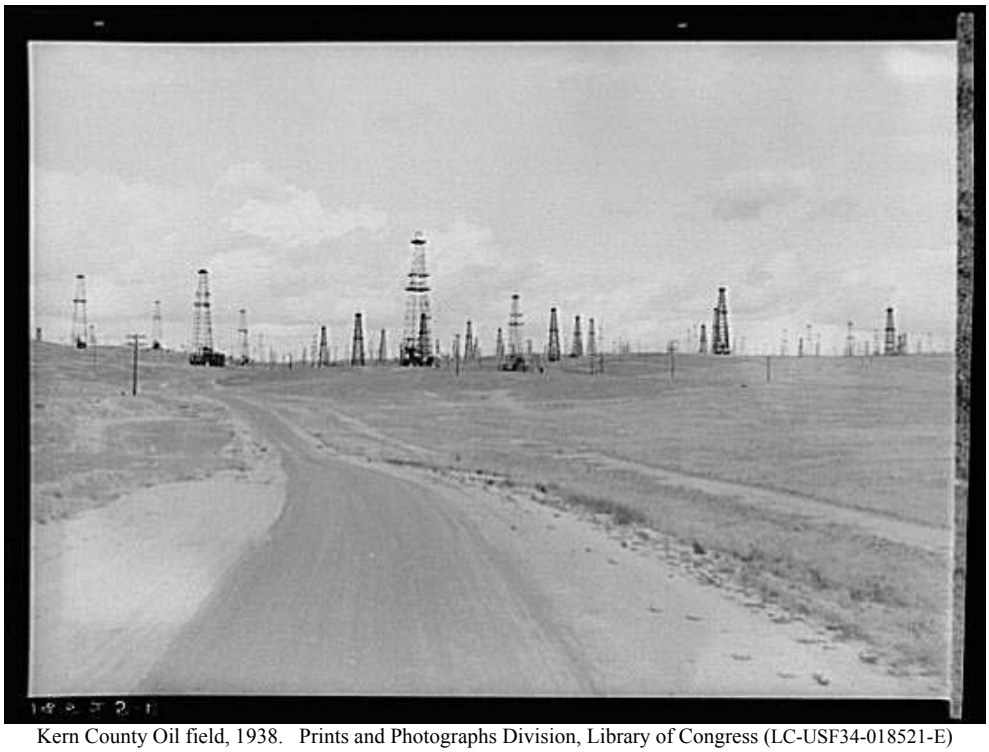
Bottom of the Barrel:
The Hidden Costs of Petroleum Use in California



Kern County Oil field, 1938. Prints and Photographs Division, Library of Congress (LC-USF34-018521-E)

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The complete report is available on line at www.sierraclub.org/ca/oilreport and www.ceert.org

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Report Updates: This report presents a current snapshot of findings from a research project in progress. CEERT continues to work with others in public health, environmental, and scientific fields to assess and report on the true impacts and costs of our over reliance on petroleum for transportation fuels. Much work remains to be done to refine the definitition and scope of those impacts. As such, this report will be revised as additional information becomes available. Readers are encouraged to refer to the most current updated report on our website at: http://www.ceert.org.

Executive Summary

The weekly trip to the gas station has become a vivid reminder of the increasing cost of oil. But the cost of California's oil addiction goes far beyond the price at the pump and is paid by each Californian in the form of air quality impacts, congestion in our cities, health care related to pollution, national defense spending to maintain access to foreign resources, global warming and other environmental damage. Perhaps the biggest price is a political system that serves the oil companies before the people of California. This political power is wielded in ways which prevent California, the largest consumer of gasoline in the United States, from escaping from the grip of its fossil fuel monopoly.

Though the total bill for California has not been calculated, the impact to our people, our environment, and the economy is clearly massive, and easily reaches into the billions of dollars per year. The oil companies do their best to hide these facts and deflect the blame onto others but the answer to many of these problems lies in finding alternatives to oil.

The Economic Costs

The economic costs of oil addiction filter through our entire economy, affecting all of California's citizens. California consumes far more gasoline than any other state; so much gasoline in fact that every penny increase in a gallon of gas costs the state's consumers roughly $160 million last year. The magnitude of such a cost sets our state up for massive economic shocks as oil and petroleum supplies become more constrained. Put another way, between 2004 and 2005 the average price of gasoline in California went up 35 cents, which cost the state's consumers roughly an additional $5.5 billion dollars in that one year. That's $5.5 billion dollars going to the oil companies from the pockets of Californians. The record $39.3 billion Californians spent on gasoline in 2005 is sure to be eclipsed again this year with the average price running another 39 cents higher.

Our transportation system also has huge economic costs. In Los Angeles one of the nation's most crowded and polluted cities, traffic congestion costs the average rush hour driver $1,598 per year, and adds up to $10.6 billion for the cities commuters as a whole. Across all of California's major metropolitan areas these costs added up to a whopping $17.3 billion in 2003. Even with regional planning incorporating smart land use there is a cost. Work conducted for the six county Sacramento Area Council of Governments determined that the total hidden costs of transportation in 2025 would be an estimated $2.5 billion and $9.5 billion per year. California has 58 counties and the cumulative for the state cost will certainly be enormous.

Health Impacts

The California Air Resources Board estimates that hospitalizing and treating patients for illnesses related to air pollution exposure in the state costs the state of California roughly $2.3 billion per year. The Board also estimates that the state spends $70 billion a year in order to prevent premature deaths linked to air pollution exposure in excess of the State's particulate matter (PM) and ozone standards.

Looked at on a regional basis, poor air quality can have huge impacts on the state's most polluted air basins. In the San Joaquin Valley, home to some of the state's poorest communities, impacts from oil industry related pollution cost residents roughly $3 billion per year. The air district has estimated that the cost of fixing this problem in the San Joaquin Valley would cost $7.5 billion over the next 6 years.

Environmental Impacts

Clearly the biggest environmental threat posed by our addiction to oil comes from global warming. As a consequence transportation accounts for nearly half of California's total energy use and represents the largest source of greenhouse gasses in the state, at slightly more than 40% of the state's total emissions. The global warming implications for California are catastrophic and the true cost of this impact may not be known for generations. California will become hotter and the health of Californian's and their environment will suffer. Winters will become shorter, wetter, and stormier, and summers will become longer, hotter and drier. California's agricultural industry will be placed under stress. California's coasts will be put at risk and its fisheries threatened. The list goes on.

The environmental impact from the refining industry is particularly harsh. California's refineries are the largest generators of industrial hazardous waste in the state, with the 17 largest facilities producing nearly 13 million tons of hazardous waste in 2002. But the impacts go beyond this into the surrounding neighborhoods. The South Coast Air Quality Management District reported 996 public complaints of odors, smoke, and oil fallout, alleging refinery sources in calendar years 2003 and 2004; an average of more than one a day.

Problems with the nation's pipelines also causes significant environmental harm yet receives almost no headlines like the ones written for the recent shutdown of the BP pipeline in Alaska. According to the Office of Pipeline Safety (OPS), roughly 6.7 million gallons are spilled from pipelines per year. That is equal to half the Exxon Valdez each year. In 2006 after only nine months of reporting we have already spilled more than 8 million gallons. Similar spillage occurs along our treasured coasts where oil is extracted and in our ports where the oil is unloaded from tankers.

Cost to Our Political Process

Oil companies are simply willing to spend what it takes to remain top dog inside the Capitol and in campaign politics. Their efforts in California and in Washington, DC have kept alternative fuels hovering at only 6% of transportation fuel supplies. While environmental and public health groups have repeatedly developed policies for conservation and development of alternatives, the oil companies have continued to find ways stop these measures. This happens in the legislature, at regulatory agencies, in elections and in the courts. Recent news stories have left little doubt about their unrivaled power:

> **The oil and auto industries persuaded (California) to kill or water down the alternative-fuel mandates.** Jeffrey Ball, Wall Street Journal, August 3, 2006
>
> **Oil company lobbyists have helped tie up or kill almost a dozen bills considered hostile to the industry... Backed by profits last year that ran into the billions of dollars, oil giants like Chevron Corp., ConocoPhillips Co. and Occidental Petroleum – all active in California politics – have almost unlimited resources to throw into political campaigns.** Tom Chorneau, San Francisco Chronicle, July 14th, 2006

During the past legislative session the Western States Petroleum Association (WSPA) spent more than $5 million dollars to defeat every piece of meaningful legislation to provide alternative fuels or increase conservation efforts. Most oil companies spend approximately $2 million a year on campaign contributions and lobbying expenses combined. On one initiative the oil industry has spent $68 million in opposition. The incredible spike in political spending, $28 million by Chevron, $24 million by Aera (partnership between Shell and Exxon) has helped set a record for spending on a single campaign. All this begs the question, is there any limit to how much these companies are willing to spend to maintain their monopoly on transportation fuel?

The Solutions

With over $140 billion in profits in 2005 and even more expected there may be no limits to the political resources of the oil industry. While Europe has mandated a 20% reduction in fossil fuel use by 2020, California's energy officials have been left with only making the claim that it could be feasible to achieve a 15% reduction by 2020; if only the state would do something about it. Increased fuel efficiency and alternative fuels could slow demand and increase fuel production capacity if proponents could somehow solve the political problem posed by raw oil industry power. Despite hybrid vehicle technologies, scientific advances that make it possible to "refine" diesel or other transportation fuels from non-fossil fuel sources or what would otherwise be treated as agricultural waste products, consumption of non-petroleum fuels in California has not increased. To put it another way, as a result of industry control of the market and market infrastructure, transportation fuels remain locked in a fossil fuel monopoly safeguarded by billion-dollar-a-month profits and the rawest of political power.

Unless action is taken, the future is frighteningly clear: fuel demand bolstered by population growth and economic activity will place increased pressure on shrinking conventional fossil fuel resources and thus encourage industry to spread its environmentally devastating practices into the world's few remaining undisturbed and pristine ecosystems. In the meantime, the industry will continue to be rewarded with untold profits while gouging consumers and choking the planet with ever increasing levels of air pollutants and global warming emissions. The time has passed by, for well-intended promises, state energy commission "recommendations", and general directives scheduled for far off distant time horizons (assuming we don't run out of fuel before we can get there). Specific hard choices must be made on some basis other than campaign contributions and massive statewide TV buys. This report tells the story of how the state is literally scraping the bottom of California's barrel of oil; its impacts on environmental and public health, and the potential economic consequences of continued reliance on petroleum.

California's transportation system.

