







Analyzing the Financial Risk of Holding Fossil Fuel Assets in CalPERS' Portfolio

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Introduction

Purpose

This report analyzes the medium- to long-term financial risk associated with the California Public Employees' Retirement System (CalPERS) fossil fuel investments and examines some of the factors contributing to that risk. Our analysis is based on CalPERS' investment portfolio as of July of 2016, specifically, the fund's holdings of the Carbon Underground 200™ companies (CU200).¹ As compiled annually by Fossil Free IndexesSM LLC, these are the 100 global oil and gas companies and the 100 global coal companies that own or hold rights to the largest "proved reserves" of fossil fuels.

Background

At the 2015 United Nations climate change conference in Paris (COP21), 195 nations agreed to undertake policies to reduce greenhouse gas (GHG) emissions to levels that will keep the global temperature rise "well below 2°C."² Scientists reported in *Nature* that to reach this goal, total carbon emissions between 2011 and 2050 must be limited to approximately one-third of the potential emissions that would be released if today's known global fossil fuel reserves are burned.³ Under the carbon budget established by the Paris Agreement, an estimated 80% of coal reserves, 50% of natural gas reserves, and 33% of oil reserves must remain in the ground and not be burned.

In order to ensure these emissions targets will be met, governments must eventually structure energy markets with regulations and tax policies that affect both supply and demand for fossil fuels and renewable energy. Government regulation, along with technological advances, is how "keep it in the ground" and the transition from a carbon-based energy system to a renewable energy system occurs over time. In this report, we use the UN 2-degrees benchmark as the target for how the regulatory and technological forces will structure the fossil fuel markets.

On the supply side, government reductions in subsidies and increases in taxes on fossil fuels, with contemporaneous government funding to the renewable energy sector, will result in significantly higher prices for fossil fuels compared to renewable energy, largely impacting competitiveness. Furthermore, government regulations to reduce the use of fossil fuels in electricity, transportation, industry, buildings and homes, and plastics should dramatically lower demand for fossil fuels. If the global economy meets the 2-degree targets, then fossil fuel companies will not be able to extract and monetized reserve assets, which will become "stranded assets." In this report, we estimate the financial value of these potentially stranded fossil fuel assets (SFFA) to the companies, and hence to shareholders, including CalPERS. We also estimate the broader environmental and health costs to society (the "social cost of carbon") of extracting and burning their reserves.

¹ "The Carbon Underground 200 – 2017 Edition," Fossil Free Indexes, last modified 2017, <http://fossilfreeindexes.com/research/the-carbon-underground/>.

² UN Climate Change, last modified April 20, 2018, <https://unfccc.int/process/the-paris-agreement/what-is-the-paris-agreement>.

³ Christophe Mcglade and Paul Ekins, "The Geographical Distribution of Fossil Fuels Unused When Limiting Global Warming to 2 °C," *Nature* 517 (January 2015)

CalPERS is the largest public pension fund in the U.S. with \$354 billion in assets under management as of June 30th, 2018.⁴ At that date CalPERS reported over 1.9 million active members and 2,892 participating employers. Members' annual financial contributions accounted for 13% and employers' contributions for 26% of the fund's revenue, and investment returns comprised the remaining 61%. As of June 30, 2016 (the time frame of this study), CalPERS had \$302 billion in assets under management, with 1.8 million active members.⁵

Fossil Free Indexes released a research report in 2014 that examined reserve-related CO2 emissions from the Carbon Underground (CU200) companies in the CalPERS portfolio. From 2004-2013, CalPERS invested in 59 additional CU200 companies, increasing from 90 in 2004 to 149 in 2013 (see chart below). With this increase, "the emissions intensity of CalPERS holdings of CU200 companies increased, rising 29% over the time reviewed, measured as potential carbon emissions financed by dollar of CU200 investment held, based on market value."⁶ While Fossil Free Indexes' report did not address the financial risk of investing in fossil fuels, our report provides that analysis.

Like our report, the Fossil Free Indexes report focused on CalPERS' holdings in the Carbon Underground 200 companies, which hold the majority of fossil fuel reserves. The CU200 list excludes consideration of the compounded effect of adding supply chain fossil fuels in other industries, such as utilities, pipelines, and oil field services. Focusing on CU200 provides a strong starting point in analyzing the financial risks of investing in those companies, but clearly underestimates the total financial risk and social cost of carbon emissions in the CalPERS' portfolio.

The market value of CalPERS' holdings in coal decreased significantly between 2010 and 2016, even though CalPERS continues to hold stock with a market value of \$1.424 billion in 58 of the 100 CU200 coal companies in 2016 (see Appendix 2). Coal illustrates the volatility and the financial risk of holding coal assets, which we think is a harbinger for all fossil fuel holdings. US domestic coal consumption has declined by 32% over the past 10 years; the top 13 national coal producers lost 92% of their aggregate value between 2011 and 2016.⁷ Coal prices declined for several reasons, including the surge in domestic natural gas production and increasing concern over coal's effects on greenhouse gas emissions, air pollution, and people's health. As You Sow's report "White Paper: Financial Risks of Investments in Coal" shows the risk of investing in coal and explains why investors must demand fossil fuel companies deliver 2°C transition plans.⁸ In 2016 CalPERS owned stock with market value of \$7.182 billion in 84 of the 100 Carbon Underground 200 oil and gas companies. While new coal projects are rare, exploration, development, and production in oil and

⁴ "CalPERS Comprehensive Annual Fiscal Report (as of June 30, 2018)," CalPERS, last modified June 30, 2018, <https://www.calpers.ca.gov/docs/forms-publications/cafr-2018.pdf>.

⁵ 2015-2016 Comprehensive Annual Financial Report. <https://www.calpers.ca.gov/docs/forms-publications/annual-investment-report-2016.pdf>

⁶ *The CalPERS Portfolio and Fossil Fuel Reserve-related CO2 Emissions, 2004-2013* (Fossil Free Indexes Research Report, Sept 2014)

⁷ Coats, Christopher. "Market Cap of U.S. Coal Companies Continues to Fall." *Institute for Energy Economics & Financial Analysis*, 23 Mar. 2016, ieefa.org/market-cap-u-s-coal-companies-continues-fall/.

⁸ Leslie Lowe and Amy Galland, *White Paper: Financial Risks of Investments in Coal – Update* (As You Sow, October 2012), <https://static1.squarespace.com/static/59a706d4f5e2319b70240ef9/t/5a7e4362ec212d8118a67dd2/1518224230301/CoalWhitePaperUpdate-2012.pdf>.

gas continue, even though companies already own more proved reserves than can be extracted and burned if the planet is to remain under the 2-degree target.

Market returns on energy are relatively low compared to other sectors, and we conclude that the low returns on energy assets do not justify the risks. The cumulative total return to the energy sector from the market peak (Oct 2007) to Dec 31, 2018 is -4.8%, and energy is the lowest-performing sector. Returns to the other sectors range from 3.3% for financials to 623% for consumer discretionary, compared to the benchmark S&P 500 return of 355%.⁹ The stock market surge from January through April of 2019 sent the S&P 500 to new record highs, but the energy sector performed weakly during the broad-based rally—energy stocks in the S&P 500 were down 13% over last year, compared to a 10% rise in the S&P 500¹⁰.

Good market returns are critical to sustaining the future security of CalPERS members and beneficiaries. In addition, large institutional investors such as CalPERS play an important role in the global economy as providers of long-term finance satisfying “long-term physical investment needs across all sectors in the economy and specifically in key drivers of growth, competitiveness and employment”.¹¹ For these reasons, any financial risk to CalPERS’ portfolio must be carefully reviewed and evaluated. In this paper we examine the financial risk to the CALPERS portfolio associated with climate change, in order to provide asset owners with information we believe to be critical to making wise financial choices.

Analysis

In this report we analyze the factors that contribute to CalPERS’ financial risks and potential losses along with the societal costs associated with owned assets of fossil fuel companies:

- **The future cost of stranded fossil fuel assets (SFFA).** Fossil fuel reserves will decline in value as costs of renewable energy continue to decline and as governments regulate and tax greenhouse gas emissions.
- **Litigation risk.** Legal liability includes the potential costs to fossil fuel companies resulting from lawsuits against greenhouse emitters. Indirectly, these costs will be borne by asset owners and their funders. Pension funds will not be able to meet their obligations to beneficiaries if a fund loses too much money by holding on to failing fossil fuel stocks for too long.
- **The social cost of carbon.** The costs to society of the harms to people’s health and the environment caused by GHG emissions are already high and will continue to rise rapidly along with the GHG emissions. Additionally, the fossil fuel companies and their shareholders are both at risk of suffering reputational damage.

⁹ RBC Capital Markets, LLC / Portfolio Advisory Group, “U.S. Equities | Economic and market update”, January 2019. Data sources: FactSet, Russell Investment Group, Standard & Poor’s, J.P. Morgan Asset Management

¹⁰ https://www.reuters.com/article/usa-stocks-weekahead/rpt-wall-st-week-ahead-record-breaking-rally-leaving-energy-stocks-behind-idUSL1N22E1ZT?utm_source=applenews

¹¹ OECD, *The Role of Banks, Equity Markets and Institutional Investors in Long-Term Financing for Growth and Development*, February 2013, <https://www.oecd.org/finance/private-pensions/G20reportLTFinancingForGrowthRussianPresidency2013.pdf>. P. 4

Key Findings

Our estimate of potential financial losses resulting from stranded assets associated with staying within the 2°C target is based on the proved reserves¹² held by Carbon Underground 200™ Companies, published by Fossil Free IndexesSM LLC,¹³ and data from the Carbon Majors Report¹⁴ applied to the 2016 CalPERS portfolio. [See appendix for description of data and methods.]

Key Findings

1

If investors continue to invest in companies whose value is at least partly based on proved reserves, these shareholders will suffer from a decline in stock prices when market prices correctly incorporate the diminished value of stranded assets. Unlike coal, oil and gas continue to have substantial market value, which we show do not correctly reflect the impact of potential stranded assets on future earnings. According to our projections, if CalPERS does not remove CU200 companies from their portfolio, the total value of CalPERS's potential stranded oil, coal, and gas assets in the CU200 companies held in 2016 will reach \$42 billion before 2050.

2

CalPERS invested in 22 of the top 90 global cumulative emitters (called the Carbon Majors) in 2016. These 23 companies together produced 22.8% of total global greenhouse gas emissions over the period 1988-2015.¹⁵ CalPERS' ownership of this subset of the Carbon Majors was responsible for 0.105% of their cumulative global GHG emissions, and thus as an investor, CalPERS participates in the risks attributable to the Carbon Majors.¹⁶

3

The total carbon emissions associated with the reserves of the CU200 companies in CalPERS' 2016 portfolio amounts to 414,453 million metric tons of CO₂. If the reserves are extracted and burned, the estimated cost to society from environmental, health, and social harm is \$51 trillion, based on EPA's \$123 per ton of emitted CO₂. The share of this social cost represented by the shares owned by CalPERS amounts to \$234,684 million.¹⁷

¹² Proved reserves are the estimated quantities that engineering data demonstrate are recoverable with reasonable certainty. More detail in the accounting for reserves blue box under Stranded Assets.

¹³ "The Carbon Underground 200 – 2017 Edition," Fossil Free Indexes, last modified 2017, <http://fossilfreeindexes.com/research/the-carbon-underground/>.

¹⁴ Paul Griffin, *The Carbon Majors Database: CDP Carbon Majors Report 2017*, July 2017, <http://goo.gl/hiyUeW>.

¹⁵ Griffin, *The Carbon Majors Database*; <http://climateaccountability.org/carbonmajors.html>

¹⁶ See Appendix 3 for data and calculations. The last spreadsheet table shows the calculations for the share of GHG emissions responsible by CalPERS in their holdings of Carbon Major companies.

¹⁷ Environmental Protection Agency. Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866, *Interagency Working Group on Social Cost of Greenhouse Gases*, United States Government. https://19january2017snapshot.epa.gov/sites/production/files/2016-12/documents/sc_co2_tsd_august_2016.pdf

Our Assumptions:

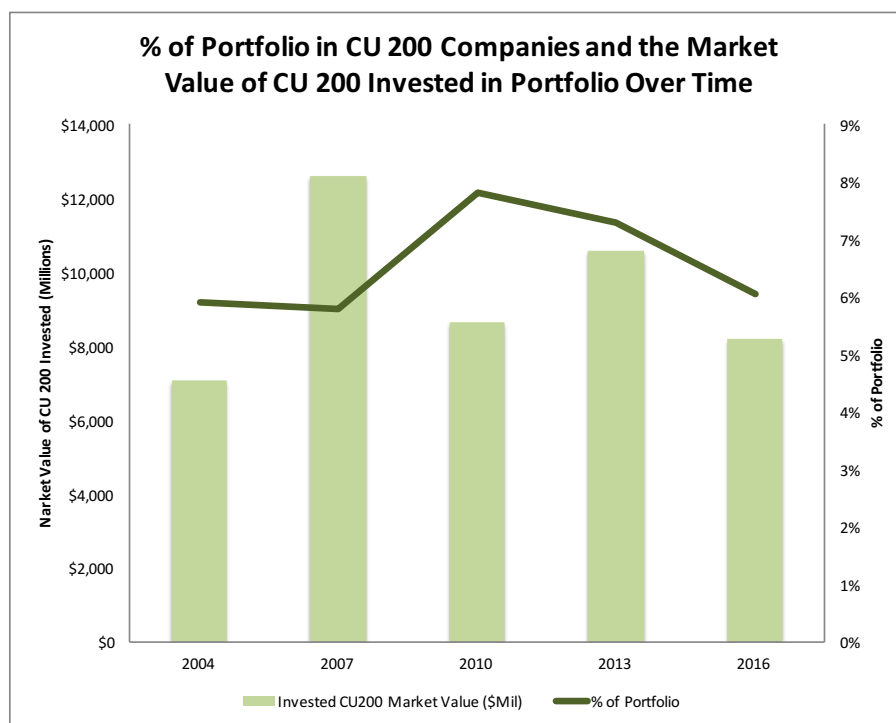
- Our analysis is based on the goal established by the Paris Agreement and reiterated in the latest report of the Intergovernmental Panel on Climate Change (IPCC): to limit greenhouse gas emissions to levels that can keep the global temperature rise “well below” 2°C.
- To keep global temperature rise below 2°C, fossil fuel companies will be required to keep 80% of proved coal reserves, 50% of gas reserves, and 33% of oil reserves underground.¹⁸ We refer to these reserves as “stranded assets,” although we recognize that until governments act to prohibit extraction and combustion, or until peak oil demand is reached as renewable energy becomes even more competitive, companies will continue to treat these assets as viable, and stock prices will not correctly reflect the future cost of “stranding.”
- Our estimations assume that stranded assets are evenly distributed among fossil fuel companies, proportionate to their holdings of proved reserves that must not be extracted. For example, all coal companies are assumed to be required to keep 80% of their proved reserves in the ground.

