

Stormy Seas, Rising Risks

*What Investors Should Know About
Climate Change Impacts at Oil Refineries*



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Christina Carlson
Gretchen Goldman
Kristina Dahl

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Christina Carlson is a policy research assistant in the Center for Science and Democracy. **Dr. Gretchen Goldman** is a lead analyst in the center. **Dr. Kristina Dahl** is a climate scientist and consultant to UCS.

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[INTRODUCTION]

Fossil fuel energy companies face tremendous risks from the impacts of climate change. Sea level rise and enhanced storm surge can damage or destroy coastal energy facilities, curtail production (or stop it altogether), and inundate nearby communities.

Oil refineries are especially vulnerable, as they often sit on low-lying land. Yet many companies—ironically, including those whose operations have contributed to the emissions that *cause* climate change—fail to disclose such vulnerabilities, even though the U.S. Securities and Exchange Commission (SEC) asks all publicly traded companies to consider the climate-related risks they face and to disclose those that are material. When companies neglect to disclose and prepare for these risks, they face greater potential for spills and other damages caused or made worse by climate impacts. Investors, taxpayers, and communities should not have to bear the burden of this failure. They should instead take action, pressuring companies to fully consider and disclose their climate change risks. For its part, the SEC should educate companies about these climate impacts and ensure they are reported. Greater transparency about the risks associated with our fossil fuel energy infrastructure allows us to make more informed decisions about our energy choices.

Coastal Impacts of Climate Change

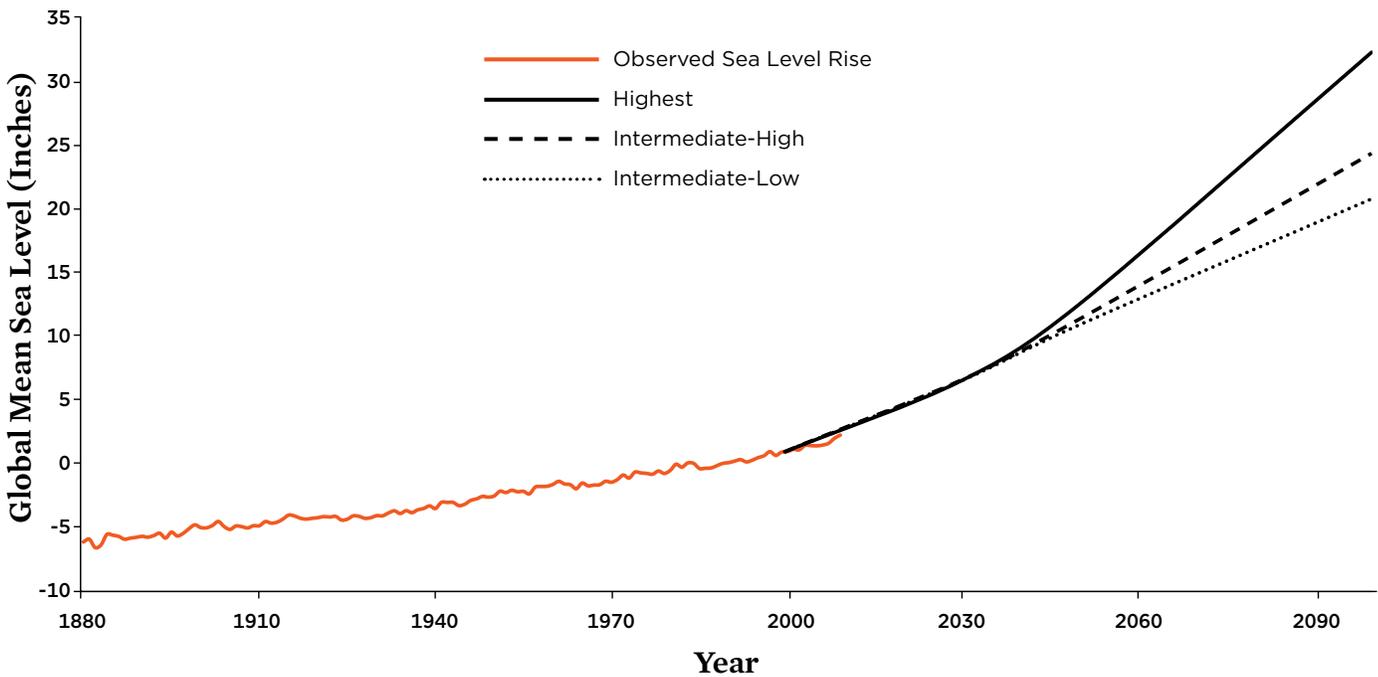
Oil and gas companies often have large refining operations at or near the coastline. Many of these facilities are on land less than 10 feet above the high tide line (Strauss and Ziemlinski 2012). Climate change impacts, including sea level rise and changes in storm intensity, add to the risks that these coastal facilities face now and in the future. (See Figure 1, p. 2 and Figure 2, p. 3.)