Today there are more than 30 million motor vehicles and motorcycles in California using nearly 170,000 miles of public roads to drive more than 400 billion vehicle miles; a distance greater than 2100 trips to the sun and back.♣ At the same time California drivers consumed nearly 20 billion gallons of fuel. This is even with extensive transit systems within the metropolitan areas of the state.[1] California also has more than 1800 miles of coastline, 286 miles of inland waterways, 7,400 miles of rail capable of carrying freight, and 257 public-use airports of which 42 are certified for air carrier operations.[2]

Given California's role as an important gateway to the Pacific Rim and the size and importance of its economy, the ability to transport freight both to and from domestic and foreign markets has been a key element of its economic success. The state has nine container ports, with the combined Port of Los Angeles/ Long Beach being America's busiest moving up to nine million cargo containers through their shared 7500 acre harbor complex.[3] In total there are more than 250,000 vessel trips in California waters each year.[4] More than two thirds of the value of goods shipped from California is transported by truck, and an additional ~20 percent is shipped via courier services, which rely heavily on the road system.[5] All of this transportation demand comes with a huge thirst for transportation fuels, a thirst almost entirely met through the use of fuels based on the extraction and processing of crude petroleum oil.

Petroleum Production and Use in California and Throughout the World

California has 21 facilities (20 that are operational) that qualify as petroleum refineries of which 15 process crude oil for the production of transportation fuels that meet California's strict standards.[6] In-state oil production accounts for slightly less than 40% of the state's consumption of crude oil (roughly 37% of the value of oil sold from in-state refineries), with another 20% coming from Alaska, and the remaining 40% from other countries. Petroleum production in California and Alaska has been in steady decline since the mid to late 1980s and is now at levels last seen in 1943.[7] During that same time in-state demand for transportation fuel has increased by nearly 50%, reaching nearly 16 billion gallons of gasoline, nearly 3 billion gallons of diesel and just under 4 billion gallons of jet fuel in 2005.[8] During 2004 California's crude oil imports were nearly 400 million barrels and, in the absence of any new state policy initiatives, could increase to more than 450 million barrels by 2015 and more than 500 million barrels by 2025.[9]

California is the fourth largest producer of petroleum in the United States[10] and competes with Texas for the status of the largest consumer of petroleum and transportation fuels in America.[11] While there are more than 48,000 productive wells that produced nearly 256 million barrels a year from oil fields throughout 15 California counties,[12] the state's major sources of petroleum production are located in the Kern County region of the southern San Joaquin Valley, the Los Angeles Basin, and in state and federal waters off the coast of Southern California extending from the coast of Santa Barbara County in the north, to Orange County in the South.[13] California has 23 offshore oil platforms and 5 artificial oil and gas islands along its coast, with more than 1,400 actively producing wells. Nineteen of the platforms are more than 3 miles from the coast placing them in Federal waters and under the jurisdiction of the U.S. Department of the

♣ Projections by the California Energy Commission and Public Policy Institute of California indicate that the growth rate in vehicle travel is expected to easily outpace the growth in population.

Interior's Minerals Management Service. The remaining facilities (4 platforms and 5 artificial oil and gas islands) lie within 3 miles of the coast in State waters and are regulated by the California State Lands Commission and the California Department of Conservation's Division of Oil, Gas, and Geothermal Resources.[14]

Like all developed and rapidly developing economies California faces the challenge of meeting its transportation energy demands in the face of increasing international competition for the world's remaining reserves of crude oil.[15] No longer is the competition for the world's petroleum limited to just the developed economies of the world.[16] China alone has been responsible for 40% of the increase in demand for the world's petroleum supplies since 2002,[17] and India — the world's sixth largest importer of crude oil — is fast becoming another major player in the international energy markets.[18]

It may seem obvious that in order for the future energy demand of the world's major economies to be met, there must be supplies sufficient to at least match the forecasted demand. However, it is not at all clear that this demand can be met through conventional sources for very much longer. There is an intense controversy over what the world's conventional oil and gas reserve levels really are,[19]♦ and estimates for proved oil reserves vary widely with most falling in the range of slightly more than 1 trillion barrels.[20] Since oil production first began in the mid to late 1800s, the world has consumed a cumulative total of about 1 trillion barrels,[21] and at the rate the world is currently consuming oil it will take only another 30 years to consume the next trillion barrels.ψ[22] Regardless of whether one subscribes to the view that the world is about to run out of conventional supplies of oil or not,[23] the current market situation is reflective of an inability of current total world production to consistently meet total world demand.[24] According to the International Energy Agency, the oil industry will have to spend more than $3 trillion ($6 trillion if natural gas is included; values in 2004 dollars) for the exploration and development of new resources between 2005 and 2030,[25] and the world's largest oil company has noted that the industry will have to "…add some 100 million oil-equivalent barrels per day by 2015 to meet demand – an amount close to 80 percent of today's production levels".[26] Meanwhile new oil discoveries have been in decline and the costs of exploration have jumped.[27]

While it is clear that transportation and the use of fuels derived from petroleum has served an important role in developing California's economy, it has come with a price. Many California residents feel that that price has been most evident with the recent dramatic increase in the price of crude oil especially during the past two years, from a low of around $30 a barrel to a recent high approaching $80 a barrel,[28] and which they have clearly felt when purchasing fuel at their local gas station.[29] And while Californian's, like most American's, likely feel some relief with the recent decline in the price of fuel they should not fail to recognize that this is likely to be only a temporary respite from continued high oil prices.[30] However, many Californian's may not be aware of another and significant and hidden cost that comes with the use of petroleum for transportation fuel, and that is the hidden cost that is being paid by the environment both in the United States and in California.ϕ Industry practices at the very beginning of the oil discovery process all the way to the fuel pump, come with an enormous environmental cost. Moreover, the latest scientific, medical and economic research is allowing

♦ The dispute is over what can practically and economically be expected to be recoverable in the future.

ψ Assuming no further increase in oil demand. Of course oil demand will continue to increase in which case 1 trillion barrels of conventional proved reserves will not last 30 years.

ϕ Not of course forgetting that these practices are employed with greater or lesser responsibility around the globe

us to develop a better understanding of the impacts that the use of petroleum fuels has on public health.

OIL INDUSTRY PROFITS AND HOW IT USES THEM

While the discovery of new proved reserves continues to decline, the ability of the world's petroleum infrastructure to consistently produce sufficient oil to meet the world's ever growing thirst for more oil is operating at maximum capacity. Global refinery capacity is operating at maximal levels, the global tanker vessel fleet is transporting foreign crude to international market as fast as it can, and oil production is usually running at maximum capacity.[31] Against this backdrop oil prices and oil industry profits and the US trade deficit are at record highs.

The average price of a barrel of crude oil was $46.78 per barrel in 2005.[32] At that price the state's oil companies spent nearly $2billion dollars on crude oil in 2005. Meanwhile the California Energy Commission estimates that the average price of California gasoline was $2.47 per gallon in 2005, placing the cost of gasoline to California consumers at slightly more than $39 billion in 2005.[33] Every 1¢ increase in the price of gasoline costs California consumers just under an additional $160 million at 2005 consumption levels.[34] Oil companies earned gross revenues of $1.62 trillion and net profits of $140 billion in 2005.[35] Seventy-six percent of the gross revenues, and 81% of the net profits were shared between the five largest integrated oil companies: Exxon-Mobil, Royal Dutch-Shell, BP (Amoco-Arco), Chevron, and Conoco Phillips. Exxon-Mobil alone accounted for 25% of the net profits in 2005. Meanwhile the US trade deficit reached almost $726 billion in 2005. Nearly one quarter ($176 billion) of that was to pay for the importation of foreign crude.[36] The 2006 trade deficit is running at a similar pace tracking towards $717 billion. Oil again is being pointed to as an important factor in the deficit. The August trade numbers have been released, and more than $27 billion of the nearly $70 billion dollar deficit in trade that month was due to oil.[37] The increase in the price of oil added $70 billion to the 2005 trade deficit over the previous record setting year. It could add $80-100 billion more in 2006.[38] The average price of a barrel of crude oil was $46.78 per barrel in 2005.[39] At that price the state's oil companies spent nearly $2billion dollars on crude oil in 2005. Meanwhile the California Energy Commission estimates that the average price of California gasoline was $2.47 per gallon in 2005, placing the cost of gasoline to California consumers at slightly more than $39 billion in 2005.[40] Every 1¢ increase in the price of gasoline costs California consumers just under an additional $160 million at 2005 consumption levels.[41]

In recent years there has been a significant consolidation in the US domestic oil industry that in the year 2001[42] resulted in the five largest oil companies in the US controlling:

- 61% of the domestic retail gasoline market,
- 47% of the domestic oil refinery market, and
- 41% of domestic oil exploration and production.

In 2004 the price increases attributed to this industry consolidation were held responsible for a 25% increase in annual household energy bills and a 35% increase in the annual household cost for petroleum products during the previous 4 years (1999-2003).[43] Indeed the Government Accountability Office — the congressional watchdog —found that from the mid-1990s through

2000 the increased market concentration resulting from mergers had generally led to higher wholesale gasoline prices in the United States. For the health-protective reformulated gasolines designed to minimize the air pollution from motor vehicles and sold in the East Coast and Gulf Coast markets, the wholesale price rose by about 1 cent per gallon. Meanwhile, the wholesale price of health protective fuel formulations in California jumped by more than 7 cents per gallon.[44] Notably, seven oil companies — Chevron, Shell, BP, Conoco Phillips, Valero, Tesoro, and ExxonMobil — controlled 98% of California's fuel market in 2004.[45]

There is evidence to suggest that the US and California oil markets could be entering a phase with parallels eerily familiar to Californian's who experienced the market manipulation that occurred during the state's 2000-2001 energy crisis.[46] Referring to a spike in gasoline prices experienced in the Midwest during the Spring of 2000, FTC Chairman Robert Pitofsky noted,

> "The spike appears to have been caused by a mixture of structural and operating decisions made previously (high capacity utilization, low inventory levels, the choice of ethanol as an oxygenate), unexpected occurrences (pipeline breaks, production difficulties), errors by refiners in forecasting industry supply (misestimating supply, slow reactions), and decisions by firms to maximize their profits (curtailing production, keeping available supply off the market). The damage was ultimately limited by the ability of the industry to respond to the price spike within three or four weeks with increased supply of products. However, if the problem was short-term, so too was the resolution, and similar price spikes are capable of replication. Unless gasoline demand abates or refining capacity grows, price spikes are likely to occur in the future in the Midwest and other areas of the country."[47]

