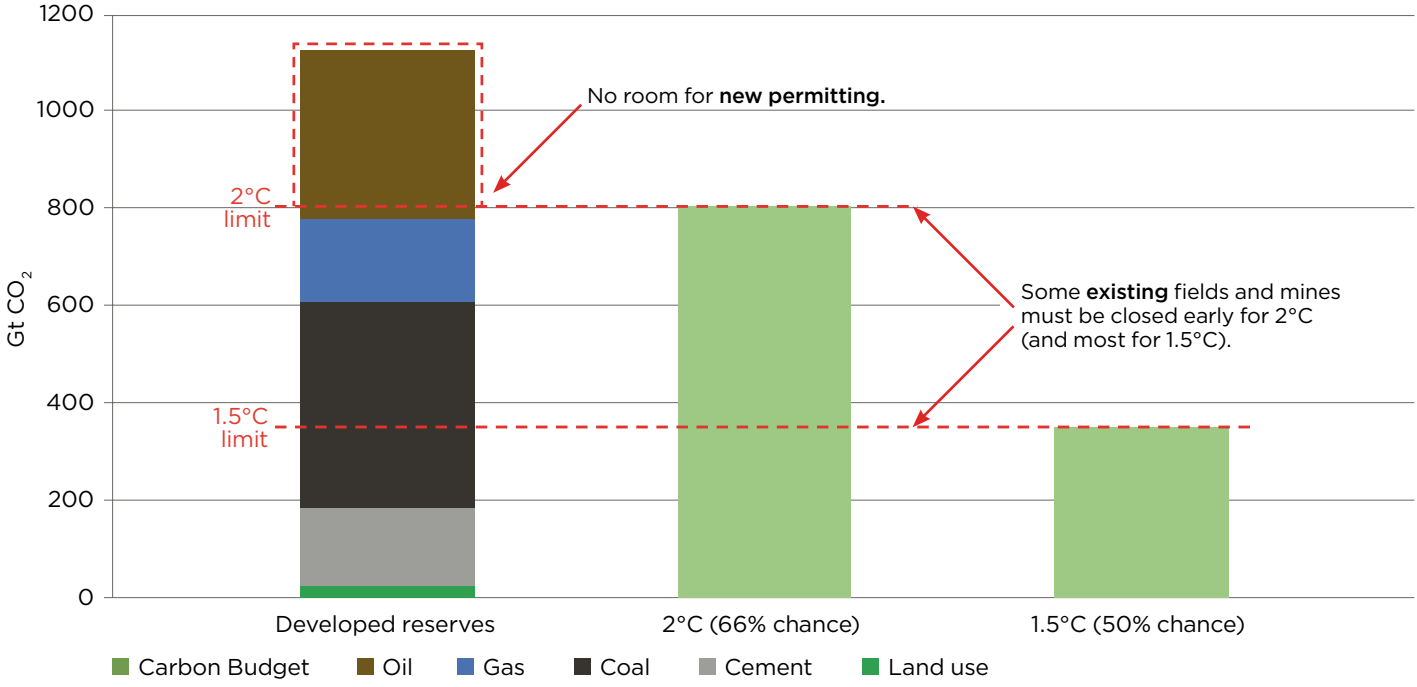
In December 2015, world governments agreed in Paris to limit global average temperature rise to well below 2 degrees Celsius above pre-industrial levels, and to strive to limit it to 1.5 degrees Celsius. Recent analysis has shown that there is no room for the expansion of fossil fuel production if the world is to achieve the Paris goals.[1]

The potential carbon emissions from the oil, gas, and coal in the world's *currently operating* fields and mines would fully exhaust and exceed carbon budgets consistent with the Paris goals (see Figure ES 1). Staying within these climate limits will require government action to manage the decline of fossil fuel production globally.

This report applies that analysis to oil and gas production and climate leadership in California, a state that has pledged to be a subnational leader in upholding the Paris goals. Our recommendations draw on key findings related to:

1. The climate implications of ongoing permitting of new oil wells in California;
2. The ways that a managed decline of existing wells can prioritize health and equity; and
3. Elements of a just transition for affected workers and communities.

Figure ES 1: Carbon Dioxide Emissions from Developed Fossil Fuel Reserves, Compared to Carbon Budgets for Likely Chance of 2°C and Medium Chance of 1.5°C[a]



ES1 Sources: Rystad Energy, International Energy Agency (IEA), World Energy Council, Intergovernmental Panel on Climate Change (IPCC), Oil Change International analysis[2]

a We include projections of land use and cement emissions for context because they are the primary non-energy sources of carbon dioxide emissions. Cement emissions are the most difficult to reduce given current technological options.

PERMITTING OF NEW WELLS

In California, a primary way the oil industry is enabling new barrels of extraction is by drilling new production wells. Under Governor Jerry Brown's administration, the California Division of Oil, Gas, and Geothermal Resources (DOGGR) has issued more than 20,000 permits to oil companies to drill new wells, including both production and injection wells.[3] One of the simplest steps the state can take to limit fossil fuel production would be to stop issuing permits for the drilling of new oil and gas wells.

FINDINGS:

- **Continued permitting of new oil and gas production wells could enable 560 million barrels of additional oil production over the next 12 years** (see Figure ES 2).[b]
- This would add more than 360 million metric tons of carbon dioxide equivalent (CO_2e) pollution to the atmosphere over that same period. New wells drilled from 2019 to 2030 could increase the total emissions associated with California oil production by more than 55 percent compared to emissions from existing wells over that period.

RECOMMENDATION:

- **Cease issuing permits for new oil and gas extraction wells.** This would limit new fossil fuel production in California, as required by the Paris goals.

INITIATING A MANAGED DECLINE OF EXISTING WELLS

Public health studies suggest that the greatest exposure to toxic air pollution occurs within one-half mile (approximately 2,500 feet) of active oil and gas wells.[4] Currently, California has no statewide policy to limit the proximity of oil and gas wells to homes and other sensitive areas, putting it in a minority among producing states.[5] The state should lead in phasing out existing wells by prioritizing closure for those wells with the greatest health risks.

FINDINGS:

- **Nearly 8,500 active oil and gas wells are within 2,500 feet of homes, schools, and hospitals, and are disproportionately located in many of the state's most polluted communities.**[c]
- These wells were responsible for **12 percent of statewide oil production in 2016:** Phasing out their production would cause a significant but manageable additional drop in production (see Figure ES 3).

RECOMMENDATION:

- **Implement a 2,500-foot health buffer zone around homes, schools, and hospitals in which production from existing oil and gas wells is phased out as quickly as possible.** This would begin a proactive managed decline of existing extraction in a way that prioritizes the health of historically overburdened communities.

THE IMPACT OF A COMPREHENSIVE APPROACH

The science tells us that climate safety requires rapid decarbonization within a few decades. Recent studies have shown that tackling carbon extraction as well as burning is the most effective way to reduce emissions, whereas continuing to invest in extraction will make reducing emissions much harder. Climate leadership thus requires bold and decisive action to reduce both supply of and demand for fossil fuels.

FINDING:

- The cumulative oil production avoided by halting new well permits combined with phasing out wells within 2,500 feet of sensitive areas could total 660 million barrels from 2019 through 2030. **If extracted and burned, this oil would cause a total of more than 425 million metric tons of carbon pollution over the same period.**

To put this in context, meeting Governor Brown's goal to reduce oil use in cars and trucks by 50 percent by 2030 would save about 430 million barrels of oil over the next 12 years, compared to reference-case projections.[6] **If California does not limit production, it could add a greater amount of new oil supply to the market, undermining the effectiveness of demand-side measures.**[d]

RECOMMENDATION:

- **Develop a plan for the managed decline of California's entire fossil fuel sector as part of the state's climate initiatives,** including complementary measures to address supply, demand, and related infrastructure. Such a plan should include ceasing the expansion of long-lived infrastructure like refineries and pipelines, setting milestones for reducing oil refining, imports, and refined products exports, and accelerating the growth of clean transportation alternatives.

By pulling at supply and demand levers together, California can manage the phase-out of production while reducing oil imports.

JUST TRANSITION

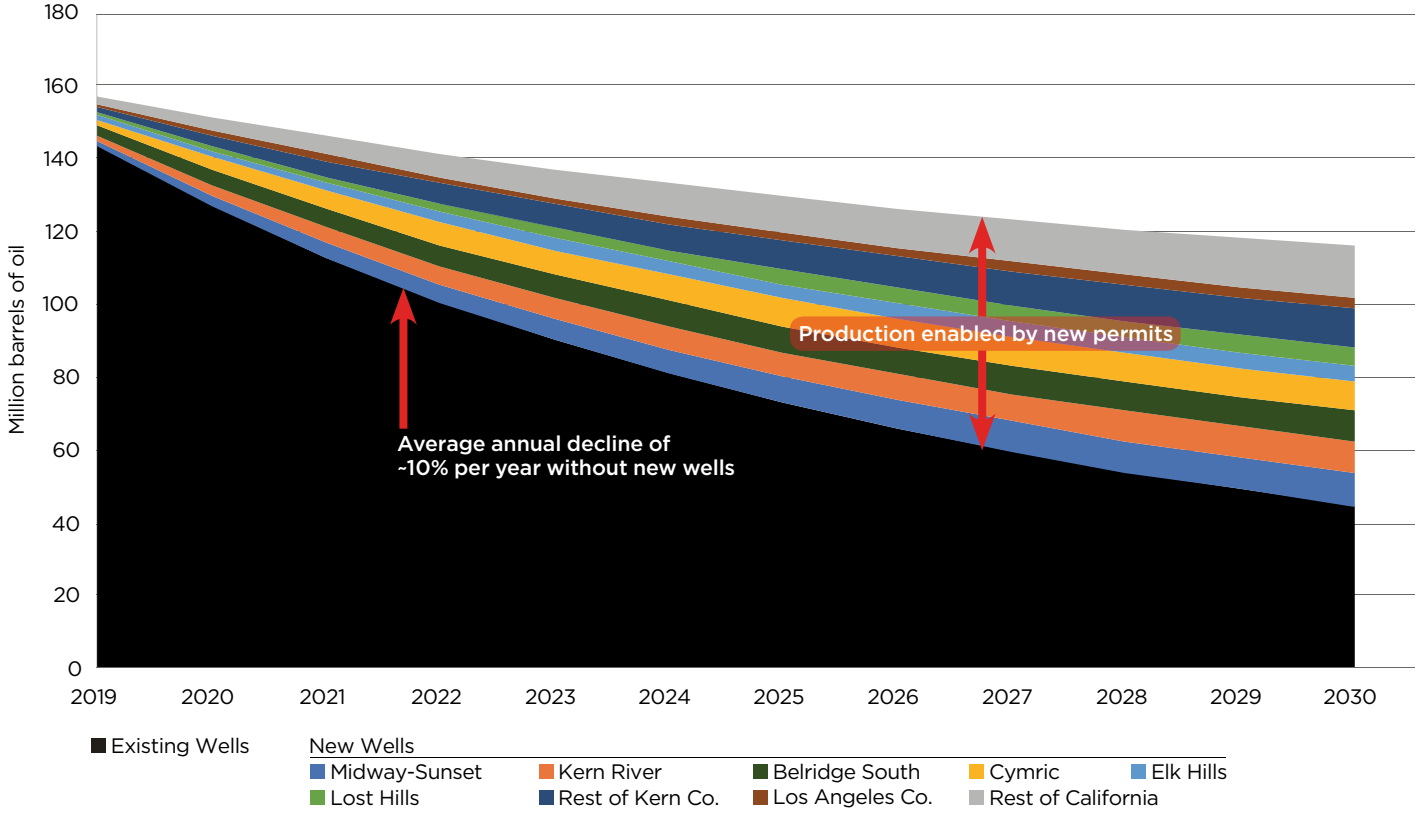
Workers in California's oil and gas extraction sector, which currently employs about 14,500 people,[7] have already experienced the job losses of an unmanaged decline in production in recent years, driven by oil prices and corporate profit margins. A managed and just transition away from extraction entails providing decent work and social protection for affected workers and investing in more equitable and resilient local economies.

FINDINGS:

- A Just Transition Fee placed on oil production could raise adequate funds to cover basic social protection costs for workers before phasing out with the decline of extraction. **A 5 to 10 percent fee on the value of oil production could generate $3.5 to $6.9 billion in revenue from 2019 through 2030**, depending on the fee rate and the price of oil (Figure ES 4). This estimate is based on only the production volumes that would continue without new wells and as wells within 2,500 feet of homes, schools, and hospitals are phased out.
- At the high end of the above revenue range, the Just Transition Fee could cover five years of wage replacement and four years of public college tuition for workers facing job losses through 2030, plus other just transition needs, based on our initial estimates of these costs.

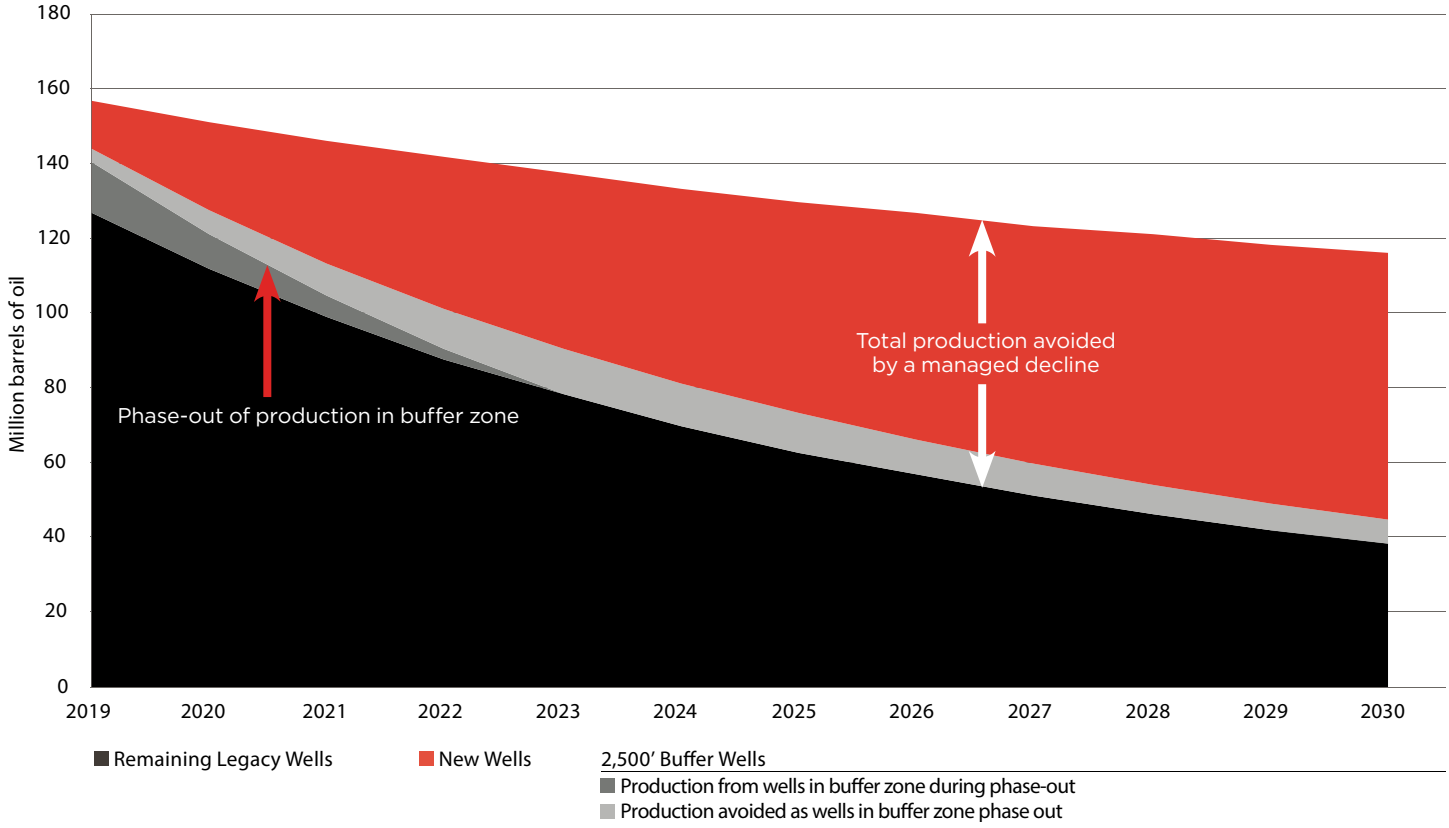
b See Appendix I for a description of the methodology and sources behind our projections of the impact of new well permitting.
c See Appendix II for a description of the methodology and sources behind our analysis of active oil and gas wells within 2,500 feet of homes, schools, and hospitals.
d These totals are for illustrative purposes and should not be interpreted as additive, given how demand and supply interact. The ultimate global emissions reduction impact of either policy would depend on the elasticities of supply and demand.

Figure ES 2: California Oil Production with and without New Well Permits, 2019-2030



ES2 Sources: Oil Change International analysis, using historical data from DOGGR and DrillingInfo[8]

Figure ES 3: Projected California Oil Production with and without New Wells and a 2,500' Health Buffer Zone, 2019-2030



ES3 Sources: Oil Change International and FracTracker Alliance analysis, using historical data from DOGGR and DrillingInfo[9]

RECOMMENDATIONS:

- **Establish a statewide Just Transition Task Force to develop and implement a comprehensive and inclusive transition plan for California.** Such a forum should facilitate a process of democratic social dialogue and planning between employers, workers, unions, frontline communities and organizations, and local and state agencies, and give clear leadership and agency to workers and communities most impacted by the transition.
- **Establish a Just Transition Fee on oil production that is exclusively dedicated to funding support for workers and communities through the transition to clean energy.** This source of revenue would ensure the industry shares in responsibility for the transition of its workforce.

WHY CALIFORNIA MUST LEAD

Traditional climate policy in California and elsewhere has largely focused on regulating the point of emissions, or the demand for fossil fuels, while leaving the supply of fossil fuels to be moderated by the market. That approach is no longer tenable (if it ever was). The expansion of fossil fuel extraction leads indirectly to higher emissions through lower prices, infrastructure lock-in, and perverse political incentives.

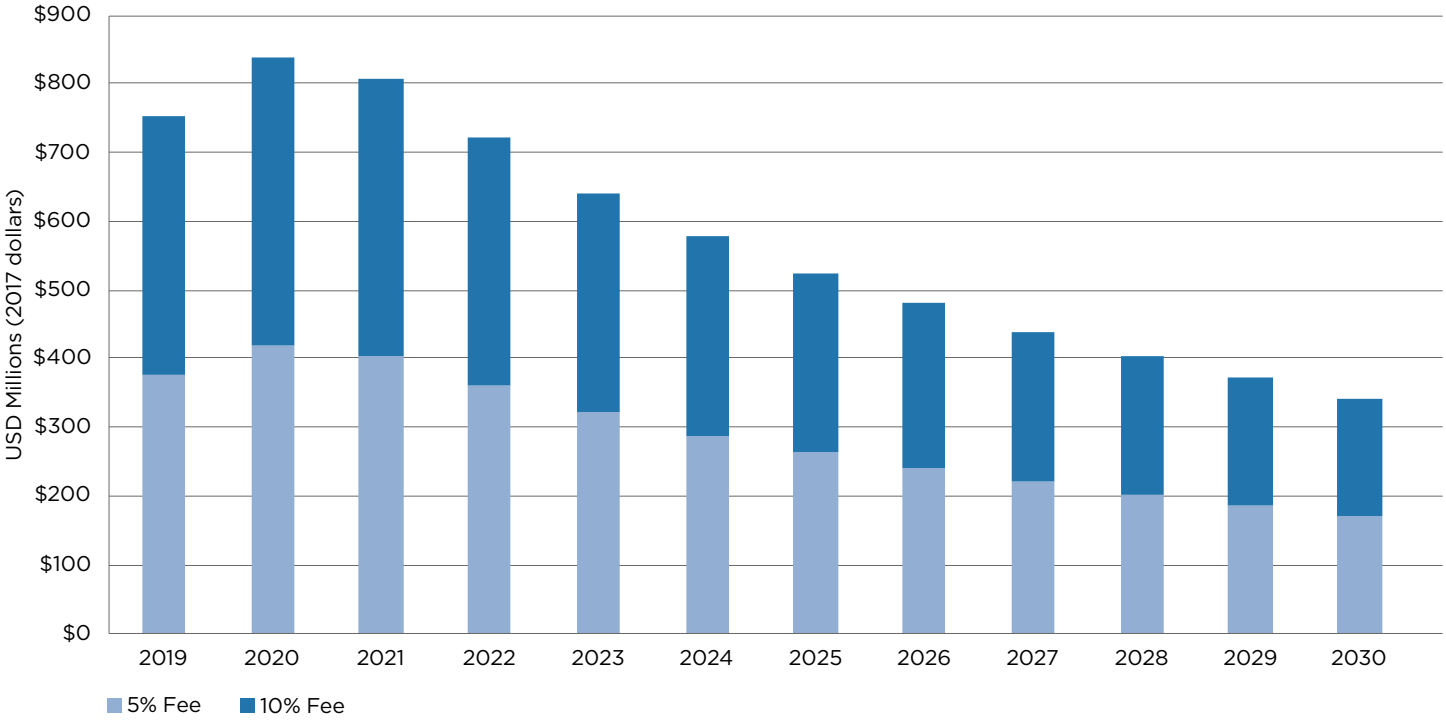
By establishing policies to align its oil production with the Paris goals, California would set an example of urgently needed global leadership among wealthy fossil fuel producers, spur significant reductions in carbon emissions, protect the health of local communities unfairly harmed by extraction now, and provide a predictable pathway around which to plan a just and equitable economic transition.

From the lens of global equity, California is one of the oil producers with the greatest capacity to reduce its extraction quickly while minimizing social and economic disruption. While any energy transition will be challenging and disruptive to the workers and communities on its front lines, California's economy as a whole is diverse and no longer extraction-dependent. As of the third quarter of 2017, all forms of mining, including oil and gas extraction, accounted for just under 0.3 percent of California's gross domestic product (GDP).[11] Of the 15 countries and U.S. states that have extracted the most oil over the past century, California has the second-highest GDP per capita, trailing only Norway.[12]

California has been a first mover in innovative energy policies in the past. The state created a positive chain reaction four decades ago when it enacted the nation's very first energy efficiency standards.[13] California spearheaded the nation's strongest vehicle efficiency standards, and is now taking the Trump administration to court to defend them at the federal level.[14] It's time for California to become a first mover once again, and show the world how to manage a fair and equitable transition away from oil extraction.

One of the most powerful – and most underutilized – climate policy levers is also the simplest: stop digging for more fossil fuels.

Figure ES 4: Dedicated Just Transition Revenue that Could Be Generated by a 5-10% Fee on Oil Production, 2019-2030



ES4 Sources: Oil Change International analysis, Energy Information Administration[10]

I. INTRODUCTION

California has been at the forefront of U.S. states in acknowledging the urgency of the global climate crisis and in encouraging development of clean energy resources. From the severe drought of recent years to longer, more damaging wildfire seasons, the human and economic toll of climate change is already being felt across California. The state estimates that drought caused $2.7 billion in agricultural losses in the Central Valley in 2015 alone, costing more than 20,000 jobs.[15] In the absence of strong action to reduce emissions as quickly as possible, such impacts will get significantly worse throughout the 21st century.