Around the world, sea level is rising in response to global warming (Dutton and Lambeck 2012). The planet has warmed by about 1.5°F (0.8°C) since 1880 as a result of human activities—primarily the burning of fossil fuels, and the accumulation of heat-trapping gases in the atmosphere (Hartmann et al. 2013; Hansen et al. 2010). Global sea levels rose roughly eight inches from 1880 to 2009, with global warming the main driver (Church and White 2011; Church et al. 2011). And as air temperature increases, so does the temperature of the oceans, which have absorbed more than 90 percent of human-caused warming since 1955 (Levitus et al. 2012).

As seawater warms, it expands. This expansion, together with the shrinkage of mountain glaciers and polar ice sheets due to melting, are the primary reasons why global sea level is rising (Cazenave and Llovel 2010; Lombard et al. 2005). And the rate of this rise has nearly doubled in recent years. In the 15-year period from 1993 to 2008, the global rate of sea level rise was more than two-thirds higher than the 20th-century average (Church and White 2011; Ablain et al. 2009; Leuliette, Nerem, and Mitchum 2004).

In the United States, the East and Gulf Coasts have the fastest rates of local sea level rise, due in part to local subsidence—the sinking of land—and changes in ocean currents (NOAA 2014a; Ezer et al. 2013; Sallenger, Doran, and Howd 2012). (See Box 1, p. 5.) Galveston, TX, for example, has experienced more than a foot of sea level rise in the past 50 years, compared with the global average of about four inches (NOAA 2014b; Church and White 2011). Recently published

FIGURE 1. Historical and Projected Sea Level Rise



Sea levels are expected to rise faster in the next century, with some parts of the world, such as the U.S. East and Gulf Coasts, expected to see higher rates than others. Shown here are recently published sea level rise projections that used different IPCC RCP scenarios, which make several different assumptions about how oceans and land-based ice could respond to future warming. The intermediate-high scenario was used for the UCS analysis.

SOURCE: KOPP ET AL. 2014

projections suggest that, under a mid-range scenario of future warming, the Gulf of Mexico may experience three to four feet of sea level rise by the end of this century, while many locations along the Mid-Atlantic and Northeast Coasts are projected to experience two to three feet (Kopp et al. 2014). (Figure 1.)

With sea level rise to date, storm surge—abnormal rise of water above the normally predicted tide line, primarily as a result of strong winds—from hurricanes in recent years has been as high as 28 feet above normal tide levels, resulting in devastation to coastal areas (NHC 2014). Strong winds can also make waves larger, and with storm surge bringing these pounding waves farther inland, more structures are exposed to the destructive battering power of the ocean. During Hurricane Ike in 2008, the storm surge traveled up to 30 miles inland in parts of Texas and Louisiana (NHC 2015).

In addition, climate change may affect the strength of the coastal storms themselves. Recent studies have shown a substantial increase in the proportion of more intense hurricanes (i.e., Category 4 and 5) in the North Atlantic basin since 1975 (Holland and Bruyere 2014; IPCC 2013a). (See Figure 2, p. 3.) And as the climate continues to warm, it is likely that the

most intense categories of hurricanes will occur more often (IPCC 2012). Moreover, as sea levels rise, the storm surge associated with hurricanes is riding on the back of an increased baseline, making even lower-intensity storms more damaging. It is also likely that global warming will cause hurricanes to have higher rainfall rates by the end of the 21st century, further increasing flood risks (GFDL 2013; Knutson and Tuleya 2008; Knutson and Tuleya 2004).