An industry survey similarly found evidence for oil companies allowing conditions to develop that worked to maintain tight supplies with the result that shortfalls led to increased profits,

> "Increasing capacity and output to gain market share or to offset the cost of regulatory upgrades is now frowned upon."
>
> "Indeed, many"…"discussants openly questioned the once-universal imperative of a refinery not 'going short' – that is not having enough product to meet market demand. Rather than investing in and operating refineries to ensure that markets are fully supplied all the time, refiners suggested that they were focusing first on ensuring that their branded retailers are adequately supplied by curtailing sales to wholesale markets if needed."[48]

Keeping capacity tight serves to ensure that the few players that remain in the market are almost always assured a profit, even when "mistakes" occur.[49] This appears to also hold true for the California market. The Office of California's Attorney General determined in its investigation into the state's nation-beating high pump prices that, "refiners maintain lower inventory levels relative to consumption than refiners in the rest of the United States and have reduced inventories in recent years."[50] The Energy Commission has since found that: unscheduled refinery outages, congestion at marine ports and in the pipeline system led to fuel feedstock shortages that in turn contributed to markedly increased prices during the spring of 2006.[51] A

recent investigation revealed that refinery margins have been slowly increasing even while costs to consumers have been going up.[52]

The International Energy Agency (IEA) urged in 2003 that oil companies must significantly increase their total investments in exploration and development if they were to meet the long-term growth in demand for crude oil in the coming decades.[53] It has repeated this call to arms every year since and recommends that the industry invest an average of $120 billion per year ($240 billion if natural gas is included) in exploration and development between 2005 and 2025 in order to keep pace with anticipated demand.[54] Despite this the largest oil companies have undertaken further acquisitions of either their smaller international competitors or their competitors' proved reserves. This is in order to increase their individual reserve holdings but does nothing to supplement the world's total of new reserves. This pattern continues today. Expenditures on acquisitions of reserves set new records in 2005, rising 13% to reach $54 billion. Despite this, oil companies found themselves so flush with cash that rather than increasing their budgets for either exploration, or environmental cleanup, they funneled $128 billion to dividends and stock buybacks. Expenditures on stock buybacks exceeded those for acquisition of proved reserve by almost 20%, and were nearly 80% higher than spending on exploration last year.[55] While total spending on exploration reached a record $36 billion in 2005. At 13% of total spending it represented the smallest share of industry investment in this area since 2001 when spending on exploration was at 15%.

When challenged on its low investments in exploration, the petroleum industry protests in its defense that it is prevented from making greater exploration efforts because the governments of nations holding the largest reserves block it's access.[56] Meanwhile, the national oil companies of countries like China, Russia, India… and soon Pakistan, are moving aggressively forward in developing new resources of this "strategic commodity". At the same time they are competing with the major oil companies for already developed reserves.

Despite acknowledging that it faces the challenges of developing new reserves, the oil industry works aggressively to prevent governments from adopting policies that might increase fuel diversity, and thus consumer choice, and at the same time reduce our dependence on petroleum. In California the oil industry argues that mandates don't work. Yet they expect Californian's to accept that operating under current market conditions is anything other than an oil industry mandate.

Since the year 2000, the oil and gas industry has spent nearly $100 million on contributions to federal election campaigns with an average of 80% of the contributions going to members of the Republican party.[57] If funds formerly accounted for before the Federal Elections Reform Act (Bipartisan Campaign Reform Act) of 2002 were included this total would likely be found to exceed $100 million.[58] Oil companies contributed at least $60 million dollars directly to state election campaigns across the country between 1999 and 2004. Only 18% of the state election campaigns that they helped to fund were unsuccessful. California political contributions totaled nearly $7.4 million during these years.[59] During the last two elections alone, the oil and gas industry contributed $7.3 million towards election campaigns.[60]§

One fruit of the oil companies' largesse at the federal level was the inclusion of provisions in the 2005 Federal Energy Policy Act (2005 EPACT) that provided the oil and gas industry with nearly $6 billion in subsidies.[61] This, while the industry was collecting the largest

§ Total contributions to date for 2006 = $2,544,357
Total contributions for 2004 = $4,777,686

profits recorded in corporate history. A curious aspect of the 2005 EPACT is that it contains a provision wherein oil companies do not need to compensate taxpayers with cash royalties, rather they can provide some amount of the extracted oil as an in-kind contribution to the federal government. This program already existed before 2005, but has been extended as a result of the EPACT. More than one third of the oil and gas produced in the United States comes from federal lands. There is a concern that, if this program were to expand that it could significantly and negatively impact the federal treasury. The Government Accountability Office estimates that depending on the outcome of a pending lawsuit against the federal government the program could end up costing taxpayers as much as $80 billion in lost royalties.[62]

THE IMPACTS CAUSED BY THE USE OF OIL

While California's world-leading environmental regulations have done much to try to mitigate the impacts of its resource use, the use of fuels derived from petroleum still come with large hidden monetary costs, ranging from the impacts on wild public lands, to food prices resulting from damage to the productivity of California's agriculture and our coastal ecosystems including our commercial fisheries. The hidden costs also include:

- lost worker productivity resulting from sick days brought on by poor air quality, and
- the increased health insurance premiums under our private health insurance plans and the federal and state taxes we pay to support the MediCare and MediCal programs in order to cover the costs of treatment for those suffering from asthma and other respiratory diseases as well as
- the cancer's attributable to the use and combustion of these fuels (especially the particulates from the burning of diesel fuel).

Not all of these costs are or can be easily put into dollar terms. However, as this survey shows, there are still other real and serious costs attributable to the use of gasoline and other petroleum based fuels.

CALIFORNIA'S AIR QUALITY

California has the Nation's most polluted air. According to the state Air Resources Board nearly 90% of Californians breathe unhealthy air during some part of the year. The key challenge that faces Californian's is in how to reduce the emissions of pollutants that give rise to particulate matter, smog and ozone. Smog results when chemical pollutants in the air react with each other. Both the chemical pollutants and their reaction products can be harmful to human health. The chemical pollutants most responsible for smog and ozone formation are oxides of nitrogen (NOx) and oxides of sulfur (SOx) — produced by motor vehicle engines and other combustion sources — and volatile organic compounds (VOCs). As outlined above: the production, transportation and use of petroleum and petroleum products are a primary source of these air pollutants. Increased temperatures under climate change — largely a product of the use of transportation fuels as previously noted — will increase the rate of release of VOCs. These increased temperatures will also accelerate the rate of the reactions that produce smog and

ozone. Thus warming due to climate change would not only increase the supply of the chemical pollutants, but also the rate at which they react. SOx compounds contribute to the formation of secondary particulate compounds when they react with other pollutants in the air, and can irritate the lining of a person's airways if breathed-in directly. The SOx compounds can react with the moisture in the mucous lining of the airways to form a very powerful acid (sulfuric acid). This same reaction can occur in the air, thereby contributing to acid rain. Direct contact with SOx compounds and they're reaction products can cause serious health problems for those suffering from asthma, or in those individuals with compromised heart and lung function. NOx compounds pose similar challenges to human and environmental health as the SOx compounds. They can similarly form a powerful acid — nitric acid — if breathed directly into the lungs. The particulate compounds formed when NOx reacts with other compounds in the air can likewise pose a challenge to the health of individuals. Ozone is one of the most dangerous compounds produced during the formation of smog. It is a free-radical compound; one of the most highly reactive chemical compounds recognized by the science of chemistry. High concentrations of ozone can be dangerous at ground-level. There is a strong association between: daily mortality, particulate matter concentration, and ozone levels. Warming due to climate change will worsen this problem.

The Los Angeles area has been affected by high ground-level ozone levels for more than half a century. Its air still ranks as some of the worst in the nation. About 70% of Los Angeles's smog comes from mobile sources such as the region's 11 million cars and trucks, agricultural and construction equipment, and gasoline-powered lawn and garden equipment. California's San Joaquin Valley has also joined the notorious and exclusive club of regions with the Nation's worst air (Houston is the remaining member), being in extreme non-attainment for both ozone and fine particulate matter. Most California counties are in various levels of non-attainment for either ozone or particulate matter.[63] Consequently, California has the tightest restrictions on vehicle emissions in the nation.

Nearly five million California residents have asthma, and nearly 1.5 million of them are children. It is the leading cause of school absenteeism. Ozone is of special concern for asthmatics. High ozone levels increases the number of asthma attacks, the need for medication and other medical treatment, and results in more hospital admissions and emergency room visits for asthmatics. There are now 160,000 California children hospitalized due to asthma every year.[64] There are also challenges for adults with asthma. The California Health Interview Survey has found that adults exposed to medium and high levels of traffic have an of 40 percent and 80 percent increased likelihood of daily or weekly asthma symptoms respectively, compared to exposure during low level traffic conditions.[65] In 2002 almost three quarters of a million Californiansδ experienced asthma symptoms every day or week, indicating a chronic exposure to environmental triggers.[66] Exposure to traffic has also been associated with an increased risk of heart attacks in those with heart disease.[67]

Plants are also susceptible to the damaging effects of ozone. Just as it can damage lung tissue, it can damage the delicate tissues within the interiors of leaves, and can lead to reduced agricultural yields (especially in foliage crops and cotton), and reduce the health of landscape and wild vegetation.[68] The damaging effects of ozone on plants were in fact first discovered in Los Angeles in the mid-1940s after the link was made between high ozone levels and repeated

δ The number is now likely much higher. In 2002 — as part of this same study — 667,000 children were noted as having asthma. The number of children acknowledged as having asthma has since more than doubled.

injury to vegetable crops.[69]

Fine particulate matter (1/100th the width of a human hair) is of particular concern, not only because it can penetrate deep into the lungs, but also because there are few places where it can be avoided in densely populated urban environments. The particles are so fine that they can enter any indoor living space. Patient admission rates to hospitals among elderly and children for respiratory and cardiac problems increase when concentrations of particulate matter rise. Even at levels below federal air quality standards, particulate matter has been shown to trigger heart attacks in people who are obese, inactive, or have a history of heart problems. Infants living in cities with high levels of fine particles have a 26% greater chance of sudden infant death syndrome (SIDS), and infants exposed to high levels of air pollution are 40% more likely to die of respiratory causes.[70]

According to the American Lung Association and based on California Air Resources Board data, combined exposure to particulate matter and ozone in California is estimated to lead to 7100 premature deaths per year; a rate nearly twice that of traffic accidents (3,200 deaths per year) and comparable to that caused by second-hand smoke (4,200 – 7,400 deaths per year). Continuous exposure to high levels of particulate matter shortens life-span by an estimated 14 years.[71] Chronic exposure to elevated levels of ozone has been linked to the onset of asthma in children.[72] Those continuously exposed to high levels of particulate matter run the same risk of developing lung cancer as non-smokers exposed to second-hand cigarette smoke.[73] Recent epidemiological work indicates that the magnitude of past mortality estimates related to particulate matter exposure may be significantly underestimated; by as much as 2 to 3 times.[74] Thus these estimates of total mortality are likely to be revised substantially higher.