California Governor Jerry Brown has invited leaders from state, tribal, and local governments, business, and citizens from around the world to a Global Climate Action Summit in San Francisco in September 2018. He did so with the recognition that "so far the response is not adequate to the challenge" and "no nation or state is doing what they should be doing."[16] The goal is to "inspire deeper commitments from each other and from national governments – in support of the Paris Agreement,"[17] the global accord struck in 2015 with the aim of averting catastrophic levels of climate change.

This report examines the implications of the Paris Agreement, and the climate limits agreed to within it, for oil production in California.

As we discuss in **Section II**, fossil fuel projects already operating or under construction globally contain more oil, gas, and coal than the world can afford to burn under the Paris goals. It is in this context that climate leadership is being redefined. Climate success will require that governments stop the expansion of fossil fuel production, beginning now, and manage its decline in line with climate limits over the next several decades. As 500 leaders and civil society organizations from around the world have affirmed in signing the Lofoten Declaration, wealthy fossil fuel producers – including California – have an urgent responsibility to lead.[18]

Within California, the oil sector as a whole – including oil-based transportation, refining, and oil and gas extraction – is the largest source of climate pollution, accounting for around 50 percent of annual greenhouse gas emissions.[19] The state is among the leading consumers, refiners, and producers of oil in the United States.[20]

Santa Rosa, California, in the aftermath of devastating wildfires in the fall of 2017 that killed over 40 people. Press Tree Media, CC BY-NC 2.0

While California has developed an initial suite of policies to reduce oil consumption, statewide policies have yet to meaningfully address oil production or plan for a managed phase-out of related infrastructure such as refineries and export terminals. This gap in addressing fossil fuel supply and infrastructure undermines the state's global climate commitments while exacerbating the unjust burden of pollution borne by local communities living in and around extraction and refining zones, from Los Angeles to the Central Valley to the Bay Area.

In **Sections III, IV, and V,** we examine the potential impact of steps that California can take – from ceasing the permitting of new wells to establishing a health buffer zone for existing wells around sensitive areas – to close the supply-side ambition gap in its suite of climate policies. Such steps would begin the managed transition off fossil fuel production that is required by the Paris Agreement goals.

As we discuss in **Section VI**, such steps will have a profound effect on workers, families, and communities that depend on the sector for their livelihoods. To ensure that the transition off of fossil fuel production is a just transition, it is vital that the state provides support and social protection for people and communities affected by the shift toward a climate-safe economy. This shift should entail creating decent work in new sectors and building a more fair and resilient economy. We propose one strategy by which the state can raise significant dedicated funds for a just transition from the oil industry itself, which should share the responsibility for transition of its workforce.

If the world is to succeed in achieving the Paris goals, it is clear that a managed phase-out of the entire fossil fuel sector must occur, beginning now. Policies that limit and reduce fossil fuel supply must be implemented alongside policies that tackle demand and consumption. In recognizing the need for such a comprehensive approach, countries such as France,[21] Ireland,[22] Costa Rica,[23] Belize,[24] and New Zealand[25] have already begun, or are working to implement, fossil fuel production phase-outs.

As California prepares to host leaders from around the world, the state has a transformative opportunity to help redefine what climate leadership means – by becoming the first major fossil fuel producer to commit to phase out its oil extraction.

II. THE GLOBAL CARBON BUDGET: THE PARIS GOALS REQUIRE A MANAGED DECLINE OF FOSSIL FUEL PRODUCTION

The Paris Agreement, now officially in force and ratified by more than 170 nations, sets a global temperature goal of staying well below 2 degrees Celsius above pre-industrial levels while striving to limit the increase to 1.5 degrees Celsius.[26] California is a founding member of global and U.S. alliances of subnational jurisdictions that have committed themselves to meeting the goals of the agreement.[27]

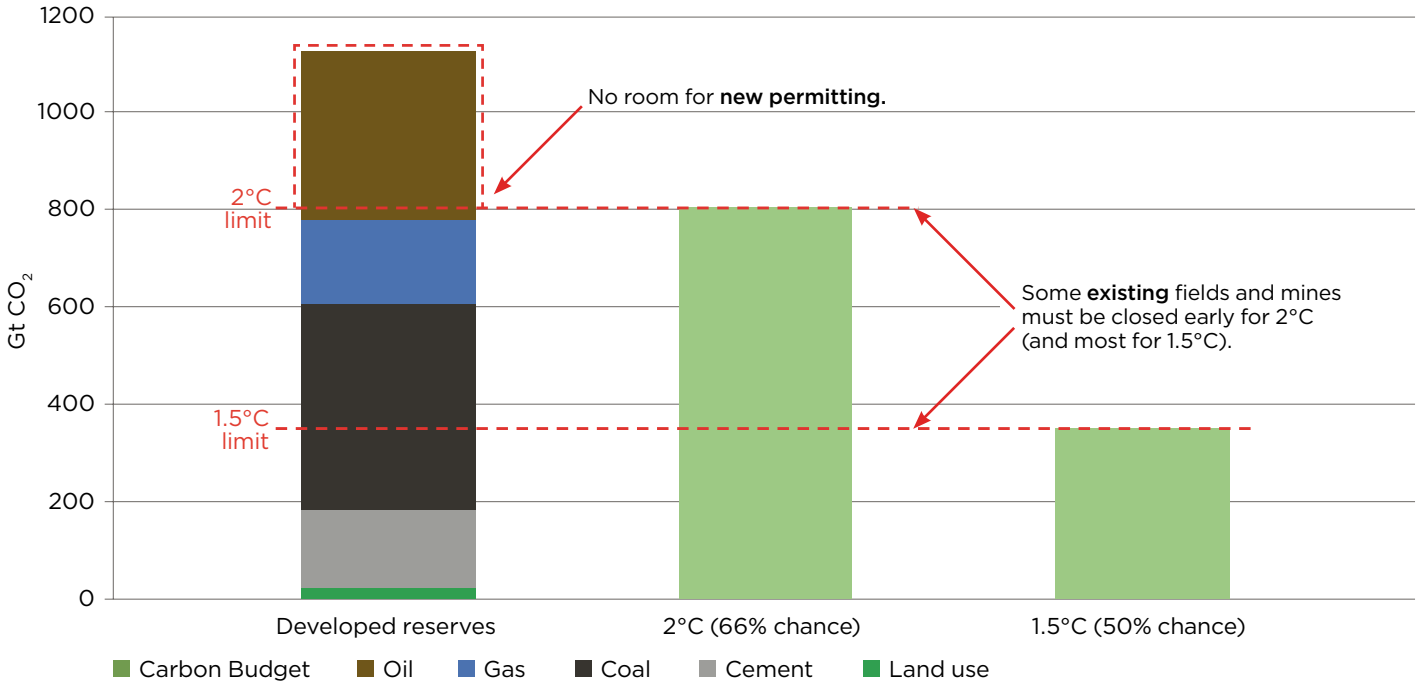
ENOUGH ALREADY

Basic climate science shows that – all else equal – total *cumulative* carbon dioxide emissions (CO_2) over time determine how much global warming will occur. There is a set level of total cumulative emissions that can occur for a given temperature limit. This is our 'carbon budget.'[e]

In our September 2016 report, *The Sky's Limit: Why the Paris Climate Goals Require a Managed Decline of Fossil Fuel Production*,[28] we analyzed what a Paris-aligned carbon budget would mean for fossil fuel production globally (Figure 1).

The results show that the carbon embedded in already-developed oil and gas fields and coal mines – those currently operating or under-construction around the world – would fully exhaust and exceed the carbon budgets the world must stay within to achieve the Paris Agreement goals.

Figure 1: Carbon Dioxide Emissions from Developed Fossil Fuel Reserves, Compared to Carbon Budgets for Likely Chance of 2°C and Medium Chance of 1.5°C[f]

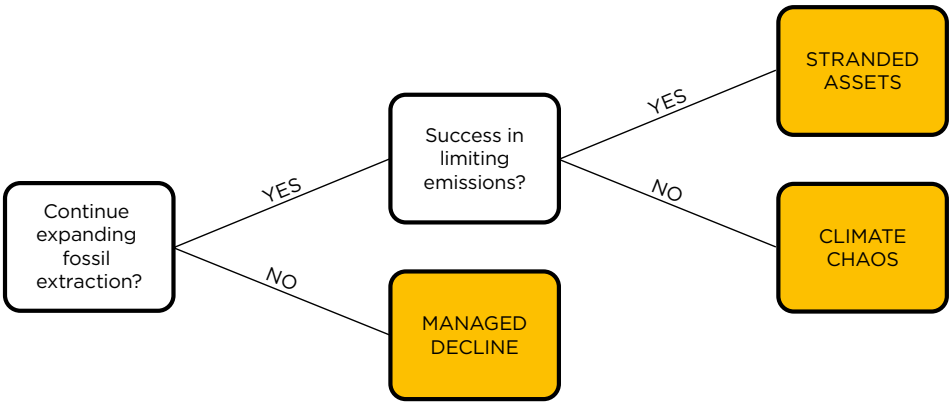


Sources: Rystad Energy, IEA, World Energy Council, IPCC[29]

e The effect of short-lived greenhouse gases such as methane is factored into the calculation of carbon budgets. The IPCC carbon budgets used in this analysis are calculated based on assumptions about the future emissions of other greenhouse gases.

f We used the carbon budgets, calculated by the Intergovernmental Panel on Climate Change, that would give a likely (66 percent) chance of limiting temperature increases below 2 degrees Celsius and a medium (50 percent) chance of limiting temperature increases to below 1.5 degrees Celsius – equivalent to the range of the Paris goals. The carbon budgets used reflect remaining room for emissions at the start of 2017. We compared these budgets to the cumulative CO_2 that will be released over time from all coal, gas, and oil projects currently operating or under-construction around the world. We include projections of land use and cement emissions for context because they are the primary non-energy sources of carbon dioxide emissions. Cement emissions are the most difficult to reduce given current technological options.

Figure 2: Logic Tree of Fossil Fuel Supply vs. Emissions Restrictions



Source: Oil Change International

Logically, these findings tell us there are three possible futures when it comes to our current climate crisis:

1. **Managed Decline:** We succeed in restricting new fossil fuel supply projects and carefully managing the decline of the fossil industry over time, while planning for a just transition for workers and communities. This path gives us a likely chance of achieving the goals of the Paris Agreement and avoiding the worst impacts of climate change.
2. **Unmanaged Decline:** We allow further fossil fuel development to continue, but eventually manage to limit emissions within carbon budgets. Meeting the Paris goals would become much harder and would lead to a sudden and dramatic shutdown of fossil fuel production, stranding assets, damaging economies, and harming workers and communities reliant on the energy sector.
3. **Climate Catastrophe:** We fail to restrict emissions. New long-lived fossil fuel infrastructure locks us into a high-carbon future that puts the Paris targets out of reach. Climate change reaches dangerous levels, causing compounding, irreparable harm for people and ecosystems around the world.

Clearly, the first option is the safest and most efficient path. By stopping new fossil fuel developments and beginning a carefully managed decline of the fossil fuel industry towards an economy powered by clean energy, we can achieve the brightest future.

GREATER AMBITION IS NEEDED NOW

Even though the Paris Agreement commits the world to keeping global warming "well below" 2 degrees Celsius – and an expert review leading up to the agreement described 2 degrees Celsius as "a defense line that needs to be stringently defended"[30] – governments are dangerously off track from meeting this imperative.

The existing pledges put forward by signatories of the Paris Agreement are inadequate to meet those goals: They would put the world on course for warming in the range of 2.6 to 4 degrees Celsius.[31]

Scientists have modeled ranges of possible emission pathways that would lead to achieving the Paris goals. Those show that to have a likely (2 in 3) chance of keeping warming below 2 degrees Celsius, global emissions must be halved within roughly the next 20 years. To limit warming to 1.5 degrees Celsius, emissions must be halved in about 15 years and reach zero by 2050.[32] These estimates also rely on unproven negative emissions technology – if it does not work out, those cuts will need to be achieved earlier.

CLIMATE LEADERSHIP REQUIRES LIMITING FOSSIL FUEL SUPPLY

Given greater ambition is urgently needed to stay within the Paris targets, a logical response from governments would be to utilize all the tools available to them to accelerate action. In other policy arenas, measures to limit the supply of a harmful substance – like cigarettes or asbestos – have been widely accepted and utilized as components of comprehensive policy plans to limit damaging effects.

However, governments around the world and in the United States have only just begun to consider limiting fossil fuel supply as part of their policy toolkit to tackle climate change. In practice, this means that most climate policy measures have primarily addressed emissions where they come out of the chimney or tailpipe, seeking to reduce demand for fossil fuels and increase the supply of clean alternatives while leaving the supply of fossil fuels to the market.[33]

This limited approach is contributing to the dangerous gap in global ambition on climate. **Fossil fuel extraction leads to higher emissions through lower prices, the 'lock-in' of long-lived infrastructure, and perverse political and legal incentives**:

- **Infrastructure Lock-In:** Given the long-lived nature of fossil fuel projects, approvals and investments made now risk *locking in* years or decades worth of fossil fuel production and emissions we cannot afford. Once significant investments have been made, companies have an incentive to continue production as long as the current market price covers their marginal costs.[34]
- **Legal Lock-In:** In addition to the economic incentive companies have to continue operation of a project once it is built, governments must often overcome higher legal hurdles to close down a project once it is operating. Such action may also get tied up in lawsuits as fossil fuel companies seek to protect their investments.[35] It is typically easier to prevent construction of a new project than it is to shut down an existing project.

- **Undermining Demand-Side Policies through Price Effects:** In a global market, the price signals sent by reducing supply or demand in one place will cause some respective increase in production or consumption elsewhere, an economic phenomenon called 'leakage.' This happens to a degree on both sides of the supply and demand equation. In neither case is leakage 100 percent. For every barrel of oil *not* produced, and every barrel of oil *not* consumed, there are global emissions reductions.[36] Pulling at demand and supply levers simultaneously reduces the leakage effect on both ends. A recent study by the Stockholm Environment Institute concluded that global oil consumption would drop by 0.2 to 0.6 barrels for each barrel not produced in California.[37]
- **Strengthening Lobbies against Further Climate Action:** The fossil fuel industry continues to wield significant influence over politics around the world and in California (see Box 1). This often has the effect of reducing the ambition of demand-side policies and undercutting industry regulation.[38] In order to successfully address the global climate crisis, politicians must begin saying "no" to the fossil fuel sector.

Climate leadership requires managing the decline of the fossil fuel industry. Any action that enables the expansion of fossil fuel production and infrastructure undercuts efforts to limit emissions. **At this moment, a comprehensive approach to climate action is urgently needed:** This must include complementary policies to restrict the supply of and demand for fossil fuels, combined with policies to rapidly incentivize the proliferation of clean energy alternatives.

WHY CALIFORNIA SHOULD BE A FIRST-MOVER IN PHASING OUT EXTRACTION

Our *Sky's Limit* report shows that to achieve the goals enshrined in the Paris Agreement, no new fossil fuel development can be allowed and a significant portion of existing projects must be retired before their reserves are depleted. This raises important questions about which countries and regions should act first and fastest, and what obligations exist for supporting regions with fewer resources to manage the transition.

In a forthcoming paper on supply-side equity from Oil Change International and the Stockholm Environment Institute, the authors enumerate five key ethical principles by which we might aim to manage these concerns fairly and enable an equitable and just phase-out of fossil fuel extraction.[39]

Kern River oil field in Kern County, California. Antandrus at English Wikipedia (CC BY-SA 3.0)

Briefly, these five principles are:

- **Curb Extraction at a Pace Consistent with Climate Protection:** The overall global pace of the managed decline must be consistent with a precautionary interpretation of the Paris objectives of keeping warming well below 2 degrees Celsius, and aiming to keep warming below 1.5 degrees Celsius; this implies sharply curbing future extraction and developing no new oil and gas fields or coal mines.
- **Ensure a Just Transition:** This decline must afford fossil fuel-dependent workers and their communities a viable, positive future.
- **Respect Human Rights and Safeguard Local Environment:** Prioritize for closure any extraction activities that violate human rights, especially of poor, marginalized, ethnic minority, and indigenous communities, and local environmental protections.
- **Transition Fastest Where It Is Least Disruptive:** Phase out extraction fastest in the countries where it is least socially and economically disruptive, particularly in wealthier, less extraction-dependent countries, including the early closure of oil and gas fields and coal mines.
- **Share Transition Costs Fairly:** Ensure that poorer countries whose economies depend on extraction receive support for an effective and just transition.

Applying this equity lens, California rises to the top as a region that should move first and fastest in sharply curbing future extraction.

If California were a country, it would rank as one of the wealthiest, most historically prolific oil producers. Compared to other countries and U.S. states, California ranks 15th in terms of cumulative barrels of oil extracted since 1900.[40] Of those 15 jurisdictions, California has the second-highest gross domestic product (GDP) per capita, trailing only Norway and just ahead of Texas and Canada.[41]

At the same time, California's economy as a whole is diverse and no longer extraction-dependent. As of the third quarter of 2017, mining, including oil and gas extraction, accounted for just under 0.3 percent of California's GDP.[42]

California is one of the oil producers with the greatest capacity to reduce its extraction quickly while minimizing social and economic disruption.

As we discuss further in Section IV, extraction in California is currently violating people's rights, with the health burden falling disproportionately on already disadvantaged communities. Oil wells operating within blocks of neighborhoods or schools should never have been permitted in the first place – and should be prioritized for closure now.

The Murphy oil site in West Adams, Los Angeles, sits as close as 200 feet from homes and playgrounds. Sarah Craig/Faces of Fracking (CC BY-NC-ND 2.0)

III. IN CALIFORNIA, NO EXPANSION = NO NEW WELLS

As we saw in Section II, staying within safe climate limits requires a managed decline of fossil fuel production globally. Any expansion of the industry digs the world into a deeper hole, risking either climate chaos or a far more sudden and disruptive transition down the road. In California, the state is enabling new production through the issuance of permits to drill hundreds to thousands of additional oil and gas wells every year.

Under the Brown administration, the California Division of Oil, Gas, and Geothermal Resources (DOGGR) has issued more than 20,000 new well permits to oil companies, including for both production and injection wells, and companies have drilled close to 14,000 new wells. Permit approvals hit a three-decade high in 2015, as oil company applications increased in response to the spike in oil prices from 2010 to 2014.[43]

While communities on the front lines of the pollution fueled by oil production have long called for more aggressive action to curb extraction, California policymakers have only recently begun to consider supply-side measures as part of their policy toolkit. In approving the state's updated climate plan in December 2017, the California Air Resources Board (ARB) resolved "to evaluate and explore opportunities to achieve significant cuts in greenhouse gas emissions from all sources, **including supply-side opportunities to reduce production of energy sources, that contribute to climate change, air pollution, and other environmental and health hazards**" (emphasis added).[44]

One of the simplest steps the state of California could take is to stop issuing permits to drill new oil and gas production wells.

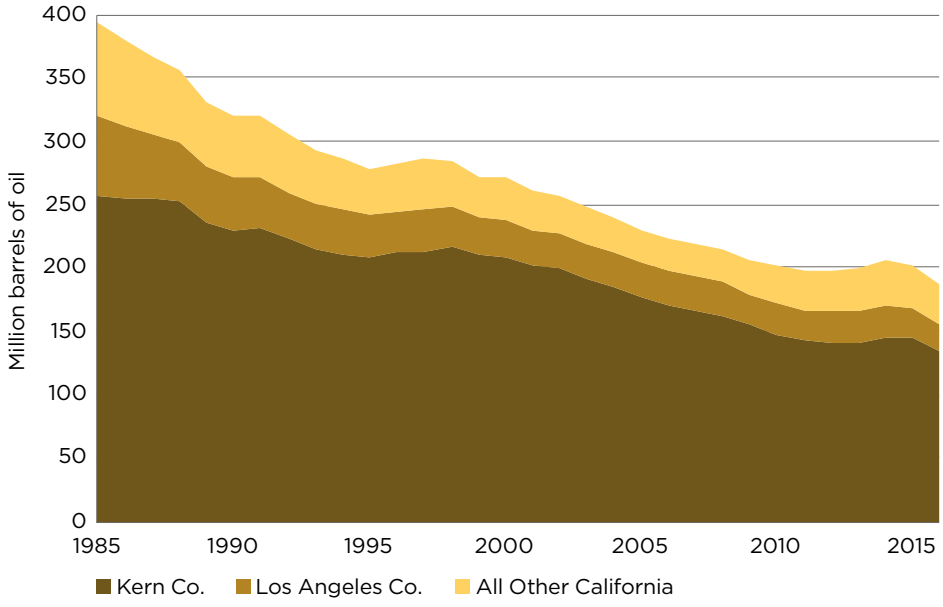
OVERVIEW OF CALIFORNIA OIL PRODUCTION

The oil industry has been drilling new wells in California for over a century. (While California also produces fossil gas,[g] most of it is extracted as a byproduct of oil production.) Since 1900, only Texas has extracted more oil than California among U.S. states.[45] The majority of production – consistently more than 70 percent – is centered in Kern County in the San Joaquin Valley, followed by Los Angeles County (see Figure 3). While California has been the third-most prolific oil-producing state for several decades, its overall production peaked in 1985 and the state has recently fallen to fourth.[h]

Oil production in California comes with steep environmental costs, which are being exacerbated by the increasing depletion of the state's oil fields. The majority of oil produced in California is heavy oil, which requires a large amount of energy to extract and process.[47] Much of the state's production now depends on energy- and water-intensive "enhanced oil recovery" (EOR) techniques, including waterflooding, steamflooding, and cyclic-steam injection, to loosen and push oil toward extraction wells. Hydraulic fracturing, or fracking, and acidizing is also used to 'stimulate,' or enable production from a significant proportion of wells.

Carbon emissions from the oil extraction process remained steady in California from 2000 to 2015, even as overall oil production fell by 30 percent over that same period,[48] meaning the carbon intensity of production has increased. As discussed in Section IV, the toxic air emissions and other pollution caused by oil wells operating in neighborhoods is a significant threat to

Figure 3: California Oil Production, 1985-2016



Source: DOGGR[46]

g We use the term fossil gas to mean natural gas produced from fossil fuel sources.
h In 2017, California was the fourth-largest producer of crude oil among U.S. states. In terms of total liquids, including crude, condensate, and natural gas liquids, California fell to seventh place in 2017, based on data from Rystad Energy UCube, May 2018.

Oil wells with an active flare in the middle of potato fields in Kern County. © Brooke Anderson

public health. Meanwhile, water use in oil production has consistently increased since 2000: more water has been required to produce declining amounts of oil,[49] and the resulting wastewater poses a major disposal challenge and contamination threat to groundwater, soil, and aquifers.[50]

THE CLIMATE IMPACT OF NO NEW WELLS

To estimate the climate harm of business-as-usual permitting of new oil production wells in California, we created a production model to project future production with and without new permits, based on historical well data in the state.