On the U.S. East Coast nor'easters, storms that are slower moving but much larger in area than hurricanes, can do just as much damage, depending on their intensity, path, duration, and frequency. When combined with elevated seas, they can inundate large areas, causing extensive flooding and beach erosion, especially at high tides (NOAA 2013a).

Why Focus on Refineries?

Refineries are critical components of the U.S. energy system, and their operations affect all Americans. Refineries take crude oil and turn it into transportation fuel and other widely used products. For example, a barrel (42 U.S. gallons) of crude

oil that goes to a refinery yields about 19 gallons of gasoline and 12 gallons of diesel (EIA 2014a).

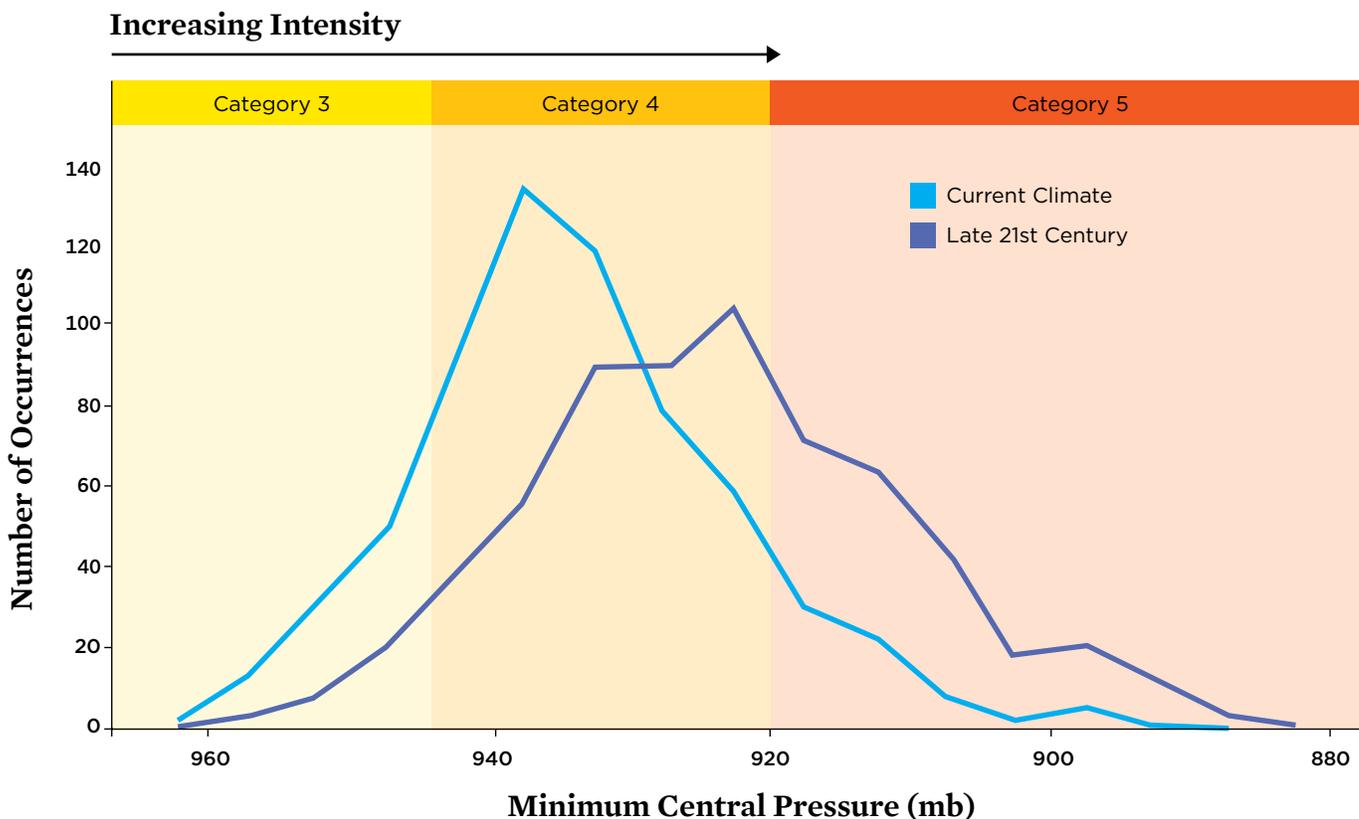
Refineries have long operating lives, so companies typically invest in updates and expansions, or sell facilities to other parties, rather than abandon old facilities or construct new ones. Since 1993, only three refineries have been built in the United States (EIA 2014b). Yet as of January 1, 2014, there were 139 operating U.S. refineries (EIA 2014c).