The California Air Resources Board provided revised estimates for the annual health impact from exposure solely to ozone and at levels currently experienced in California.[75] These comparisons were against attainment levels for the proposed State 8-hour and 1-hour ozone standards throughout California. The estimates indicate that — for ozone exposure alone — there will be:

- 4,200 hospitalizations due to respiratory diseases for all ages.
- 660 emergency room visits for asthma for children under 18 years of age.
- 4.7 million school absences for children 5 to 17 years of age.
- 3.1 million minor restricted activity days for adults above 18 years of age.

Research conducted as part of the "Children's Health Study"[76] has now shown that California's poor air quality in fact interferes with lung development in children.[77] Other significant findings resulting from scientific and medical research conducted as part of this 10-year study include:[78]

- "Significant lung function deficits are most closely associated with exposure to nitrogen dioxide, atmospheric acidity, PM 2.5 and PM10. This decreased lung development may have permanent adverse effects in adulthood;
- Children living in high ozone communities, who are especially active, are up to three times more likely to develop asthma;
- Children living near roadways with high traffic experienced an increased risk for having been diagnosed with asthma;

- Short-term exposures to elevated ozone levels are associated with a significant increase (up to 1.3 million per year) in school absences from both upper respiratory illness with symptoms such as runny nose and lower respiratory illnesses such as asthma attacks;
- Children who move to cleaner communities with lower levels of PM have improvements in lung function growth rates. This means that even small reductions in air pollution can have immediate benefits to the long-term respiratory health of children living in polluted communities;
- Bronchitic symptoms are associated with exposure to nitrogen dioxide and the organic carbon fraction of PM2.5 in asthmatic children;
- The strength of the air pollution effects are generally greater in children who spend more time outdoors; and,
- Results from the study suggest that boys in general are more susceptible to adverse respiratory symptoms and asthma outcomes than girls. Girls appear to have greater susceptibility for adverse effects on lung function development. There is limited evidence supporting sex differences in responses to ambient air pollutants; however, children of both sexes appear to have adverse respiratory effects of exposure to current levels of air pollution"

All of these health impacts come with a cost, and there has been much research attempting to estimate exactly how much California's poor air quality is costing Californian's. These costs are not obvious and are external to the normal valuation system we currently employ in our economy. However, there is a rapidly developing area of academic research that specializes in studying these "hidden" or "external" costs and the California Air Resources Board works with some of the most highly respected researchers in the world to determine these costs.

THE HIDDEN COST OF CALIFORNIA'S AIR QUALITY

The costs of poor air quality can be attributed to:

- reduced productivity
    - due to lost work days
    - lost school days and
    - reduced activity amongst the millions of Californians most sensitive to the effects of poor air
- increased medical costs due to hospital visits and admissions
- the increased use of prescription medications
- other medical treatment needed to treat both acute and chronic health problems linked to the effects of poor air quality.
- Damage to sensitive agricultural crops and sensitive forest species
- Damage to infrastructure caused by the highly reactive compounds released into the air by the combustion of fuels

The California Air Resources Board estimates that hospitalizing and treating patients for illnesses related to air pollution exposure in the state costs the state of California roughly $2.3

billion per year. The Board also estimates that the state spends $70 billion a year in order to prevent premature deaths linked to air pollution exposure in excess of the State's PM and ozone standards.[79] Estimates by the American Lung Association of California are in relative agreement with these numbers.

A separate study conducted by the Institute for Economic and Environmental Studies found that poor air quality — due to the levels of ozone and particulate matter — in the San Joaquin Valley costs the valley's residents $3 billion per year. The cost of air pollution represents:

- 460 premature deaths among those age 30 and older
- 23,300 asthma attacks
- 188,000 days of school absences
- 3,230 cases of acute bronchitis in children
- 3,000 lost work days
- 325 new cases of chronic bronchitis
- 188,400 days of reduced activity in adults
- 260 hospital admissions
- More than 17,000 days of respiratory symptoms in children

The South Coast Air Quality Management District conducted a socioeconomic analysis as part of its Air Quality Management Plan. The analysis estimates the overall economic benefit to the South Coast Air Basin to exceed $6.6 billion as a result of the plan's implementation.[80] The San Joaquin Valley Unified Air Pollution Control District has estimated that it will cost the valley $7.5 billion over the next 6 years in order to meet federal ozone standards.[81]

Given the large role that the petroleum industry and transportation play in contributing to the state's air pollution, these economic sectors are responsible for a significant share of these costs. However, these are not the only costs Californian's assume in continuing to participate in a transportation system rooted in petroleum-derived fuels.

THE HIDDEN COSTS OF TRANSPORTATION

Because of the incredible complexity of everything that goes into making our transportation system work, there are few researchers who have directly taken on the task of trying to estimate the hidden or externalized cost of the transportation system itself.[82] The Texas A&M University's Texas Transportation Institute issues a highly regarded annual report on its analysis of urban mobility throughout the country.[83] In its most recent analysis it estimated that in 2003, traffic congestion alone cost Americans nearly $64 billion a year. Estimates were also made for several of California's key cities.

While this analysis is limited to some of California's major metropolitan centers — accounting for nearly 74% of the states population in 2003 — it does allow for some broad-based

City Region	Congestion Cost	Cost per Peak Traveler	Cost per Person	Population
Los Angeles	$10,686 million	$1,598	$855	12,500,000
San Francisco – Oakland	$2,605 million	$1,224	$631	4,125,000
San Diego	$1,411 million	$900	$492	2,870,000
Riverside – San Bernardino	$863 million	$947	$517	1,670,000
San Jose	$823 million	$900	$492	1,675,000
Sacramento	$669 million	$685	$374	1,655,000
Oxnard – Ventura	$176 million	$571	$307	575,000
Fresno	$72 million	$224	$120	595,000
Bakersfield	$30 million	$128	$69	440,000
TOTAL	$17,335 million			26,105,000
AVERAGE COST		$797	$429	

conclusions. As each of the state's urban areas expands congestion and the external costs that go with it increase. The total cost of congestion alone in California was estimated total in excess of $17.3 billion in 2003.

As everyone who owns a car and drives in a city knows, the greater the congestion, the lower the mileage driven per gallon of fuel. Another consequence of this innocuous fact is that there is a greater build up of air pollutants under these conditions, including VOCs that contribute to both ozone, smog and particulate matter pollution. The State's growing urban areas face the challenge of having a growing difficulty in reducing air pollution their areas in the face of these trends.

The most recent work on hidden transportation costs in California was conducted by the Institute of Transportation Studies at UC-Davis for the Sacramento Area Council of Government's Blueprint Plan looking out to the year 2025.[84] Sacramento is the only California city for which there has been a relatively current analysis performed in this manner to date. This work indicated that for residents of six counties in the Sacramento area in the year 2025 the annual total social cost of transportation† would be between $17 and $32 billion (2002 dollars). External costs are estimated to range between $2.5 and $9.5 billion a year (2002 dollars). This translates to the equivalent cost of $12-$23 per gallon for total social cost, and $2-$7 per gallon for the external cost based on projected fuel consumption in the SACOG area in 2025.

The International Center for Technology Assessment (ICTA) conducted an analysis that estimated the externalized costs associated with the use of gasoline in 1998. The report considered inputs deemed to account for the externalities of gasoline usage. Total external costs were estimated to fall between $558.7 billion and $1.69 trillion per year. Assuming a $1.00 per gallon price for 1998, would mean that an additional $4.60 to $14.14 would need to be added to the retail price of a gallon of gasoline.[85] The academic fields that were the basis for providing cost numbers for this analysis have progressed in the last eight years and our understanding of the health impacts of air pollution has as well. A thorough update of this comprehensive analysis would likely lead to a substantial upward revision of the total cost estimates in each of the five categories independent of adjustments in dollar valuation.

While there is a range of items that can be included as externalities — depending on the researchers perspective — including tax subsidies, coast guard services to maintain seaways for marine tanker vessel traffic, and the costs of the role of the US military in protecting international petroleum infrastructure and access to foreign supplies to oil, the research on the

† This analysis made independent estimates of the costs due to congestion. They fall within the range of the estimates made by the Texas Transportation Institute.

total and external costs of transportation has merely scratched the surface on this issue. Clearly when viewed in conjunction with the costs to California of air pollution — as briefly outlined above — there are tens of billions in unaccounted costs associated with the use of petroleum fuels and our transportation system as it is now designed. As recent developments indicate, things are not going well in Detroit these days, and if American auto-manufacturers fail to begin to chart an independent path from the oil industry they are in danger of falling further "In The Tank".[86]

The Petroleum Supply Chain

The process of making and using gasoline and other petroleum fuels is very complex. The process of discovering crude oil and getting it from the oil well to market can be described in four broad categories:

1: Exploration, development and production: Onshore and offshore
2: Shipping and Storage of Crude Oil and Refined Oil Products
3: Refining Crude Oil
4: Final Use - Combustion in vehicles

Each step in the process of exploiting oil, poses serious environmental and health hazards. At each stage, the oil industry has been required to put safety measures and standards in place to mitigate its impact on both the environment and public health. Despite this, the industry is still one of most environmental damaging in the world.

1: Exploration, development, and production

The environmental impacts that result from taking an oil development project from its initial exploratory phase to commercial extraction can exceed those of a major oil spill.[87] Significant impacts include:

- Deforestation, resulting from the clearing of land (especially in remote locations) for the construction of roads and building of drilling pads for the placement of drilling platforms
- Soil compaction
- Soil erosion due to increased surface runoff
- Disturbance of benthic ecosystems
- Chemical contamination of land, water, and marine sediments. Drilling during the exploratory and commercial phases requires the use of large amounts of water, which becomes contaminated with petroleum waste, drilling muds/fluids, and by-products of drilling such as well water, drill cuttings, and other material from the boreholes. This water may then be released (either by accident or design) into the environment.
- Short and long-term harm to wildlife (particularly migratory birds, marine mammals, and other coastal and bottom dwelling organisms).