¹⁸ Mcglade and Ekins, "The Geographical", "The Geographical Distribution of Fossil Fuels Unused When Limiting Global Warming to 2 °C," *Nature* 517 (January 2015)

Risks to CalPERS Portfolio

Risks to CalPERS Portfolio

As of June 30, 2016 CalPERS held just over \$8.6 billion, or 5.92% of its domestic and international equities in 142 of the Carbon Underground 200 (CU200) companies. (See chart) CalPERS' CU200 investments represented about 2.8% of the 2016 portfolio's \$302 billion market value. Between 2004 and 2013, the value of CalPERS' holdings (including domestic equity, international equity, corporate bonds and international fixed income) in the CU200 increased from \$7.07 billion to \$10.6 billion.¹⁹ In 2016, the market value of the CU200 domestic and international equities had declined to \$8.6 billion because of the decline in value of coal companies and other factors, including the general state of the bond and stock markets.²⁰



¹⁹ *The CalPERS Portfolio and Fossil Fuel Reserve-Related CO2 Emissions 2004-2013*. Fossil Free Indexes, 2014

²⁰ In the chart, the figures for 2004-2013 include fixed income and corporate bonds, while 2016 numbers only include domestic and international equities.

Stranded Assets Risk

Companies provide public information on their proved reserves, which are reserves estimated to have a very high probability of existence and exploitability. (See sidebar on reserve category definitions.) Although reserves only become a company asset after the oil or gas is extracted, companies report their proved reserves in their SEC 10-K filings, and investors use this information in calculating estimated future company earnings. Proved reserves can lose value precipitously when markets respond to new technology, government regulations, and national strategies that replace fossil fuel energy with renewable energy in order to stay within the 2°C limit.

Just as it is impossible to time the stock market, local effects of climate change are as unpredictable as they are inevitable. The most recent IPCC report states that a 1.5°C target, rather than the 2°C target, is required to prevent catastrophic changes. The 1.5°C target requires a 45% reduction in carbon pollution by 2030 (compared to a 20% cut to meet a 2°C target), and 100% reduction by 2050 (compared to by 2075 with 2°C target).²¹ This means that the global economy has only twelve years to dramatically reduce carbon emissions. Currently, fossil fuel companies' market values are based on their expected future revenues and profits, which are in turn based partly on their known carbon reserves. Yet most companies are continuing to invest in exploring for more reserves, which only increases their potentially stranded assets.

Accounting for reserves

Fossil fuel reserves have three categories, of which the most important is *proved reserves*, which is referred to as “reserves” by convention.

Proved reserves are the estimated quantities that engineering data demonstrate are recoverable with reasonable certainty (i.e., at least a 90% probability that the quantities actually recovered equal or exceed estimate) from known reservoirs under existing operating and economic conditions, which include using existing equipment and current technology (technical feasibility) with current break-even profitability and regulatory and contractual approval (business feasibility). Proved reserves are subdivided into two categories: Proved developed (recovered from existing wells) and proved undeveloped (recovered from new wells with undrilled acreage, or from existing wells with required major expenditure).

Probable reserves are the additional reserves that are less certain to be recovered than proved reserves, but which together with proved reserves have at least 50% probability that the quantities recovered will at least equal the proved plus probable reserve estimates.

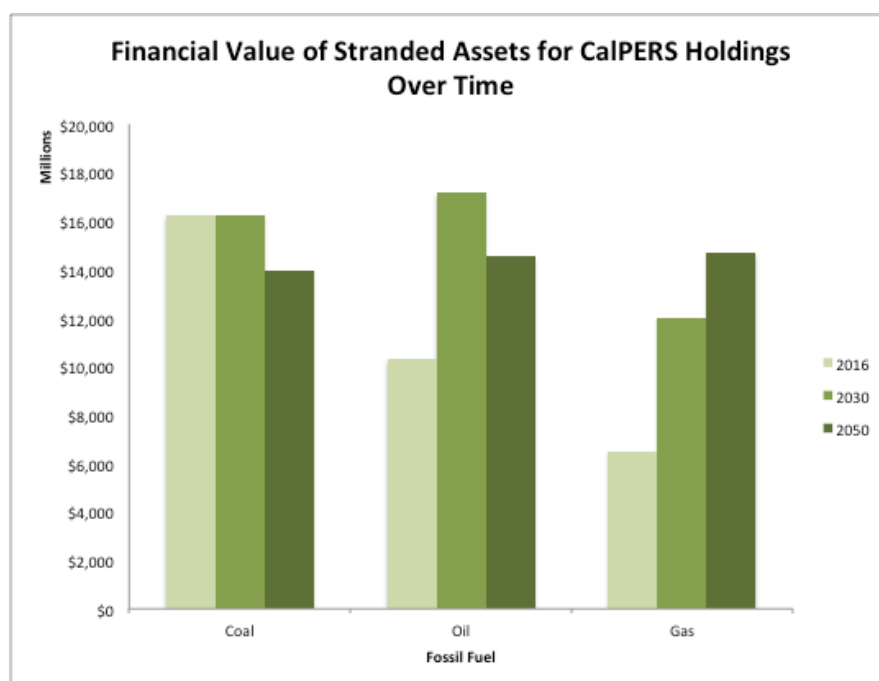
Possible reserves include the additional reserves that are less certain to be recovered than probable reserves, with at least a 10% probability that the total quantities recovered will equal or exceed the sum of proved, probable, and possible estimates.

Reserves are not considered inventory (asset) until they have been extracted. Although proved reserves are not counted as inventory, the SEC has companies disclose proved reserves in a note in their 10-K Annual Report in order to inform investors about the company proved reserves, and since 2009 the SEC has also allowed companies the optional reporting of probable and possible reserves. Then mandatory reporting of proved reserves, while not accounted for in a balance sheet, indicates the company reserves that are expected to generate future revenues. To the extent that the proved reserves will become stranded then the company's expected future revenues are overstated. For investors considering fossil fuel companies, this accounting note in the report is critical in evaluating the company's actual future

²¹ <http://www.ipcc.ch/> Excellent overview: <https://www.theguardian.com/environment/2018/oct/08/global-warming-must-not-exceed-15c-warns-landmark-un-report>

In calculating the financial value of stranded fossil fuel assets (SFFA) for each Carbon Underground 200 company in the CalPERS portfolio, this report uses Fossil Free Indexes' data on untapped proved reserves. We converted the proved reserves, originally stated in gigatons of CO₂ (metric gigatons, or Gt CO₂), into the appropriate units for each fossil fuel type using the equivalencies given by the EPA (see Table 1).²² We multiplied these values by current and predicted prices given by the International Energy Agency (IEA) (see Table 2) to obtain the financial value of these reserves in 2016, 2030, and 2050. Lastly, we calculated the value of potentially stranded assets using the 2°C scenario benchmarks (i.e., the value, at each date, of 80% of coal reserves, 50% of gas reserves, and 33% of oil reserves) to arrive at the percentage of reserves that cannot be burned and should be considered stranded by prudent investors.

As of June 30, 2016, potential SFFA of CU200 companies in CalPERS' portfolio had a total market value exceeding \$12 trillion; the value of CalPERS' share of these CU200 companies is over \$32 billion. Thus the potential financial risk to the fund is enormous—unless CalPERS acts preemptively. Barring unforeseen market shocks or the regulatory bursting of the carbon bubble in the meantime, and based on the IEA's projected prices of oil and natural gas, CalPERS' stake in these stranded assets is projected to increase from \$10 billion in 2016 to \$14 billion in 2050 for oil; and from \$6 billion to \$14 billion for gas.²³ (See chart) The price of coal is expected to continue to fall precipitously. It is clear that holding onto oil and gas company assets is not a prudent financial choice, as the value of stranded assets will be higher in the future than they are now.



We believe that the CU200 companies are significantly overvalued because of the inevitability of SFFA. Our simple estimated valuation of SFFA is comparable to the results of a detailed study of

²² "Greenhouse Gases Equivalencies Calculator - Calculations and References," EPA, accessed July 30, 2018, <https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references>.

²³ "Annual Energy Outlook 2017 with Projections to 2050." *U.S. Energy Information Administration*, 5 Jan. 2017, [www.eia.gov/outlooks/aeo/pdf/0383\(2017\).pdf](http://www.eia.gov/outlooks/aeo/pdf/0383(2017).pdf).

the value of SFFA published in *Nature Climate Change*, which estimates global stranded asset valuation of \$9 to \$12 trillion in 2035 (2016 US\$).²⁴

Furthermore, our estimation is conservative because it covers only CU200 companies, and also because it only covers proved reserves. Carbon Tracker Initiative's 2019 report discusses how companies continued exploration also creates future reserves and resources that are at great risk of being stranded, and current disclosure practices do not provide information on these risks.²⁵ Carbon Tracker's 2015 report estimated oil, gas, and coal companies have an overhang of \$1.9 trillion in unneeded capital expenditures (through 2025), which are in danger of not being recovered and thus will add to stranded assets.²⁶

In 2016, CalPERS owned shares in some of the largest coal, oil, and gas companies, which hold significant proved reserves and thus large SFFA. State Bill 185, passed in 2015, required the fund to divest from companies receiving 50% or more of their revenues from thermal coal.

Investors are forward-looking and include future expected earnings in their valuation of a company's assets. If the market perceives that governments are planning regulations or policies that will replace demand for fossil fuels with demand for renewable energy, or if renewable energy continues to be price-competitive with fossil fuels, then a fossil fuel company's market value will decline as its expected earnings decline. If investor expectations change quickly, then fossil fuel market values could decline precipitously.

In the idealized, perfectly competitive market, economists assume that investor information is perfect, including future expectations of company earnings, so that today's stock prices would reflect the negative effect that the known stranded assets will have on future company earnings. However, we all acknowledge that the stock market does not operate in a perfectly competitive economy, and investors, companies, and the government make decisions based on imperfect information, including the company valuation of proved assets that typically ignores potential stranded assets as well as the overall risk global warming poses to both the market and business models. Stock market swings happen as investors, and computer programs, attempt to cope with imperfect knowledge about the future stream of profits. If investors had the same information as companies, and both had perfect foresight about earnings streams, including the impact of stranded assets on earnings and future market value, CU200 stocks would most likely look much less attractive to long-term investors.

One of our co-authors, Sara Jankoska, analyzed the relationship between stranded assets and the market value of fossil fuel companies.²⁷ For publicly held fossil fuel companies, she found that as the percentage of stranded assets held by a fossil fuel company increased, the company's market value decreased.²⁸ This statistically significant result implies that shareholders will experience a decline in

²⁴ Mercure et al (2018). "Macroeconomic impact of stranded fossil fuel assets", *Nature Climate Change Letters*. Published June 4. <https://doi.org/10.1038/s41558-018-0182-1>

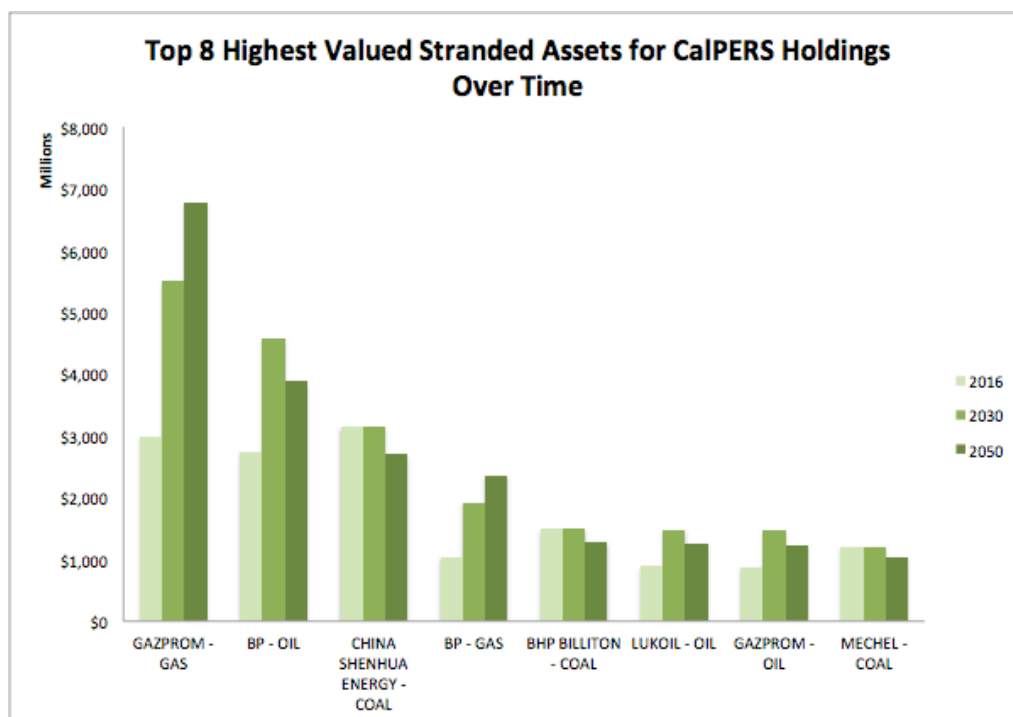
²⁵ Carbon Tracker, *Reporting for a Secure Climate*, May 2019. <https://www.carbontracker.org/reports/reporting-for-a-secure-climate-a-model-disclosure-for-upstream-oil-and-gas/>

²⁶ Carbon Tracker, *The \$2 Trillion Stranded Assets Danger Zone: How fossil fuel firms risk destroying investor returns*, 2015. <https://www.carbontracker.org/reports/stranded-assets-danger-zone/>

²⁷ Jankoska, Sara, (2018). "The Implications of Climate Change for the Value of Fossil Fuel Assets." Honors Thesis, Department of Economics, University of California, Berkeley.