Methodology

In modeling future production, we utilized historical well data from DrillingInfo, an industry database that contains information on all oil and gas wells drilled in the state of California. We analyzed trends in drilling rate, well productivity, and decline rates for 17 categories of wells, and extrapolated these, taking into account alternative oil price scenarios. The categories were chosen based on the highest-producing fields and counties and to account for differences in well type. The model projected production with and without new oil wells from 2019 through 2030. We did not model fossil gas production given its limited significance in the state.

We provide a mid-case projection based on historical trends across a range of oil prices, as well as high- and low-oil price projections. A detailed technical explanation of the methodology is provided in Appendix I.

Results

If new production wells continue to be drilled, our mid-case scenario projects that they would enable extraction of about 560 million additional barrels of oil from 2019 through 2030. As Figure 4 illustrates, the bulk of new drilling would continue to center in Kern County. In the mid-case scenario:

- More than three-quarters of the production enabled by new wells from 2019 through 2030 is likely to come from Kern County, with continued drilling in major legacy fields;
- Less than 5 percent of the new production enabled would be in Los Angeles County, where community resistance and the density of urban land use is likely to constrain significant expansion;
- Counties with smaller but still significant existing volumes of production, such as Monterey,[i] Fresno, Orange, Santa Barbara, San Luis Obispo, and Ventura Counties could together see more than 15 percent of the production enabled by new wells from 2019 through 2030.

Emissions Impact

The 560 million barrels of additional oil extracted via new wells would produce just over 360 million metric tons of carbon dioxide equivalent (CO_2e) pollution from 2019 through 2030. Newly drilled wells would increase the cumulative carbon pollution associated with California oil production by more than 55 percent compared to projected emissions of oil from existing wells through 2030 (see Figure 5).

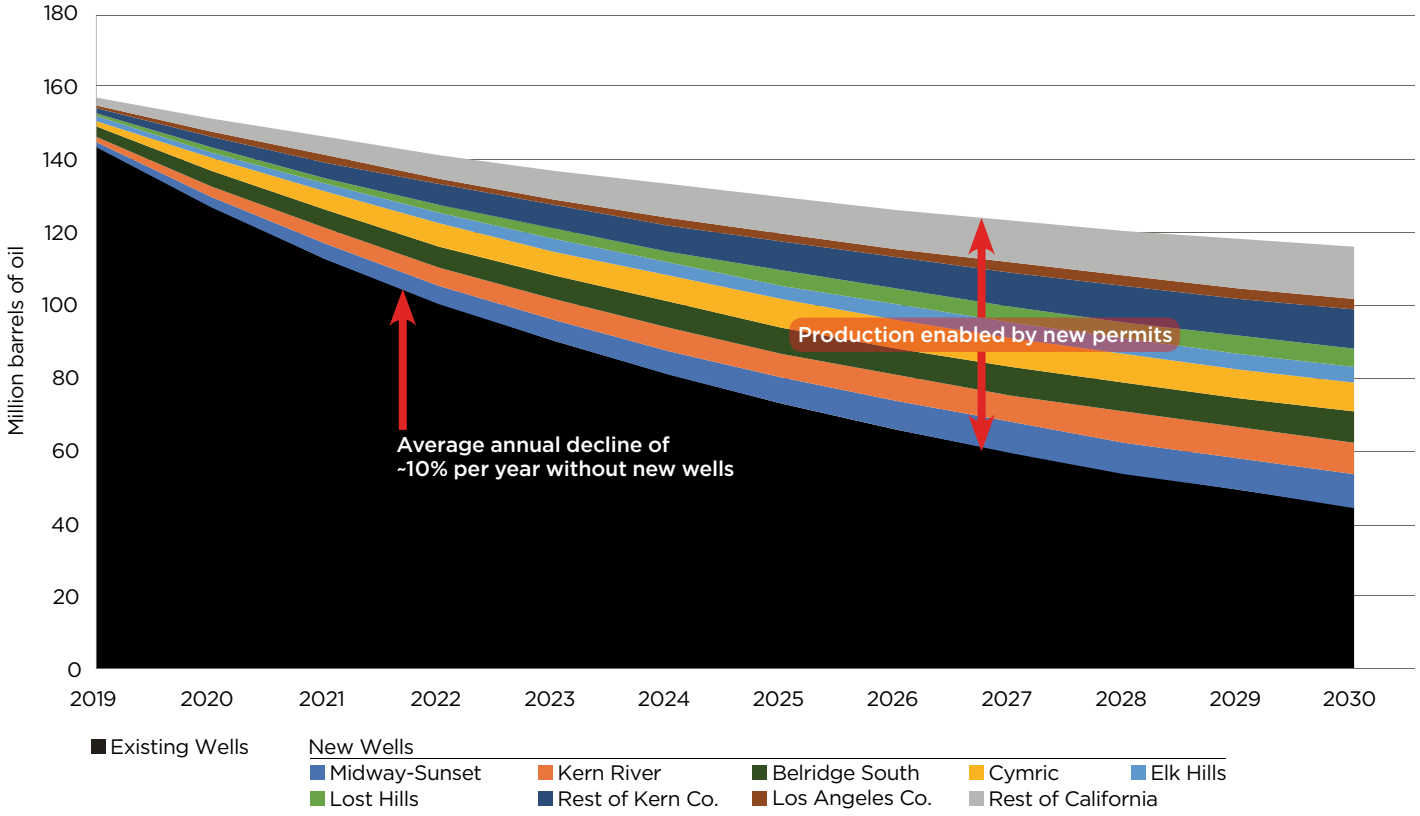
Range of Projections

The number of new production wells oil companies drill is sensitive to oil price. Our mid-case analysis is based on historical trends in well counts across high- and low-price years, and projects a trend into the future that follows the middle of the historical range and trajectory. To reflect sensitivity to price, we also projected high- and low-oil price scenarios. The high-case projection is based on historical trends in well counts across higher-oil price years such as 2005 to 2008 and 2010 to 2014. The low-case projection is based on historical trends in well counts across lower-oil price years, such as 2000 to 2005, 2009, and 2015 to 2017.

Figure 6 illustrates that new wells drilled over the next 12 years could enable significant levels of additional production in all cases, ranging from approximately 330 million barrels in the low-case scenario to 780 million barrels in the high-case scenario. The corresponding carbon emissions associated with the low- and high-case scenarios range from 210 million metric tons CO_2e to 500 million metric tons CO_2e (see Table 1).

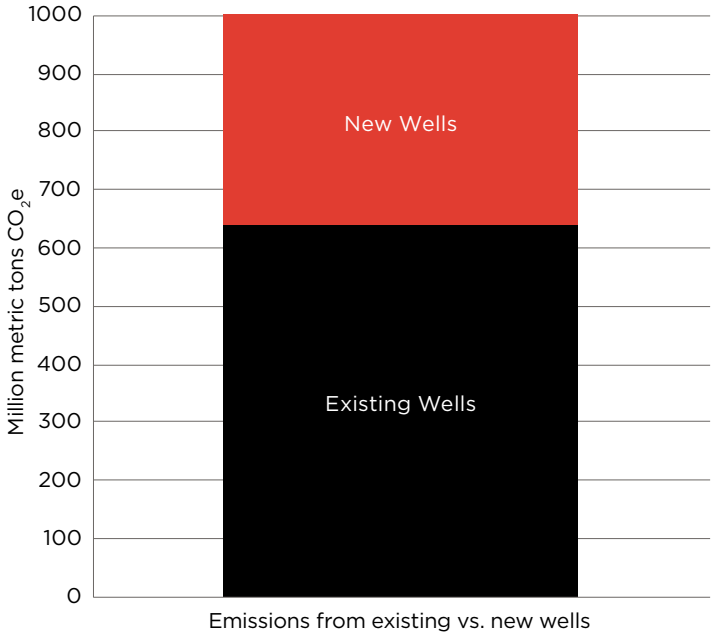
i In Monterey County, local voters passed a ballot measure, Measure Z, in 2016 approving a ban on fracking as well as on the drilling of new oil and gas production wells and wastewater injection. Despite the support of 56 percent of voters, oil companies sued and the trial court upheld only the ban on fracking. If the grassroots group Protect Monterey County is successful in its appeal, however, and the ban on drilling new wells is upheld, that measure could prevent more than 35 million barrels of additional oil extraction through 2030.

Figure 4: California Oil Production with and without New Well Permits, 2019-2030



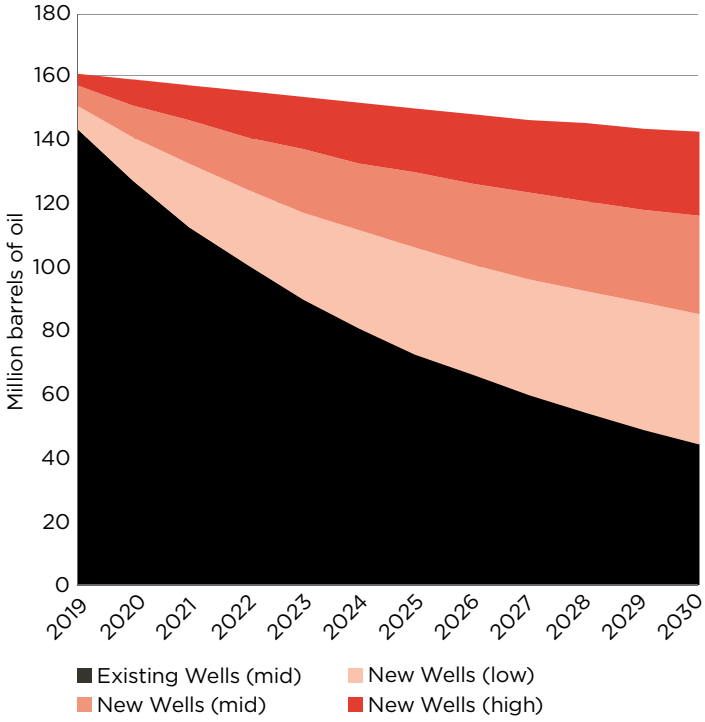
Source: Oil Change International analysis, using historical data from DOGGR and DrillingInfo[51]

Figure 5: Cumulative Carbon Emissions Enabled from Existing vs. New Oil Wells in California, 2019-2030 (Mid Case)



Sources: Oil Change International analysis using historical data from DOGGR and DrillingInfo, Carnegie Oil-Climate Index[52]

Figure 6: California Oil Production, 2019-2030, without New Well Permits and with New Permits in a Range of Price Scenarios



Source: Oil Change International analysis,[53] using historical data from DOGGR and DrillingInfo

Table 1: Projected Oil Production and Associated Emissions Enabled by New Oil Wells, 2019-2030

Scenario	Projected cumulative oil production (Million barrels)	Total emissions (Million metric tons CO_2e)
Low case	326	214
Mid case	563	364
High case	782	504

Source: Oil Change International analysis, Carnegie Oil-Climate Index

Toward a Paris-Aligned Phase-Out

As illustrated in Figure 4, ceasing permits for new oil wells would lead to a steady decline in oil production of about 10 percent per year on average from 2019 to 2030. Ongoing permitting slows the decline considerably, to 3 percent per year on average in the mid-case scenario.[j]

To put these rates in a climate context, it's instructive to consider the rate of decline in U.S. carbon emissions that would align with global success in meeting the Paris goals. Analysis by Climate Action Tracker suggests that total U.S. emissions should drop to an upper limit of around 1,600 million metric tons CO_2e by 2030 to be within range of keeping global temperature rise to 1.5 degrees Celsius.[54] That estimate, based on an assessment of the United States' fair share of global emissions reductions, would require cutting emissions by 75 percent below 2015 levels by 2030[55] – or by about 9 percent per year.

California would help model and drive this increased ambition by cutting its own oil production by 10 percent per year. As is discussed further in Section V, such action would maximize the effectiveness of California's existing demand-side goals to reduce oil use and increase efficiency and should occur as part of a managed drawdown of the state's oil sector as a whole. California's existing climate plan aims to cut carbon emissions by roughly 40 percent below 2015 levels by 2030[56] – a lower level of ambition than the above analysis suggests is needed if the world is to achieve the Paris Agreement.

Box 1: California Policymakers Must Separate Oil and State

Much like its federal counterpart, California's capital of Sacramento is the scene of intense lobbying and advocacy. Major power players work to exert influence on policymakers deciding the fate of policy for a state whose economy, if it were a country, would rank as sixth-largest in the world. And much like Washington, Sacramento is awash in money from the oil and gas industry.

Oil companies and industry associations regularly rank as top spenders on lobbying and political campaigns across the state. In 2017, while the California legislature negotiated the extension of the state's cap-and-trade system, Chevron and the Western States Petroleum Association (WSPA) ranked first and second in lobbying expenditures.[57] In part because of the massive lobbying effort by the oil industry, the final legislation was fundamentally weakened, causing many environmental and environmental justice groups to oppose the final bill.

According to analysis by Maplight, WSPA and its members have contributed some $170 million to California political campaigns since 2001, including $89 million by Chevron and another $40 million by Aera, a natural gas and oil exploration and production company jointly owned by ExxonMobil and Shell.[58]

In 2015, as the state legislature considered legislation that would mandate a 50 percent cut in oil demand by 2030, the oil industry pumped in record spending to kill the provision. Over a three-month span alone, oil industry actors spent over $11 million in lobbying activities and advertisements.[59] Despite support from the Governor and a Democratic supermajority in the legislature, the oil demand reduction provision was ultimately stripped from the legislation.

The influence of the industry in California is clear. The ambition of the state's climate action is being undercut as the oil and gas industry pours millions into lobbying to weaken laws, avoid new regulations, and keep a firm grip on policymaking in the state.

j In the low-case scenario, the average decline is projected to be 5 percent annually with new permits. In the high-case scenario, the average annual decline would slow to over 1 percent per year from 2019 to 2030.

IV. PRIORITIZING EQUITY IN THE PHASE-OUT OF EXISTING OIL PRODUCTION: HEALTH BUFFER ZONE

As shown in Section II, stopping the expansion of fossil fuel production is a necessary first step toward staying within safe climate limits. But policy cannot stop there. Some currently operating oil, gas, and coal projects must be closed before their resources are fully extracted for the world to stay below 2 degrees Celsius of temperature rise – and many must be closed early to stay within 1.5 degrees Celsius. California has a responsibility to lead the way, not only as a wealthy oil producer with the resources to do so, but also to protect the health and wellbeing of Californian communities that are being unjustly harmed by ongoing extraction.

Enacting a statewide buffer zone around homes, schools, and hospitals – in which existing oil and gas wells would be phased out and no new wells could be permitted – would initiate a proactive managed decline of existing California oil production in a way that prioritizes the health of historically overburdened communities.

Homes sit right next to the Jefferson oil site in Los Angeles.
Sarah Craig/Faces of Fracking (CC BY-NC-ND 2.0)

EXTRACTION AS ENVIRONMENTAL INJUSTICE

According to research conducted by NRDC and the FracTracker Alliance, approximately 5.4 million people in California, or 14 percent of the state's population, live within a mile of one or more oil and gas wells. One-third of these residents live in areas of the state with the highest concentrations of environmental pollution, and nearly 92 percent of Californians living in these heavily burdened neighborhoods are people of color.[60] In 2016, the city of Los Angeles settled a lawsuit over its track record of allowing wells to be drilled closer to homes with fewer safeguards and to operate for longer hours in low-income, primarily African American and Latino neighborhoods, compared to wells in wealthier, whiter areas.[61] In Kern County, 64 percent of people living in heavily polluted areas and within a mile of oil and gas wells are Latino.[62]

Studies have linked proximity to oil and gas wells to a host of health risks, including increased risk of asthma and other respiratory illnesses, premature births and high-risk pregnancies, and cancer.[63] Oil and gas extraction produces air pollutants, including volatile organic compounds like benzene and formaldehyde, particulate matter, and hydrogen sulfide.[64] Other risks include noise pollution, spills of toxic chemicals, roadway accidents, and explosions.

"I don't think it's fair that our communities are suffering through this just because of our income and our ethnicity. We deserve to have healthy communities too." – Giselle Cabrera, Wilmington resident[65]

"The concentration of toxic emissions is highest at the source of pollution, thus increasing the health risks for residents living in closest proximity to oil drilling." – Letter from over 250 health professionals to the Los Angeles City Council[66]

Even though some Californians live less than 100 feet from an active oil well – in South Los Angeles, for instance[67] – the state of California has never conducted

a comprehensive, long-term study of the health impacts of siting oil and gas wells so close to homes, schools, and hospitals.[68] For years, Los Angeles residents have complained of nosebleeds, nausea, respiratory illness, chronic migraines, and dizziness – conditions that they believe are linked to oil wells in their neighborhoods.[69] In Kern County, Bakersfield has some of the worst concentrations of air pollution in the country[70] as toxics and other pollutants from both agriculture and oil operations get trapped by the region's geography and climate.[71]

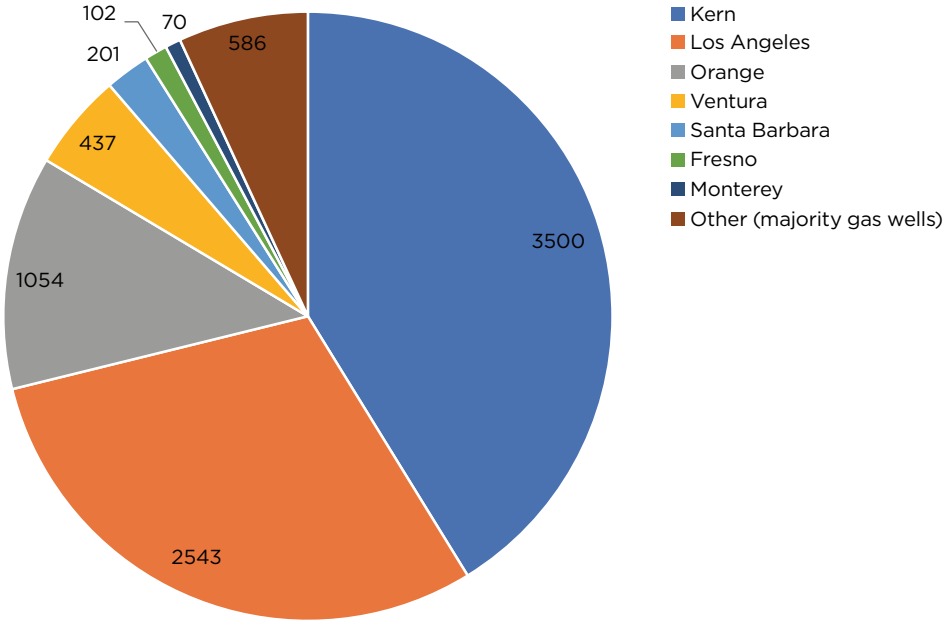
In releasing a recent report on public health and safety risks of oil and gas wells within Los Angeles, the director of the County's Bureau of Toxicology and Environmental Assessment conceded, "There may be situations in and around Los Angeles where we have operations that simply are too close to people where no mitigation measures are going to be protective of that community."[72]

TARGETING WELLS WITH THE HIGHEST HEALTH RISKS

This analysis examined what the production impact would be if state regulators enacted a 2,500-foot buffer zone statewide, phasing out the operation and permitting of oil and gas wells within that distance of homes, schools, and hospitals. This distance reduces harm and begins to answer the call of environmental justice groups.

Currently, California has no statewide policy to limit the proximity of oil wells to residential areas, putting California in a minority among oil- and gas-producing states.[73] Some jurisdictions have enacted their own setback policies, ranging from 210 feet to 750 feet.[74] In 2015, the California Commission on Science and Technology (CCST) prepared a wide-ranging assessment of the risks of hydraulic fracking in California, finding that the health impacts were in large part due to oil and gas production generally and not limited to fracking activities alone. Based on studies from outside of California, the report found that, **"[F]rom a public health perspective, the most significant exposures to toxic air contaminants … occur within one-half mile (800 meters [or 2,640 feet]) from active oil and gas development."** [emphasis added][75]

Figure 7: Number of Active Production Wells within 2,500' of Homes, Schools, or Hospitals by County



Sources: FracTracker Alliance and Oil Change International analysis, DOGGR[79]

In Los Angeles, community groups led by the environmental justice coalition Stand Together Against Neighborhood Drilling Los Angeles (STAND-L.A.) are calling on the city government to pass a 2,500-foot buffer zone law for new and existing wells.[76] That distance aligns with the finding of the CCST report. A recent review of scientific literature suggests that health exposure risks are greatest within 2,500 feet, though risks extend beyond that distance.[77,78]

2,500-FOOT BUFFER ZONE: A NECESSARY AND PREDICTABLE PATH TO MANAGE DECLINE

We commissioned Kyle Ferrar, an expert in geospatial and demographic analysis of Californian oil production at the FracTracker Alliance, to assess how a statewide 2,500-foot buffer zone would affect production, using well data from DOGGR and a combination of county and city zoning data, county parcel data, and building footprint data (see Appendix II for full methodology).

This analysis shows that a 2,500-foot buffer zone statewide would take 8,493 active or newly permitted oil and gas wells out of production. Together, these wells produced 22.8 million barrels of oil in 2016, or approximately 12 percent of total California oil production that year.[k] From 2010 to 2016, wells within the buffer zone produced 10 percent of annual statewide production on average.

As shown in Figures 7 and 8, the most wells would be taken offline in Kern County, but the most significant impact by percentage of county production levels would be in Los Angeles and Orange Counties, where a higher proportion of existing production is based in densely populated areas:

- In Los Angeles County, wells that would be taken offline by a buffer zone accounted for nearly 80 percent of all onshore oil production in 2016, or 9.6 million barrels, and nearly 50 percent of total onshore and offshore production.
- In Orange County, wells that would be affected by the buffer accounted for almost 98 percent of the county's 2016 onshore production, or 2.2 million barrels, and two-thirds of total production.
- In Kern County, wells that would be affected by the buffer accounted for close to 5 percent of 2016 production, or 6.1 million barrels.

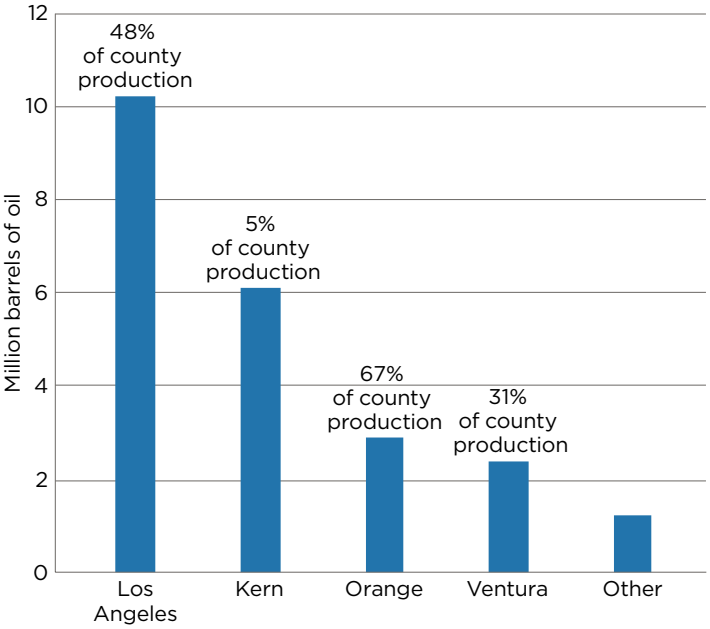
k 2016 is the last year for which DOGGR had published official statewide production statistics at the time of this analysis.