Once an oil company gains a lease to access lands or sea bottom that may potentially

contain oil it must conduct exploratory surveys to locate potential deposits beneath the earth's surface. These surveys can employ remote sensing techniques or seismic testing, or both in combination to locate potential deposits. The use of seismic techniques during the exploratory phase of development is just the beginning of what is a highly disruptive and invasive process. Seismic survey techniques employ explosives and/or explosive-like devices to map the strata beneath the earth's surface and ocean bottom.[88] These survey techniques pose a hazard to wildlife on land and especially for marine mammals and other marine life.[89]

On land this requires that the first roads be built into remote areas. Once potential deposits are identified, drilling rigs (sometimes weighing as much as several thousand tons) are brought in and placed over the location of the deposit (requiring more extensive road construction on land) in order to conduct test drilling. This involves large work crews with supporting vehicle and/or marine vessel traffic and the use of additional supporting infrastructure. Not all test wells are successful and not all potential deposits prove to hold petroleum or enough petroleum to make the project commercially viable. If, however, the test wells indicate that there is a significant deposit of petroleum, the project proceeds to commercialization. This usually involves the creation of more wells in order to maximize production, and the construction of permanent supporting infrastructure including pipelines to deliver the crude oil to market.[90] Moreover, some of the compounds used in the drilling muds (aka drilling fluids)[91] that help lubricate and cool the drill bits and drill lines, stabilize the walls of the bore hole, and liquefy earthen cuttings, can have impacts on both worker health[92] and the environment. Studies conducted for the Minerals Management Service in the Gulf of Mexico indicate that sediments associated with the release of these fluids around drilling rigs have higher levels of toxic compounds in the sediments including heavy metals, and elevated organic carbon levels resulting in anoxic zones, and reduced species richness.[93] On land these fluids (which build up as drilling waste) are collected and stored in waste and evaporation pits where they can pose a hazard to groundwater and to migratory birds.[94] Activity associated with the routine operation of an oil field can also have significant consequences for wildlife and marine life, and indigenous communities may also suffer displacement and disruption of their traditional lifestyles. Activities associated with exploration and development can also be an important source of air pollutants generating pollution at levels equivalent to major metropolitan areas in the US.[95]

The US oil and gas industry generates solid and liquid waste (primarily during drilling and extraction) at a rate that rivals the total combined municipal, agricultural, mining, and industrial wastes in the rest of the country.[96] According to the most recent statistics available from the US-EPA, in 1995 the exploration and extraction of oil and gas in the US led to the production of 146 million barrels of drilling waste and 22 million barrels of associated wastes. The bulk of the associated waste is what the industry calls "produced water". Produced water is water that is found associated with a bore hole during test drilling or comes from the oil extracted from a producing well and often contains many of the hazardous and toxic materials also found in the raw crude being extracted. These include — but are not limited to — benzene, toluene, cyclohexane, xylene, other aromatics, alkanes, cycloalkanes, and polyaromatic hydorcarbons. Produced water is often a brine (water considerably saltier than seawater) associated with the deep underground oil deposits. This brine is what remains of the buried prehistoric inland sea that also gave rise to the oil deposits. Produced water may also contain heavy metals such as arsenic, barium, cadmium, chromium, and mercury as well as radioactive

isotopes (referred to as NORM "naturally occurring radioactive materials"). High-pressure reinjection of produced water into oil wells is sometimes used to increase a well's oil production. Produced water that is not reinjected must undergo significant treatment to purify it if it is to be released without causing environmental harm by further leading to soil degradation and/or polluting aquifers, surface and groundwaters. Fifty-eight per cent of the associated wastes were reinjected as produced water during 1995.[97] A key concern also comes with releases from abandoned oil wells that were not properly shutdown.[98]

California oil production is highly dependent on the use of "injection wells" using produced water to enhance the recovery rates of oil from its tens of thousands of wells. Currently over 50% of the producing wells in California are injection wells and account for 60% of California's oil production. Besides the recovered produced water the injection fluid under this program is allowed to contain "diatomaceous earth-filter backwash, thermally enhanced oil recovery cogeneration plant fluid, water-softener regeneration brine, air scrubber waste, drilling mud filtrate, naturally occurring radioactive materials, and tank bottoms."[99] The state's injection well program is administered under the US-EPA's Underground Injection Control Program.[100] California crude production comes with the added danger of often being a sour (acidic) crude rich in the gas hydrogen sulfide (H2S) which is toxic in high concentrations and a potential danger to anyone either working or living near a producing well.[101]

Regardless of whether oil exploration occurs on the ocean or land there is a risk of a blowout or spill of crude oil into the environment and the chronic loss of produced water.[102] While all crude oils have their own unique set of characteristics, they all contain compounds that are toxic to human health and the environment, and some of the compounds are powerful carcinogens.[103]♥ According to the National Academy of Sciences there is a significant potential for major spills to occur from oil producing facilities, especially in older production fields with aging infrastructures.[104] This threat is expected to grow as the industry increases the number of new producing wells at oil fields to meet the world's growing thirst for oil. The Government Accountability Office — an independent nonpartisan agency that oversees and consults for the US Congress; also known as the "congressional watchdog') — has warned that on federal public lands administered by the Bureau of Land Management (BLM), the

> "BLM's ability to meet its environmental mitigation responsibilities for oil and gas development has been lessened by a dramatic increase in oil and gas operations on federal lands over the past 6 years. Nationwide, the total number of drilling permits approved by BLM more than tripled, from 1,803 in fiscal year 1999 to 6,399 in fiscal year 2004. BLM officials in five out of eight field offices that GAO visited explained that as a result of the increases in drilling permit workloads, staff had to devote increased time to processing drilling permits, leaving less time for mitigation activities, such as environmental inspections and idle-well reviews."[105]

The industry is also pushing drilling and production technology to work in environments formerly out of reach (such as at the edge or off the edge of the continental shelf). Because industry has little knowledge or limited previous experience operating at these new technological and environmental limits,[106] the risk of accidents and spills happening at this new frontier should

♥ Also see sections 4: Combustion in vehicles, below on compounds that are in, and derived from petroleum.

also be considered significant.⊕[107] A recent study estimated that there is a more than 40% chance of oil spill of 1000 barrels or more happening in California coastal waters from offshore drilling operations in the next 25 years.[108]

On average, an estimated 21,000 barrels (880,000 gallons or 3,000 metric tons) of petroleum is spilled into the waters of North America due to oil and gas exploration each year. Worldwide more than 260,000 barrels (11,000,000 gallons or 38,000 metric tons) of oil are routinely spilled into the seas from this source each year. The bulk of the spills in US waters occur near shore where they can threaten or damage sensitive coastal environments in the main petroleum producing areas of the Gulf of Mexico, off of the coast of southern California, and off northern Alaska.

2: Shipping and Storing Oil and Refined Oil Products

Once an oil field has begun producing crude, the oil needs to be transported to the refinery for processing and the refined products must then be distributed to market. Pipelines are typically used to transport oil on land, and from large fields on the sea floor to storage terminals on shore. The oil can next be moved either to the refinery or to a marine terminal at a seaport where the oil can be loaded on to a tanker vessel for shipment to a distant refinery.[109] California's imported petroleum is transported in tanker vessels from countries around the world and delivered to refineries in the San Francisco Bay and Los Angeles area.[110] Pipelines and tanker vessels are also used to transport large volumes of refined products such as gasoline and diesel from the refineries to storage facilities near markets. With each additional step in the handling and transportation of crude oil and refined products the likelihood for the accidental and possibly catastrophic release of oil increases.

In 2004, between 2.1 and 2.3 billion metric tons of oil were transported by sea; an amount equivalent to nearly 35% of the total tonnage of world cargo shipped that year.[111] Tanker vessels account for one quarter of the total number of cargo vessels in the world.[112] The shipping of crude through international waters contributes significantly to the total emissions from international shipping,[113] the levels of which rival the total NOx and PM emissions from all of the world's road traffic combined. International shipping has become a significant source of aerosols and a dominant source of sulfur dioxide emissions on the planet.[114] This has very much to do with the use of bunker fuel oil — a fuel oil high in sulfur and other undesirable compounds — to power marine cargo and tanker vessels.[115] Oil tankers can also be significant sources of volatile organic compounds (VOCs) important in the formation of ozone and smog.[116] The shipment of crude oil and refined products also further contributes to the significant levels of air pollution associated with the cargo and tanker vessel traffic in the urban areas surrounding ports. Shipping at the port of Los Angeles-Long Beach is responsible for ten percent of the nitrous oxide and twenty-five percent of the diesel particulate matter emissions in the region, while the port's immediate residents disproportionately suffer the direct negative effects of these as concentrated pollutants.[117]

The National Academy of Sciences estimates that on average more than 64,000 barrels

⊕ The United Nations Environment Program's Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection noted that, "Recent technological developments… …make it possible to explore for oil and gas - and to exploit them - from ever deeper waters; the current limit is about 2000 metres. The potential contamination - for example, from the release of oil or gas could damage large areas of the oceans and their ecosystems. And a blowout in deep water could be difficult to control quickly, and have serious ecological effects."

(2,700,000 gallons or 9,100 metric tons) of crude oil and refined products are spilled into North American waters annually, while annual spills worldwide total in excess of 1 million barrels (44,000,000 gallons or 150,000 metric tons).[118] The National Academy noted that,

> "Although the number of spill incidents and the amounts of oil spilled have shown a meaningful decreasing trend in recent years, significant and large spills worldwide continue to characterize the industry. In addition, history has shown that one very large accident can change the statistics in a major way. It should be noted that most of the large catastrophic tanker accidents are single rare events, and the amount of oil spilled during these events tends to overshadow all other spills."[119]

The National Academy also cautions that because the demand for oil in the coming decades will continue to grow the resulting increase in tanker traffic means that there is a significant potential for a large spill.