²⁸ The study uses a data base of 265 publicly held coal, oil, and gas companies over four years (2013, 2014, 2016, 2017). These results are based on a regression of the market value of a fossil fuel company on the stranded assets, as a fraction

stock prices of these companies as investors incorporate the impact of stranded assets on future company revenues and earnings. Using this model, Jankoska estimated how much the CalPERS portfolio might be negatively affected by holding large fossil fuel companies when market valuations reflect the value of stranded assets. For example, if CalPERS removed their top five coal companies, top five oil companies, and top five gas companies from the CalPERS 2016 portfolio, then this would protect the portfolio from declining in value by \$139 million (coal), \$418 million (oil), and \$585 million (gas).



Our findings are in line with recent research, which predicts the demise of the fossil-fuel industry as a result of ongoing improvements in renewable energy combined with new climate policies. A UK study predicts a global wealth loss of \$1trillion to \$4 trillion resulting from continued investments in fossil fuel discovery and extraction by countries, including the U.S., by 2035.²⁹ Leaders of over 30 central banks, including Mark Carney of the Bank of England and François Villeroy de Galhau of the Banque de France, endorsed a report warning that a massive reallocation of capital will be

of total reserves and inventory, a control variable for industry (oil, coal, and gas), an interaction variable between stranded assets and each industry control variable, and fixed effect estimators for company fixed effects and year fixed effects. The stranded assets variable is calculated using the reported Gt CO₂ reserves and the following benchmarks: 80% for coal, 50% for gas and 33% for oil, then multiplied by the historical average price of each fossil fuel type in each year as given by the EIA to come up with the dollar value. Finally, the stranded asset metric is divided by the total proven reserves and inventory, standardizing it across all the companies. The industry control variables account for any industry related effects and are set to 1 when a given company owns a specific type of stranded assets, oil, coal, or gas, and zero otherwise. The interaction term between stranded assets and the industry control variable accounts for the different effect of stranded assets on the outcome, depending on industry. Finally, the company-fixed effects account for any within-company time-invariant effects, while the year-fixed effects account for any year-specific effects.

²⁹ Radboud University Nijmegen. "'Carbon bubble' coming that could wipe trillions from the global economy: Demand for fossil fuels will decline in the near future with major macroeconomic and geopolitical consequences." *ScienceDaily*. ScienceDaily, 4 June 2018. <www.sciencedaily.com/releases/2018/06/180604121041.htm>.

required to reduce greenhouse emissions dramatically, with recommendations for how the central banks can, and must, play leading roles.³⁰

The Case of Exxon

One example of the financial risk associated with writing off reserves is ExxonMobil's announcement in February 2017 that it would write off reserves in oil (tar) sands, which Exxon deemed to be stranded due to the uneconomic cost of extraction and transport. Oil sands reserves accounted for 19% of Exxon's total reserves. Exxon had already experienced investor concerns about the investigation initiated by New York's and Massachusetts' attorneys general. When Exxon wrote off the reserves, investors lost further confidence in Exxon's future revenues and profits.³¹

Thus in Q4 of 2017, Exxon saw its production and cash generation decline. Investors were expecting higher growth rates, but low production indicated an inability to live up to investors' expectations. Even as the stock price is increasing in 2018 and 2019, the high level of volatility due to rapidly changing conditions is not compatible with a long-term investor's desire for predictability in returns.

The company is now making investments in new oil fields, which Exxon expects will increase production five to ten years in the future. Still, the stock price volatility does not reflect investor confidence. With regulation likely ahead, prudent investors have reason to be skeptical of Exxon's ability to produce reliable and consistent returns in the future.³²

Legal Liability and Litigation Risk

In addition to the aforementioned market risk and reputational risk, CalPERS' fossil fuel investments face at least three types of financial risk arising from legal liability and potential litigation: physical damage suits, regulatory non-compliance challenges, and insurance fees.

Current and Future Risks. Several municipalities in California have filed lawsuits against fossil fuel companies for current and future physical harm to property or infrastructure. The counties of San Mateo, Marin, and Santa Cruz; the cities of Imperial Beach, Oakland, Santa Cruz, and Richmond; and the City and County of San Francisco are working to sue companies seeking compensation for sea level rise mitigation and other climate change-related damage.³³ (See case study box) It is currently too early to predict the impact of these suits on share value, but the risk is

³⁰ https://www.banque-france.fr/sites/default/files/media/2019/04/17/ngfs_first_comprehensive_report_-_17042019_0.pdf

³¹ Sanzillo, Tom. "IEEFA Report: Red Flags on ExxonMobil: Core Financials Show a Company Decline." *Institute for Energy Economics and Financial Analysis*, Oct. 2016, ieefa.org/wp-content/uploads/2016/10/Red-Flags-on-ExxonMobil-XOM-A-Note-to-Institutional-Investors_October-2016.pdf

³² Smith, Geoffrey. "Exxon's Big Write-Off Could Help It Dodge SEC Troubles." *Fortune*, Fortune, 23 Feb. 2017, fortune.com/2017/02/23/exxon-mobil-oil-sands-sec/.

³³ Hasemyer, David, et al. "Fossil Fuels on Trial: Where the Major Climate Change Lawsuits Stand Today." *InsideClimate News*, InsideClimate News, 9 Jan. 2019, insideclimatenews.org/news/04042018/climate-change-fossil-fuel-company-lawsuits-timeline-exxon-children-california-cities-attorney-general.

undeniable. Abyd Karmali, Managing Director, Climate Finance at Bank of America Merrill Lynch, warned investors at COP 21 in 2015 about legal risk inherent in the transition to a low-carbon economy. *The Telegraph* summarized his remarks, “oil, gas and coal companies face the mounting risk of legal damages for alleged climate abuse as global leaders signal an end to business-as-usual and draw up sweeping plans to curb greenhouse gas emissions.”³⁴

The ongoing lawsuit by New York’s attorney general against Exxon uses a different strategy, claiming Exxon defrauded shareholders by deceiving them about the company’s management of the risks posed by climate change regulation.³⁵

Plentiful evidence in the public record shows that the largest oil companies were fully aware *decades ago* of the deleterious effects of their operations and products on the global climate, and the consequences for people and the environment. What is happening in the fossil fuel industry today is analogous to what happened to tobacco over a decade ago, when tobacco companies refused to acknowledge the health hazards their products posed to consumers and knowingly spread uncertainty about the connection between smoking and various diseases. In 2006 Judge Gladys Kessler found these companies guilty of racketeering. She wrote, “They suppressed research, they destroyed documents, they manipulated the use of nicotine so as to increase and perpetuate addiction, they distorted the truth about low-tar and light cigarettes so as to discourage smokers from quitting, and they abused the legal system in order to achieve their goal—to make money with little, if any, regard for individual suffering, soaring health costs, or the integrity of the legal system.”³⁶ When investors withdrew their capital, tobacco stocks plummeted. Unfortunately for all of us, including pension fund members and beneficiaries, the damage caused by carbon emissions is much greater and broader, and includes damage to property and the environment as well as health. Fossil fuel companies are vulnerable in the same way tobacco producers were and are likely to face similar financial turmoil once reporting liabilities are properly enforced and plaintiffs win damages related to climate change. We note that in recent years, CalPERS staff and some board members have proposed re-investing in tobacco, since increasing sales abroad have recovered some value in the now-international tobacco companies. Unlike tobacco, however, fossil fuel stocks that lose value due to market forces or regulatory action are unlikely to recover, as the planet must move to clean energy or suffer disastrous consequences.

The recent history of PG&E is another cautionary tale about unacceptable volatility in share valuation due to climate-associated events and increased risk and liability. In 2016 CalPERS held 192,001 shares in PG&E, then worth \$122,726,478, trading at \$64.03. After fire liability assessments, the stock fell to \$6.36 in January 2019. Post-bankruptcy filing with news of a possible legislative or regulatory bailout, the stock has risen to the low \$20s. Is this degree of value destruction, let alone price volatility, acceptable for a public pension fund? We see the PG&E story as a demonstration of investment risk resulting from the confluence of climate-related physical changes and the necessary transformation of our electrical power sources.

³⁴ Ambrose Evans-Pritchard, “Fossil fuel companies risk plague of ‘asbestos’ lawsuits as tide turns on climate change,” *The Telegraph*, October 27, 2015, 1, accessed July 30, 2018, <https://www.telegraph.co.uk/finance/newsbysector/energy/11958713/Fossil-fuel-companies-risk-plague-of-asbestos-lawsuits-as-tide-turns-on-climate-change.html>.

³⁵ Schwartz, John. “New York Sues Exxon Mobil, Saying It Deceived Shareholders on Climate Change.” *The New York Times*, The New York Times, 24 Oct. 2018, www.nytimes.com/2018/10/24/climate/exxon-lawsuit-climate-change.html.

³⁶ Zieve, Allison M., and Gregory A. Beck. *UNITED STATES COURT OF APPEALS FOR THE SIXTH CIRCUIT. Case 10-5234, Document: 006110697376. Appeal from the United States District Court for the Western District of Kentucky*, www.lung.org/assets/documents/advocacy-archive/amicus-curiae-tobacco-control.pdf.

Case Studies: Fossil Fuel Litigation in the Bay Area

Municipalities around the world, facing the effects of climate change and the need to mitigate harms to local residents and businesses, are reacting to the news that fossil fuel companies have known for decades about the climate effects of burning fossil fuels, yet hid that knowledge from governments, shareholders, and the public. In the Bay Area alone, the cities of Richmond, Oakland, and San Francisco and the counties of San Mateo and Marin have filed lawsuits. Each cites companies' willful obfuscation of the truth as well as the continuous harm to the environment and human health as their case. Fossil fuel companies, the filings cases argue, are liable for negligent and ultimately destructive choices to ignore scientific results and continue extracting and burning fossil fuels.

San Mateo and Marin Counties

On July 17th, 2017, attorneys representing San Mateo and Marin counties and the City of Imperial Beach filed lawsuits against 37 fossil fuel companies, accusing them of consciously emitting greenhouse gases that have had a significant effect on global warming, adversely affecting sea levels in their communities. Additionally, the lawsuits claim that these companies concealed the true extent of the damages their products were causing in order to undermine public support for greenhouse gas regulation and promote the use of their products. The suits aim to hold the 37 companies accountable for over 20% of total global emissions over the past five decades.³⁷ San Mateo and Marin counties note that they are already confronting the financial impacts of climate change in local communities. They anticipate continued impacts to public spaces and infrastructure such as wastewater treatment facilities and roads. Unless the principle of "polluter pays" holds, these counties will be required to spend millions of taxpayer dollars to mitigate the damages.

San Francisco and Oakland

"Global warming is here, and it is harming San Francisco now," states the lawsuit against the five largest oil companies, filed by the City of Oakland and the City and County of San Francisco: "This egregious state of affairs is no accident."³⁸ According to San Francisco City Attorney Dennis Herrera and Oakland City Attorney Barbara Parker, climate change caused by five fossil fuel companies will result in billions of dollars of losses to both cities. As coastal areas, rising sea levels will render coastline public property to be unusable. Sewer systems may be damaged by changing sea levels and lead to city wide overflows. Both cities' international airports are built on fill adjacent to San Francisco Bay and must be diked or otherwise armored, or moved upland (at vast expense and disruption to commerce) as sea levels rise. Human costs will be high and falling disproportionately on vulnerable communities, as some of the poorest residential neighborhoods in both cities are close to the bay shore. While the San Francisco and Oakland suits were dismissed in Federal District Court, the cities have appealed.

Richmond

On June 22, 2018, Richmond filed a lawsuit in the California Supreme Court against 29 fossil fuel companies because they failed to warn the public about the dangers of greenhouse gas emissions and have been negligent in minimizing the damage. The city argues that these 29 fossil fuel companies have known that the pollution from their business contributes to the worsening of Earth's climate and the rising sea levels and failed to act to change their business models or mitigate the damage. The companies are responsible for 215.9 gigatons of global CO₂ emissions between 1965 and 2015. Because they continue to produce and promote their fossil fuel products the city of Richmond believes that they should be held accountable for the damage they are doing to the environment and local residents.