A 2,500-foot buffer zone would significantly limit onshore production from oil fields that have long plagued residents with pollution. In Los Angeles County, over 90 percent of production would be taken offline at the Inglewood, Long Beach, and Beverly Hills fields, as well as at smaller fields situated in densely populated sections of South Los Angeles. Onshore oil wells in the Wilmington field, where parts of the surrounding neighborhood are among the top 5 percent of communities with the highest pollution exposure in the state,[81] would also be significantly curtailed. In Orange County, the Huntington Beach and Brea-Olinda fields would see the most significant cutbacks.

Related analysis has shown that more than 850,000 Californians currently live within 2,500 feet of an active oil or gas well, including over half a million residents in Los Angeles County alone.[82]

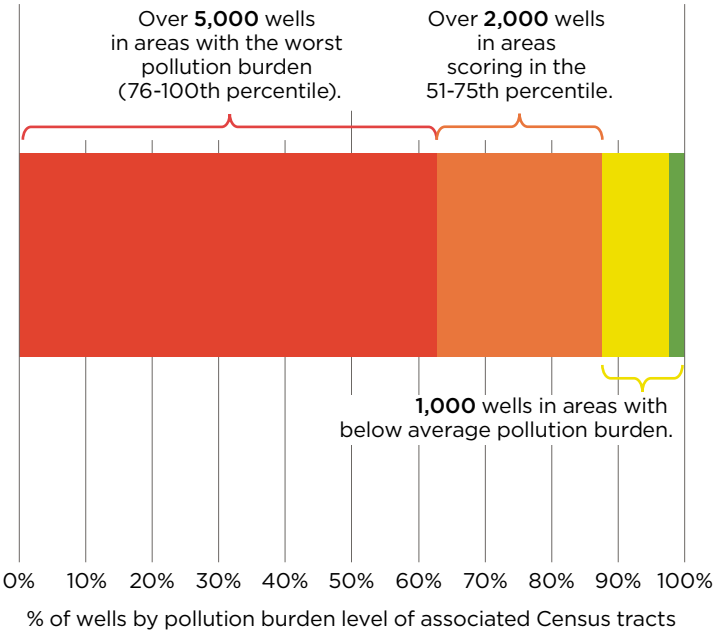
The affected communities are disproportionately among the most severely polluted in California. Overlaying the location of oil and gas wells within the 2,500-foot buffer zone with CalEnviroScreen 3.0, a state tool that tracks California communities most affected by multiple sources of pollution, shows that 63 percent of the wells are located in Census tracts that rank in the top 25th percentile for pollution burden (see Figure 9). This is the case for 71 percent of the wells in Los Angeles County and 70 percent of the wells in Kern County. By contrast, only 2 percent of the wells are in areas that rank in the lowest 25th percentile for pollution burden.

Figure 8: Volumes of 2016 Oil Production within 2,500' of Homes, Schools, or Hospitals by County



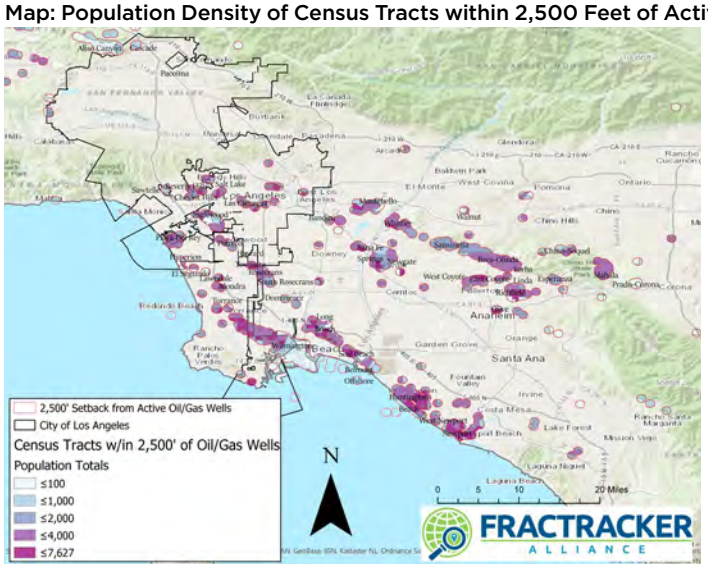
Sources: FracTracker Alliance and Oil Change International analysis, DOGGR[80]

Figure 9: Wells within 2,500' of Homes, Schools, or Hospitals by Pollution Burden Level of Their Location

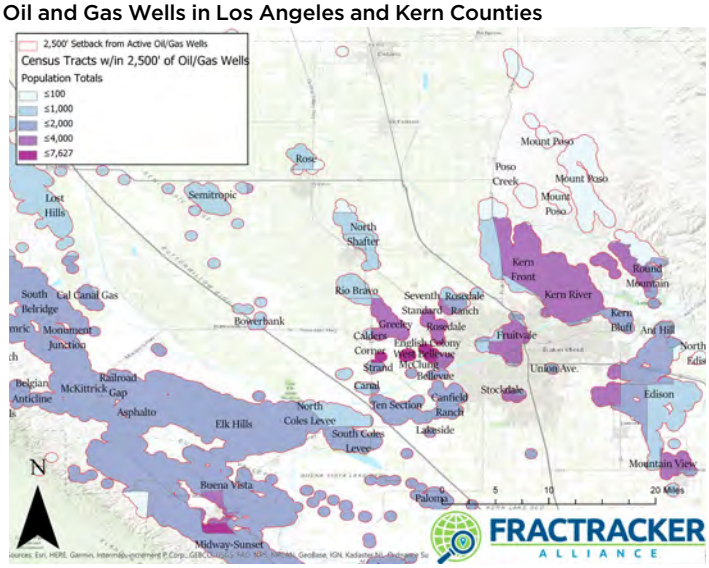


Sources: FracTracker Alliance and Oil Change International analysis, CalEnviroScreen 3.0[83]

Map: Population Density of Census Tracts within 2,500 Feet of Active Oil and Gas Wells in Los Angeles and Kern Counties



Los Angeles County



Kern County

Source: FracTracker Alliance

V. THE COMBINED IMPACT OF MANAGED DECLINE POLICIES

By ceasing to allow the drilling of new oil and gas wells and beginning a managed phase-out of existing wells, California would set an example of urgently needed global leadership among wealthy fossil fuel producers, spur significant reductions in carbon emissions, protect the health of communities unfairly harmed by current extraction, and provide a predictable pathway around which to plan an economic transition (as we discuss in greater depth in Section VI).

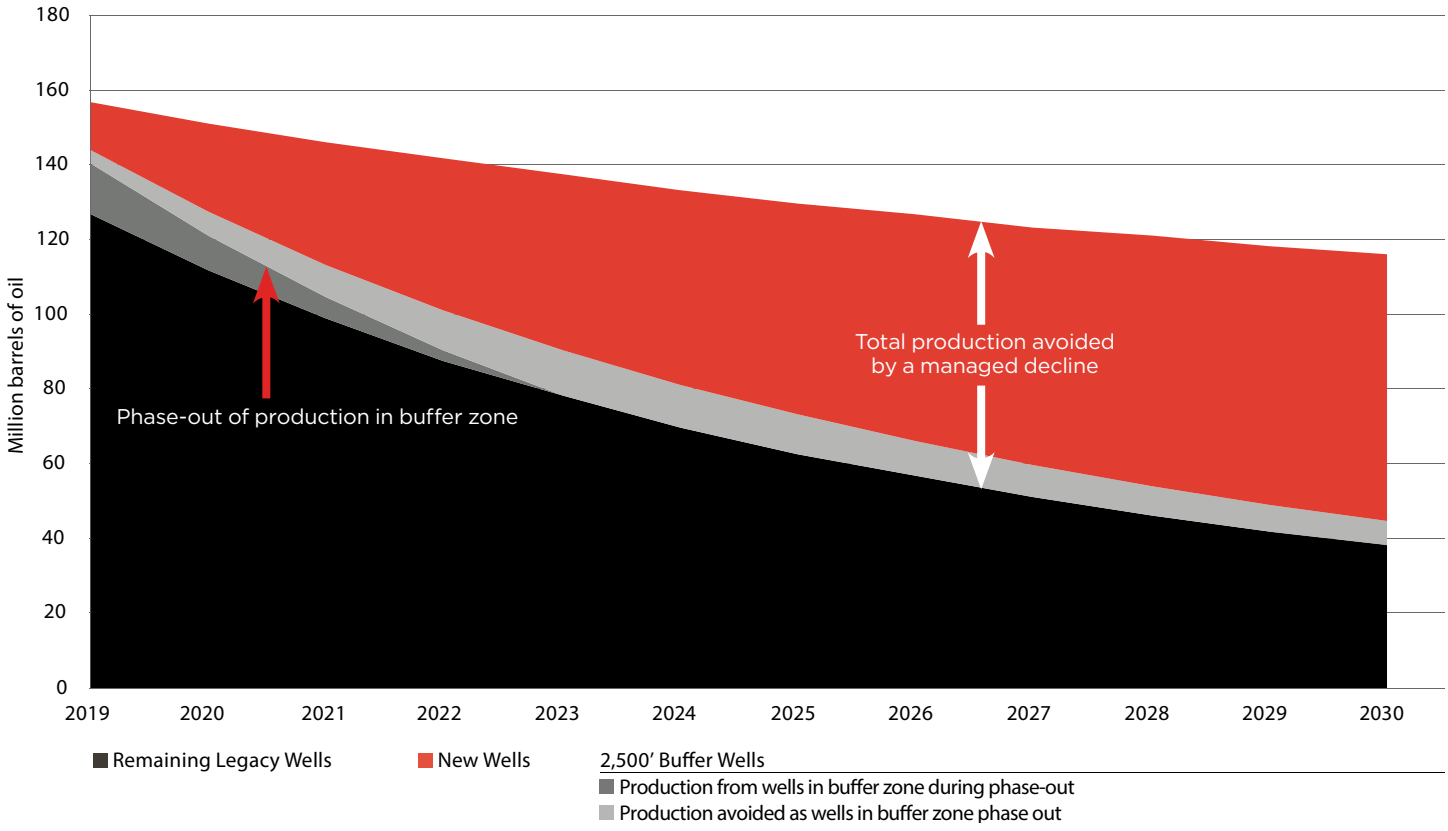
As shown in Figure 10, phasing out oil wells within the buffer zone would lead to a significant but manageable additional drop in statewide production when coupled with the ban on new well permits. Significant proportions of production would be taken offline in several dozen fields that are clustered closest to homes and thereby pose the biggest immediate threat.

To avoid further harm, wells within the buffer zone should be phased out as rapidly as possible.

Figure 10 illustrates a scenario in which production from wells within the 2,500-foot zone are phased out over the course of five years.[l]

In this scenario, the cumulative oil production avoided by a permit ban combined with a 2,500-foot buffer could total 660 million barrels from 2019 through 2030.[m] If extracted and burned, this oil would cause a total of more than 425 million metric tons of carbon pollution.

Figure 10: Projected California Oil Production with and without New Wells and a 2,500' Health Buffer Zone, 2019-2030



Sources: Oil Change International and FracTracker Alliance analysis[85]

l While the phase-out should occur as quickly as possible, this analysis provides a basic illustration of what a five-year phase-out period could look like. We do not attempt to model a phase-out based on priority health criteria. A phase-out could begin with wells that are closest to homes, are located within communities facing the most severe pollution burden, or otherwise pose the greatest risk to community health.

m This projection is based on the mid-case scenario for new wells presented in Section III.

To put these totals in context, meeting Governor Brown's goal to reduce oil use in cars and trucks by 50 percent by 2030 would save about 430 million barrels of oil over the next 12 years, compared to ARB's reference-case projections.[84] Ongoing state permitting of new wells and ongoing production from wells in the buffer zone could add a greater amount of new oil supply to the market, undermining the effectiveness of demand-side measures (as discussed further in this section).[n]

A MANDATE TO PREVENT HARM

The state has clear regulatory authority both to stop issuing permits for new wells and to institute a health and safety buffer zone.

Each new oil and gas well requires an approval from the Division of Oil, Gas, and Geothermal Resources. To inform decisions, DOGGR is required to fully analyze the harms and risks of proposed actions under the California Environmental Quality Act (CEQA). Each well approval is a discretionary action in which DOGGR must take into account the protection of health, safety, welfare, and the environment before deciding whether or not to issue a permit. While DOGGR currently approves hundreds of permits for new oil and gas wells annually without a CEQA assessment, proper consideration of the damages from these new wells would result in denial of the permit applications.

Agencies including the Air Resources Board and DOGGR also have clear authority to prohibit wells near where people live, work, and go to school to protect public health. The Air Resources Board previously promulgated a similar setback prohibiting the operation of certain diesel engines near schools.[86]

The Governor could accomplish the regulatory actions recommended in this report through the following steps:

- Direct DOGGR to comply with all environmental and health protection requirements and deny permits based on their unacceptable harms to human health and the climate;
- Order that agencies, including the Air Resources Board and DOGGR, create a plan for phasing out existing oil and gas production within 2,500 feet of homes, schools, and hospitals. Existing wells within this health and safety zone should be shut down as quickly as possible.

These actions are within executive authority and would not require new legislation.

MANAGING THE DECLINE OF OIL EXTRACTION, INFRASTRUCTURE, AND CONSUMPTION TOGETHER

While this report focuses on oil production, a managed decline should involve planning for the transition of California's entire fossil fuel sector, including oil production, refining, exports, and oil-based transportation infrastructure. When climate safety requires rapid decarbonization within a few decades, climate leadership requires bold and decisive action to reduce both supply and demand for fossil fuels.

While California uses a lot of oil – significantly more than it currently produces[o] – the state has relatively well developed existing policies to tackle oil demand and is working to increase their ambition. In 2015, Governor Brown committed to put the state on a path to reduce oil use in cars and trucks by 50 percent by 2030 as one of his key climate policy 'pillars.'[87] In January of 2018, Governor Brown increased the state's goal for zero-emission vehicles to five million on the road by 2030 – after use of zero-emission vehicles grew by 1,300 percent over the previous six years.[88]

Pairing aggressive action to reduce oil demand with a managed decline of oil production and related infrastructure – also known as cutting with 'both arms of the scissors' – will increase and reinforce the effectiveness of the state's climate protection policies. But failing to act on one end can limit the effectiveness of action on the other, given how each part of the oil market chain is linked.[89]

For example, meeting the state's goals to reduce oil consumption in transportation would cause some decrease in global oil prices, in turn encouraging greater consumption in other states or countries. However, simultaneously reducing California's production of oil would have the opposite price effect and encourage less consumption, thus reinforcing the benefits of demand-side measures.[90]

Similarly, if California succeeds in rapidly reducing its oil use and production, it will also need to refine less oil. It follows that the state should also stop permitting the expansion of new refining and other fossil fuel infrastructure, which could enable greater production in other regions by increasing fuel exports from the state's refineries, as discussed in Box 2.

By establishing complementary oil supply and demand transition measures, California can show global leadership while *reducing its own oil imports over the long-term.* If the state meets its goal of cutting oil use in vehicles by 50 percent by 2030 and enacts the policies described in this report to limit production, California can significantly reduce its imports of oil by 2030 as well.[p] In this way, aggressive action on oil use and production can couple with a reduction in imports of crude from places like the Amazon of Ecuador and Canada's tar sands where extraction is violating indigenous rights and destroying critically important forest ecosystems.

n These totals are for illustrative purposes and should not be interpreted as additive, given how demand and supply interact. The ultimate global emissions reduction impact of either policy would depend on the elasticities of supply and demand, as discussed in Erickson and Lazarus, "How limiting oil production could help California meet its climate goals" (see endnote 37).

o In 2015, oil consumption in California totaled approximately 650 million barrels. Gasoline and diesel accounted for about 70 percent of consumption. Jet fuel accounted for about 17 percent, with other forms of fuel accounting for the rest. See U.S. Energy Information Administration, "Total End-Use Energy Consumption Estimates, 1960-2015, California," State Profile and Energy Estimates.

p For example, in 2015, gasoline and diesel consumption in California was nearly 450 million barrels in total. Production was just over 200 million barrels. That's a gap of about 250 million barrels. If California achieves Governor Brown's goal of reducing oil use in cars and trucks by 50 percent below 2015 levels by 2030, gasoline and diesel consumption would drop to around 224 million barrels in 2030. If California undertakes the managed decline of oil production described in this report, production would drop to around 40 million barrels in 2030 – significantly reducing the level of imports (assuming other oil uses such as jet fuel for aviation remain flat or decline). Aggressive action on oil use and production can achieve a reduction in imports.

Box 2: Saying 'No' to the Expansion of Fossil Fuel Infrastructure

In responding to the Trump administration's push for new oil drilling off of California's coast, Lieutenant Governor Gavin Newsom and the California State Lands Commission rightly asserted that "the fossil fuel era is ending."[91] This era must end within a few decades if the world is to prevent catastrophic climate change, and it must end most rapidly in places like California. It follows that the state must stop permitting the construction of any new long-lived fossil fuel infrastructure in California, from oil refineries to coal export terminals to new piers for oil tankers.

New fossil fuel infrastructure has a lock-in effect in driving future production: It requires significant upfront investment and provides a financial incentive to continue using the associated infrastructure for decades into the future. A managed decline of oil production should coincide with planning for the transition of California's entire fossil fuel sector.

As analysis from Communities for a Better Environment warns, increased production from California's refineries is already fueling exports. Allowing California to become the "gas station of the Pacific Rim" – i.e., exporting more and more refined oil products as in-state demand decreases – would harm both the climate and the health of communities surrounding refineries, which already face an unfair burden of toxic pollution.[92] It could also enable expanded fossil fuel production in places like Canada's tar sands, the Bakken shale fields of North Dakota, or the Ecuadorian Amazon by providing these production zones with greater market access.

Communities across California, especially communities of color, have long been leading the fight to stop expansion of new fossil fuel infrastructure. Environmental justice groups in Richmond confronted Chevron for nearly a decade to challenge a major expansion of its refinery intended to process more and dirtier crude oil.[93] When a local developer proposed exporting coal through Oakland, community groups campaigned for a city ban on the handling or storage of coal.[94] Residents of Kern County recently won a court challenge against local approval of a massive refinery and rail expansion project that would have enabled the unloading of over 200 tanker train cars per day.[95] In the Bay Area, residents are fighting Phillips 66's plan to expand its refinery, which could increase the volume of tar sands oil shipped across the San Francisco Bay by up to 35 times.[96] In many cases, state and local environmental reviews of these projects have been challenged for failing to adequately account for their cumulative health and climate burden.[97]

Fire at the Chevron refinery in Richmond, CA, in August 2012.
Greg Kunit (CC BY-NC-SA 2.0)

Permitting any project that allows the footprint of the fossil fuel industry to expand is incompatible with climate leadership, given that a managed decline of the entire sector is imperative. Politicians must begin saying "no" to fossil fuel companies, period.

VI. A JUST TRANSITION MUST BE EQUALLY AMBITIOUS

As discussed in previous sections, phasing out fossil fuel production in the state is necessary both for climate limits and the health of people on the front lines of extraction. However, this decline will affect workers, families, and communities that depend on the sector for their livelihoods. It is vital that the state prioritize working with affected communities to develop an ambitious just transition[98] strategy that supports and invests in their vision of a brighter future.

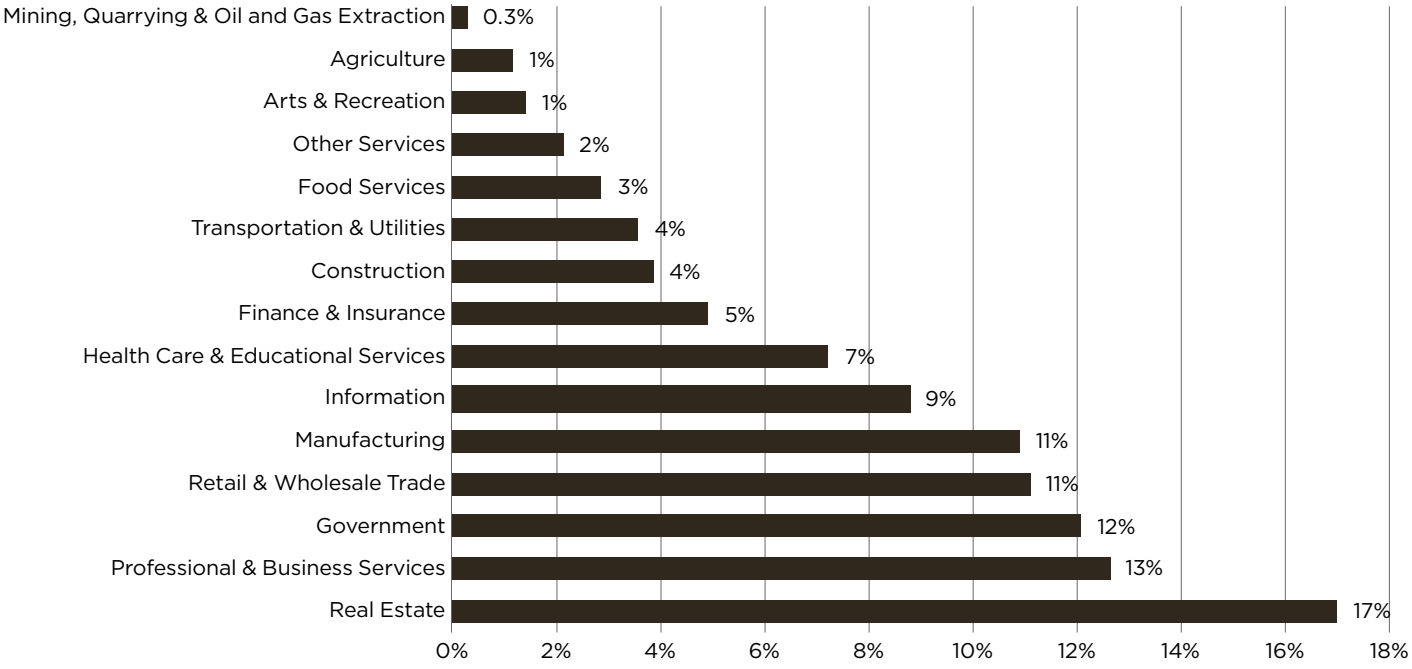
The International Trade Union Confederation (ITUC) has summarized that a just transition must involve "providing decent work and social protection for those whose livelihoods, incomes and employment are affected by the need to adapt to climate change and by the need to reduce emissions to levels that avert dangerous climate change."[100, 101] Key elements of a just transition plan as laid out by the ITUC include: social dialogue between stakeholders, job training and skills development, social protection, and economic diversification with investments in low-emission and job-rich sectors.