Though refineries are vital, most oil industry profits come from crude oil extraction; refineries do not have high profit margins even though they operate almost continuously (EIA 2014d; UCS 2014). Thus any disruption in refining operations could have a material impact on related cash flows. Disruptions include diminished refining utilization rates, maintenance downtime, changes in supply chains or distribution centers, power outages, or plant closures (Davis and Clemmer 2014). Closures can occur because of damage to the

facility or danger to employees, nearby communities, or the public. These facilities are already vulnerable to such disruptions, with a history of spills, explosions, and other industrial accidents at many sites, as well as indirect effects from disruptions to oil drilling. And with 120 oil and gas facilities situated within 10 feet of the local high tide line, U.S. refineries are especially vulnerable to storm and climate-related impacts (Strauss and Ziemlinski 2012). (See Box 1, p 5.)

Past weather- and climate-related refining outages have had significant impacts on gasoline prices and in turn have affected the U.S. economy as a whole. In 2005, for example, Hurricanes Katrina and Rita devastated the Gulf coast, shutting down 23 percent of the U.S. refining capacity, causing a significant drop in gasoline production and resulting in a 50 percent jump in the weekly average spot price of conventional gasoline (Kirgiz, Burtis, and Lunin 2009; Reuters 2005).

FIGURE 2. Climate Change Impacts on Atlantic Hurricane Frequency and Intensity



Research shows that climate change will lead to an increase in Atlantic hurricane intensities over the next century. There will likely be fewer Atlantic hurricanes overall, but the ones that do form could be more damaging. This is because hurricanes are expected to achieve higher wind speeds and involve more rainfall as sea surface temperatures rise.

SOURCE: MICHON 2010

To reduce the vulnerabilities of companies' refining operations, they will need both to mitigate and adapt to climate-related risks. A 2013 report by IPICEA, an oil and gas industry association affiliated with the United Nations, highlights the importance of the oil and gas industry incorporating climate-related risks including physical risks into risk management and adaptation processes (IPICEA 2013). Our energy choices will play a vital role in both mitigating these risks and reducing global warming emissions. Beyond adapting to changing conditions, the companies producing and refining oil also need to cut their carbon emissions dramatically. Unless we reduce carbon emissions and avoid the worst effects of climate change, the need for costly adaptation, emergency-response, and clean-up measures will only grow. But companies' limited efforts in this area to date, and in many cases, their outright opposition to emissions reductions, means that climate change has continued unabated, along with serious risks to the public and to the companies' own operations (See Box 2, p. 6).

As a result of these growing risks and companies' failure to disclose or prepare for climate impacts, investors and the public have had to bear the costs of disasters at refineries. Investors see the hit in their financial returns, and members of the public suffer when they pay at the pump and in their tax dollars—which are used when governments perform emergency responses and cleanup efforts as well as issue federal loans. This is not a sustainable or economically efficient

system. Thus it is imperative that companies actively consider, report, and act to prevent or minimize climate-related risks to their refineries.

The SEC and Investors Demand Disclosure of Climate Change Risks

In 2007, Andrew Cuomo, then attorney general of the State of New York, investigated five companies interested in building new coal-fired power plants in the state. As noted in a 2012 UCS report, Cuomo issued subpoenas to the companies on the grounds that the proposed plants carried substantial business risks related to climate change—particularly from potential legislation to restrict carbon emissions—and that these risks had not been adequately disclosed, thereby misleading investors (Grifo et al. 2012). Four of the companies reached agreements with the attorney general to disclose in their SEC Form 10-K filings the business risks they faced, physical and legislative alike, that were associated with climate change (Confessore 2008).

This unprecedented case sent a strong and convincing message, as it came during a time of broader demand by institutional investors that publicly traded companies give greater consideration to climate change risk (Sheehan 2008).