Liability for Historical Emissions

Historical emissions are now being taken into account when suing fossil fuel companies for existing damages. The lawsuits by local governments against 37 fossil fuel companies cite harms caused to their communities in recent decades. Rising sea levels, the increased frequency and far greater severity of droughts, floods, fires, and adverse effects to vital infrastructure from sea level rise are included in the calculation of actionable damages. These damages could amount to colossal financial costs for the companies named in the suits.

The Carbon Majors Database 2017 report³⁹ reveals that the fossil fuel industry emitted as much greenhouse gas in the 28 years from 1988 to 2015 as in the 237 years from the start of the industrial revolution to 1988. The data show that 70.6% of cumulative carbon dioxide emissions (metric tons equivalent) between 1988 and 2015 is attributable to just 100 producers, of which 57 are investor-owned. As of 30 June 2016, CalPERS was invested in 22 of those 57 publicly or privately traded Carbon Majors companies, which are responsible for 22.8% of the cumulative global carbon dioxide emissions; securities held by CalPERS are responsible for 0.105% of cumulative global carbon dioxide emissions.

A company's emissions are a signal of its investors' participation in the fossil fuel industry. In the current climate crisis, investors want to know the amount of carbon associated with their funds' fossil fuel holdings, because that metric represents potential future risk to the companies and thus to the investment. Furthermore, legal liabilities are based on more than direct human health effects; they also include long-term impacts to society and the environment. Similarly, cumulative global emissions indicate the scope of the damage caused by these companies over the past 30 years (the average court case time period). The cumulative global emissions used here is a conservative estimate given the lack of data for historical emissions of approximately half of the companies, but it provides a lower bound estimation of emissions attributable to companies in the CalPERS portfolio.

Non-Compliance

Governments are establishing specific reporting guidelines and requirements for fossil fuel emissions. Companies' non-compliance with laws and regulations, such as emissions reporting requirements and environmental regulations, can lead to substantial fines that adversely impact asset values, and thus shareholder portfolios. For the most part, in the G20 member countries, companies with equity or public debt are legally obliged to disclose all material information, including climate-related information so that investors have accurate information on emissions and climate risk in order to make informed decisions. As regulations are enforced, regulators may impose fines on fossil fuel companies that underreport or fail to report; and litigation risk increases. A recent example that showcases how these legal risks can turn into large financial losses are the consequences ExxonMobil is facing as a result of their failure to comply with the air quality regulations set forth by

³⁷ Kelly, Kevin. "San Mateo County Sues 37 Fossil Fuel Firms over Sea Level Rise." *The Mercury News*, The Mercury News, 19 July 2017, www.mercurynews.com/2017/07/17/san-mateo-county-sues-37-fossil-fuel-firms-over-sea-level-rise/.

³⁸ People of the State of California vs. BP P.L.C., Chevron, Exxon, et al. "Complaint for Public Nuisance, *Case No.: CGC-17-561370*. September 19, 2017. <https://www.sfcityattorney.org/wp-content/uploads/2017/09/2017-09-19-File-Stamped-Complaint-for-Public-Nuisance.pdf>

³⁹ Griffin, *The Carbon Majors Database*, 2017. cms/reports/documents/000/002/327/original/Carbon-Majors-Report-2017.pdf

the EPA. Exxon is not only required to pay a \$2.5 million fine but also close to \$300 million as a part of the settlement that requires the company to install new technologies.⁴⁰

Fossil fuel companies have been neglecting or delaying emissions reporting for years, failing to follow federal regulations as well as failing to disclose known environmental or financial risk caused by their operations or products. In addition, they often fail to operate within established industry standards such as the framework proposed by the Task Force on Climate-Related Financial Disclosures.⁴¹ However, in recent years pressure is being exerted to make these companies accountable for the costs to society caused by the company's carbon emissions. Regulatory frameworks for climate risk disclosure by emissions data are set out in the Global Reporting Initiative (GRI), and by the Carbon Disclosure Project (CDP). Under SB 964, CalPERS and CalSTRS must report the climate-related financial risk in their portfolios, beginning by January 2020.⁴²

Insurance

The future costs of insuring fossil fuel projects and operations pose significant financial risk to companies and their insurers and investors. In his speech addressing London's insurance market, Mark Carney, Governor of the Bank of England, noted the various types of risks associated with climate change that insurers, and entities that self-insure, face. Once insurance premiums correctly incorporate climate risks to the potential physical harms endured by the public, many companies will face extremely high costs for required liability insurance. Insurance companies are likely also to be responsible for third-party liability claims stemming from lawsuits filed against fossil fuel companies.⁴³

The Social Cost of Carbon: Indirect and Long-Term Impacts

Fossil fuel companies' production of coal, oil, and gas are responsible for environmental degradation and the health problems resulting from air pollution, hotter days, wildfires, and droughts. However, fossil fuel companies do not pay for the harm to the planet and people—these costs are passed along to the public to pay, either directly in repairing harm to the environmental or indirectly through adverse effects on public health and economic losses across the global economy.

In this section we analyze the broad social costs associated with carbon emissions, both today and in the future, from Carbon Underground 200 companies. We use the “social cost of carbon” (SCC), a monetary measure of long-term damages (i.e., discounted over many decades) caused by a metric ton of carbon dioxide (tCO₂) emissions in a specific year. This widely used metric is a comprehensive estimate of the cost to society of climate change, including changes in human health, agricultural productivity, property damages from flood risk, and energy system costs. Greenhouse gas emissions

⁴⁰ “Under Agreement with the Justice Department and Environmental Protection Agency, ExxonMobil to Reduce Harmful Air Pollution at Eight U.S. Chemical Plants.” *EPA*, Environmental Protection Agency, 31 Oct. 2017, www.epa.gov/newsreleases/under-agreement-justice-department-and-environmental-protection-agency-exxonmobil.

⁴¹ *Annex: Implementing the Recommendations of the TCFD* (June 2017), Table A1, p. 72. <https://www.fsb-tcfd.org/publications/final-implementing-tcfd-recommendations/>

⁴² https://leginfo.ca.gov/faces/billTextClient.xhtml?bill_id=201720180SB964

⁴³ Carney, Mark, “A Transition in Thinking and Action”, speech given at International Climate Risk Conference for Supervisors, De Nederlandsche Bank, Amsterdam, 6 April 2018. <https://www.bankofengland.co.uk/-/media/boe/files/speech/2018/a-transition-in-thinking-and-action-speech-by-mark-carney.pdf?la=en&hash=82F57A11AD2FAFD4E822C3B3F7E19BA23E98BF67>

are given in CO₂ metric ton equivalents. For example, SCC equal to \$100 per tCO₂ indicates that each ton of CO₂ emissions requires \$100 to mitigate the damage.

SCC has been studied and estimated by scientists and economists under a variety of methods and assumptions.⁴⁴ Here we use SCC as measured by the U.S. Environmental Protection Agency (EPA), which omits some important potential physical, ecological, and economic damages from climate change because of lack of precise data.⁴⁵ The EPA provides a range of estimates for SCC, using different discount rates for selected years between 2010 to 2050.⁴⁶ The discount rate, which is the interest rate used to calculate today's value of future cash flows, plays an important role in determining the social cost of carbon because the costs to future generations of today's emissions from coal, oil, and gas remain in the atmosphere for decades. Those who think that people living today are more important than future generations use a higher discount rate—a high discount rate assigns a low value to the future, and thus a lower value to today's SCC. Those who value the lives of future generations use a lower discount rate, which increases today's SCC.

The EPA estimates of SCC range from \$12 to \$123 per tCO₂ for the year 2020. This report uses the high impact value for SCC of \$123 per tCO₂ for the year 2020 (3% discount rate). We use the high impact value because actual damages from climate change have traditionally been underestimated, and SCC has continually been revised upwards as it is updated. Climate scientists and even many economists think most current valuations of SCC are gross underestimations of the social costs of carbon emissions. For example, MIT economist Robert Pindyck, using a discount rate of 2.5% and excluding catastrophic outcomes where GDP decreases more than 20%, estimates SCC to be \$121.⁴⁷ The IPCC estimates a range of SCC in 2030 from \$10 to \$200 if we are to stay below the 1.5 °C, or a higher SCC of \$135 to \$5500 to stay below 2 °C pathway.⁴⁸

Impact on Society and the Global Economy

The social cost of carbon related to CalPERS' portfolio poses a clear financial risk to the integrity of the fund over time. In this report we use SCC to estimate the potential social costs attributable to fossil fuel companies' reserves if extracted and burned. This provides an additional measure of the financial risks related to excess fossil fuel reserves, whether or not governments act to keep them in the ground. Either the reserves are extracted and burned, which we show below presents a very high cost to society, or the reserves will become stranded and CalPERS investments will lose value precipitously.

If companies extract and burn all proved reserves currently reported, the costs incurred by society will run into trillions of dollars. From a societal viewpoint, CalPERS' investments in fossil fuel

⁴⁴ The Intergovernmental Panel on Climate Change Report provides a good summary of the approaches and estimates of SCC. *Global Warming of 1.5°C. An IPCC Special Report*, 2018, Ch 2, pp 76-78. <https://www.ipcc.ch/sr15/>

⁴⁵ Interagency Working Group on Social Cost of Greenhouse Gases, United States Government. "Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866," https://www.epa.gov/sites/production/files/2016-12/documents/sc_co2_tsd_august_2016.pdf. This group acknowledges their use of *Valuing Climate Damages: Updating Estimation of the Social Cost of Carbon Dioxide*, National Academy Press, 2017. <https://www.nap.edu/catalog/24651/>

⁴⁶ Ibid. Table ES-1.

⁴⁷ Pindyck, Robert S. "The Social Cost of Carbon Revisited," NBER Working Paper No. 22807, *National Bureau of Economic Research*. November 2016, Table 2.

⁴⁸ Intergovernmental Panel on Climate Change, *Global Warming of 1.5°C. An IPCC Special Report*, 2018, Ch. 2, p 78.

companies make CalPERS responsible for a portion of those trillions of dollars of damage to public health, the environment, and the global economy. As stated in Key Finding #3, the potential total carbon emissions from CU200 company reserves in CalPERS 2016 portfolio equals 414,453 million tCO₂, which results in a \$51 trillion in costs to society from environmental, health, and social harms. The SCC attributable to the shares owned by CalPERS in 2016 is \$234,684 million, based on \$123 per tCO₂.⁴⁹ Even if we used a low SCC of \$60 per tCO₂, the total cost attributable to CalPERS' stock ownership would still be \$114,480 million, a considerable financial burden to society.

The companies in the CalPERS portfolio with the highest social cost of carbon are shown in the graph. GAZPROM stands out with its very high SCC of over \$10 trillion, and ROSNEFT is in second place with SCC of \$4 trillion. The other six companies have a combined SCC of approximately \$2 trillion.

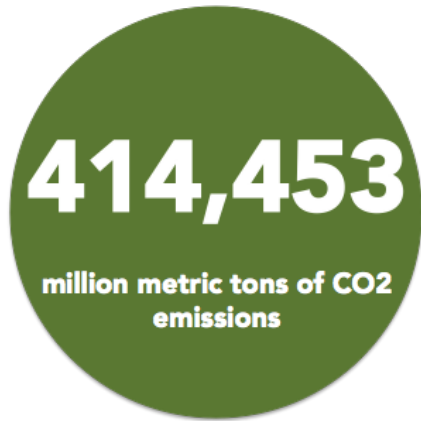
From a financial viewpoint, the high SCC of the CU200 companies' emissions exposes the rising potential of legal liability for fossil fuel companies, as discussed above. If a government sues a company for all the damage that it has done or could do (and a growing number of municipalities, plus the state of Rhode Island, are now bringing suit against oil companies), the company is likely to suffer greatly, both financially and reputationally. Lawsuits create bad publicity for companies, causing stock prices to drop. These are foreseeable risks to CalPERS' portfolio value, which threaten the fund's ability to fulfill its fiduciary responsibilities to its members and beneficiaries. The CU200 companies accounted for about 6% of CalPERS' global equities in 2016; their devaluation would be a severe blow to the Fund's viability.

From a societal viewpoint, the GHG emissions must also be taken into account as a risk to CalPERS because reputation can have detrimental impacts on revenue. Many members of CalPERS care about their social impact, especially if the negative social consequences of investing in fossil fuel companies is accompanied by a lower rate of return and greater financial risk. California leads the country in legislation to create a modern, sustainable economy, beginning with California Global Warming Solutions Act of 2006 (AB 32) that mandated a sharp reduction in greenhouse gas emissions.⁵⁰ The California legislature passed SB 100 in 2018, setting a firm target of 100% clean electricity by 2045. State employees are proud of California's leadership in tackling the climate emergency. Members, many of whom have testified before the CalPERS Board of Administration, are upset about the fact that their pension fund is investing in fossil fuel companies, which are earning below-par returns while financing oil, gas, and coal operations that undermine California's development of a low-carbon economy and compromise the environmental sustainability of the planet.

⁴⁹ Calculations of CalPERS' SCC: Carbon Majors total greenhouse gas emissions amount to 414,453 million metric tons of CO₂, which is 22.8% of the cumulative emissions (shown in appendix 3). Therefore, the total cumulative emissions totals to 1.8 trillion. Given that CalPERS' ownership total cumulative emissions is 0.105%; their emissions are of 1,908 million metric tons of CO₂. Using SCC of \$123 per metric ton, we attribute \$234,684 million to CalPERS.