Engaging affected workers and communities as partners in transition planning and dedicating financial support to state and local transition needs is not only an ethical imperative, but will also help reduce fear and political resistance to the significant economic shifts that come with the phase-out of production.[102] Recent research shows union members are more inclined to support environmental action than the general population in the United States.[103] Decent work and a healthier environment should – and can – go hand-in-hand if the state commits to the deep investment required to make it so. Transformation is not only about phasing out polluting sectors, it must also mean new jobs, new industries, new skills, new investment, and the opportunity to create a more equitable and resilient economy.

Wind turbines in the San Gorgonio Pass. Eric Allix Rogers (CC BY-NC-ND 2.0)

"[T]he fossil fuel era is ending, and California is not interested in the boom-or-bust oil economy." -
Lieutenant Governor Gavin Newsom and the State Lands Commission[99]

Figure 11: Share of California GDP by Industry Sector, 3rd Quarter of 2017



Source: U.S Bureau of Economic Analysis[106]

HOW MANY WORKERS?

The fossil fuel industry has played a role in California's economy for over a century. While oil production was a primary driver of growth in the early twentieth century, mining, including oil and gas extraction, today accounts for less than one-third of one percent (0.3 percent) of California's economy by percentage of GDP (see Figure 11).[104,105]

In 2012, about 22,800 people were employed in oil and gas extraction. The most recent jobs census from the Department of Labor shows that number has dropped to fewer than 14,500 as of the third quarter of 2017, representing less than one-tenth of one percent (0.1 percent) of private sector workers in California.[107, q]

While the number of workers in extraction is relatively small statewide, employment is more concentrated in certain regions. More than two-thirds of California's oil and gas extraction workforce work in Kern County and Los Angeles County. In Kern County, about 7,300 people work in extraction, making up 3 percent of the private workforce. In Los Angeles County, where a 2,500-foot public health buffer would have the greatest impact on production, fewer than 2,000 people are employed in oil and gas extraction, representing well under one percent of county private employment.[108]

MOVING FROM UNMANAGED TO MANAGED DECLINE

The decline of oil production will profoundly affect those whose livelihoods and families depend on it, and its impact cannot be reduced simply to numbers of jobs.

In recent years, workers in Kern County in particular have experienced the job shocks of an unmanaged decline in production – one driven by oil prices and the profit margins of companies, and lacking a plan for social support.[109] Employment in oil and gas extraction in Kern County shrunk by nearly 40 percent between 2014 and 2017 as a result of industry restructuring and efforts to cut operating costs.[110] These are challenging shocks for local communities and governments to absorb, particularly given that Kern County already has unemployment and poverty rates well above the state average.[111]

Active government support for a just transition is critical to protect people and communities, many of whom have experienced the boom-and-bust oil economy for decades. A primary goal of a just transition must be to minimize the negative consequences and maximize the benefits of an energy shift for those living and working at the front lines of the fossil fuel industry, who have shouldered a heavy burden for the energy system that Californians rely on.

q Beyond direct extraction jobs, oil and gas pipeline construction and refining together employ around 22,000 Californians. Data from the third quarter of 2017 show around 10,400 people employed in oil and gas pipeline construction and a little over 11,000 people employed in petroleum refining.

Box 3: Developing Clean Energy Jobs in the San Joaquin Valley

In 2014, California passed AB 2672, requiring the California Public Utilities Commission (CPUC) to assess various options to increase access to affordable energy in the San Joaquin Valley. The first phase of that assessment identified 170 communities in the San Joaquin Valley lacking adequate access to safe and reliable energy. These communities rely instead on expensive, hazardous, and polluting energy sources such as monthly allotments of propane. The second phase established a team that includes the Center on Race, Poverty & the Environment (CRPE), Leadership Counsel for Justice and Accountability, and Self-Help Enterprises to facilitate the development of pilot projects – including renewable resource solutions such as community solar – to increase affordable energy access with an eye towards replicability in the region and statewide.

CRPE's goal in this work is to make the transition to affordable energy a just one by ensuring that low-income communities of color are not left behind as the state moves to achieve its renewable goals, and by assisting in the development of a new energy economy with transferable, cleaner jobs in the San Joaquin Valley. Taking advantage of opportunities to further a just transition of the energy labor force in the Valley is critical, given CRPE's efforts to reduce regional oil and gas extraction operations. The deployment of new energy resources will require a robust workforce in both the construction of energy resources and in making improvements necessary for many homes to be able to use new energy technologies.

A California Energy Commission study analyzing barriers to low-income customer access to renewable energy found that local hire practices can increase local participation in, and therefore the cost-effectiveness and affordability of, renewable energy solutions like community solar. Establishing local hire provisions at each stage of implementation of new energy solutions would help pave the way for a sustainable community-driven energy economy. The practices and policy provisions modeled in these pilots will inform the CPUC program and help shape future projects in other rural – and even urban – disadvantaged communities.

Contributed by Roger Lin, Center on Race, Poverty & the Environment

ESTABLISHING A JUST TRANSITION TASK FORCE

A crucial first step California can take to focus energy and resources on a just transition is to convene a comprehensive and inclusive statewide planning process. To achieve this, we recommend the establishment of a Just Transition Task Force – as has been done in Scotland[112] and in Canada,[113, r] for example – to facilitate the process of social dialogue and planning between employers, workers, unions, frontline communities and organizations, and local and state agencies.[114] This type of dialogue has been identified as a core element of effective just transition planning by the ITUC and in case studies of transition experiences in other regions. The state has a central role to play in convening it.

Such a forum should serve several purposes. Programs to diversify the economies and tax base of oil-dependent communities, and to ensure social protection for those exposed to job losses, should be rolled out before the oil and gas sector significantly declines. To get this sequencing right, clear and specific plans need to be developed and put in place. A Just Transition Task Force should help state and local policymakers, as well as impacted communities, workers, and labor unions, identify the needs of different regions of the state and better anticipate possible negative and positive consequences of policy proposals. Some of this information could be obtained by expanding the mandate of existing climate research programs in the state to prioritize just transition. By facilitating an open and democratic process of dialogue, a statewide planning body should help reconcile differing visions, concerns, and conflicts from the outset, and help create the political space for reform.[115]

It is important to note that, historically, workers and communities on the front lines of the fossil fuel industry have often been left out of decision-making processes affecting land use, the siting of polluting infrastructure, and their health and safety where they live and work. To address this democratic deficit, community organizations from the San Joaquin Valley (see Box 3) to the Bay Area (see Box 4) are already at the forefront of developing grassroots-led visions of what a just transition to a clean energy economy could look like locally and how it can and should address systemic racial and economic injustices. A state-convened forum should have a goal of fostering, supporting, funding, and learning from such community-led efforts, rather than superseding them.

r We note that the announced Just Transition Task Force in Canada is expected to focus largely on coal. It will be important for long-term success that such task forces take all fossil fuels into consideration and plan for a managed decline and just transition of the entire sector in line with the Paris goals.

Rooftop solar installation at the Port of Los Angeles. Office of Mayor Eric Garcetti (CC BY-NC-ND 2.0)

ESTIMATING THE PRICE TAG

There is much that can be done through administrative, regulatory, and policy measures. However, a just transition will require a meaningful deployment of resources. We can make an initial estimate for two elements that are significant and are reasonably quantifiable: social protection and retraining for workers. We do not include investment in economic diversification and clean infrastructure (a significant portion of which may be made commercially). Nor do we estimate the costs of remediation of polluted sites, which will depend on specific circumstances.

Social protection

Transition assistance should include full wage replacement, health benefits, and pension contributions, particularly for workers close to retirement. A Washington state ballot initiative to establish a carbon tax and just transition program can serve as an example. The initiative proposes to provide at least these benefits to every worker within five years of retirement, and to younger workers matching each year of service for up to five years. For those that have been in the industry longer, the state would cover wage insurance for up to five years for re-employed workers.[116]

We can project a rough estimate of the cost of wage replacement for workers in California's oil and gas extraction sector based on available data on the current distribution of jobs and their annual average salaries. If the drilling of new wells ceases starting in 2019, the cumulative cost of covering one year of full wage replacement for all workers facing job losses through 2030 could be $850 million. Offering each affected worker up to five years of wage replacement, as put forward in the Washington state initiative, would cost a maximum of $4.3 billion, in the unlikely event that none of those workers found new jobs within five years.[117] The costs would not be evenly distributed – the need for transition assistance would likely be most significant over the first five years of the drilling phase-out, as there are more jobs in developing new production than in maintaining existing production.

Retraining

Investment in workforce training should target regions with a high share of the labor force affected by a managed decline in oil and gas production.[118] Skills development should build on existing certified union apprenticeship programs and other existing organized labor infrastructure.

For example, the International Brotherhood of Electrical Workers Local 11 and the LA Chapter of the National Electrical Contractors Association run a state-of-the-art Net Zero Plus Electrical Training

Institute in Los Angeles. Their mission is to train the "next generation" of energy specialists with the skills to increase energy efficiency and independence, contribute to grid balance, and meet sustainability goals. Three- to five-year apprenticeship programs involve on-the-job training and 240 hours of instruction, with courses ranging from $75 to $1,500.[119] In Kern County, community members and workers are calling for the restoration of funding for vocational training in local high schools and investment in job training programs and higher education opportunities in California's Central Valley.[120]

In Washington's clean energy transition proposal, the state would pay for up to two years of retraining costs, including community or technical college tuition.[121] The Labor Network for Sustainability calls for funding up to four years of education and training for people who lose their jobs because of a climate-friendly transition.[122]

In California, covering tuition costs for all workers facing job losses over the first 12 years of the transition period could range from a total of $120 million to $470 million, depending on whether workers seek to attend two years of community college or four years at an in-state public university.[123]

Initial Estimates

Ultimately, the cost of the transition away from oil and gas production in California will depend on the scope, elements, and local conditions in which any program will be implemented, and the speed of investment and re-employment in new renewable energy and emerging sustainability sectors. Further research is needed to fully quantify the level of investment needed for a holistic and robust transition plan.

The terms of social protection policies should be determined through negotiation with California's labor representatives.

However, we present these initial estimates to help inform that discussion. They suggest an annual price tag – given the managed decline policies we have proposed in this report – of up to $40 million per year for retraining and of $70 million per year for each year of replacement wages offered for social protection.[s] These costs are not insignificant, but they are orders of magnitude smaller than the costs of climate change to the state. A recent UC Berkeley study estimates that every 1 degree Celsius of warming would result in a loss of $26 billion to California's GDP.[124]

In the following section, we present a proposal for how just transition funds could be raised from the oil industry itself, which after all should rightly share responsibility for transition of its workforce.

s This is based on the average annual cost per year over 12 years of providing up to four years of public college tuition (i.e., the cumulative total of $470 million divided by 12 years) and the average annual cost per year over 12 years of providing one year of wage replacement to all workers (i.e., the cumulative total of $850 million divided by 12 years).

Box 4: Organizing for a Community-Based Just Transition in Richmond, California

Richmond is a story of organizing, vision, and inspiration. A city with a population of about 80 percent people of color that has faced a legacy of environmental racism, blight, and economic divestment in the shadows of the 2,900-acre Chevron refinery has also become a proving ground for post-carbon organizing. Here, Communities for a Better Environment, the Asian Pacific Environmental Network, and Urban Tilth are co-anchoring a just transition, away from an extractive and exploitative economy to a local and living economy that supports the well-being of families, empowers people, cleans the environment, and creates safe and healthy neighborhoods. Community groups are building upon the concept of "Our Power" – frontline community power to create a regenerative, non-extractive economy with energy democracy, food and land security, health and improved air quality, local ownership, and inclusive democratic governance.

Specifically, the co-anchor community organizations launched a community-based Just Transition strategy in 2015 and formally established the Richmond Our Power Coalition in 2017. In line with the Our Power concept, the Coalition is determined to revitalize the city by investing in community innovation and governance while fostering local resiliency and connections within the broader community. Some examples are the recent launch of one Coalition partner, Cooperation Richmond – which provides technical and financial assistance for cooperative development – and a forthcoming public lands policy that ensures community benefits from local development. Other Coalition partners include Alliance of Californians for Community Empowerment, Idle No More SF Bay, Rich City Rides, and Safe Return Project.

The Coalition also prioritizes leadership development programs to continue growing the political consciousness and leadership of community residents, the creation of councils that ensure community control over public resources, and support for citywide policy campaigns. As one key step, Coalition members are working to win a citywide energy policy for the expansion of equitable renewable energy access that brings jobs, sustainable development, transparency, community benefits, and energy democracy to Richmond's residents. The campaign for City Council adoption of this innovative and strategic local energy transition policy is set to launch in the summer of 2018 as of this writing.

Contributed by José López, Communities for a Better Environment

RAISING DEDICATED FUNDS FOR CALIFORNIA'S JUST TRANSITION

As discussed above, implementing a just transition will require significant dedicated funds. In this section we propose an innovative source of financing: a Just Transition Fee that companies would pay based on the value of their oil production. The fee could raise millions of dollars per year to fund transition needs before phasing out with the decline of extraction.

Why Implement a Just Transition Fee?

In California, the fossil fuel industry is not subject to an oil and gas production or severance tax. California is the only major oil- and gas-producing state in the United States besides Pennsylvania – and one of the only major oil-producing jurisdictions in the world – without a similar measure.[125] Oil companies in Norway, for example, pay a 78 percent production tax.[126]

This lack of a severance tax is a de facto subsidy to oil and gas production in California. Adding a Just Transition Fee would not only increase revenue but would also reduce financial incentives for the expansion of fossil fuel production and thus help reduce emissions.[127,128]

A Just Transition Fee Could Raise Millions per Year

Estimating the dedicated revenue California could raise via a Just Transition Fee depends on the rate of the fee, the volume of oil subject to the fee, and the market value of that oil at the point of production. Oil companies pay production taxes on the gross value of the oil extracted, i.e., the number of barrels multiplied by the price of each barrel.

On the low end of ambition, California could apply a rate on par with top U.S. oil producers Texas[129] and North Dakota,[130] which have 4.6 and 5 percent production taxes respectively. A higher rate, of 10 percent, would mirror previous proposals in California to establish a production tax. Such a rate would still be lower than federal royalty rates, and less than the $10 per barrel fee proposed in 2016 by President Obama to fund infrastructure projects.[131]

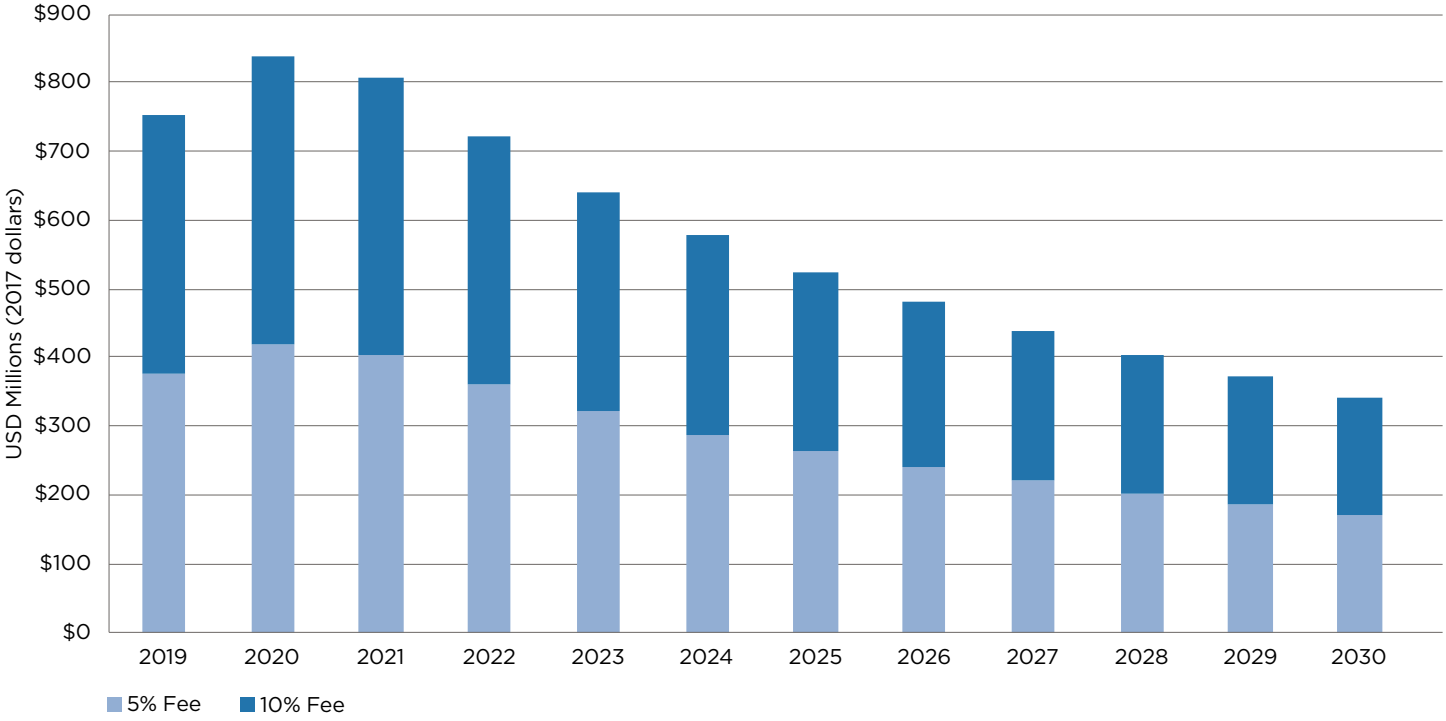
Figure 12 shows the range of revenue that could be generated by a 5 to 10 percent Just Transition Fee – if enacted with the other managed decline policies proposed in this report and based on the Energy Information Administration's (EIA) oil price forecast.[132] We assess only the revenue that would be raised without new production wells and as wells within 2,500 feet of homes, schools, and hospitals are phased out.

Total revenue generated over the next 12 years could be $3.5 billion to $6.9 billion. This would provide a significant injection of dedicated resources, which would potentially be sufficient to fund an ambitious set of just transition policies. It is for Californian labor representatives to negotiate the shape of a just transition. Indeed, a social dialogue must be at the heart of a just transition. However, by way of illustration:

- On the low end, this revenue could cover up to four years of full wage replacement for workers based on the estimates in the previous section.
- On the high end, this revenue would cover full wage replacement for five years plus four years of college tuition, while providing over $2 billion in additional resources to dedicate toward other just transition needs.

The most significant funds would be front-loaded – raised over the first five years before production declines more

Figure 12: Dedicated Just Transition Revenue that Could Be Generated via a 5-10% Fee on Oil Production, 2019-2030



Sources: Oil Change International analysis, EIA[133]

significantly – which would correspond with the need for upfront investment and support for impacted communities and workers. The fee itself would be expected to have some downward pressure on underlying oil production (though additional analysis would be required to assess the extent).[t] Its purpose would be exclusively linked to funding the transition away from oil and gas production and would therefore avoid creating a perverse link between oil revenue and the broader state budget.

BUILDING TOGETHER

The success of the transition off fossil fuel production will depend on deep collaboration between government, workers, local residents, labor unions, and climate justice and environmental advocates. It will also depend on solidarity between the environmental and labor movements. By working meaningfully together, these movements can disrupt the misleading "jobs versus the environment" trope and move policies forward at the local, state, and national levels that benefit climate-friendly job growth.

While the decline of the fossil fuel sector will take years, now is the time for the environmental movement to show solidarity with workers and advocate for policies to ensure that new investments and clean energy industries provide 'high-road' jobs with family-sustaining wages, good benefits, and job security. To do this, environmental groups should take a more proactive approach to championing workers issues such as fair wages, health and safety standards, and the right to organize in emerging clean energy sectors.

t Rystad Energy projections from May 2018 suggest that 87 percent of California crude oil production from 2019 through 2030 will break even at oil prices of $60 per barrel or less. If prices remain at or above current levels (the EIA projects that West Coast oil prices will be significantly higher than $60 per barrel from 2020 onwards), a 5 to 10 percent tax on the value of production may not have significant additional downward pressure on production from already-developed fields.

CONCLUSION

Global climate leadership is being redefined. There is a growing recognition that you cannot be a climate leader if you continue to enable new fossil fuel production, which is inconsistent with climate limits. If no major producers step up to stop the expansion of extraction and begin phasing out existing fields and mines, the Paris goals will become increasingly difficult to achieve. Wealthy fossil fuel producers have a responsibility to lead, and this must include planning for a just and equitable managed decline of existing production.

Governor Brown has committed both himself and the state of California to lead. As we have presented in this report, addressing fossil fuel production in the state is essential to fulfilling that promise.

By taking action to end permitting for new oil and gas wells, phasing out fossil fuel production within 2,500 feet of sensitive areas, and ensuring a just transition with support for affected workers, communities, and local budgets, California would become the first major oil and gas producer to begin the necessary managed decline of oil and gas. And with aggressive action to limit both supply and demand, this could be achieved with a long-term decline in oil imports.

It would be a win for impacted communities, a win for the state, and a win for the climate.

Saying no to new wells and initiating a managed decline of existing production would set an international precedent. California would become the first major fossil fuel producer to take these steps (joining smaller producers such as New Zealand, Costa Rica, Ireland, Belize, and France). These actions have the potential to change the global conversation and push other wealthy fossil fuel producers like Norway and Canada to follow suit with the ambition required for a climate-safe future.

As Governor Brown himself put it:

"Let's lead the whole world to realize this is not your normal political challenge. This is much bigger. This is life itself. It requires courage and imagination."

Californians march in Oakland in February of 2015 to demand that Governor Brown ban fracking. © Kelly Johnson

APPENDIX I: METHODOLOGY FOR ESTIMATING THE PRODUCTION IMPACT OF MANAGED DECLINE POLICIES

In modeling future production, we utilized historical well data from DrillingInfo, an industry database that contains information on all oil and gas wells drilled in the state of California. We consulted with earth scientist David Hughes for both data research and advice.

In California, future oil production will be determined by the rate of production from existing wells and, if permits were to continue, the rate of production from each new well that starts producing in a given year.

The production from new wells depends on three primary factors:

1. How many wells start producing annually;
2. The productivity of those wells; and
3. The rate at which production from those wells declines into the future.

A typical Californian oil well hits its monthly production peak within the first year, declines initially at a faster rate over several years post-peak, and then settles into a slower long-term decline rate. The rates of new wells added, their production, and decline depend on a variety of factors, including: oil price and the economics of production, production technology, the geology of fields and reservoirs, and remaining reserves within a given field.

To estimate production scenarios into the future, this analysis used a dataset of all California oil wells drilled from 1977 to present sourced from DrillingInfo, a U.S.-based industry database. The wells were grouped into 17 categories (outlined below) to analyze historical trends for the three key data points summarized above and to extrapolate those trends into the future, estimating mid-, low-, and high-case scenarios.