There are 200,000 miles of oil pipeline in the United States,[120] and these carry about two thirds of the nation's crude oil and refined oil products.[121] California has roughly 2,800 miles of pipelines that transport refined petroleum products to market.[122] Monitoring and preventing pipeline corrosion is a constant battle for the pipeline owners.[123] Pipeline accidents can pollute the water, ground, and air, lead to property damage, injury or death and can be a major cause of fires. Pipelines are monitored by the US Department of Transportation's, Office of Pipeline Safety (OPS). In California, the State Fire Marshall serves to monitor some of the pipeline's in the state for the OPS. The OPS's small staff of slightly more than 150 — 100 of whom are inspectors — must also monitor some 2 million miles of natural gas pipelines.[124] In 2004 the Government Accountability Office conducted a study of the OPS. While acknowledging that,

> "Although in recent years OPS has made a number of changes in its enforcement strategy that have the potential to improve pipeline safety, the effectiveness of this strategy cannot currently be determined because the agency has not incorporated three key elements of effective program management—clear program goals, a well-defined strategy for achieving those goals, and performance measures linked to the program goals. Without these three key elements, OPS cannot determine whether recent and planned changes in its enforcement strategy are having or will have the desired effects on pipeline safety. "

the GAO went on to analyze the OPS's safety statistics and determined that between 1994 through 2003, accidents on interstate pipelines decreased by nearly 49 percent: from 245 in 1994 to 126 in 2003. The National Academy of Sciences has noted that the documentation for spills on land is poor and leads to large uncertainty in the estimates.[125] The GAO did note that the industry's safety record had not improved for "serious accidents", those "with the greatest consequence—those resulting in a fatality, an injury, or in property damage of $50,000 or more". The number of serious accidents stayed about the same over the 10-year period.[126] In it's 2000 analysis of pipeline safety the GAO determined that during the period from 1989 through 1998 pipeline accidents killed 226 people and incurred approximately $700 million in property damage annually. In its 2000 report the GAO also determined that, "pipelines that transport hazardous liquid account for nearly eight times as many major accidents per mile of pipeline as pipelines that transport natural gas to homes and businesses."[127]

The National Academy of Sciences is especially disconcerted by the potential for large spills to occur from aging pipelines and other coastal facilities, as these facilities often lie near sensitive coastal areas.[128] Indeed the National Energy Policy Development Group — convened by Vice President Dick Cheney for the Whitehouse — noted in its 2001 report that the number of inland oil spills were increasing and referred to federal government data that indicated the average number of inland oil spill notifications grew from 9,000 notifications a year in the early 1990s to between 10,000 - 12,000 a year in the late 1990s. Many of these yearly inland oil spills were over 100,000 gallons each. The National Energy Policy Development Group attributed this increase to the aging of pipelines, storage tanks, and other infrastructure components,[129] paralleling the concerns of the National Academy. A recent profile of the nation's pipelines found that — according to an OPS database — during the 1990s an average of 6.7 million gallons of oil leaked from pipelines each year.[130] According to the profile there is an industry consensus that the OPS database significantly under-reports spills, possibly by as much as half. If that were the case, at a spill rate approaching 13 million gallons per year, spills from pipelines on land would exceed the equivalent of one Exxon Valdez per year. OPS statistics report that during 2005 and for the first 9 months of 2006, 171 accidents occurred totaling nearly 116 million dollars in damage and releasing nearly 200,000 barrels (more than 8 million gallons) of petroleum and refined products into the environment.[131] Annual average cleanup costs for pipelines in California are estimated at about $9 million.[132]

California has 40 operational marine terminals — most over 50 years old — and 2 associated major storage facilities for refined products at locations in the San Francisco Bay area and in Southern California. Together they have 38 storage tanks that can hold a combined 2 million barrels of oil.[133] The Energy Commission estimates that the state has roughly 90 terminals that receive and store refined petroleum products for later transfer to tanker trucks via loading racks for delivery to retail stations. Of no less concern is the potential for accidents resulting from leaks or collapse of storage tanks holding crude oil and refined petroleum products. The National Academy of Sciences warns that, "Areas near major petroleum handling facilities face the greatest threat" of spills.[134] Storage of crude oil and refined products can be a significant source of VOC emissions that contribute to the formation of ozone.[135] This is because the storage tanks typically have floating roofs that are not sealed, thereby allowing emissions to escape from the tops of the tanks. With the huge amount of gasoline and diesel fuel Californian's consume on a daily basis (44 million gallons of gasoline and 10 million gallons of diesel) the transport of fuels from the storage terminals by tanker truck to the retail location is a significant source of hazardous air emissions. A typical tanker truck carries 4000-6000 gallons requiring 9000-13,500 round trips daily (3.3 million to 5 million trips annually) between the delivery point and the storage terminals. The fact that most if not all of these tanker trucks are equipped with diesel engines would indicate that the transport of fuels to their final retail location results in the production of significant amounts of diesel exhaust, a major source of toxic particulates.[136]

3: The Refinery

It should be no surprise given that crude oil is a complex mix of often hazardous and toxic compounds that oil refineries are a major source of pollution. This pollution threatens the air, ground and water.[137] Refineries are regulated under a number of laws:

- CERCLA - the superfund law (Comprehensive Environmental Response, Compensation, and Liability Act)
- the Clean Air Act
- the Clean Water Act
- the Emergency Planning and Community Right-to-Know Act (EPCRA)
- Occupational Safety & Health Administration (OSHA)
- 1990 Oil Pollution Act – passed in response to the Exxon Valdez spill of 1989
- Safe Drinking Water Act
- TSCA (Toxic Substances Control Act)

to name just a few.[138]

From the first days of refining in the late 1800s when kerosene was distilled from the first processed crude oils, petroleum refineries have evolved to become large complexes designed to systematically separate the compounds that makeup crude oil into a diverse array of products. This is done using a sequence of thermal and chemical techniques to separate out and modify those compounds according to their weight. Using these approaches a modern refinery produces everything from gasoline and jet fuel, to kerosene and diesel, to waxes and asphalt.[139] Oil refineries are also a major producer of feedstocks for the chemicals industry.

Oil refineries are sources of toxic air and water emissions, hazardous wastes, thermal and noise pollution. Under EPCRA refiners are required to report to the Environmental Protection Agency's (EPA) Toxic Release Inventory (TRI) program any releases of toxic chemicals and transfer of wastes to locations off the refinery site.[140] According to the EPA's most recent analysis of TRI data the petroleum refining industry releases 75% of its toxic emissions to the air, 24% to the water (including 20% to underground injection and 4% to surface waters), and 1% to the land. The main hazardous air pollutants released by the industry are the BTEX compounds (benzene, toluene, ethyl benzene, and mixed xylenes).[141] Refineries must report on their annual emissions for about 600 chemicals. There can be considerable shortfalls in this reporting, however. According to an analysis conducted by the Environmental Defense Fund, "Of the hundreds of toxic chemicals in crude oil and refinery products, only a few are typically reported to TRI. Many of those not included have similar structural, physical, and toxicological properties to those that are reported." As an example of how serious under-reporting can be, the Environmental Defense Fund noted that on the study of an Amoco refinery in Yorktown, Virginia that the refinery's TRI report forms only covered 9% of the total hydrocarbons released.[142]

Nearby communities suffer the immediate and direct effects of pollutant releases from refineries. They have a special concern about unreported releases and fugitive emissions that result from the routine day to day operations of their local refinery. For the one air district for which data were available – the South Coast Air Quality Management District – the California Energy Commission reports that there were 996 public complaints of odors, smoke, and oil fallout, alleging refinery sources in calendar years 2003 and 2004; an average of more than one complaint about a release per day for two consecutive years.[143]

Californian refineries process approximately 11-12% of the nation's petroleum, on the basis of its crude intake capacity. Refineries are the largest and most intensive consumers of energy in California and throughout the US,[144] and the state's refineries are also the largest

source of SOx (oxides of sulfur) compounds in the state.[145] Refineries can also be major sources of NOx (oxides of nitrogen), especially during flaring and flaring accidents.[146] Both of these classes of compounds can irritate the lungs and can contribute to ozone formation, another powerful irritant to the lungs and eyes. SOx and NOx can react to form particulates that are also powerful lung irritants. [147] Not surprisingly refineries also emit significant amounts of VOCs.[148] All of these compounds are strictly regulated under both Federal and California law as criteria pollutants.∏

Like most industrial processes, oil refining utilizes huge amounts of water, for cooling, and production. Much of the resulting wastewater is contaminated with chemical compounds used in the refining process and found in the original crude oil. These compounds are extremely hazardous and pose a threat to community health. Even after treatment many of these contaminants still remain to impact water and — as some of the compounds are volatile they can also escape to — pollute the overlying air.[149] California's refineries are the largest generators of industrial hazardous waste (including wastewater) in the state, with the 17 largest facilities producing nearly 13 million tons of hazardous waste in 2002.∇ This was a nearly 18 percent reduction in hazardous waste production from levels reported in 1998. According to the Department of Toxic Substances Control, the bulk of the industry's total reductions were due to process changes at just one facility. However, some of the refineries did not completely report their wastewater discharges. Sixteen refineries did not report producing any Class A waste.[150] At least half of the state's refineries are recognized as having extensive soil and groundwater pollution. The Energy Commission estimates that the average refinery cleanup costs are around $600 million annually.[151]

There is evidence that the incidence of childhood leukemia and other cancers are higher for children living near oil refineries and oil infrastructure facilities.[152] Minority and low-income communities tend to be located near refineries, and are impacted disproportionately by the pollutant releases from refineries.[153]

California has not seen a new refinery built since 1969 and nationally a new refinery has not been built since 1976. During the past 20 years the number of state refinery facilities has fallen from 35 to 21 (approximately 40 percent – matching the national trend) while at the same time total crude oil processing capacity dropped by only 20 percent from its peak in 1987. This is due to the average production capacity of refineries increasing to nearly 92%.[154]

The California Energy Commission has estimated that as the state's demand for petroleum based fuels continues to increase, by 2015 refiners will require between 4.2 and 7.6 million barrels of additional storage tank capacity. By 2025 this will need to increase to between 6 and 11.7 million gallons. Given the challenges involved in permitting new refinery facilities in the state, the Energy Commission does not anticipate that any new oil refineries will be built through to 2025.[155] Even so there are still considerable challenges in permitting the expansion of new supporting infrastructure to increase current refinery capacity. The assumption is that refiners will be able to increase their processing capacity even further in order to better meet demand. Any shortfalls would require the increased importation of finished refined product in

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∏ For a more detailed discussion of the role of these compounds in air quality see the section below on **California's Air Quality**

∇ 12,696,443 tons/year of SB-14 Class A (aqueous) waste,
83,923 tons/year of SB-14 Class B (nonaquesous) waste.
as per SB 14 (Roberti, 1989) - The Hazardous Waste Source Reduction and Management Review Act of 1989
These waste categrories cover such materials as oil/water separation sludge, aqueous solutions containing organic residues, and wastes containing spent catalysts.

order to meet this anticipated demand.