⁵⁰ California Air Resources Board, <https://www.arb.ca.gov/cc/ab32/ab32.htm>

Carbon emissions from CU200 reserves held by companies in CalPERS 2016,
with SCC of \$51 trillion



Conclusion

Conclusions and Recommendations

CalPERS investing in fossil fuel assets creates financial and reputational risks as the climate crisis escalates along with increased public awareness of the social costs of carbon and legal regulations of greenhouse gas emissions. The authors believe that it is CalPERS' fiduciary duty, in the best interest of current and future fund valuations and in the public interest, to begin now to divest from fossil fuels, beginning with the highest-ranked CU200 companies, which are those with the largest proved reserves and the highest social cost of carbon. While the market has not yet fully recognized the risk associated with continued fossil fuel investment due to a bullish White House and a lack of stringent regulations, we are at a turning point in history, when the world is rapidly transitioning to renewable energy and away from fossil fuels. By beginning to divest now in a timeframe consistent with maintaining returns and avoiding fees, CalPERS can avoid significant financial risks and also end up on the right side of history. Internal and external auditors should play an important role in accounting for potential stranded assets by factoring in the risk accurately. Standards bodies such as the Global Reporting Initiative (GRI) and the Task Force on Climate-Related Financial Disclosures (TCFD) are producing frameworks to standardize accounting for the material risks of climate change, including the risk related to stranded assets.⁵¹

Divestment Trends

Some pension funds are taking action now. New York City is divesting its five pension funds of over \$5 billion in fossil fuels investments. Similarly, the World Bank and Dutch Bank ING are also committing to divestment strategies. As the largest public pension fund in the United States, CalPERS' actions have significant influence on the decisions of other pension funds. CalPERS divestment could be a deciding factor in changing pension funds' investment behavior nationally.

Reputational Risk

As public opinion turns away from fossil fuels, CalPERS faces reputational risk and even the potential for fiduciary lawsuits with continued fossil fuel investments. Elliott Harris, now Chief Economist of the United Nations, called on CalPERS in January 2018 to lead the transition away from fossil fuels. Pressure on the fund will only increase. The sooner CalPERS begins publicly to move away from risky fossil fuel investments, the better for the fund's reputation as well as its financial health.

Social and Fiduciary Responsibility

Climate change calls on institutional investors such as pension funds to examine their role as caretakers of their shareholders' future. There are 1.9 Million CalPERS members who depend on the fund for retirement security. The volatility of fossil fuel investments and the risks outlined in this report indicate that fossil fuels are no longer responsible or forward-thinking investments. It is

⁵¹ Annex: *Implementing the Recommendations of the TCFD* (June 2017), Table A1, p. 72. <https://www.fsb-tcfd.org/publications/final-implementing-tcfd-recommendations/>

critical that institutional investors assume their social and fiduciary responsibility and cease taking unnecessary risks, by divesting from fossil fuels.

Our Future

As students and stewards of the future Earth, we have a vested interest in the livability of the planet in our lifetimes. CalPERS plays an important role in determining what that future looks like. We believe the information presented in this report will help investors make more informed decisions regarding financial priorities of the fund over the next few years. Moreover, adopting a new fossil free investment strategy can help the CalPERS thrive.

Table 1: Greenhouse gas equivalencies conversion equations

Fossil Fuel	Conversion Equation
Coal	0.43 metric tons CO ₂ / barrel
Oil	0.0053 metric tons CO ₂ /therm
Gas	9.14 x 10 ⁻⁴ metric tons CO ₂ /pound of coal

Table 2: Predicted prices for 2015, 2030, and 2050

Fossil Fuel	2015	2030	2050
Coal (per ton)	\$64	\$64	\$55
Oil (per barrel)	\$51	\$85	\$72
Gas (per mBTU)	\$2.60	\$4.80	\$5.90

Source: "Greenhouse Gas" EPA, op cit.

Appendix 1: Carbon Underground 200 Companies in CalPERS 2016 portfolio

Coal Companies

Coal Companies	Book Value 6/30/2016	Market Value 6/30/16
1 Adani Enterprises	\$6,585,167	\$4,717,886
2 Adaro Energy	\$5,558,876	\$2,708,015
3 African Rainbow Minerals	\$4,492,475	\$2,879,493
4 AGL Energy	\$34,295,328	\$39,301,043
5 ALLETE	\$2,908,647	\$4,910,816
6 Alliance Resource Partners	\$3,698,118	\$1,919,777
7 Alpha Natural Resources	\$483,885	\$30,561
8 Anglo American	\$203,333,667	\$68,026,498
9 Arcelormittal	\$122,195,519	\$32,119,063
10 Arch Coal	\$285,364	\$24,122
11 BHP Billiton	\$457,430,440	\$265,578,847
12 Black Hills	\$4,292,142	\$6,759,629
13 Bukit Asam	\$2,986,008	\$1,532,892
14 China Cinda Asset Management	\$5,897,910	\$3,634,564
15 China Coal Energy	\$3,990,355	\$2,319,882
16 China Shenhua Energy	\$44,473,172	\$30,279,484
17 Cloud Peak Energy	\$5,889,977	\$1,089,782
18 Coal India	\$15,511,310	\$11,342,519
19 CONSOL Energy	\$26,005,135	\$22,137,665
20 Datang International Power Generation	\$2,418,394	\$1,697,962
21 Evraz	\$4,644,216	\$5,760,440
22 Exxaro Resources	\$4,308,779	\$1,620,898
23 Feishang Anthracite Resource	\$4,809	\$3,883
24 FirstEnergy	\$58,458,554	\$56,419,852
25 Glencore	\$164,643,709	\$79,504,463
26 Hallador Energy	\$20,787	\$11,959
27 Huadian Power Intl	\$5,033,565	\$3,002,475
28 Indo Tambangraya Megah	\$1,453,680	\$650,946
29 ITOCHU	\$58,399,000	\$66,573,071
30 Jastrzebska Spolka Weglowa	\$2,137,413	\$1,124,998
31 Jindal Steel & Power	\$6,546,714	\$1,926,700
32 LG International	\$2,159,876	\$2,383,214
33 Mechel	\$2,700,621	\$1,578,671
34 Mitsubishi	\$84,990,704	\$68,281,018

35	Mitsui	\$77,688,691	\$58,638,017
36	NACCO Industries	\$885,856	\$989,744
37	New Hope	\$1,922,038	\$642,797
38	Peabody Energy	\$13,515,957	\$63,277
39	PGE	\$20,941,368	\$12,903,559
40	Public Power	\$902,355	\$751,057
41	Rio Tinto	\$316,090,546	\$199,111,921
42	Rusal	\$2,460,294	\$1,187,488
43	Sasol	\$76,858,987	\$68,063,286
44	Semirara Mining And Power	\$1,595,899	\$1,226,701
45	Severstal	\$6,829,784	\$7,716,338
46	South32	\$21,219,843	\$14,549,493
47	Southern Copper	\$15,015,186	\$18,711,008
48	Steel Authority Of India	\$5,435,465	\$2,755,812
49	Sundance Energy	\$1,302,127	\$110,218
50	Tata Power	\$4,555,150	\$3,295,377
51	Tata Steel	\$6,699,382	\$4,900,892
52	Teck Resources	\$30,120,183	\$43,803,744
53	Vale	\$79,223,813	\$76,595,003
54	Vedanta	\$16,734,567	\$17,137,487
55	Wesfarmers	\$77,557,394	\$94,586,364
56	Westmoreland Coal	\$1,240,230	\$317,819
57	Whitehaven Coal	\$6,603,961	\$1,155,248
58	Yanzhou Coal Mining	\$5,822,902	\$3,470,196
Total		\$2,139,456,294	\$1,424,535,934

Oil and Gas Companies

Oil and Gas Companies		Book Value 6/30/2016	Market Value 6/30/16
1	Andarko Petroleum	\$63,647,406	\$80,866,251
2	Antero Resources	\$10,279,879	\$6,325,251
3	AP Moeller	\$61,464,225	\$45,097,768
4	Apache	\$80,147,089	\$81,267,508
5	ARC Resources	\$22,449,070	\$17,420,498
6	BASF	\$174,447,028	\$213,741,197
7	BHP Billiton	\$457,430,440	\$265,578,847
8	Birchcliff Energy	\$1,949,430	\$1,581,001
9	BP	\$557,676,161	\$393,672,279
10	Cabot Oil + Gas	\$24,605,373	\$33,828,964

11	California Resources	\$13,513,545	\$6,561,686
12	Canadian Natural Resources	\$97,441,012	\$96,479,647
13	Cenovus	\$67,124,547	\$37,347,238
14	Centrica	\$83,614,106	\$59,200,291
15	Chesapeake Energy	\$56,986,715	\$23,500,591
16	Chevron	\$391,042,154	\$605,315,473
17	Cimarex Energy	\$9,353,946	\$24,459,813
18	Concho Resources	\$12,233,933	\$29,159,120
19	ConocoPhillips	\$163,549,317	\$195,347,194
20	CONSOL Energy	\$26,005,135	\$22,137,665
21	Continental Resources	\$6,083,335	\$11,447,285
22	Crescent Point Energy	\$45,438,972	\$18,735,542
23	Denbury Resources	\$27,361,469	\$17,655,115
24	Devon Energy	\$49,520,759	\$45,150,801
25	DNO	\$2,440,623	\$1,954,916
26	Ecopetrol	\$13,589,580	\$11,396,282
27	Encana	\$68,903,528	\$27,953,083
28	Energen	\$13,940,512	\$17,159,036
29	ENI	\$218,891,418	\$138,687,892
30	EOG Resources	\$110,693,215	\$172,092,556
31	EP Energy	\$2,528,143	\$2,007,768
32	EQT	\$27,956,097	\$43,878,392
33	Exxon Mobil	\$683,336,616	\$1,251,114,696
34	Freeport McMoRan	\$98,047,975	\$52,232,932
35	Galp Energia	\$24,102,418	\$24,865,229
36	Gazprom	\$236,731,729	\$161,563,069
37	Gulfport Energy	\$8,059,891	\$3,021,035
38	Hess	\$70,531,193	\$79,790,053
39	Husky Energy	\$26,758,489	\$11,428,105
40	Imperial Oil	\$36,743,877	\$29,172,772
41	Inpex	\$47,575,891	\$27,010,831
42	JX Holdings	\$49,823,908	\$35,484,427
43	Linn Energy	\$15,476,809	\$52,405
44	Lukoil	\$120,885,554	\$116,311,948
45	Lundin Petroleum	\$18,041,474	\$18,384,214
46	Marathon Oil	\$50,705,445	\$51,476,806
47	MEG Energy	\$3,283,943	\$3,297,473
48	Memorial Resource Development	\$1,688,968	\$1,293,804
49	Mitsui	\$77,688,691	\$58,638,017
50	Mol Hungarian Oil And Gas	\$14,534,633	\$13,297,012

51	Murphy Oil	\$52,660,709	\$45,241,347
52	National Fuel Gas	\$8,281,069	\$13,182,077
53	Newfield Exploration	\$13,471,299	\$24,337,099
54	Noble Energy	\$23,651,784	\$27,907,482
55	Novatek	\$52,863,205	\$58,216,120
56	Occidental Petroleum	\$235,411,979	\$297,064,623
57	Oil Search	\$20,764,583	\$19,051,622
58	OMV	\$23,142,001	\$14,923,163
59	PDC Energy	\$4,248,878	\$6,561,774
60	Petrobras	\$126,605,003	\$53,435,497
61	Peyto Exploration + Dev	\$12,995,396	\$13,839,761
62	Pioneer Natural Resources	\$78,174,635	\$105,804,462
63	PTT	\$16,147,060	\$10,979,780
64	QEP Resources	\$34,000,837	\$32,951,620
65	Range Resources	\$15,555,539	\$21,087,795
66	Repsol	\$106,733,007	\$61,040,742
67	Rosneft	\$30,688,434	\$34,302,829
68	Royal Dutch Shell	\$827,633,920	\$754,481,254
69	SandRidge Energy	\$11,804,692	\$40,818
70	Santos	\$37,086,130	\$16,386,570
71	Sasol	\$76,858,987	\$68,063,286
72	Seven Generations Energy	\$7,930,997	\$11,202,247
73	Sinopec Engineering	\$7,659,563	\$7,240,646
74	SK Innovation	\$28,717,963	\$35,372,064
75	SM Energy	\$12,204,243	\$10,539,545
76	Southwestern Energy	\$35,146,456	\$25,646,787
77	Statoil	\$148,712,411	\$126,524,971
78	Suncor Energy	\$182,691,374	\$134,220,217
79	Total S.A.	\$469,166,184	\$384,834,939
80	Tourmaline Oil	\$21,103,610	\$12,684,163
81	Ultra Petroleum	\$9,379,466	\$576,723
82	Whiting Petroleum	\$24,843,969	\$10,576,233
83	Woodside Petroleum	\$78,719,375	\$44,141,918
84	WPX Energy	\$20,519,201	\$19,861,159
Total		\$7,385,779,843	\$7,181,721,041