Categories of Wells

The data were sorted into 17 categories of wells by field and/or county and well type to isolate the largest producers and reflect distinctive geologies and well characteristics (see Table A1). Each of the top six fields in Kern County, which are among the seven most productive fields in California, were analyzed separately. These six fields alone accounted for 58 percent of California oil production in 2016. Los Angeles, Fresno, and Monterey Counties were analyzed separately, as they contain the next most productive oil fields in the state. The remaining fields in Kern County were analyzed as a single category, as were all other fields outside of Kern, Los Angeles, Fresno, and Monterey Counties. In 2016, Kern, Los Angeles, Fresno, and Monterey Counties accounted for over 91 percent of oil production statewide; 72 percent came from Kern County alone.[134]

Wells were categorized by type as either conventional or cyclic steam wells, which enabled further categorization of the

Table A1: Categories of Wells Analyzed

County	Field	Well Type
Kern	Midway-Sunset	Conventional
Kern	Midway-Sunset	Cyclic Steam
Kern	Kern River	All (primarily Cyclic Steam)
Kern	Belridge South	Conventional
Kern	Belridge South	Cyclic Steam
Kern	Cymric	All (primarily Cyclic Steam)
Kern	Lost Hills	Conventional
Kern	Lost Hills	Cyclic Steam
Kern	Elk Hills	Conventional
Kern	All other fields	Conventional
Kern	All other fields	Cyclic Steam
Los Angeles	All fields (including Wilmington, Inglewood, and Long Beach)	All (primarily Conventional)
Fresno	All fields (primarily Coalinga)	Conventional
Fresno	All fields (primarily Coalinga)	Cyclic Steam
Monterey	All fields (primarily San Ardo)	All (primarily Cyclic Steam)
All other counties	--	Conventional
All other counties	--	Cyclic Steam

data to account for differences in the production and decline profiles of these well types. In this case, conventional means a well used to pump oil out of the ground without steam injection. Cyclic steam wells involve alternating injections of steam and withdrawals of oil, a technique that helps enable production of heavier oil. In some fields or counties, production is overwhelmingly dominated by one type of well – for example, Los Angeles County and the Elk Hills field in Kern County have few to no cyclic steam wells, while newer wells in the Kern River field are primarily all cyclic steam wells. Where one well type dominates production, areas were not further divided into categories by well type. In fields or counties where production is significantly split between use of conventional and cyclic steam wells, the data was further divided into categories by well type.

Trends in New Wells Added by Year

To explore trends, we analyzed the well categories by vintage year: the year a well began producing oil. Historical data on well counts for vintage years 2000 to 2017 were used to extrapolate trends into the future for each category. This range of years helped capture trends across low- and high-oil-price years. Of the three main data points extrapolated in our model, drill rates of new wells are the most sensitive to oil price

For each category analyzed, the number of wells added per vintage year was graphed in Excel. High-, mid-, and low-case trendlines were then extrapolated into the future by visual inspection. The high-case projection is based on historical trends in well counts across higher-oil-price years such as 2005 to 2008 and 2010 to 2014. The low-case projection is based on historical trends in well counts across lower-oil-price years, such as 2000 to 2005, 2009, and 2015 to 2017. The mid-case line projected a trend into the future that followed the middle of the historical range and trajectory of well counts.

In some cases, such as the Elk Hills field in Kern County, historical well counts showed high sensitivity to oil price (peaking at 269 in 2014 and plummeting to 15 in 2015). The trendlines follow a wide high- to low-range accordingly. In the case of Los Angeles, conservative trendlines were drawn, given constraints placed on new drilling by population density and growing community resistance to new drilling. In cases where the historical data on well counts showed an overall upward trend, including for Belridge South cyclic steam wells, Lost Hills cyclic steam wells, and Fresno and Monterey County wells, the high-case trendline stays below the peak in historical well counts reached in the high-price years of 2010 to 2014. Given the overall depletion of the state's fields, and the U.S. oil industry's current focus on exploiting shale resources in the Permian Basin of Texas and New Mexico, we assume that California well counts will not again reach those historical peaks.

Trends in Well Productivity

In most of California's major oil fields, the productivity of new wells drilled has been on a downward trend for several decades, which reflects the age and increasing depletion of the fields. For instance, in the Midway-Sunset field, still the state's top overall producer, 1985-vintage wells produced, on average, 84 barrels of oil per day during their peak month of production. For 2000-vintage wells in Midway-Sunset, peak-month production was down to 64 barrels per day. For 2015-vintage wells, it had declined further to 40 barrels per day.

Historical data on the average first 12 months of production per well were used to extrapolate well productivity trends into the future for each category. Since most categories of wells peak during their first year of production, this provided a consistent baseline from which annual decline rates were then applied (as discussed in the next section). For a few outlying cases, such as Lost Hills - Cyclic Steam, Kern - All other fields - Cyclic Steam, and All Other Counties - Cyclic Steam, average production for both the first 12 and second 12 months of production was extrapolated, due to the fact that wells in these categories took longer to reach peak production.

Historical production data for vintage years 2000 to 2016[u] were graphed (a full 12 months of production data was not yet available for 2017 vintage year wells). Trendlines were again drawn by visual inspection to project average annual production into the future. In almost all cases, historical trends indicated a gradual downward trend in productivity. The "all other counties" well categories were an exception, as was the Fresno conventional well category.

We did not project high or low cases for productivity. Productivity was assumed to be largely a function of time and technology, rather than of oil price. Historical trends over time would reflect historical changes in drilling technology, but our trendlines are not sensitive to future technological developments. Future analyses could seek to capture more nuanced trends in productivity by further dividing wells into categories by geologic reservoir and/or by the direction of drilling (horizontal, vertical or directional).

Estimating Rates of Decline

Well decline rates per category were estimated based on historical data on average decline rates. First, the year-on-year rates of decline were graphed to assess overall trends in rates of decline at different well ages. For example, this analysis showed that wells in the Belridge South conventional well category decline at the fastest rate between months 12 and 24, decline at about half of that initial rate at every 12-month interval from months 24 to 60, and then settle into a slower, long-term decline rate of just over 5 percent per 12-month interval. In this way, appropriate intervals across which to average initial, short, and long-term decline rates were assessed for each category of wells.

u The Kern River field was an exception. In this case, the first 12 months' production was extrapolated based on data from 2007 through 2016. This is due to the fact that a significant spike upward in productivity from prior years was not expected to continue into the future, particularly given more recent years showed a slightly downward trend.

Once appropriate intervals were assessed, average exponential rates of decline within those intervals were calculated. (For example, production from Belridge South conventional wells declined approximately 13 percent on average at each 12-month interval between months 24 and 60, and this was used as the short-term decline rate.)

We assumed that decline rates do not change with vintage.

The average decline rates of production were calculated based on the average production of all wells *operating* in a given month. Those decline rates, therefore, do not account for the additional decline in production caused by wells dropping out of operation over time. To account for this in our model, we additionally estimated the rate at which wells are turned off over the lifespan of a vintage class. As with the production decline rate estimates, these rates were derived from averaged historical data. The number of wells operating at each 12-month interval was graphed to assess whether there were significant changes in the rate at which wells went offline over time or vintage year grouping. In about a quarter of the categories, there was little change in the rate of well decline. In those cases, a single average exponential rate of decline was calculated over the 10 years of available data. In the rest of the cases, where the rate appeared to shift over time, an initial and long-term well decline rate was calculated.

Constructing the Model

To arrive at the projection of future production with and without new wells, these primary data points – counts of new wells added per year, their average first 12 months' production, and their near- and long-term rates of decline – were extrapolated and then combined for each category. For existing wells, projections of future production were based on applying the same decline rates described above to historical well count and production data.

Our model projected future production from 2018 through 2030. The findings of this report, however, are based on totaling potential future production and associated emissions from new wells from 2019 through 2030. This is due to the fact that wells that begin operation in 2018 could have been permitted anytime in the last year or two, prior to the time of this analysis.

Adjustment from Vintage-Year Baseline

Almost all of the historical well production data used in this analysis was based off the vintage year of the wells. This differs from calendar year production data: For instance, a vintage year 2017 well could have begun producing in December 2017 and, therefore, its first 12 months of production would span from December 2017 through November 2018. In this same way, production volumes projected for vintage year 2030 wells could include volumes that will not be extracted until sometime in 2031. To adjust for this, and avoid an overestimate, the cumulative production and emissions totals referenced in the findings of this report exclude half of projected 2030 production.

Forward Projection of Production from Wells within a 2,500-foot Buffer Zone

To estimate the cumulative impact of ceasing permits and enacting a 2,500-foot buffer zone, the projected future production of wells within the buffer zone had to be integrated into the model.

Wells identified as operating within the buffer zone were divided into the model's existing categories based on their classification in DOGGR's database in terms of field and/or county, well type, and first year of production, as provided by Kyle Ferrar of the FracTracker Alliance.

Wells that began producing in 2015 and earlier were integrated into the model based on historical DOGGR data on their aggregate 2016 production. Because of data limitations, wells that began producing in 2016 or 2017 were integrated into the model based on DOGGR data on the count of new wells added in the buffer zone in the respective year, multiplied by the model's value for average first 12 months' production in the respective vintage year. The same decline rates were then applied to project these wells' production into the future.

Table A2: Selected Model Projections by Field and/or County (Mid Case)

Field or County Category	2020 Production	2025 Production	2030 Production	Cumulative 2019 through 2030 Production
	Thousand barrels			Million barrels
Belridge South - New Wells	3,800	7,400	8,000	73
Belridge South - Existing Wells	13,800	6,500	3,200	95
Cymric - New	3,600	7,700	8,200	75
Cymric - Existing	8,100	2,000	530	42
Elk Hills - New	1,700	3,700	4,100	36
Elk Hills - Existing	6,100	2,900	1,400	42
Kern River - New	2,900	6,700	8,600	67
Kern River - Existing*	17,700	10,700	6,600	143
Lost Hills - New	1,200	3,800	5,400	38
Lost Hills - Existing	7,600	4,100	2,200	56
Midway-Sunset - New	3,000	7,300	9,300	72
Midway-Sunset - Existing*	17,500	9,800	5,500	134
Other Kern fields - New	3,200	7,900	10,400	79
Other Kern fields - Existing*	17,100	10,500	7,000	140
Los Angeles - New	1,100	2,500	3,200	25
Los Angeles - Existing*	14,700	9,300	5,800	122
Fresno - New	940	2,400	3,500	24
Fresno - Existing*	5,500	4,200	3,200	52
Monterey - New	1,300	3,700	5,000	36
Monterey - Existing*	5,800	2,800	1,400	41
All other counties - New	1,300	3,600	5,600	37
All other counties - Existing*	13,100	10,100	7,900	126
	Million barrels			
New Wells Total	24	57	71	563
Existing Wells Total[a]	127	73	45	994
Existing Wells within 2,500' Buffer Zone	16	10	7	134[b]
Total[c]	151	129	115	1,556

* Denotes that some production from existing wells includes wells within 2,500' of homes, schools, and hospitals.

Notes:

a. These totals include production from wells within 2,500 feet from homes, schools, and hospitals.

b. If wells within 2,500 feet of homes, schools and hospitals are phased out over a five-year period, the total production avoided would be less – 103 million barrels as projected in this scenario.

c. Some totals may not sum precisely due to rounding.

Testing and Benchmarking the Model

Once the model was run, projections were compared to historical data from DOGGR and to future projections available from Rystad Energy, an independent oil and gas consultancy, and the EIA. To assess the decline rates applied in the model, the model's projection for 2016 and 2017 production was compared to historical totals for those years. The model's production projections for both years were 1 percent lower than the actual totals. The model's cumulative projection of 2019 to 2030 production in the mid-case scenario was compared to base case projections of state production over those same years available from Rystad Energy, as of April 2018, and from the EIA's 2018 Annual Energy Outlook.[135] We excluded federal offshore production, which is not included in our model. The mid-case output of the model (1,556 million barrels) was 3 percent higher than Rystad's projection (1,517 million barrels) and 14 percent higher than the EIA's projection (1,367 million barrels).

Emissions Factors for CO_2 Estimates

The Carnegie Oil-Climate Index, which provides a global database comparing the climate impact of oils through the supply chain, conducted an analysis of 154 California oil fields in 2017.[136] The analysis provides an estimate of the total greenhouse gas emissions (expressed as CO_2 equivalents) associated with each barrel of oil produced from each field, from extraction to refining to combustion. These emissions factors were used to estimate the total carbon emissions associated with the production projections in this report.

For the Kern County fields modeled individually, the emissions factors were taken directly from Carnegie estimates. For model categories that combine multiple fields, such as Los Angeles County, weighted emissions factors were calculated. This was done using DOGGR data on 2016 production volumes from the significant fields within the given county or group of counties. The emissions factor for each field was multiplied by its 2016 production, and this total was then divided by the aggregate production of the fields to arrive at the weighted emissions factor for the given category of wells.

A limitation of this approach is that emissions factors were available by field but not by well type. Thus, carbon emissions estimates do not account for differences in emissions between conventional versus cyclic steam wells within given fields or counties.

Table A3: Emissions Factors Used for Calculating Total CO_2e Emissions of California Oil Production

Field or County Category	Emissions Factor (metric ton CO_2e/barrel)
Belridge South	0.69
Cymric	0.60
Kern River	0.65
Midway-Sunset	0.76
Elk Hills	0.51
Lost Hills	0.54
Fresno County	0.69
Monterey County	0.76
Los Angeles County	0.59
Other Kern fields	0.65
All other counties	0.56

APPENDIX II: METHODOLOGY FOR IDENTIFYING WELLS WITHIN 2,500 FEET OF SENSITIVE AREAS

Kyle Ferrar of the FracTracker Alliance conducted a geospatial analysis for Oil Change International to identify oil and gas wells in California that would be affected by a 2,500-foot setback or buffer from homes, schools, and hospitals.

The setback analysis was conducted using ESRI ArcGIS Pro software, version 2.1.2. Using GIS techniques, 2,500-foot buffers were generated from building structures identified as places of residence, schools, and medical centers. To create a shapefile of building structures multiple GIS datasets were merged and the boundaries of structures traced.[137,138,139] A combination of county and city zoning data, county parcel data, and building footprint data was used to trace boundaries around residences. Existing footprint data was vetted using zoning codes. Quality control to eliminate structures that were not occupied residences was conducted manually and with the assistance of county- and city-level zoning data. In areas where building footprint data was not readily available, boundaries were identified by screening satellite imagery in areas zoned for residential use. Areas located within 2,500 feet of well-heads were prioritized for screening satellite imagery in areas zoned for residential use and additional building footprints were generated. A 2,500-foot buffer was then added around these boundaries.

The 2,500-foot buffer was utilized to select active oil and gas production wells located within 2,500 feet of homes, schools, and hospitals. Active and permitted oil and gas wells within the setback zone were identified. The shapefile of active California oil and gas wells was generated by limiting the California DOGGR "All Wells" dataset to just the wells with a status identified as "active" or "new," and well type as "oil and gas" and "dry gas."[140] This limitation on the dataset was justified to remain conservative to the most viable modes of exposure to contaminants from well sites, under the assumption that "plugged," "buried," or "idle" wells that are not producing (or at least not reporting production figures to DOGGR) do not purvey as much of a risk of air emissions. The main route of transport for pollutants to the surrounding communities is via air emissions from "producing" oil and gas wells. Well production data was also downloaded from DOGGR.[141]

Using GIS, the locations of wells found to be within 2,500 feet of a residence, school or hospital were also overlaid onto the California Office of Environmental Health Hazard Assessment's (OEHHA) CalEnviroScreen 3.0 California Communities Environmental Health Screening Tool.[142] Well counts within the CalEnviroScreen census tracts were summed, and the results were exported. They provide a breakdown of the environmental justice rankings for the communities most impacted by current oil and gas extraction (those living within 2,500 feet of oil and gas wells).

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Oil Change International
714 G Street SE, Suite 202
Washington, DC 20003
www.priceofoil.org

Petroleum & Other Liquids

Crude Oil and Lease Condensate Production by API Gravity

Period-Unit: Monthly-Thousand Barrels per Day

API Gravity	Graph Clear	Sep-23	Oct-23	Nov-23	Dec-23	Jan-24	Feb-24	View History
Lower 48 States	☐	12,831	12,793	12,867	12,831	12,150	12,722	2015-2024
20.0º or Lower	☐	240	238	240	242	236	233	2015-2024
20.1º to 25.0º	☐	116	200	169	139	197	314	2015-2024
25.1º to 30.0º	☐	932	825	819	836	730	702	2015-2024
30.1º to 35.0º	☐	1,394	1,336	1,246	1,258	1,227	1,200	2015-2024
35.1º to 40.0º	☐	3,355	3,195	3,062	3,038	2,697	2,986	2015-2024
40.1º to 45.0º	☐	3,687	3,731	3,887	3,872	3,671	3,823	2015-2024
45.1º to 50.0º	☐	2,245	2,227	2,493	2,337	2,333	2,332	2015-2024
50.1º to 55.0º	☐	513	705	584	729	674	742	2015-2024
55.1º or Higher	☐	345	333	365	349	353	355	2015-2024
Unkown	☐	4	3	3	32	32	35	2015-2024
Arkansas	☐	12	12	12	12	11	12	2015-2024
30.0º or Lower	☐	5	5	5	5	5	5	2015-2024
30.1º to 40.0º	☐	3	3	3	3	3	3	2015-2024
40.1º to 50.0º	☐	3	3	3	3	3	3	2015-2024
50.1º or Higher	☐	0	0	0	0	0	0	2015-2024
California	☐	307	306	305	303	299	293	2015-2024
30.0º or Lower	☐	288	285	282	273	271	266	2015-2024
30.1º to 40.0º	☐	7	11	11	29	27	26	2015-2024
40.1º to 50.0º	☐	12	9	12	0	1	1	2015-2024
50.1º or Higher	☐	0	0	0	0	0	0	2015-2024
Colorado	☐	457	464	476	485	445	467	2015-2024
30.0º or Lower	☐	1	0	0	0	0	0	2015-2024
30.1º to 40.0º	☐	123	107	89	92	90	104	2015-2024
40.1º to 50.0º	☐	168	198	222	214	185	185	2015-2024
50.1º or Higher	☐	165	158	165	179	170	177	2015-2024
Federal Gulf of Mexico	☐	1,997	1,950	1,845	1,824	1,747	1,800	2015-2024

30.0º or Lower	☐	806	793	752	752	699	786	2015-2024
30.1º to 40.0º	☐	1,142	1,116	1,066	1,046	1,020	988	2015-2024
40.1º to 50.0º	☐	49	41	26	26	28	25	2015-2024
50.1º or Higher	☐	0	0	0	0	0	2	2015-2024
Kansas	☐	75	73	74	73	61	73	2015-2024
30.0º or Lower	☐	15	15	14	14	12	15	2015-2024
30.1º to 40.0º	☐	51	50	54	54	44	53	2015-2024
40.1º to 50.0º	☐	9	8	6	5	5	5	2015-2024
50.1º or Higher	☐	0	0	0	0	0	0	2015-2024
Louisiana	☐	94	91	89	89	87	89	2015-2024
30.0º or Lower	☐	22	20	24	23	23	21	2015-2024
30.1º to 40.0º	☐	47	37	42	43	40	41	2015-2024
40.1º to 50.0º	☐	20	30	19	19	19	20	2015-2024
50.1º or Higher	☐	4	4	4	4	5	6	2015-2024
Montana	☐	64	64	64	64	62	69	2015-2024
30.0º or Lower	☐	2	2	2	2	2	2	2015-2024
30.1º to 40.0º	☐	35	34	30	33	25	37	2015-2024
40.1º to 50.0º	☐	26	27	32	29	34	30	2015-2024
50.1º or Higher	☐	0	0	0	0	0	0	2015-2024
New Mexico	☐	1,831	1,839	1,905	1,925	1,862	1,982	2015-2024
30.0º or Lower	☐	0	0	0	0	0	0	2015-2024
30.1º to 40.0º	☐	194	155	162	129	118	149	2015-2024
40.1º to 50.0º	☐	1,566	1,591	1,644	1,702	1,638	1,753	2015-2024
50.1º or Higher	☐	71	93	99	94	105	79	2015-2024
North Dakota	☐	1,308	1,273	1,288	1,274	1,114	1,287	2015-2024
30.0º or Lower	☐	8	5	5	6	5	5	2015-2024
30.1º to 40.0º	☐	219	185	193	173	168	153	2015-2024
40.1º to 50.0º	☐	1,059	1,046	1,049	1,052	894	1,083	2015-2024
50.1º or Higher	☐	21	37	42	44	47	47	2015-2024
Ohio	☐	84	89	94	93	91	84	2015-2024
30.0º or Lower	☐	0	0	0	0	0	0	2015-2024
30.1º to 40.0º	☐	2	2	2	2	2	2	2015-2024
40.1º to 50.0º	☐	1	1	1	1	1	1	2015-2024
50.1º or Higher	☐	80	85	91	90	88	81	2015-2024
Oklahoma	☐	426	424	421	420	389	399	2015-2024

30.0º or Lower	☐	18	18	18	18	18	19	2015-2024
30.1º to 40.0º	☐	86	78	75	83	73	70	2015-2024
40.1º to 50.0º	☐	239	241	240	228	204	217	2015-2024
50.1º or Higher	☐	82	87	88	91	95	93	2015-2024
Pennsylvania	☐	12	13	16	13	14	12	2015-2024
30.0º or Lower	☐	0	0	0	0	0	0	2015-2024
30.1º to 40.0º	☐	0	0	0	0	0	0	2015-2024
40.1º to 50.0º	☐	0	0	0	0	0	0	2015-2024
50.1º or Higher	☐	12	13	15	13	13	12	2015-2024
Texas	☐	5,570	5,586	5,658	5,631	5,376	5,548	2015-2024
30.0º or Lower	☐	71	67	72	70	77	75	2015-2024
30.1º to 40.0º	☐	2,668	2,563	2,384	2,419	2,135	2,379	2015-2024
40.1º to 50.0º	☐	2,495	2,493	2,851	2,671	2,747	2,572	2015-2024
50.1º or Higher	☐	337	464	351	471	418	521	2015-2024
Utah	☐	168	172	175	174	167	160	2015-2024
30.0º or Lower	☐	3	3	4	3	3	3	2015-2024
30.1º to 40.0º	☐	60	75	87	84	80	76	2015-2024
40.1º to 50.0º	☐	102	91	81	84	79	76	2015-2024
50.1º or Higher	☐	3	3	4	3	5	5	2015-2024
West Virginia	☐	48	55	51	46	45	42	2015-2024
30.0º or Lower	☐	0	0	0	0	0	0	2015-2024
30.1º to 40.0º	☐	0	0	0	0	0	0	2015-2024
40.1º to 50.0º	☐	0	0	0	0	0	0	2015-2024
50.1º or Higher	☐	48	54	51	46	45	41	2015-2024
Wyoming	☐	272	278	289	294	279	298	2015-2024
30.0º or Lower	☐	23	25	24	23	23	23	2015-2024
30.1º to 40.0º	☐	81	84	80	89	82	89	2015-2024
40.1º to 50.0º	☐	143	140	155	147	144	157	2015-2024
50.1º or Higher	☐	26	30	29	35	30	29	2015-2024
Other States	☐	107	105	106	109	100	109	2015-2024
30.0º or Lower	☐	26	25	26	27	25	28	2015-2024
30.1º to 40.0º	☐	31	31	31	31	28	31	2015-2024
40.1º to 50.0º	☐	41	39	40	41	38	42	2015-2024
50.1º or Higher	☐	9	9	9	9	8	8	2015-2024

Click on the source key icon to learn how to download series into Excel, or to embed a chart or map on your website.