4: The Use of Petroleum Derived Fuels in Transportation

All through the supply chain: from the oil well to the fuel tank, people (oil industry workers, environmental cleanup crews, government inspectors, transportation workers, communities near oil industry infrastructure, etc.) and the environment are exposed to the compounds found in crude oil or its refined products. While getting what they often presume to be "the clean final product" the average consumer probably does not realize precisely how toxic and hazardous the cocktail of compounds is, that they routinely expose themselves to when using their preferred fuel. The danger does not end there however. While the California Air Resources Board has some of the strictest standards in the world for preventing the escape of the fuel compounds to the air, some of the many compounds eventually find their way out of the fuel system of the car and into the air as volatile organic compounds (VOCs). At nearly 1,400 tons per day, the distribution and use of petroleum fuels accounted for nearly 60% of statewide VOC emissions that came from the top 25 sources in 2005.[156] These compounds can then react with other pollutants in California's air to form ozone and smog. Moreover, many of the combustion products that come out of the exhaust pipe can also be either toxic or hazardous.[157] There are compounds that are unique to both and notably diesel and diesel exhaust can contain heavy metals.[158]¥

Other important combustion products include carbon dioxide (CO2) oxides of nitrogen (NOx), oxides of sulfur (SOx), carbon monoxide (CO) from the incomplete combustion of the fuel in the engine, and particulate matter (PM - soot). SOx and NOx can also react to indirectly form secondary particulates. Some of these particulates are referred to as fine particulates and can penetrate deep into the lungs. Ozone and particulates can be a hazard to anyone's health, but are particularly a problem for people suffering from heart and lung disease, and from asthma. Emissions from transportation sources are an important contributor to California having some of the nation's unhealthiest air.[159] According to the state Air Resources Board, ninety percent of Californians breathe unhealthy air because of excessive amounts of one or more air pollutants during some part of the year. The California Air Resources Board has many easily accessible databases available to the public. The ARB publishes annual inventories for many of these compounds according to the state's major air basins as part of its annual almanac, which is also available on the web.[160] The costs to the state of its poor air quality is reviewed in the following section of this report.

Combustion of petroleum-based fuels has resulted in the state's transportation sector accounting for nearly 40% of California's GHG emissions; the largest source in the state.[161] Climate change is expected to have major impacts on California.¶ Besides the anticipated ecological impacts of climate change there are manifold economic and political implications for California. Perhaps key are the issues associated with water. These include maintaining sufficient supplies for California's many needs - for municipalities, agriculture, industry, recreation, the preservation of wildlife and their habitat, and hydroelectric and other forms of power generation. Coping with the anticipated increase in the frequency of flooding, and fires raises issues for urban planning, the insurance, and real estate industries.[162] For all of these

¥ See Appendix A for a list of the substances found in gasoline and diesel or as their combustion products.

¶ See Appendix B for a list of the anticipated impacts the state will suffer because of global warming/climate change.

reasons the state has placed a major focus on dealing with reducing the GHG emissions from the transportation sector in order to help California play its role in fighting global warming.

While the petroleum industry is responsible for creating large amounts of water pollution, they are not alone. The National Academy of Sciences estimates that releases associated with the consumption of petroleum account for nearly 85 percent of the petroleum that finds its way into North American waters. These releases originate either from individual boat owners, non-tank vessels, or runoff from paved urban areas. Nearly 600,000 barrels (25,000,000 gallons or 84,000 metric tons) of petroleum compounds are released into North American waters on average each year. This compares with total annual average releases to the waters of North America of just under 2 million barrels (about 76,000,000 gallons or 260,000 metric tons) from all sources including natural seeps. Since the lion's share of petroleum consumption occurs on land, watercourses (rivers, waste- and storm-water streams) transport a significant amount of petroleum compounds to the marine environment. Two-stroke engines are also a small but important source. Together, these two sources (runoff from land and two-stroke engines) are responsible for nearly 75% of the petroleum that finds its way to North American waters as a result of human activities.[163] This is particularly worrisome because, much of this pollution finds its way and is concentrated in estuaries and bays; some of the most vulnerable ecosystems. Annual worldwide estimates of petroleum input to the sea exceed 9 million barrels (about 380,000,000 gallons or 1,300,000 metric tons) .

WHAT ARE THE ALTERNATIVES?

Despite the mounting evidence that growing competition for the world's limited petroleum supplies will continue to keep prices high,[164] advocates for the petroleum industry resist any attempts by California to adopt policies that would seek to either reduce the state's dependence on petroleum, or to increase the supply of alternatives to the California consumer. It seems clear that with the daunting challenges the state faces: of not only avoiding a greater dependence on; but also potentially reducing its reliance on foreign sources of oil; and in dealing with climate change, that California must move towards developing a new transportation energy economy. California cannot achieve the Governor's world leading targets for reducing the state's global warming emissions[165] without dealing with the transportation sector. As the World's 12th largest emitter of greenhouse gases (GHGs), one of the focal points of the state's global warming policy will have to be on how to reduce the state's emissions due to its use of petroleum. This challenge is made all the more difficult in the face of California's growing population and increasing transportation demands.[166]

Californian's love their cars and love to drive,[167] and as one of the world's leading economies the shipping and transport of goods is key to the state's continued economic success. As a consequence transportation accounts for nearly half of California's total energy use and represents the largest source of GHGs in the state: at slightly more than 40% of the state's total emissions.[168] In 2002 the state adopted legislation in order to begin to address the GHG emissions that come from transportation,[169] and this is currently facing legal challenge from the automobile manufacturers on the grounds that the bill is being used by California to regulate fuel economy.[170] A bill dealing with alternative fuels and alternative fuel vehicles — that just passed in both the Senate and Assembly, and if implemented would have been able to demonstrate that fuel economy is not the only route through which automobile manufacturers could achieve GHG

reductions[171] — was paradoxically vetoed by the Governor. The state's Climate Action Team (CAT) views the increased use of alternative fuels as being critical to the state achieving its GHG emissions reductions targets. Referring to the California law now being challenged in court by the automobile manufacturers, the CAT noted:

> "The Air Resources Board's vehicle climate change standards address a significant portion of the transportation sector. ***However, an aggressive alternative fuels program will significantly reduce climate change emissions***."[172] [Emphasis added.]

A major proposition initiative currently underway in the state seeks to help provide a funding base for the research, development, and implementation of alternative transportation pathways in the state. It seeks to do this by raising California's low extraction fees to levels comparable to those collected by other oil producing states. It faces major opposition from the state's oil companies and awaits the decision of California voters on November 7th.

If not alternative fuels then what could Californian's do…???:

- Californians could resort to supporting efforts to enter and expose the last remaining pristine habitats in the country to the devastating industry practices previously described in this report.
- Or Californians could open up their coastal waters to more offshore drilling,[173] further threatening their fisheries and much-valued coastline.
- Or Californian's could begin using even more damaging and resource intensive pathways that involve the manufacturing of fuels from even more polluting sources such as oil sands, coal, or oil shale.

The extraction and conversion of the low-quality hydrocarbons in heavy oils requires the clearing of large areas of land and the use of considerable amounts of energy and resources.[174] For example, it takes roughly half as much of the energy in a barrel of synthetic sweet crude oil to generate that barrel from the raw resource. Heavy oils are also a significant source of pollutants.[175] Reclamation and restoration of the cleared land is also energy and resource intensive.[176] The same critique also holds true for the use of coal and oil shale.[177] The pursuit of these pathways would actually make it more difficult — if not impossible — for California to meet its GHG reductions targets.

Since seeking greater vehicle fuel efficiency is federally pre-empted,[178] the clear alternative that California is left with is… alternative fuels. The State's policy makers were among the first people in the world to recognize that California's continued use of petroleum-derived fuels is making the state increasingly vulnerable to a growing dependence on foreign sources of crude oil, while at the same time massively increasing the state's environmental footprint. This understanding has been reinforced by the recent dramatic increase in the price of crude oil during the past two and a half years, from a low of around $30 a barrel to a recent high approaching $80 a barrel,[179] and which has revealed a potential to disrupt the state's economy. The California Energy Commission has been in the lead on this issue and, beginning with a report in 2003 and continuing on to its most recent biennial Integrated Energy Policy Report, has advocated that the state pursue an aggressive policy towards reducing the state's dependence on petroleum.[180] This policy approach includes increasing the use of alternative fuels and has

culminated in the adoption of a Bioenergy Action Plan,[181] and an interagency study of sustainable alternative fuels which is due to be delivered to the legislature by June 30, 2007.[182] The California Biomass Collaborative is also in the process of developing the state's Biomass Roadmap which has sustainability at its core.[183]

Some have argued that California's past alternative fuels endeavors, going back to the late 1980s, have until now been unsuccessful in making any market headway. Ironically, it was in part because of the past threat posed to the oil industry by the possibility that cleaner alternative fuels might succeed in gaining a foothold in the market that the state's past policies ended up forcing the oil industry and car manufacturers to work together in order to make cleaner fuels that ran better in cleaner burning cars; thereby preserving the oil industry's market. The state's past alternative fuels strategy was a victim of its own success, though not quite in ways that state policy makers had envisioned. Today the reality on the ground has changed from when air quality considerations were used to drive the state's transportation policy. With little more than a handful of companies now having a near monopoly on the state's fuel market — one that appears destined to remain in short supply — and in these days when China, Russia and even India have returned to the primacy of "strategic commodities" policies, Californian's must encourage alternative pathways in order to increase alternative supplies of fuel. Moreover, these alternative supply pathways must be environmentally sustainable (ie for each alternative fuel "system" from source to final use in the vehicle), introduce more competition into the marketplace, and reduce our dependence on a fuel source that is in limited supply. It is more important than ever that California leave behind technologies first conceived in the Victorian era and move the state's economy towards a new transportation technology system. Otherwise California will remain trapped using petroleum derived fuels with all of its costs for society: from the impacts associated with the exploration and development of new resources; through the routine extraction and transport of the crude oil; through to the refining of the crude into transportation fuels; through to the transportation and dispensing of the finished fuels, and finally with the use (combustion) of the fuels.