Appendix 2: Carbon Underground 200's share of stranded assets, 2016

Stranded Assets for Coal Companies

Company	% of shares owned by CalPERS	Financial Value of Stranded Assets - Coal (based on % owned) ⁵²	Predicted Value in 2030 ⁵³	Predicted Value in 2050 ⁵⁴
1 Rusal	1.23%	\$264,267,126	\$264,267,126	\$227,104,561
2 BHP Billiton	0.94%	\$1,987,287,723	\$1,987,287,723	\$1,707,825,387
3 PGE	0.87%	\$337,008,443	\$337,008,443	\$289,616,631
4 Cloud Peak Energy	0.86%	\$455,727,675	\$455,727,675	\$391,640,971
5 Arcelormittal	0.77%	\$127,558,907	\$127,558,907	\$109,620,935
6 Alpha Natural Resources	0.76%	\$723,436,534	\$723,436,534	\$621,703,272
7 ITOCHU	0.71%	\$133,486,447	\$133,486,447	\$114,714,916
8 Rio Tinto	0.70%	\$411,113,231	\$411,113,231	\$353,300,432
9 CONSOL Energy	0.60%	\$322,325,275	\$322,325,275	\$276,998,283
10 Teck Resources	0.58%	\$20,663,282	\$20,663,282	\$17,757,508
11 Anglo American	0.50%	\$597,176,249	\$597,176,249	\$513,198,339
12 China Shenhua Energy	0.48%	\$3,140,584,064	\$3,140,584,064	\$2,698,939,430
13 Vedanta	0.47%	\$33,202,572	\$33,202,572	\$28,533,461
14 Mechel	0.45%	\$1,199,129,989	\$1,199,129,989	\$1,030,502,334
15 AGL Energy	0.42%	\$250,539,417	\$250,539,417	\$215,307,311
16 Sasol	0.38%	\$195,873,541	\$195,873,541	\$168,328,824
17 FirstEnergy	0.38%	\$49,290,555	\$49,290,555	\$42,359,071
18 Arch Coal	0.38%	\$394,487,525	\$394,487,525	\$339,012,717
19 Sundance Energy	0.38%	\$58,311,605	\$58,311,605	\$50,111,536
20 Wesfarmers	0.28%	\$65,488,849	\$65,488,849	\$56,279,479
21 Glencore	0.27%	\$658,065,713	\$658,065,713	\$565,525,222
22 NACCO Industries	0.26%	\$110,966,789	\$110,966,789	\$95,362,084
23 Peabody Energy	0.25%	\$563,549,870	\$563,549,870	\$484,300,670
24 Mitsubishi	0.25%	\$388,871,585	\$388,871,585	\$334,186,518
25 South32	0.24%	\$126,118,449	\$126,118,449	\$108,383,042
26 Jastrzebska Spolka Weglowa	0.22%	\$155,780,197	\$155,780,197	\$133,873,607

⁵² Converted gigatons of CO₂ equivalent untapped reserves into tons of coal (Table 1). Assumed 80% of coal reserves would be stranded according to the 2° scenario. Multiplied stranded assets per company by 2015 price of \$64/ton (Table 2). Financial value takes into account the percent of shares that CalPERS owns. See Carbon Underground 200 (2016) for untapped reserves per company.

⁵³ Multiplied stranded assets per company by predicted price of coal in 2030 of \$64/ton (Table 2)

⁵⁴ Multiplied stranded assets per company by predicted price of coal in 2050 of \$55/ton (Table 2)

27	Evraz	0.22%	\$374,837,435	\$374,837,435	\$322,125,921
28	African Rainbow Minerals	0.21%	\$24,525,621	\$24,525,621	\$21,076,706
29	Jindal Steel & Power	0.21%	\$210,969,005	\$210,969,005	\$181,301,489
30	Black Hills	0.21%	\$28,436,202	\$28,436,202	\$24,437,361
31	LG International	0.19%	\$27,344,527	\$27,344,527	\$23,499,203
32	Westmoreland Coal	0.18%	\$132,527,536	\$132,527,536	\$113,890,851
33	Severstal	0.18%	\$160,123,820	\$160,123,820	\$137,606,407
34	Alliance Resource Partners	0.16%	\$171,921,747	\$171,921,747	\$147,745,252
35	ALLETE	0.15%	\$31,160,408	\$31,160,408	\$26,778,476
36	Whitehaven Coal	0.14%	\$68,288,798	\$68,288,798	\$58,685,685
37	Adani Enterprises	0.14%	\$340,872,351	\$340,872,351	\$292,937,177
38	Adaro Energy	0.13%	\$81,349,303	\$81,349,303	\$69,909,557
39	Public Power	0.12%	\$311,112,652	\$311,112,652	\$267,362,435
40	Bukit Asam	0.11%	\$170,405,397	\$170,405,397	\$146,442,138
41	Tata Power	0.11%	\$13,313,918	\$13,313,918	\$11,441,649
42	Exxaro Resources	0.11%	\$295,921,948	\$295,921,948	\$254,307,924
43	Vale	0.11%	\$103,510,205	\$103,510,205	\$88,954,083
44	Yanzhou Coal Mining	0.11%	\$156,052,465	\$156,052,465	\$134,107,587
45	Tata Steel	0.11%	\$72,149,492	\$72,149,492	\$62,003,470
46	Steel Authority Of India	0.10%	\$15,324,437	\$15,324,437	\$13,169,438
47	Southern Copper	0.09%	\$12,452,222	\$12,452,222	\$10,701,128
48	Indo Tambangraya Megah	0.08%	\$12,507,303	\$12,507,303	\$10,748,463
49	New Hope	0.07%	\$34,930,185	\$34,930,185	\$30,018,128
50	Mitsui	0.07%	\$20,636,209	\$20,636,209	\$17,734,242
51	Huadian Power Intl	0.06%	\$8,461,116	\$8,461,116	\$7,271,271
52	Datang International Power	0.05%	\$14,719,743	\$14,719,743	\$12,649,779
53	Coal India	0.04%	\$475,704,934	\$475,704,934	\$408,808,928
54	China Coal Energy	0.03%	\$93,794,164	\$93,794,164	\$80,604,360
55	China Cinda Asset Mgmt	0.03%	\$26,918,702	\$26,918,702	\$23,133,260
56	Semirara Mining And Power	0.01%	\$1,146,241	\$1,146,241	\$985,051
57	Hallador Energy	0.01%	\$1,228,071	\$1,228,071	\$1,055,373
58	Feishang Anthracite Resource	0.00%	\$235,728	\$235,728	\$202,579
Total			\$16,263,193,501	\$16,263,193,501	\$13,976,181,915

Stranded Assets for Oil Companies

	Company	% of shares owned by CalPERS	Financial Value of Stranded Assets - Oil (based on % owned) ⁵⁵	Predicted Value in 2030 ⁵⁶	Predicted Value in 2050 ⁵⁷
1	AP Moeller	3.75%	\$202,449,310	\$337,415,517	\$285,810,791
2	BP	1.83%	\$2,844,929,383	\$4,741,548,972	\$4,016,370,894
3	DNO	1.63%	\$65,826,039	\$109,710,065	\$92,930,878
4	California Resources	1.38%	\$114,183,680	\$190,306,133	\$161,200,489
5	Denbury Resources	1.24%	\$58,018,954	\$96,698,256	\$81,909,111
6	Ecopetrol	1.16%	\$237,511,452	\$395,852,420	\$335,310,286
7	BHP Billiton	0.94%	\$101,294,415	\$168,824,025	\$143,003,880
8	Murphy Oil	0.83%	\$56,029,961	\$93,383,268	\$79,101,121
9	QEP Resources	0.78%	\$30,225,279	\$50,375,465	\$42,670,982
10	JX Holdings	0.73%	\$14,950,113	\$24,916,855	\$21,106,042
11	Chesapeake Energy	0.70%	\$49,911,048	\$83,185,080	\$70,462,656
12	Linn Energy	0.67%	\$30,742,251	\$51,237,085	\$43,400,825
13	WPX Energy	0.64%	\$20,249,262	\$33,748,770	\$28,587,193
14	Petrobras	0.60%	\$882,305,658	\$1,470,509,429	\$1,245,607,987
15	CONSOL Energy	0.60%	\$6,337,311	\$10,562,186	\$8,946,792
16	SM Energy	0.57%	\$20,812,648	\$34,687,747	\$29,382,562
17	Southwestern Energy	0.52%	\$3,049,669	\$5,082,782	\$4,305,415
18	Occidental Petroleum	0.51%	\$132,539,989	\$220,899,982	\$187,115,279
19	ENI	0.47%	\$279,094,723	\$465,157,872	\$394,016,080
20	Whiting Petroleum	0.46%	\$52,461,382	\$87,435,637	\$74,063,128
21	Lundin Petroleum	0.44%	\$26,900,284	\$44,833,806	\$37,976,871
22	Royal Dutch Shell	0.44%	\$398,498,050	\$664,163,416	\$562,585,482
23	Encana	0.43%	\$23,621,566	\$39,369,277	\$33,348,093
24	Hess	0.42%	\$54,642,104	\$91,070,173	\$77,141,794
25	Pioneer Natural Resources	0.41%	\$27,128,311	\$45,213,852	\$38,298,792
26	Marathon Oil	0.40%	\$83,101,726	\$138,502,877	\$117,320,084
27	Lukoil	0.39%	\$889,104,941	\$1,481,841,568	\$1,255,206,975
28	Apache	0.38%	\$59,341,167	\$98,901,945	\$83,775,766

⁵⁵ Converted gigatons of CO₂ equivalent untapped reserves into barrels of oil (Table 1). Assumed 33% of oil reserves would be stranded according to the 2° scenario. Multiplied stranded assets per company by 2015 price of \$51/barrel (Table 2). Financial value takes into account the percent of shares that CalPERS owns. See Carbon Underground 200 (2016) for untapped reserves per company.

⁵⁶ Multiplied stranded assets per company by predicted price of oil in 2030 of \$85/barrel (Table 2)

⁵⁷ Multiplied stranded assets per company by predicted price of oil in 2050 of \$72/barrel (Table 2)

29	Sasol	0.38%	\$24,924,077	\$41,540,128	\$35,186,932
30	EOG Resources	0.37%	\$84,903,621	\$141,506,036	\$119,863,936
31	Energen	0.37%	\$15,796,028	\$26,326,713	\$22,300,275
32	ConocoPhillips	0.36%	\$216,465,108	\$360,775,180	\$305,597,799
33	Repsol	0.36%	\$44,798,561	\$74,664,268	\$63,245,027
34	Centrica	0.36%	\$4,357,724	\$7,262,873	\$6,152,080
35	Freeport McMoRan	0.36%	\$11,974,514	\$19,957,524	\$16,905,197
36	Total S.A.	0.34%	\$276,273,910	\$460,456,517	\$390,033,755
37	EQT	0.33%	\$5,264,088	\$8,773,481	\$7,431,654
38	Oil Search	0.33%	\$2,694,835	\$4,491,392	\$3,804,473
39	Gazprom	0.33%	\$875,449,837	\$1,459,083,062	\$1,235,929,182
40	Cenovus	0.33%	\$44,365,108	\$73,941,846	\$62,633,093
41	Exxon Mobil	0.32%	\$589,269,573	\$982,115,955	\$831,909,985
42	Peyto Exploration + Dev	0.31%	\$862,566	\$1,437,610	\$1,217,740
43	Chevron	0.31%	\$292,353,114	\$487,255,190	\$412,733,808
44	SandRidge Energy	0.30%	\$6,206,556	\$10,344,260	\$8,762,197
45	Andarko Petroleum	0.30%	\$46,572,290	\$77,620,483	\$65,749,115
46	Suncor Energy	0.29%	\$88,430,066	\$147,383,444	\$124,842,446
47	SK Innovation	0.29%	\$30,045,786	\$50,076,309	\$42,417,580
48	ARC Resources	0.29%	\$5,094,625	\$8,491,041	\$7,192,411
49	Range Resources	0.29%	\$20,252,928	\$33,754,880	\$28,592,369
50	Canadian Natural Resources	0.29%	\$92,442,493	\$154,070,822	\$130,507,049
51	Cabot Oil + Gas	0.28%	\$2,543,494	\$4,239,157	\$3,590,815
52	MEG Energy	0.28%	\$19,687,483	\$32,812,472	\$27,794,094
53	Newfield Exploration	0.28%	\$12,268,163	\$20,446,939	\$17,319,760
54	National Fuel Gas	0.27%	\$1,485,081	\$2,475,136	\$2,096,586
55	Santos	0.27%	\$2,091,676	\$3,486,126	\$2,952,954
56	Woodside Petroleum	0.26%	\$4,720,414	\$7,867,357	\$6,664,114
57	PDC Energy	0.24%	\$5,863,292	\$9,772,153	\$8,277,588
58	Inpex	0.24%	\$48,125,667	\$80,209,445	\$67,942,118
59	Devon Energy	0.24%	\$30,794,255	\$51,323,758	\$43,474,242
60	Crescent Point Energy	0.24%	\$18,245,763	\$30,409,605	\$25,758,724
61	Statoil	0.23%	\$92,076,293	\$153,460,488	\$129,990,061
62	Cimarex Energy	0.22%	\$7,095,060	\$11,825,100	\$10,016,556
63	Seven Generations Energy	0.21%	\$5,792,946	\$9,654,910	\$8,178,276
64	Tourmaline Oil	0.21%	\$2,185,901	\$3,643,168	\$3,085,978
65	Novatek	0.19%	\$37,975,180	\$63,291,966	\$53,612,019
66	Concho Resources	0.19%	\$11,324,922	\$18,874,871	\$15,988,126
67	Noble Energy	0.18%	\$13,394,655	\$22,324,424	\$18,910,101
68	Ultra Petroleum	0.17%	\$917,223	\$1,528,705	\$1,294,903

69	OMV	0.16%	\$16,351,098	\$27,251,830	\$23,083,903
70	Sinopec Engineering	0.15%	\$24,533,730	\$40,889,549	\$34,635,853
71	EP Energy	0.15%	\$9,133,129	\$15,221,882	\$12,893,830
72	Mol Hungarian Oil And Gas	0.14%	\$4,481,503	\$7,469,171	\$6,326,827
73	PTT	0.12%	\$3,451,829	\$5,753,049	\$4,873,171
74	Birchcliff Energy	0.11%	\$488,787	\$814,646	\$690,053
75	Imperial Oil	0.11%	\$26,362,169	\$43,936,948	\$37,217,180
76	Galp Energia	0.11%	\$4,224,326	\$7,040,543	\$5,963,754
77	Husky Energy	0.09%	\$7,220,500	\$12,034,167	\$10,193,647
78	Antero Resources	0.08%	\$5,576,631	\$9,294,384	\$7,872,890
79	BASF	0.08%	\$6,121,349	\$10,202,248	\$8,641,904
80	Mitsui	0.07%	\$2,071,958	\$3,453,263	\$2,925,117
81	Continental Resources	0.07%	\$7,847,290	\$13,078,816	\$11,078,527
82	Rosneft	0.06%	\$312,152,509	\$520,254,182	\$440,685,895
83	Gulfport Energy	0.05%	\$165,487	\$275,812	\$233,629
84	Memorial Resource Dev	0.04%	\$1,067,904	\$1,779,840	\$1,507,629
Total			\$10,291,895,753	\$17,153,159,589	\$14,529,735,181