- = No Data Reported; **--** = Not Applicable; **NA** = Not Available; **W** = Withheld to avoid disclosure of individual company data.

Notes: API gravity is the American Petroleum Institute's measure of specific gravity of crude oil or condensate in degrees. The measuring scale is calibrated in terms of degrees API. Degrees API = (141.5 / sp.gr.60 deg.F/60 deg.F) - 131.5. At the individual state/area level, production volumes in the "Unknown" category are proportionately distributed to the nine API categories, which are then combined into four categories in order to avoid disclosure of company-specific data. Alaska production by API category is not available. The "Other states" grouping includes Alabama, Arizona, Federal Offshore California, Florida, Illinois, Indiana, Kentucky, Michigan, Mississippi, Missouri, Nebraska, Nevada, New York, South Dakota, Tennessee, and Virginia. The sum of individual states may not equal total Lower 48 volumes due to independent rounding. A zero may indicate volume of less than 0.5 thousand barrels per day. Previous months' production volumes may have been revised for all states/areas. See Definitions, Sources, and Notes link above for more information on this table.

Release Date: 4/30/2024

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Desert Sun.

ENVIRONMENT

21 oil wells now found leaking methane near California homes

Janet Wilson
Palm Springs Desert Sun

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A total of 21 oil wells have been found to be leaking methane in or near two Bakersfield neighborhoods, and more than two dozen are being tested by state and regional air regulators.

California Geologic Energy Management Division, or CalGEM, said in an update on its website that state and regional air regulators are in the area again today to interview residents and take additional methane readings.

Repairs are at various stages for the nearly two dozen wells, several of which were found to be leaking at least 50,000 parts per million of methane — a level at which the colorless, odorless gas can explode if ignited.

Six wells owned by Sunray near the Morning Star neighborhood were tested again on Wednesday and are no longer leaking after a contractor hired by CalGEM temporarily plugged them.

Work continues on seven idle wells operated by Zynergy in the same area. CalGEM inspectors confirmed that four of the wells are repaired and no longer leaking methane. Contractors are on site Thursday to work on the remaining three wells.

A state staffer told The Desert Sun last week that California's top oil regulator was "lying" about the level of risks at the sites, and said methane can build up underground in tight spaces and explode also. Since then, CalGEM announced it was installing pressure monitors on at least some of the wells as they are repaired or closed off.

CalGEM continues its inspection efforts for the 25 wells owned by Griffin Resources. One well that was hissing and emitting high levels of methane over Memorial Day weekend was

safely depressurized on May 30. The agency has identified another well owned by the company showing high pressure readings, and is working to gain access to the site where the well is located.

Six other wells are showing low-level methane leaks, and CalGEM is evaluating options to ensure the leaks are quickly fixed. Over the weekend, the company appealed CalGEM's emergency order to permanently plug and decommission these wells and 17 others. Sunray has also appealed a CalGEM order to address problems at five oil fields across central California, saying in a letter that it has addressed many of the problems.

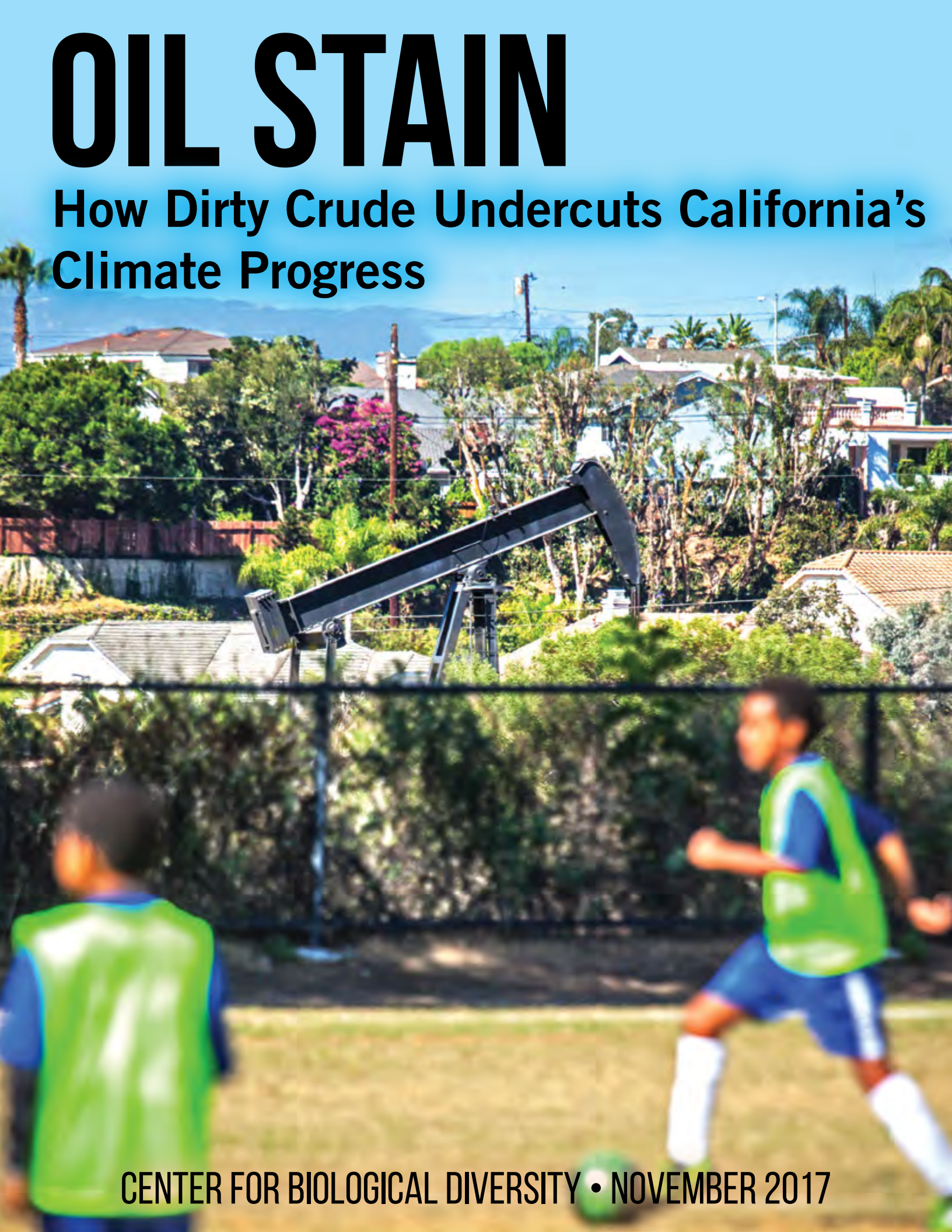
Idled wells are a burgeoning problem in California's century-old oil fields. A state study concluded two years ago that taxpayers could be saddled with more than $1 billion in cleanup costs if operators walk away from their responsibilities to properly plug and abandon them.

A report released Thursday by a consumer advocacy group and a coalition of environmental justice groups concludes costs associated with the industry to the state could top $10 trillion by 2045. Industry advocates say locally produced oil is vital, and is done under some of the strictest regulations in the world.

Janet Wilson is senior environment reporter for The Desert Sun, and co-authors USA Today's Climate Point newsletter. She can be reached at jwilson@gannett.com or @janetwilson66 on Twitter

OIL STAIN

How Dirty Crude Undercuts California's Climate Progress



CENTER FOR BIOLOGICAL DIVERSITY • NOVEMBER 2017

Lead authors: Shaye Wolf, PhD and Kassie Siegel. Contributions from Brian Nowicki, Jean Su, Kevin Bundy, John Fleming, PhD, Rebecca Fuoco, and Patrick Sullivan. All are with the Center for Biological Diversity.

This report is dedicated to the memory of Rosemarie Braz, August 4, 1961-May 3, 2017. As the Center's Climate Campaign Director from 2009 until her death, Rose launched and led campaigns to end fracking and oil production in California and fought for climate justice worldwide.

The Center for Biological Diversity is a national, nonprofit conservation organization dedicated to the protection of endangered species and wild places.

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Cover and inset image: Inglewood Oil Field © Gary Kavanagh 2017.

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Executive Summary

California has positioned itself as a global leader on climate change and is pushing its approach as a model for the rest of the world to follow. Yet few people realize that California is the nation's third-largest oil-producing state and extracts vast quantities of some of the planet's heaviest and most climate-polluting oil.

For this analysis, we used lifecycle emissions estimates for California crude oils and state oilfield data to answer two key questions:

- How dirty is California's current crude oil production?
- How dirty are California's remaining crude oil reserves?

We found that three-quarters of the state's current oil production is composed of very dirty crude that rivals Canada's tar sands crude and diluted bitumen in terms of its lifecycle greenhouse gas emissions and climate impacts.

Nearly two-thirds of remaining oil reserves in 18 of the largest oil fields in the San Joaquin and Los Angeles Basins are also very dirty, totaling 6.1 billion barrels of particularly climate-damaging crude.

A major reason why California's heavy oil is so climate-damaging is that pumping it from the ground requires energy-intensive extreme-extraction techniques such as cyclic steaming, steam flooding, waterflooding, and fracking. Refining California's heavy oils also produces large amounts of petcoke, a toxic byproduct that is worse for the climate than coal when burned.

California's dirty oil production releases pollutants to the air, water, and soil that threaten the health of surrounding communities. Many of the state's oil fields operate in densely populated areas, meaning that oil drilling occurs dangerously close to millions of Californians. Of particular concern, oil drilling in California occurs disproportionally in communities of color already suffering from severe environmental pollution.

To date, Governor Brown and California's climate policies have not only failed to reduce dirty crude production but have actually incentivized oil production overall. From subsidizing oil and gas development to weak regulation, California has rolled out the red carpet for oil companies.

This report demonstrates how the Golden State's laissez-faire approach to oil drilling stifles real climate progress. We lay out urgently needed steps to ramp down California's dirty oil production.

California must develop a plan for a just transition to 100 percent clean energy that truly protects the climate and our vulnerable communities. Necessary changes include a halt to new drilling and oil field expansion, a ban on fracking and related extreme extraction techniques, establishing buffer zones that prohibit neighborhood drilling, and ending state subsidies to the oil industry.

These actions should be taken immediately, while working to phase out all oil and gas production within the next several decades. If implemented, these steps would provide a true model for climate leadership that could be adopted by other governments.

San Ardo Oil Field by Drew Bird Photography

California's Dirty Oil Problem

California is the nation's third-largest oil-producing state.[1] It produces about 200 million barrels of oil per year.[2] Despite the state's climate policies, California oil development is not slowing down. California oil regulators issued 3,303 drilling permits for oil and gas wells in 2015 alone.[3] In 2015, Kern County — the state's largest oil-producing county — projected the development of approximately 2,697 new wells per year for the next 20 years and beyond.[4]

Much of the remaining oil in California's largest oil fields is extremely heavy and waterlogged, making it very energy-intensive to pump out of the ground, make flow, and refine. In fact, California is estimated to contain nearly one-half of the country's heavy oil.[5]

Some California crudes are, barrel for barrel, as damaging for the climate as Canadian tar sands crude, according to estimates by experts at the Carnegie Endowment for International Peace.[6] The Carnegie team estimated the lifecycle greenhouse gas emissions for 154 California crude oils including emissions produced during upstream production, midstream refining, and downstream end use of refined products.[7] In a ranking of lifecycle emissions of 75 crudes from around the globe, crude from three of California's largest oil fields — Midway-Sunset, South Belridge, and Wilmington — made the top 10.[8] California oils were the only U.S. oils in the top 10.

Using Carnegie's lifecycle emissions estimates and state oilfield data, we evaluated the carbon intensity of California's current crude oil production and remaining crude oil reserves. We ranked crude oils with lifecycle greenhouse gas emissions of 600 kg CO_2 eq per barrel or more as "very dirty," following Carnegie's ranking of these oils as "critical climate oils" and "high GHG oils."[9]

We found that eight of California's 10 largest producing oil fields[10] — accounting for nearly two-thirds of the state's total oil production[11] — produce very dirty crude with greenhouse gas emissions comparable to Canada's tar sands crude and diluted bitumen.[12] As illustrated in Table 1, of these large oil fields, the giant Midway-Sunset oil field in Kern County and the San Ardo oil field in Monterey County extract the state's most climate-damaging crude oil, followed by the Kern Front field in Kern County, the Coalinga field in Fresno County, and the South Belridge field in Kern County.

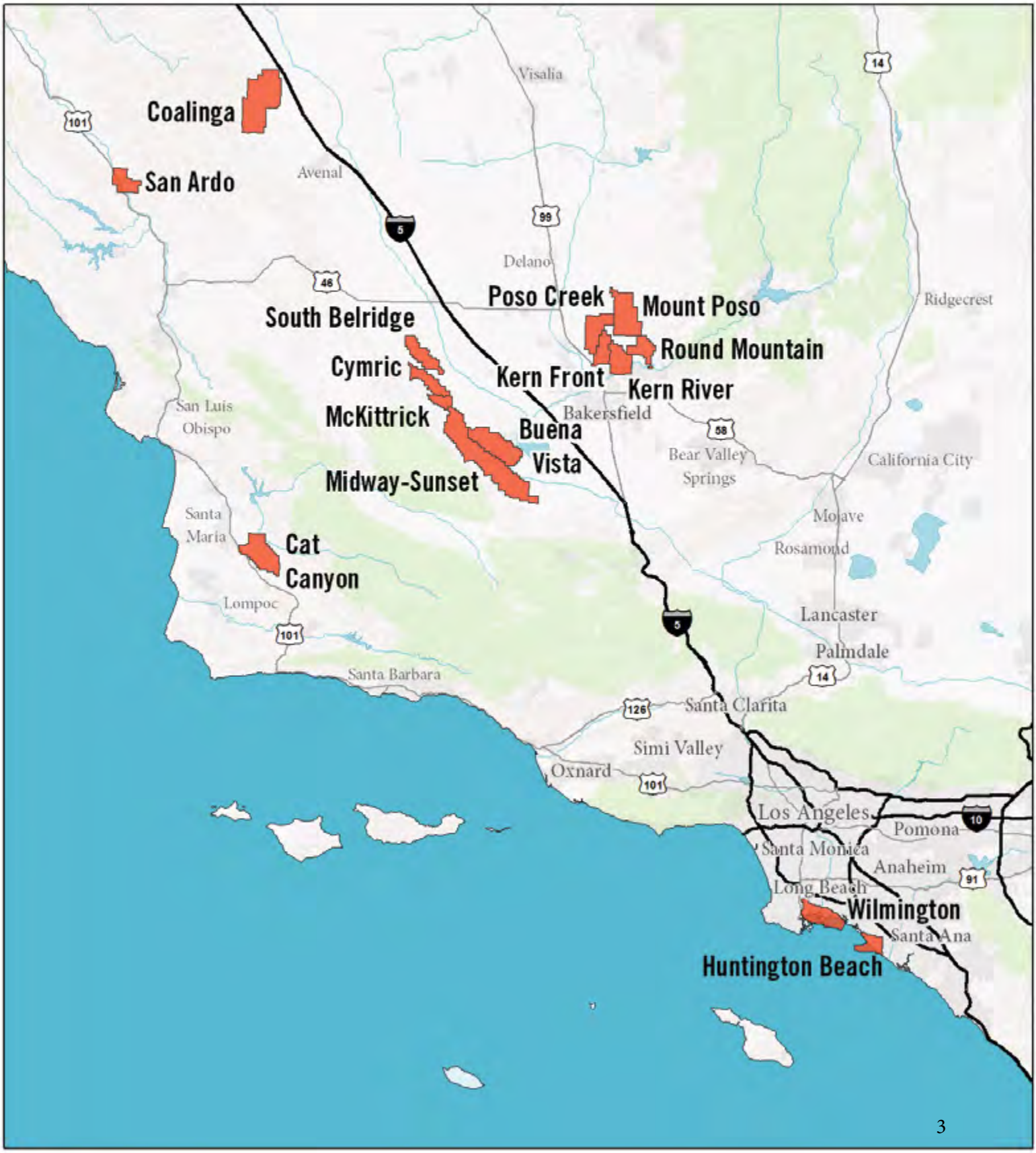
When oil production from all the state's oil fields is analyzed, three-quarters of California's current crude oil production is very dirty, with greenhouse gas emissions comparable to Canada's tar sands crude and diluted bitumen. This very dirty crude oil from 35 oil fields

Table 1. How California's Dirty Crude Compares to Tar Sands Oil: Lifecycle greenhouse gas emissions (kg CO_2 eq per barrel) and current production of crude oil from 8 of California's 10 largest oil fields, compared to lifecycle emissions of Canadian tar sands synthetic crude (i.e., Canada Athabasca SCO) and diluted bitumen (i.e., Canada Cold Lake and Athabasca Dilbit).

Crude origin	Crude type	2016 Oil Production (millions of barrels)	Lifecycle GHG Emissions (kg CO2 eq per barrel)
California	Midway-Sunset	24.69	725-800
California	San Ardo	7.93	760
Alberta, Canada	Canada Athabasca DC SCO		736
Alberta, Canada	Canada Athabasca FC-HC SCO		729
California	Kern Front	4.57	710
California	Coalinga	6.40	700
California	South Belridge	22.55	690
Alberta, Canada	Canada Cold Lake CSS Dilbit		667
California	Kern River	24.28	650
California	Wilmington	12.57	625
Alberta, Canada	Canada Athabasca SAGD Dilbit		601
California	Cymric	16.92	600

Large California Oil Fields Producing the Dirtiest Crude

These 15 California oil fields extract 1 million barrels or more of dirty crude each year that is as climate-damaging as Canadian tar sands crude and release pollutants that are dangerous to the health of surrounding communities. In 2016, these 15 fields extracted 136 million barrels of highly dirty crude.



comprised 72 percent of California's total oil production in 2014, 73 percent in 2015, and 75 percent in 2016.[13]

Comprehensive estimates of recoverable oil reserves in California are not publicly available. However, recent estimates of the remaining recoverable oil reserves in nine of the largest oil fields in the San Joaquin Basin and nine of the largest oil fields in the Los Angeles Basin average 9.5 billion barrels.[14] Of the remaining reserves in these 18 fields, nearly two-thirds — totaling 6.1 billion barrels — are very dirty, with greenhouse gas emissions, barrel for barrel, comparable to Canada's tar sands crude and diluted bitumen.[15]

As illustrated in Table 2, the massive Midway-Sunset oil field in Kern County has the largest remaining volume of very dirty crude, estimated at 1.7 billion barrels, followed by 1.5 billion barrels of very dirty crude in South Belridge, 973 million barrels in Wilmington located in Los Angeles, and 705 million barrels in Coalinga in Fresno County.

Extreme Extraction and Dirty By-products

Many of California's oils have such a high climate impact because it takes a lot of energy to extract heavy crude oil from underground geologic formations. As California's oil fields have become more depleted and waterlogged over time, oil companies

San Ardo Oil Field by Drew Bird Photography

Table 2. California's Huge Reserves of Dirty Oil: Lifecycle greenhouse gas emissions (kg CO_2 eq per barrel) and average remaining reserves in the 10 oil fields in the San Joaquin and Los Angeles Basins with the largest estimated remaining reserves. Crude oils that are particularly dirty (lifecycle emissions of 600 kg CO_2 eq per barrel or more) are highlighted in bold.

California Oilfield	County	Remaining Reserves (millions of barrels)	Lifecycle GHG Emissions (kg CO2 eq per barrel)
Midway-Sunset	Kern	1,655	**725-800**
South Belridge	Kern	1,504	**690**
Lost Hills	Kern	986	540
Wilmington-Belmont	Los Angeles	973	**625**
Coalinga	Fresno	705	**700**
Elk Hills	Kern	548	510
Huntington Beach	Orange	416	**610**
Long Beach	Los Angeles	410	510
Kern River	Kern	332	**650**
Cymric-Welport	Kern	269	**600**

have increasingly used extreme extraction techniques — involving high energy inputs and large volumes of water — to loosen this viscous, heavy crude and push it toward production wells.

Common extraction techniques — including cyclic steam injection, steam flooding, waterflooding, and fracking — are energy and water intensive. They're also dangerous: an oil field worker was killed in the Midway-Sunset field in 2011 when he fell into a sinkhole created by cyclic steam injection.

The Midway-Sunset field — the state's largest producer of dirty crude with the largest remaining reserves of dirty oil — illustrates the growth of extreme extraction in California. This field has been in production since 1894 and has required increasingly large volumes of steam to pump its heavy oil out of the ground. In 2017, more than three quarters of the field's 20,081 active wells used cyclic steam injection (67 percent) or steam flooding (10 percent) for extraction.[16]

In the South Belridge field in Kern County, also a major source of dirty crude, 41 percent of active wells used cyclic steam injection, steam flooding or waterflooding in 2017.[17] Not only does this field rely on large volumes of steam and water for oil recovery, but it also uses the most fracking of any oil field in California. In 2015 alone, 652 fracking events were reported in this field, representing 88 percent of total fracks in the state that year.[18]

As the use of extreme extraction techniques has grown, the energy intensity of oil production in California has risen significantly.[19] Recent analyses found that greenhouse gas emissions (per megajoule of crude) from oil production have increased in the six major California oil fields analyzed: Coalinga, Huntington Beach, Kern River, Midway-Sunset, South Belridge, and Wilmington.[20] In Midway-Sunset, the use of extreme extraction techniques has led to a four-fold increase in production emissions over the past fifty years.[21] As California's oil fields age, the carbon intensity of the state's oil production will continue to grow.[22]

Refining California's heavy oil also produces large amounts of a dirty byproduct called petroleum coke, or petcoke.[23] Petcoke is extremely toxic and climate damaging, emitting more carbon dioxide than coal when burned.[24] Because air quality regulations effectively prohibit the burning of petcoke within the state, California's oil industry exports petcoke abroad[25] where it is burned, harming the climate and public health.[26] Emissions from burning petcoke contribute to the high greenhouse gas footprint of California's heavy oil.

Extreme Extraction Techniques Common in California

Cyclic steam injection: Steam is repeatedly injected into the oil well to heat the crude within the underground formation, allowing it to flow more easily up the well. Cyclic steam injection requires steam generators — essentially huge boilers burning natural gas or other fossil fuels — and transportation of massive quantities of water.

Steam flooding and waterflooding: Large volumes of steam or water, respectively, are pumped into injection wells to loosen the oil and push it towards production wells.