CONCLUSION

Californians face some difficult choices:

- whether to continue using a transportation technology first developed and conceived during the Victorian era, using fuels first developed and conceived during the Victorian era;
- whether to allow their fuel choices to be determined for them by a growing monopoly of oil companies
    - who – as highlighted in this report – admit that it is in their interest to keep the market in short supply
- whether to allow the price they pay for their limited fuel choices to be determined by the ever strengthening oil industry monopoly in California
- whether to allow things to continue to move ever closer towards market conditions reminiscent of California's 2000-2001 electricity crisis
- whether to continue to support an industry that has such a damaging impact on the environment and community health (as outlined in this report)

- whether to continue to allow the industry to explore for the few remaining small deposits of oil and gas that remain in what little remains of the pristine areas of our public lands
- whether to allow the industry to expand its drilling program off California's coast
- whether to support this industry in its push to extend its archaic business model into the future by moving us from the current fuel system over to a fuel system based on even more environmentally damaging and resource intensive sources of polluting feed-stocks such as: oil sands, coal, and oil shale
- whether to increase the fuel supply by supporting the introduction of more fuel alternatives into the market, thereby
    - re-introducing competition into the fuels market place, and at the same time
    - increasing consumer choice
- whether to chose to support the development of a fuel system designed to be based on sustainable renewable resources that are less damaging to the environment and community health
- whether to chose to support moving towards an environmentally sustainable transportation model based on:
    - new cleaner and less polluting transportation vehicle technologies
    - a new cleaner and less polluting fuel system
- whether to chose an alternative that helps to further improve air quality
- whether to chose an alternative that helps to reduce the State's global warming emissions and fight the accelerating climate change that will be incredibly damaging to California
- whether to support the development of a new transportation economy
- whether to support the development of the world's first truly 21st century transportation economy
- whether to allow the development of alternative fuels to serve as the development onramp to the hydrogen highway.

But making difficult and world changing choices is nothing new to Californian's. Beginning with the great gold rush of 1849 California has always been a state that has been ahead of its time, leading to its being known as "The Great Exception".[184] This "state of the state" has not only applied to California's economic, social, and political development, but also to its coveted role as the world's leading innovator in developing new technologies and in setting new environmental standards. This is a role for which Californians should be justifiably proud.

California has always been a state that despite all outside appearances has been fairly successful at meeting the most daunting of social, political, and economic challenges in the past. In recent years however, we as a state have had limited success in facing the challenge of reinventing ourselves and in holding to our traditional place as the Great Exception. The basis for much of the state's early success — namely the state's rapid population growth — now poses a key challenge threatening our future prosperity. Our large population has always allowed us to capitalize on our rich and diverse resource base and to thereby build an economic and educational system that is the envy of the world. However, within the limited confines of the our nearly 164,000 square miles, and with a population now exceeding 37 million we can no longer continue to live as we had in the past.[185] Such a large population — projected to reach

somewhere between 44 and 48 million by the year 2025[186]* — is constantly placing the health of the state's environment and population at risk. Certainly most Californian's are familiar with the challenges they face as residents when it comes to accessing clean air and clean water.

One of the key environmental challenges that come with having a large population is the challenge of resource consumption, and California's world leading economy (it would be ranked 8th if it were ranked as a separate international economy) is one that has been fueled by the consumption of large amounts of energy.[187] The use of petroleum has been key to California's success, and here too in the latter parts of the 19th century and the early parts of the 20th century the state was blessed with a wealth of its own supplies of this critical energy feedstock.[188] Those days are now fast running out, and it is time that we move on, move on towards developing a 21st century economy built around a 21st century transportation system... before we reach the bottom of the barrel.

* California has roughly 155,000 square miles of dry land, not all of which is readily inhabitable. However it is a useful thought experiment to simply divide the population by the land base, in which case the state has a current population density in excess of 238 people per square mile. At 44-48 million the density rises to between 283 and 310 people per square mile.

APPENDIX A
The substances found in gasoline and diesel or their combustion products.

GASOLINE

Acetaldehyde*
Acetylene
Acrolein
Benzaldehyde
Benzene*
1,3-Butadiene*
n-Butane
2,3-Dimethylbutane
2,3-Dimethylpentane
2,4-Dimethylpentane (Isomer of 2,3-dimethylpentane)
Ethane
Ethanol
Ethene
Ethylbenzene*
Ethylene
Formaldehyde*
Formic acid Product of acetylene
Furan* - Product of 1,3-butadiene
n-Hexane
Isobutene
Isopentane
Methylcyclopentane
3-Methylhexane
2-Methylpentane
3-Methylpentane
2-Methylpropane
Methyl t-butyl ether (MTBE)* - Phased out in California in 2003
Naphthalene*
Nitro-PAHs*
n-Octane
PAHs*
n-Pentane
Peroxyacetyl nitrate (PAN)
Phenol Product of benzene
Propylene (propene)
Styrene*
Toluene
1,2,3-Trimethylbenzene
1,2,4-Trimethylbenzene
1,3,5-Trimethylbenzene
2,2,4-Trimethylpentane
2,3,4-Trimethylpentane
Isomer of 2,2,4-trimethylpentane
m-Xylene
o-Xylene
p-Xylene

* Known carcinogen as indicated by OEHHA.
See: Office of Environmental Health Hazard Assessment, January 17, 2006. Atmospheric Chemistry of Gasoline-Related Emissions: Formation of Pollutants of Potential Concern.
http://www.oehha.ca.gov/air/gasemiss.html

Diesel is on the next page.

DIESEL

Acetaldehyde*
acrolein
aniline*
antimony compounds*
arsenic*
benzene*
beryllium compounds*
biphenyl
hexane
bis[2-ethylhexyl]phthalate*
1,3-butadiene*
cadmium*
chlorine
chlorobenzene and their derivatives
chromium compounds
cobalt compounds*
cresol isomers
cyanide compounds
dioxins and dibenzofurans*
dibutylphthalate
ethyl benzene*
formaldehyde*
inorganic lead*
manganese compounds
mercury compounds*
methanol
methyl ethyl ketone
naphthalene*
nickel*
4-nitrobiphenyl*
phenol
phosphorus
polycyclic organic matter, including PAHs*
propionaldehyde
selenium compounds
styrene*
toluene
xylene isomers and mixtures
o-xylenes
m-xylenes
p-xylenes

* Known carcinogen as indicated by CARB and OEHHA or from state listings.
See: California Air Resources Board & Office of Environmental Health Hazard Assessment, June 1998. STAFF REPORT: INITIAL STATEMENT OF REASONS FOR RULEMAKING: PROPOSED IDENTIFICATION OF DIESEL EXHAUST AS A TOXIC AIR CONTAMINANT.
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APPENDIX B
The anticipated impacts of climate change on California

California will become hotter and the health of Californian's and their environment will suffer.

1. Average annual temperatures will increase but the increase will be more pronounced during the winter months.
2. The number of extremely hot days will increase. More hot days will have direct and negative effects on the health of all exposed organisms not already adapted to high temperatures, especially during heat waves.
    a. the frequency and severity of associated morbidity, and mortality expected from the direct effects of increased summer temperatures and humidity will increase.
    b. opportunities for ozone formation will increase, which has direct negative effects on human health.
    c . large temperature increases in rivers could result, especially during the dry season, and endanger many fish and aquatic species.
3. The pattern and severity of pest infestations will be altered.
4. Increased morbidity and mortality may occur in the resident plant community due to heat stress and reduced pest resistance.
5. Carrier-borne diseases will become more common as the host organisms that previously had limited or no success in California's environs will be able to gain a foothold and/or expand their range(s).

The upward shift in temperatures will cause the distribution of plant communities to rapidly change.

6. There will be a significant shift in either:
    a. the location of plant communities (northward and/or upslope),
    b. the makeup of those plant communities (eg desert becomes grassland, forest becomes shrub etc.),
    c. or both,
    d. with some communities seeing major species loss or the communities themselves disappearing all together.

Winters will become shorter, wetter, and stormier, and summers will become longer, hotter and drier.

7. The later winters and earlier springs brought on by the increase in annual average temperature will lead to:
    a. the accumulation of less snow pack, a significant reservoir of water for California, and
    b. an earlier spring runoff, placing further stress on California's already overburdened water supplies earlier in the dry season than has historically been the case.
8. Precipitation and weather patterns will become more variable. This variability will result in:
    a. more frequent and intense storms,
    b. more flooding, both in terms of frequency and magnitude, and more flood-associated erosion; and
    c. higher storm surges in conjunction with a rise in sea level due to thermal expansion of the oceans.
9. The increased frequency of large precipitation events will also increase the frequency of large pulse events of pesticide and fertilizer entering the water supply as a result of increased runoff and/or flushing of the water table.
10. Seasonal wind patterns may be altered. This will impact fog patterns along the coast and winter fog in the Central Valley. Fog is a subtle but significant source of moisture in both these regions.
11. Despite increased average annual precipitation the dry season is expected to lengthen leading to a fire season with more frequent, widespread and intense fires.
12. The increase in average annual precipitation will lead to a greater accumulation of fuel during the wet season that is then available for fire in the lengthened dry season.

13. Species life cycles may be altered leading in some instances to a decoupling of the life cycles of mutually beneficial organisms (eg. Insect pollinators and flowering plants).

California's agricultural industry will be placed under stress.

14. Regions considered suitable for specific crop-types will either
    a. shift, and/or
    b. in some cases shrink and
    c. in other cases expand.
15. Increased temperatures will stress crops, poultry, and livestock, potentially reducing productivity and yields.
16. The increase in pest infestations, in the frequency and intensity of storms, and in flooding, will cause more crop damage.

California's coasts will be put at risk and its fisheries threatened.

17. Sea-level rise will flood coastal areas and alter the nature of coastal wetlands and estuaries.
18. Oceanic circulation may be affected altering California's coastal current system and affect productivity.
19. El Niño events will be more frequent and may become more intense further exacerbating the impacts listed under points 5, 8, 9, 12, 16, 17, and 18.

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NC_EICSUM_TOT — EMISSIONS BY SUMMARY CATEGORY (ALL SOURCES) — EMSBYSUMCAT-TOT
DATABASE - 2003
AIR BASIN: SOUTH COAST (AIR BASIN)

DIVISION

MAJOR CATEGORY — EMISSIONS (TONS PER DAY)

SUMMARY CATEGORY	TOG	ROG	CO	NOX	SOX	PM	PM10	PM25
OIL AND GAS PRODUCTION (COMBUSTION)	2.22	.88	.69	1.18	.03	.17	.17	.17
PETROLEUM REFINING (COMBUSTION)	3.59	1.31	13.62	6.88	3.12	1.76	1.69	1.66

PETROLEUM PRODUCTION AND MARKETING								
OIL AND GAS PRODUCTION	5.23	2.55	.02	.05	.00	.00	.00	.00
PETROLEUM REFINING	6.49	4.68	8.27	4.74	11.99	1.64	1.08	.87
PETROLEUM MARKETING	22.14	21.15	.48	.05	.00	.03	.03	.02
OTHER (PETROLEUM PRODUCTION AND MARKETING)	.01	.01	.00	.00	.00	.00	.00	.00
*TOTAL PETROLEUM PRODUCTION AND MARKETING	33.87	28.39	8.77	4.84	11.99	1.67	1.11	.90

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