Stranded Assets for Gas Companies

Company	% of shares owned by CalPERS	Financial Value of Stranded Assets - Gas (based on % owned) ⁵⁸	Predicted Value in 2030 ⁵⁹	Predicted Value in 2050 ⁶⁰
1 BP	1.83%	\$1,078,670,422	\$1,991,391,547	\$2,447,752,110
2 California Resources	1.38%	\$13,226,289	\$24,417,764	\$30,013,502
3 Denbury Resources	1.24%	\$605,997	\$1,118,764	\$1,375,147
4 Ecopetrol	1.16%	\$53,829,781	\$99,378,057	\$122,152,195
5 BHP Billiton	0.94%	\$89,450,503	\$165,139,391	\$202,983,835
6 Murphy Oil	0.83%	\$18,672,990	\$34,473,212	\$42,373,323
7 QEP Resources	0.78%	\$22,003,146	\$40,621,193	\$49,930,217
8 JX Holdings	0.73%	\$13,143,401	\$24,264,740	\$29,825,410
9 Chesapeake Energy	0.70%	\$56,854,629	\$104,962,393	\$129,016,274
10 Linn Energy	0.67%	\$23,547,113	\$43,471,593	\$53,433,833
11 WPX Energy	0.64%	\$18,643,308	\$34,418,414	\$42,305,967
12 Petrobras	0.60%	\$89,776,489	\$165,741,211	\$203,723,572
13 CONSOL Energy	0.60%	\$40,597,770	\$74,949,730	\$92,125,710
14 SM Energy	0.57%	\$9,677,102	\$17,865,418	\$21,959,577
15 Southwestern Energy	0.52%	\$41,026,942	\$75,742,047	\$93,099,599
16 Occidental Petroleum	0.51%	\$23,226,870	\$42,880,375	\$52,707,127
17 ENI	0.47%	\$115,631,801	\$213,474,094	\$262,395,241
18 Whiting Petroleum	0.46%	\$4,095,399	\$7,560,736	\$9,293,405
19 Lundin Petroleum	0.44%	\$543,424	\$1,003,245	\$1,233,155
20 Royal Dutch Shell	0.44%	\$281,797,630	\$520,241,778	\$639,463,852
21 Encana	0.43%	\$23,126,881	\$42,695,781	\$52,480,231
22 Hess	0.42%	\$8,740,855	\$16,136,963	\$19,835,018
23 Pioneer Natural Resources	0.41%	\$7,488,538	\$13,824,993	\$16,993,220
24 Marathon Oil	0.40%	\$13,292,521	\$24,540,039	\$30,163,798
25 Lukoil	0.39%	\$124,448,481	\$229,751,041	\$282,402,322
26 Apache	0.38%	\$17,650,349	\$32,585,259	\$40,052,715
27 Sasol	0.38%	\$7,616,225	\$14,060,723	\$17,282,972
28 EOG Resources	0.37%	\$19,206,391	\$35,457,952	\$43,583,733

⁵⁸ Converted gigatons of CO₂ equivalent untapped reserves into mBTU of gas (Table 1). Assumed 50% of gas reserves would be stranded according to the 2° scenario. Multiplied stranded assets per company by 2015 price of \$2.60/mBTU (Table 2). Financial value takes into account the percent of shares that CalPERS owns. See Carbon Underground 200 (2016) for untapped reserves per company.

⁵⁹ Multiplied stranded assets per company by predicted price of coal in 2030 of \$4.80/mBTU (Table 2)

⁶⁰ Multiplied stranded assets per company by predicted price of coal in 2050 of \$5.90/mBTU (Table 2)

29	Energen	0.37%	\$2,159,824	\$3,987,367	\$4,901,138
30	ConocoPhillips	0.36%	\$83,515,034	\$154,181,601	\$189,514,885
31	Repsol	0.36%	\$64,036,289	\$118,220,841	\$145,313,117
32	Centrica	0.36%	\$6,778,482	\$12,514,121	\$15,381,941
33	Freeport McMoRan	0.36%	\$1,308,888	\$2,416,409	\$2,970,169
34	Total S.A.	0.34%	\$146,195,126	\$269,898,694	\$331,750,479
35	EQT	0.33%	\$39,989,644	\$73,827,034	\$90,745,729
36	Oil Search	0.33%	\$6,348,685	\$11,720,649	\$14,406,631
37	Gazprom	0.33%	\$2,977,878,421	\$5,497,621,701	\$6,757,493,341
38	Cenovus	0.33%	\$2,953,982	\$5,453,504	\$6,703,266
39	Exxon Mobil	0.32%	\$259,007,209	\$478,167,155	\$587,747,128
40	Peyto Exploration + Dev	0.31%	\$7,871,150	\$14,531,355	\$17,861,457
41	Chevron	0.31%	\$120,391,585	\$222,261,387	\$273,196,288
42	SandRidge Energy	0.30%	\$4,562,774	\$8,423,583	\$10,353,988
43	Andarko Petroleum	0.30%	\$23,932,786	\$44,183,606	\$54,309,015
44	Suncor Energy	0.29%	\$143,283	\$264,522	\$325,142
45	ARC Resources	0.29%	\$5,246,566	\$9,685,969	\$11,905,670
46	Range Resources	0.29%	\$24,115,331	\$44,520,612	\$54,723,252
47	Canadian Natural Resources	0.29%	\$20,765,458	\$38,336,231	\$47,121,617
48	Cabot Oil + Gas	0.28%	\$29,661,870	\$54,760,375	\$67,309,628
49	Newfield Exploration	0.28%	\$4,830,713	\$8,918,240	\$10,962,003
50	National Fuel Gas	0.27%	\$7,777,857	\$14,359,120	\$17,649,751
51	Santos	0.27%	\$8,514,350	\$15,718,800	\$19,321,025
52	Woodside Petroleum	0.26%	\$20,435,870	\$37,727,761	\$46,373,706
53	PDC Energy	0.24%	\$2,133,556	\$3,938,873	\$4,841,532
54	Inpex	0.24%	\$20,991,353	\$38,753,267	\$47,634,224
55	Devon Energy	0.24%	\$18,482,163	\$34,120,916	\$41,940,292
56	Crescent Point Energy	0.24%	\$923,338	\$1,704,624	\$2,095,266
57	Statoil	0.23%	\$44,231,774	\$81,658,660	\$100,372,103
58	Cimarex Energy	0.22%	\$4,393,460	\$8,111,004	\$9,969,776
59	Seven Generations Energy	0.21%	\$3,213,193	\$5,932,049	\$7,291,477
60	Tourmaline Oil	0.21%	\$8,517,650	\$15,724,892	\$19,328,513
61	Novatek	0.19%	\$158,471,861	\$292,563,436	\$359,609,223
62	Concho Resources	0.19%	\$3,821,569	\$7,055,205	\$8,672,023
63	Noble Energy	0.18%	\$13,413,079	\$24,762,607	\$30,437,371
64	Ultra Petroleum	0.17%	\$5,214,378	\$9,626,543	\$11,832,626
65	OMV	0.16%	\$5,159,890	\$9,525,950	\$11,708,981
66	Sinopec Engineering	0.15%	\$6,679,344	\$12,331,096	\$15,156,972
67	EP Energy	0.15%	\$1,895,487	\$3,499,361	\$4,301,298
68	Mol Hungarian Oil And Gas	0.14%	\$1,811,801	\$3,344,863	\$4,111,395

69	PTT	0.12%	\$5,574,880	\$10,292,087	\$12,650,690
70	Birchcliff Energy	0.11%	\$2,671,421	\$4,931,854	\$6,062,070
71	Imperial Oil	0.11%	\$589,613	\$1,088,516	\$1,337,967
72	Galp Energia	0.11%	\$343,910	\$634,910	\$780,411
73	Husky Energy	0.09%	\$2,616,674	\$4,830,783	\$5,937,838
74	Antero Resources	0.08%	\$10,209,561	\$18,848,419	\$23,167,849
75	BASF	0.08%	\$7,180,724	\$13,256,721	\$16,294,720
76	Mitsui	0.07%	\$1,937,440	\$3,576,813	\$4,396,499
77	Continental Resources	0.07%	\$2,848,023	\$5,257,889	\$6,462,822
78	Rosneft	0.06%	\$64,468,421	\$119,018,624	\$146,293,725
79	Great Eastern Shipping	0.05%	\$1,212,927	\$2,239,250	\$2,752,412
80	Gulfport Energy	0.05%	\$1,101,908	\$2,034,292	\$2,500,484
81	Memorial Resource Dev	0.04%	\$756,536	\$1,396,682	\$1,716,755
Total			\$6,485,878,361	\$11,973,929,281	\$14,717,954,741

Appendix 3: Carbon Underground 200 total carbon emissions and associated social costs of carbon

Company	% of shares owned by CalPERS	Total Carbon Emissions from Reserves (million metric tons) ⁶¹	High Impact (millions) ⁶²	2.5% Discount (millions) ⁶³	3% Discount (millions) ⁶⁴	5% Discount (millions) ⁶⁵
1 AP Moeller	3.75%	138	\$16,974	\$8,556	\$5,796	\$1,656
2 BP	1.83%	12,776	\$1,571,448	\$792,112	\$536,592	\$153,312
3 DNO	1.63%	103	\$12,669	\$6,386	\$4,326	\$1,236
4 California Resources	1.38%	250	\$30,750	\$15,500	\$10,500	\$3,000
5 Denbury Resources	1.24%	122	\$15,006	\$7,564	\$5,124	\$1,464
6 Rusal	1.23%	764	\$93,972	\$47,368	\$32,088	\$9,168
7 Ecopetrol	1.16%	715	\$87,945	\$44,330	\$30,030	\$8,580
8 BHP Billiton	0.94%	17,008	\$2,091,984	\$1,054,496	\$714,336	\$204,096
9 PGE	0.87%	1,386	\$170,478	\$85,932	\$58,212	\$16,632
10 Cloud Peak Energy	0.86%	1,886	\$231,978	\$116,932	\$79,212	\$22,632
11 Murphy Oil	0.83%	265	\$32,595	\$16,430	\$11,130	\$3,180
12 QEP Resources	0.78%	214	\$26,322	\$13,268	\$8,988	\$2,568
13 Arcelormittal	0.77%	668	\$82,164	\$41,416	\$28,056	\$8,016
14 Alpha Natural Resources	0.76%	3,385	\$416,355	\$209,870	\$142,170	\$40,620
15 JX Holdings	0.73%	125	\$15,375	\$7,750	\$5,250	\$1,500
16 ITOCHU	0.71%	1,562	\$192,126	\$96,844	\$65,604	\$18,744
17 Rio Tinto	0.70%	4,351	\$535,173	\$269,762	\$182,742	\$52,212
18 Chesapeake Energy	0.70%	510	\$62,730	\$31,620	\$21,420	\$6,120
19 Linn Energy	0.67%	260	\$31,980	\$16,120	\$10,920	\$3,120
20 WPX Energy	0.64%	200	\$24,600	\$12,400	\$8,400	\$2,400
21 Petrobras	0.60%	4,350	\$535,050	\$269,700	\$182,700	\$52,200
22 CONSOL Energy	0.60%	2,222	\$273,306	\$137,764	\$93,324	\$26,664
23 Teck Resources	0.58%	2,575	\$316,725	\$159,650	\$108,150	\$30,900

⁶¹ Totaled the carbon emissions from coal, oil, and gas reserves for each company. See Carbon Underground 200 (2016) for untapped reserves per company

⁶² Multiplied the total carbon emissions by the high impact social cost of carbon - \$123

⁶³ Multiplied the total carbon emissions by the social cost of carbon, with a discount rate of 2.5% - \$62

⁶⁴ Multiplied the total carbon emissions by the social cost of carbon, with a discount rate of 3% - \$42

⁶⁵ Multiplied the total carbon emissions by the social cost of carbon, with a discount rate of 5% - \$12