Fracking: Large volumes of water, sand, and chemicals are pumped at high pressures into the rock formation, causing it to crack and release oil and gas.

Health Dangers to Vulnerable Communities

California's dirty oil production not only fuels climate change but also releases pollutants to the air, water, and soil that endanger surrounding communities. Harmful pollutants emitted by oil production include known cancer-causing chemicals like benzene, formaldehyde, and cadmium; smog-forming chemicals like nitrogen oxides, volatile organic compounds, and methane; and particulate matter including diesel exhaust and silica dust that cause lung and heart problems.[27]

Research has found that people living near drilling sites have a higher risk for developing cancer,[28] increased asthma attacks,[29] higher hospitalization rates,[30] and more upper respiratory problems and rashes.[31] Among pregnant women, living closer to drilling sites is associated with a higher risk of having babies with

San Ardo Oil Field by Drew Bird Photography

birth defects,[32] premature births and high-risk pregnancies,[33] and low-birthweight babies.[34]

The health threats from oil production are particularly alarming because many of California's oil fields operate in densely populated areas, meaning that drilling occurs dangerously close to millions of Californians.[35] Furthermore, drilling in California occurs disproportionally in low-income communities and communities of color already suffering from severe environmental pollution.[36]

A recent analysis found that 5.4 million Californians — 14 percent of the state's population — live within a mile of at least one oil and gas well. 1.8 million people live in areas already heavily burdened by environmental pollution, and nearly 92 percent of these residents are people of color.[37] The two largest oil-producing regions in California — the San Joaquin and South Coast air basins — are notorious for having some of the worst ozone and particulate pollution in the nation that threatens the health of local residents.[38]

Inadequate Climate Policies

As the nation's third-largest oil-producing state — extracting some of the most climate-polluting oil on the planet — California cannot be a true climate change leader without addressing the dirty oil production within its borders. To date, however, Governor Brown and California policies have not only failed to tackle our state's oil drilling head on, but have actually encouraged production. These policies undermine our existing greenhouse gas reduction efforts, while hurting our health and environment.

Because climate change is driven primarily by fossil fuel production and combustion, most of the world's fossil fuels must stay in the ground to avoid the worst dangers of climate change.[39] There are more than enough fossil fuels in already developed production fields globally to far exceed targets to limit warming to 1.5°C or even 2°C.[40] Thus, new fossil fuel development and infrastructure is unsafe and unjustified, and fossil fuel production must be phased out globally within the next several decades.[41] The world's wealthiest economies, like California, need to lead the way in ending fossil fuel production.

The production and consumption of fossil fuels are interdependent, as explained by economic principles of supply and demand. When oil production rises, prices tend to fall, demand for and consumption of oil tends to rise, and renewable energy is placed at a disadvantage. Global oil market economic analyses show that increasing oil production increases consumption, while leaving oil in the ground decreases global oil consumption.[42]

Unfortunately, both U.S. and California policies aggressively promote ever greater crude oil production. In 2005, Congress exempted fracking from the Safe

Signal Hill, Greater Los Angeles area, by Harrison Weinberg

Drinking Water Act in legislation known as the "Halliburton Loophole." Thereafter, fracking spread rapidly and facilitated a dramatic increase in U.S. natural gas[43] and crude oil production.[44]

Under intense pressure from the oil industry looking to offload the oil glut, Congress lifted the 40-year old crude oil export ban in December 2015. U.S. crude oil shipments have increased to one million barrels per day.[45] U.S. exports of petcoke, one of the world's dirtiest fuel sources, have also increased dramatically.[46] Today the Energy Information Administration estimates that U.S. crude oil production will hit a record high 9.9 million barrels a day in 2018.[47]

U.S. subsidies are also spurring oil production. A recent study assessing the impact of major federal and state subsidies on oil production found that these subsidies push nearly half of new oil investments into profitability, potentially increasing U.S. oil production by 17 billion barrels over the next few decades.[48] This subsidy-dependent oil could make up as much as 20 percent of U.S. oil production through 2050 under a carbon budget consistent with limiting warming to 2°C.[49]

California policies are also extraordinarily favorable to the oil industry. California subsidizes oil and gas development in several ways, including most notably through the lack of an extraction (or "severance") tax.[50] California and Pennsylvania are the only two fossil-fuel producing states in the country that do not impose a severance tax.[51] This both deprives the state of funds needed to speed a just transition to clean energy, and makes it cheaper for oil companies to produce oil in California.[52]

In addition, California's regulation of oil and gas extraction is in many ways the weakest in the nation.[53] For example, California is one of only a handful of states that allow oil operators to dump wastewater from oil and gas production into dangerous, open, unlined pits.[54]

California regulators also fail to enforce the rules that are on the books. The state has violated the Safe Drinking Water Act for many years, including by allowing thousands of illegal and unsafe waste disposal wells to dump toxic oil waste directly into protected underground drinking water supplies.[55] Currently, hundreds of illegal waste disposal wells continue to operate throughout the state.[56]

California's inadequate oversight of oil and gas extraction encourages further production and benefits the oil industry at the expense of our air, water, and health. While California has fought climate change with one hand, with the other it has propped up the very same oil companies that use their vast profits to fight the state's climate policies and fund climate denial.[57]

In short, phasing out the state's dirty oil production will decrease oil consumption and associated greenhouse gas emissions, resulting in critical climate and health protections in California and beyond.

At the same time, California must also greatly accelerate measures to reduce its oil consumption. California's transportation sector accounts for most of its oil use and nearly 40 percent of the state's greenhouse gas emissions.[58] Currently adopted policies fall far short of meeting the state's goal of cutting petroleum use 50 percent by 2030.[59] Most notably, California has no plan to ban the sale of fossil fuel vehicles or phase out their use. The Golden State lags far behind other countries that have done so. Norway has banned the sale of petroleum vehicles starting in 2025,[60] the Netherlands in 2030,[61] and at least five other countries are in the process of doing so.[62] Paris has announced that petroleum vehicles will no longer be allowed to operate on city center streets in 2030.[63]

California should follow the lead of other countries by banning the sale of fossil fuel vehicles by 2025 and implementing a plan to rapidly phase out fossil fuel vehicle use thereafter.[64] California must also greatly increase investment in public transportation that serves the people who need it most, reducing vehicle miles traveled and improving quality of life for its residents.

Phasing Out California's Dirty Oil Production

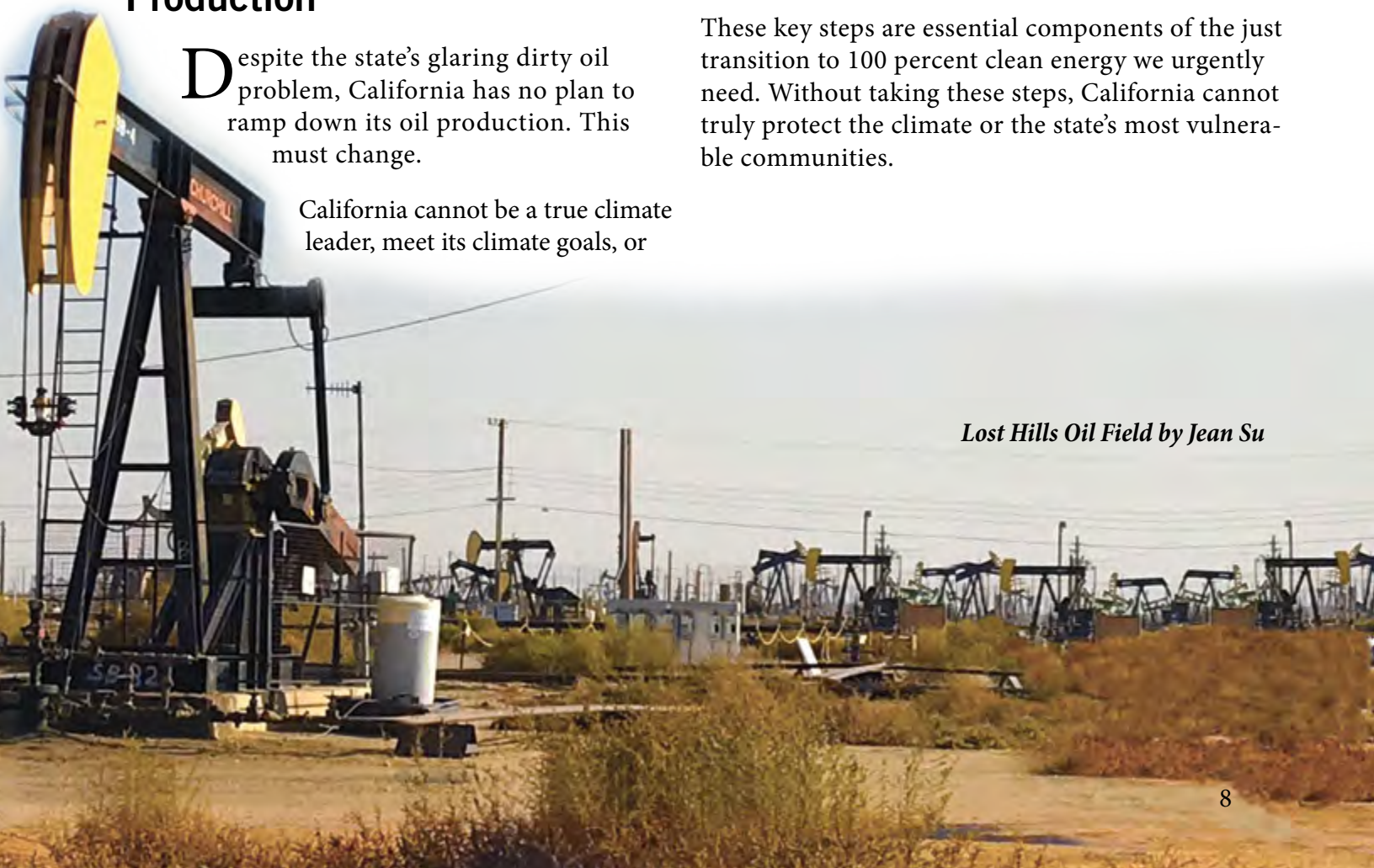
Despite the state's glaring dirty oil problem, California has no plan to ramp down its oil production. This must change.

California cannot be a true climate leader, meet its climate goals, or protect its people without phasing out oil production. California needs to develop a concrete and enforceable plan to end the state's oil production within the next several decades.

Key steps to phase out the state's dirty oil production include:

- An end to new oil development in the state through a halt to permits for new drilling, new fossil fuel infrastructure, and oil field expansion.
- A ban on fracking and related extreme techniques used to extract the state's most climate-polluting oil and other reserves that must stay in the ground.
- The creation of a health and safety buffer prohibiting oil and gas drilling in communities.
- An inventory and elimination of subsidies for oil companies which incentivize the production of oil that would otherwise stay in the ground. Because the money raised through the elimination of these subsidies will decline along with fossil fuel production, these funds should be used for the just transition to clean energy.

These key steps are essential components of the just transition to 100 percent clean energy we urgently need. Without taking these steps, California cannot truly protect the climate or the state's most vulnerable communities.



Lost Hills Oil Field by Jean Su

Supplemental Information

Table 1: Oil Production from California's 35 Dirtiest Oil Fields.

Table 2: Remaining Oil Reserves in 18 Large Oil Fields in the San Joaquin and Los Angeles Basins.

Endnotes

[1] U.S. Energy Information Administration, California State Profile and Energy Estimates (October 19, 2017), *available at* https://www.eia.gov/state/?sid=CA.

[2] California oil fields produced 201.7 million barrels of oil in 2015, 205.4 million barrels in 2014, and 199.6 million barrels in 2013. *Source:* Division of Oil, Gas, and Geothermal Resources (DOGGR), 2015 Report of California Oil and Gas Production Statistics, Department of Conservation (April 2016), *available at* ftp://ftp.consrv.ca.gov/pub/oil/annual_reports/2015/PR03_2015.pdf.

[3] Division of Oil, Gas, and Geothermal Resources (DOGGR), Weekly Summary, Notices Received and Permits Issued to Drill, Rework, and Abandon Wells, Issue No. 5226 (December 26, 2015). *See* Oil & Gas Permits Issued, Drill, Total to Date, 2015, OG, *available at* ftp://ftp.consrv.ca.gov/pub/oil/weekly_summary/2015/12-26-2015.pdf.

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[5] Independent Petroleum Association of America, The Story of California Crude (2017), *available at* http://oilindependents.org/the-story-of-california-crude/.

[6] Gordon, Deborah & Samuel Wojcicki, Need to Know: the Case for Oil Transparency in California, Carnegie Endowment for International Peace (March 15, 2017), *available at* http://carnegieendowment.org/2017/03/15/need-to-know-case-for-oil-transparency-in-california-pub-68166.

[7] See reference 6.

[8] The crude from California's largest oil field, Midway-Sunset, ranked third out of 75, making it one of the world's highest greenhouse gas emitters, followed by South Belridge in sixth place and Wilmington in tenth place. Louisiana's Lake Washington Field was the next closest, tied for 17th place. *Source:* Carnegie Endowment for International Peace, Oil-Climate Index, Viewing Total Emissions, Total Estimated GHG Emissions and Production Volumes for 75 OCI Test Oils (2017), *available at* http://oci.carnegieendowment.org/#total-emissions. *See also* Profiling Emissions in the Supply Chain at http://oci.carnegieendowment.org/#supply-chain.

[9] Gordon, Deborah & Samuel Wojcicki, Need to Know: the Case for Oil Transparency in California, Carnegie Endowment for International Peace (March 15, 2017), *available at* http://carnegieendowment.org/2017/03/15/need-to-know-case-for-oil-transparency-in-california-pub-68166.

[10] We used oil field production volumes from the 2016 report on California oil and gas statistics from the Division of Oil, Gas, and Geothermal Resources (DOGGR). *Source:* Division of Oil, Gas, and Geothermal Resources (DOGGR), 2016 Report of California Oil and Gas Production Statistics, Department of Conservation (September 2017), *available at* ftp://ftp.consrv.ca.gov/pub/oil/annual_reports/2016/2016_Annual_Report_Final_Corrected.pdf.

[11] In 2016 oil production from the 8 largest oil fields producing very dirty crude was 64 percent of total onshore and offshore state oil production (119.91 million barrels out of 186.7 million barrels). *Source:* Division of Oil, Gas, and Geothermal Resources (DOGGR), 2016 Report of California Oil and Gas Production Statistics, Department of Conservation (September 2017), *available at* ftp://ftp.consrv.ca.gov/pub/oil/annual_reports/2016/2016_Annual_Report_Final_Corrected.pdf.

Similarly, in 2015, oil production from the 8 largest oil fields producing very dirty oil was 63 percent of total state oil production (126.6 million barrels out of 201.7 million barrels). *Source:* Division of Oil, Gas, and Geothermal Resources (DOGGR), 2015 Report of California Oil and Gas Production Statistics, Department of Conservation (April 2016), *available at* ftp://ftp.consrv.ca.gov/pub/oil/annual_reports/2015/PR03_2015.pdf.

[12] Bitumen produced from Canada's tar sands must be diluted in order to flow through pipelines; the diluted bitumen product is called dilbit. Canadian tar sands synthetic crudes have lifecycle greenhouse gas emissions of 729 and 736 kg CO_2 eq per barrel, while Canadian tar sands dilbits have lifecycle greenhouse gas emissions of 601 and 667 kg CO_2 eq per barrel. *Source:* Carnegie Endowment for International Peace, Oil-Climate Index, Profiling Emissions in the Supply Chain (2017), available at http://oci.carnegieendowment.org/#supply-chain.

[13] *See* Supplemental Table 1. Based on lifecycle emissions estimates, 35 of 154 California oil fields produce very dirty crude with lifecycle greenhouse gas emissions of 600 kg CO_2 eq per barrel or more. *Source:* Gordon, Deborah & Samuel Wojcicki, Provisional OCI Results, California Oils (March 15, 2017), *available at* http://carnegieendowment.org/files/154_CA_Oils_Provisional_Results.pdf.

Using oil field production volumes from DOGGR annual reports, oil production from the 35 fields with very dirty crude totaled 139.7 million barrels in 2016 (75 percent of 186.7 million barrels total); 148.1 million barrels in 2015 (73 percent of 201.7 million barrels total); and 148.0 million barrels in 2014 (72 percent of 205.4 million barrels total). *Sources:* Division of Oil, Gas, and Geothermal Resources (DOGGR), 2014 Preliminary Report of California Oil and Gas Production Statistics, Department of Conservation (July 2015), *available at* ftp://ftp.consrv.ca.gov/pub/oil/annual_reports/2014/PR03_PreAnnual_2014.pdf; Division of Oil, Gas, and Geothermal Resources (DOGGR), 2015 Report of California Oil and Gas Production Statistics, Department of Conservation (April 2016), *available at* ftp://ftp.consrv.ca.gov/pub/oil/annual_reports/2015/PR03_2015.pdf; Division of Oil, Gas, and Geothermal Resources (DOGGR), 2016 Report of California Oil and Gas Production Statistics, Department of Conservation (September 2017), *available at* ftp://ftp.consrv.ca.gov/pub/oil/annual_reports/2016/2016_Annual_Report_Final_Corrected.pdf.

[14] The U.S. Geological Survey provides recent estimates of remaining recoverable oil reserves in the following reports: Tennyson, Marilyn E. et al., Assessment of Remaining Recoverable Oil in Selected Major Oil Fields of the San Joaquin Basin, California: U.S. Geological Survey Fact Sheet 2012–3050, 2 p. (2012), *available at* https://pubs.usgs.gov/fs/2012/3050; Gautier, Donald L. et al., Remaining Recoverable Petroleum in Ten Giant Oil Fields of the Los Angeles Basin, Southern California: U.S. Geological Survey Fact Sheet 2012–3120, v. 1.1, 2 p. (2012, revised 2013), *available at* https://pubs.usgs.gov/fs/2012/3120/. We excluded the Dominguez Hills oil field in the LA Basin from our analysis since lifecycle GHG emissions estimates are not available for the oil from this field.

[15] *See* Supplemental Table 2. Crude oil reserves in 8 of 18 large fields were very dirty, with lifecycle greenhouse gas emissions of 600 kg CO_2 eq per barrel or more, including the following fields: Midway-Sunset, South Belridge, Wilmington-Belmont, Coalinga, Huntington Beach, Kern River, Cymric-Welport, and McKittrick.

[16] Division of Oil, Gas and Geothermal Resources (DOGGR), Well Search online database (2017), *available at* https://secure.conservation.ca.gov/WellSearch/. On September 26, 2017, data were downloaded for all active wells in the Midway-Sunset oil field, totaling 20,081 wells, using the DOGGR Well Search database. We searched under the "Pool Well-Types" field for the number of wells that used cyclic steam injection coded as "SC" or steam flooding coded as "SF." We identified 13,410 wells (67 percent of total wells) classified as using cyclic steam injection and 2,089 wells (10 percent of total wells) classified as using steam flooding.

[17] Division of Oil, Gas and Geothermal Resources (DOGGR), Well Search online database (2017), *available at* https://secure.conservation.ca.gov/WellSearch/. On September 26, 2017, data were downloaded for all active wells in the South Belridge oil field, totaling 12,944 wells, using the DOGGR Well Search database. We searched under the "Pool Well-Types" field for the number of wells that used cyclic steam injection coded as "SC," steam flooding coded as "SF," or waterflooding coded as "WF." We identified 1,536 wells (12 percent of total wells) classified as using cyclic steam injection; 2,142 wells (17 percent of total wells) classified as using steam flooding; and 1,618 wells (13 percent of total wells) classified as using waterflooding.

[18] Division of Oil, Gas and Geothermal Resources (DOGGR), Well Stimulation Treatment Disclosure Search database (2017), *available at* https://secure.conservation.ca.gov/WSTDisclosure. On September 27, 2017, all data were downloaded from the state-mandated fracking disclosures database, starting in 2014. In the South Belridge oil field, 406 fracking events occurred in 2014 (62 percent of 655 total fracking events), 652 fracking events in 2015 (88 percent of 741 total events), and 137 fracking events in 2016 (93 percent of 147 total events).

[19] Most of the increase in energy intensity is due to the increasing use of steam-based extraction, and to a lesser extent due

to the higher water content of oil which requires more energy for pumping and separating. *Source:* Brandt, Adam R, Oil Depletion and the Energy Efficiency of Oil Production: the Case of California, 3 Sustainability 1833 (2011).

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[24] Petroleum coke produces more CO_2, CH_4, and N_2O per short ton than coal when combusted. *Source:* U.S. Environmental Protection Agency, Emissions Factors for Greenhouse Gas Inventories, Last Modified 19 November 2015, v2 (2017), *available at* https://www.epa.gov/sites/production/files/2016-09/documents/emission-factors_nov_2015_v2.pdf.

[25] The West Coast (PADD 5) in 2016 produced 54.3 million barrels of petroleum coke and exported 42.9 million barrels of petroleum coke. *Source:* U.S. Energy Information Administration, Petroleum Coke Supply and Disposition (2017), *available at* https://www.eia.gov/dnav/pet/pet_sum_snd_a_eppc_mbbl_a_cur.htm.

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[37] Of the 1.8 million residents living within one mile of oil and gas development and in communities identified as most vulnerable by CalEnviroScreen 2.0, nearly 92 percent are people of color: 69 percent Hispanic/Latino, 10 percent African American, 11 percent Asian, and 2 percent Other. *Source:* Srebotnjak, Tanya & Miriam Rotkin-Ellman, Drilling in California: Who's at Risk?, Natural Resources Defense Council (October 2014), *available at* https://www.nrdc.org/sites/default/files/california-fracking-risks-report.pdf.

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[39] The Intergovernmental Panel on Climate Change estimates that global fossil fuel reserves exceed the remaining 270 GtC carbon budget (from 2012 onward) for staying below 2°C by 4 to 7 times, while fossil fuel resources exceed the carbon budget for 2°C by 31 to 50 times. *Source:* Bruckner, Thomas et al., 2014: Energy Systems, *In* Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, at Table 7.2, *available at* https://www.ipcc.ch/pdf/assessment-report/ar5/wg3/ipcc_wg3_ar5_chapter7.pdf. Other studies indicate that 80 percent (Carbon Tracker Initiative 2013), 76 percent (Raupach et al. 2014), and 68 percent (Oil Change International 2016) of global fossil fuel reserves must stay in the ground to limit warming to 2°C based on a 1,000 $GtCO_2$ carbon budget from 2011 onward. *Sources:* Carbon Tracker Initiative, Unburnable Carbon – Are the World's Financial Markets Carrying a Carbon Bubble? (2013), *available at* http://www.carbontracker.org/wp-content/uploads/2014/09/Unburnable-Carbon-Full-rev2-1.pdf; Raupach, Michael et al., Sharing a Quota on Cumulative Carbon Emissions, 4 Nature Climate Change 873 (2014); Oil Change International, The Sky's Limit: Why the Paris Climate Goals Require a Managed Decline of Fossil Fuel Production (September 2016), *available at* http://priceofoil.org/2016/09/22/the-skys-limit-report/.

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