24	SM Energy	0.57%	162	\$19,926	\$10,044	\$6,804	\$1,944
25	Southwestern Energy	0.52%	337	\$41,451	\$20,894	\$14,154	\$4,044
26	Occidental Petroleum	0.51%	842	\$103,566	\$52,204	\$35,364	\$10,104
27	Anglo American	0.50%	4,259	\$523,857	\$264,058	\$178,878	\$51,108
28	China Shenhua Energy	0.48%	23,143	\$2,846,589	\$1,434,866	\$972,006	\$277,716
29	ENI	0.47%	2,504	\$307,992	\$155,248	\$105,168	\$30,048
30	Vedanta	0.47%	674	\$82,902	\$41,788	\$28,308	\$8,088
31	Whiting Petroleum	0.46%	325	\$39,975	\$20,150	\$13,650	\$3,900
32	Mechel	0.45%	9,483	\$1,166,409	\$587,946	\$398,286	\$113,796
33	Lundin Petroleum	0.44%	320	\$39,360	\$19,840	\$13,440	\$3,840
34	Royal Dutch Shell	0.44%	9,990	\$1,228,770	\$619,380	\$419,580	\$119,880
35	Encana	0.43%	364	\$44,772	\$22,568	\$15,288	\$4,368
36	Hess	0.42%	418	\$51,414	\$25,916	\$17,556	\$5,016
37	AGL Energy	0.42%	2,144	\$263,712	\$132,928	\$90,048	\$25,728
38	Pioneer Natural Resources	0.41%	242	\$29,766	\$15,004	\$10,164	\$2,904
39	Marathon Oil	0.40%	659	\$81,057	\$40,858	\$27,678	\$7,908
40	Lukoil	0.39%	7,115	\$875,145	\$441,130	\$298,830	\$85,380
41	Apache	0.38%	581	\$71,463	\$36,022	\$24,402	\$6,972
42	Sasol	0.38%	2,070	\$254,610	\$128,340	\$86,940	\$24,840
43	FirstEnergy	0.38%	463	\$56,949	\$28,706	\$19,446	\$5,556
44	Arch Coal	0.38%	3,731	\$458,913	\$231,322	\$156,702	\$44,772
45	Sundance Energy	0.38%	552	\$67,896	\$34,224	\$23,184	\$6,624
46	EOG Resources	0.37%	788	\$96,924	\$48,856	\$33,096	\$9,456
47	Energen	0.37%	134	\$16,482	\$8,308	\$5,628	\$1,608
48	ConocoPhillips	0.36%	2,459	\$302,457	\$152,458	\$103,278	\$29,508
49	Repsol	0.36%	1,034	\$127,182	\$64,108	\$43,428	\$12,408
50	Centrica	0.36%	108	\$13,284	\$6,696	\$4,536	\$1,296
51	Freeport McMoRan	0.36%	101	\$12,423	\$6,262	\$4,242	\$1,212
52	Total S.A.	0.34%	7,664	\$942,672	\$475,168	\$321,888	\$91,968
53	EQT	0.33%	538	\$66,174	\$33,356	\$22,596	\$6,456
54	Oil Search	0.33%	100	\$12,300	\$6,200	\$4,200	\$1,200
55	Gazprom	0.33%	44,069	\$5,420,487	\$2,732,278	\$1,850,898	\$528,828
56	Cenovus	0.33%	385	\$47,355	\$23,870	\$16,170	\$4,620
57	Exxon Mobil	0.32%	7,959	\$978,957	\$493,458	\$334,278	\$95,508
58	Peyto Exploration + Dev	0.31%	109	\$13,407	\$6,758	\$4,578	\$1,308
59	Chevron	0.31%	4,045	\$497,535	\$250,790	\$169,890	\$48,540
60	SandRidge Energy	0.30%	113	\$13,899	\$7,006	\$4,746	\$1,356
61	Andarko Petroleum	0.30%	728	\$89,544	\$45,136	\$30,576	\$8,736
62	Suncor Energy	0.29%	1,550	\$190,650	\$96,100	\$65,100	\$18,600
63	SK Innovation	0.29%	263	\$32,349	\$16,306	\$11,046	\$3,156

64	ARC Resources	0.29%	119	\$14,637	\$7,378	\$4,998	\$1,428
65	Range Resources	0.29%	522	\$64,206	\$32,364	\$21,924	\$6,264
66	Canadian Natural Resources	0.29%	1,125	\$138,375	\$69,750	\$47,250	\$13,500
67	Cabot Oil + Gas	0.28%	451	\$55,473	\$27,962	\$18,942	\$5,412
68	MEG Energy	0.28%	180	\$22,140	\$11,160	\$7,560	\$2,160
69	Wesfarmers	0.28%	837	\$102,951	\$51,894	\$35,154	\$10,044
70	Newfield Exploration	0.28%	184	\$22,632	\$11,408	\$7,728	\$2,208
71	National Fuel Gas	0.27%	131	\$16,113	\$8,122	\$5,502	\$1,572
72	Glencore	0.27%	8,692	\$1,069,116	\$538,904	\$365,064	\$104,304
73	Santos	0.27%	150	\$18,450	\$9,300	\$6,300	\$1,800
74	Woodside Petroleum	0.26%	364	\$44,772	\$22,568	\$15,288	\$4,368
75	NACCO Industries	0.26%	1,527	\$187,821	\$94,674	\$64,134	\$18,324
76	Peabody Energy	0.25%	8,059	\$991,257	\$499,658	\$338,478	\$96,708
77	Mitsubishi	0.25%	5,635	\$693,105	\$349,370	\$236,670	\$67,620
78	South32	0.24%	1,845	\$226,935	\$114,390	\$77,490	\$22,140
79	PDC Energy	0.24%	98	\$12,054	\$6,076	\$4,116	\$1,176
80	Inpex	0.24%	872	\$107,256	\$54,064	\$36,624	\$10,464
81	Devon Energy	0.24%	648	\$79,704	\$40,176	\$27,216	\$7,776
82	Crescent Point Energy	0.24%	214	\$26,322	\$13,268	\$8,988	\$2,568
83	Statoil	0.23%	1,836	\$225,828	\$113,832	\$77,112	\$22,032
84	Jastrzebska Spolka Weglowa	0.22%	2,513	\$309,099	\$155,806	\$105,546	\$30,156
85	Evraz	0.22%	6,102	\$750,546	\$378,324	\$256,284	\$73,224
86	Cimarex Energy	0.22%	167	\$20,541	\$10,354	\$7,014	\$2,004
87	Seven Generations Energy	0.21%	132	\$16,236	\$8,184	\$5,544	\$1,584
88	African Rainbow Minerals	0.21%	418	\$51,414	\$25,916	\$17,556	\$5,016
89	Jindal Steel & Power	0.21%	3,596	\$442,308	\$222,952	\$151,032	\$43,152
90	Tourmaline Oil	0.21%	195	\$23,985	\$12,090	\$8,190	\$2,340
91	Black Hills	0.21%	495	\$60,885	\$30,690	\$20,790	\$5,940
92	Novatek	0.19%	3,929	\$483,267	\$243,598	\$165,018	\$47,148
93	LG International	0.19%	519	\$63,837	\$32,178	\$21,798	\$6,228
94	Concho Resources	0.19%	240	\$29,520	\$14,880	\$10,080	\$2,880
95	Noble Energy	0.18%	491	\$60,393	\$30,442	\$20,622	\$5,892
96	Westmoreland Coal	0.18%	2,632	\$323,736	\$163,184	\$110,544	\$31,584
97	Severstal	0.18%	3,218	\$395,814	\$199,516	\$135,156	\$38,616
98	Ultra Petroleum	0.17%	141	\$17,343	\$8,742	\$5,922	\$1,692
99	Alliance Resource Partners	0.16%	3,748	\$461,004	\$232,376	\$157,416	\$44,976
100	OMV	0.16%	385	\$47,355	\$23,870	\$16,170	\$4,620
101	ALLETE	0.15%	723	\$88,929	\$44,826	\$30,366	\$8,676
102	Sinopec Engineering	0.15%	1,363	\$167,649	\$84,506	\$57,246	\$16,356
103	EP Energy	0.15%	205	\$25,215	\$12,710	\$8,610	\$2,460

104	Mol Hungarian Oil And Gas	0.14%	130	\$15,990	\$8,060	\$5,460	\$1,560
105	Whitehaven Coal	0.14%	1,740	\$214,020	\$107,880	\$73,080	\$20,880
106	Adani Enterprises	0.14%	27,809	\$3,420,507	\$1,724,158	\$1,167,978	\$333,708
107	Adaro Energy	0.13%	2,207	\$271,461	\$136,834	\$92,694	\$26,484
108	Public Power	0.12%	9,339	\$1,148,697	\$579,018	\$392,238	\$112,068
109	PTT	0.12%	272	\$33,456	\$16,864	\$11,424	\$3,264
110	Bukit Asam	0.11%	5,320	\$654,360	\$329,840	\$223,440	\$63,840
111	Birchcliff Energy	0.11%	107	\$13,161	\$6,634	\$4,494	\$1,284
112	Tata Power	0.11%	424	\$52,152	\$26,288	\$17,808	\$5,088
113	Exxaro Resources	0.11%	9,433	\$1,160,259	\$584,846	\$396,186	\$113,196
114	Vale	0.11%	3,310	\$407,130	\$205,220	\$139,020	\$39,720
115	Yanzhou Coal Mining	0.11%	5,093	\$626,439	\$315,766	\$213,906	\$61,116
116	Imperial Oil	0.11%	638	\$78,474	\$39,556	\$26,796	\$7,656
117	Galp Energia	0.11%	113	\$13,899	\$7,006	\$4,746	\$1,356
118	Tata Steel	0.11%	2,435	\$299,505	\$150,970	\$102,270	\$29,220
119	Steel Authority Of India	0.10%	551	\$67,773	\$34,162	\$23,142	\$6,612
120	Husky Energy	0.09%	311	\$38,253	\$19,282	\$13,062	\$3,732
121	Southern Copper	0.09%	496	\$61,008	\$30,752	\$20,832	\$5,952
122	Indo Tambangraya Megah	0.08%	550	\$67,650	\$34,100	\$23,100	\$6,600
123	Antero Resources	0.08%	698	\$85,854	\$43,276	\$29,316	\$8,376
124	BASF	0.08%	589	\$72,447	\$36,518	\$24,738	\$7,068
125	New Hope	0.07%	1,705	\$209,715	\$105,710	\$71,610	\$20,460
126	Mitsui	0.07%	1,198	\$147,354	\$74,276	\$50,316	\$14,376
127	Continental Resources	0.07%	469	\$57,687	\$29,078	\$19,698	\$5,628
128	Huadian Power Intl	0.06%	472	\$58,056	\$29,264	\$19,824	\$5,664
129	Rosneft	0.06%	16,775	\$2,063,325	\$1,040,050	\$704,550	\$201,300
130	Great Eastern Shipping	0.05%	95	\$11,685	\$5,890	\$3,990	\$1,140
131	Datang Intl Power Generation	0.05%	1,147	\$141,081	\$71,114	\$48,174	\$13,764
132	Gulfport Energy	0.05%	93	\$11,439	\$5,766	\$3,906	\$1,116
133	Memorial Resource Dev	0.04%	147	\$18,081	\$9,114	\$6,174	\$1,764
134	Coal India	0.04%	43,104	\$5,301,792	\$2,672,448	\$1,810,368	\$517,248
135	China Coal Energy	0.03%	9,942	\$1,222,866	\$616,404	\$417,564	\$119,304
136	China Cinda Asset Mgmt	0.03%	3,409	\$419,307	\$211,358	\$143,178	\$40,908
137	Semirara Mining And Power	0.01%	378	\$46,494	\$23,436	\$15,876	\$4,536
138	Hallador Energy	0.01%	504	\$61,992	\$31,248	\$21,168	\$6,048
139	Feishang Anthracite Resource	0.00%	389	\$47,847	\$24,118	\$16,338	\$4,668
Total			414,453	\$50,977,719	\$25,696,086	\$17,407,026	\$4,973,436

Appendix 4: Historical Cumulative GHG Emissions by Carbon Majors Owned by CalPERS, 2016

Historical Cumulative GHG Emissions by Carbon Majors Owned by CalPERS, 2016

Company	% of shares owned by CalPERS	Scope 1&3 Emissions (metric tons) ⁶⁶	% of Global GHG ⁶⁷	% CalPERS owns (metric tons) ⁶⁸	% CalPERS owns (% of Global GHG) ⁶⁹
1 BP	1.83%	13,791	1.50%	252.38	0.027%
2 BHP Billiton	0.94%	8,183	0.90%	76.92	0.008%
3 Alpha Natural Resources	0.76%	4,904	0.50%	37.27	0.004%
4 Rio Tinto	0.70%	6,743	0.70%	47.20	0.005%
5 Petrobras	0.60%	6,907	0.80%	41.44	0.005%
6 ENI	0.47%	5,319	0.60%	25.00	0.003%
7 Royal Dutch Shell	0.44%	15,017	1.70%	66.07	0.007%
8 Lukoil	0.39%	6,750	0.80%	26.33	0.003%
9 Sasol	0.38%	3,195	0.40%	12.14	0.002%
10 Arch Coal	0.38%	5,696	0.60%	21.64	0.002%
11 ConocoPhillips	0.36%	7,463	0.90%	26.87	0.003%
12 Repsol	0.36%	2,996	0.30%	10.79	0.001%
13 Total S.A.	0.34%	8,541	0.90%	29.04	0.003%
14 Gazprom	0.33%	35,221	3.90%	116.23	0.013%
15 Exxon Mobil	0.32%	17,785	2.00%	56.91	0.006%
16 Chevron	0.31%	11,823	1.30%	36.65	0.004%
17 Andarko Petroleum	0.30%	2,991	0.30%	8.97	0.001%
18 Glencore	0.27%	3,387	0.40%	9.14	0.001%
19 Peabody Energy	0.25%	10,364	1.20%	25.91	0.003%
20 Statoil	0.23%	4,695	0.50%	10.80	0.001%
21 Rosneft	0.06%	5,866	0.70%	3.52	0.000%
22 Coal India	0.04%	16,842	1.90%	6.74	0.001%
Total		204,479	22.80%	947.96	0.105%

⁶⁶ Carbon Majors Report Appendix I (2017). Total scope 1&3 greenhouse gas emissions from 1988-2015 per company

⁶⁷ Carbon Majors Report Appendix I (2017). % of cumulative global greenhouse gas emissions each company is responsible for

⁶⁸ Multiplied total emissions by % that CalPERS owns

⁶⁹ Multiplied % of global greenhouse gas emissions by % that CalPERS owns