Shareholder resolutions are one way that investors can encourage public companies to act differently. Company shareholders, individually or through institutional investors,



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Storm surge, like in Houston, TX after Hurricane Ike shown here, can reach far inland, flooding communities and transportation infrastructure and thereby disrupting supply chains, distribution centers, and workers' ability to get to their jobs.

BOX 1.

The Gulf Coast: Sinking Coast, Rising Seas, and Gathering Storms

As noted in a 2014 Union of Concerned Scientists (UCS) report, the Gulf Coast faces rates of sea level rise that are among the highest in the world—in some places more than three times the global average—partly because segments of the region, large swaths of the coast from Mississippi to Texas, are subsiding (Spanger-Siegfried, Fitzpatrick, and Dahl 2014; NOAA 2013b; Milliken, Anderson, and Rodriguez 2008). Louisiana, for example, has lost 1,900 square miles of land since the 1930s. Parts of the Houston area have sunk by more than seven feet in 100 years (Climate.gov 2013; Kasmarek, Gabrysch, and Johnson 2009). Subsidence rates vary widely along the Gulf Coast because local sediment types vary widely and groundwater, oil, and gas are being extracted to different extents along the coast (Kolker, Allison, and Hameed 2011).

The Gulf Coast's location, low-lying topography, and large population render it highly vulnerable to storm surge during

hurricanes and tropical storms. Hurricane Katrina alone took nearly 2,000 lives, forced about a quarter of New Orleans residents to leave the city permanently, and caused roughly \$125 billion in damage (Plyer 2013). More than a quarter of the major roads in the Gulf Coast region are on land less than four feet in elevation, which places critical transportation infrastructure well within striking range of sea level rise, storm surge, and tidal flooding (USCCSP 2008). Wetlands and barrier islands that line the Gulf Coast have historically provided a natural line of defense against storms and coastal floods. However, these fragile systems are themselves subject to the forces of nature—including subsidence, storms, erosion, and sea level rise—and human development. As these natural defenses change, so does their ability to protect the coastline from some floods (Moser et al. 2014; NRC 2012).

can file resolutions with the SEC that request company action on a particular issue. Often shareholders have direct discussions with the companies before or after filing resolutions, which increasingly focus on social and environmental issues, including climate change (As You Sow 2014).

While shareholder resolutions on corporate climate change strategies first appeared as early as 1989, in 2004 investors began asking the SEC to help improve companies' climate risk disclosures in their financial filings (ICCR 2015; Ceres 2004). Beginning in 2007, more than 100 institutional investors, representing \$7 trillion, petitioned the SEC seeking regular reporting from companies on these risks or supported the petitions (CalPERS et al. 2007). In 2010, the SEC issued guidance to companies for considering and discussing such risks in their annual Form 10-K reports (SEC 2010).¹

The 2010 SEC guidance document explicitly stated that “significant physical effects of climate change ... have the potential to have a material effect on ... business and operations. These effects can impact ... personnel, physical assets, supply chain, and distribution chain. They can include the impact of

changes in weather patterns, such as increases in storm intensity, [and of] sea-level rise.”

This guidance added to growing demands from shareholders for companies to fully consider and report physical risks from climate change. Such disclosures are intended to give investors a sense of companies' exposure to climate risks across the entire value chain (Ceres 2012). The SEC discourages “boilerplate” discussion of generalized risk or obvious

Shareholder resolutions requesting company action on a particular issue are one way that investors can encourage public companies to act differently.

¹ All publicly traded companies have long been legally mandated to discuss material risks (of diverse kinds) in their Form 10-K, which they submit annually to the SEC (SEC 2009). The 2010 SEC guidance specifically detailed the ways in which companies should consider climate change risks, and disclose those found to be material, in their Form 10-K (SEC 2010). Though, because it is not an SEC rule, this limits the enforceability of such disclosure.

BOX 2.

Spillover Effects of Refineries on Neighboring Communities

Many of the risks that energy companies and their investors face are shared by communities located near petroleum refineries. About 18.5 million people live in the vulnerability zones around refining facilities (Strauss and Ziemlinski 2012). A recent report from Coming Clean found that 134 million Americans live in the vicinity of 3,400 facilities—including petroleum refineries—that use or store hazardous chemicals (Orum et al. 2014). At least one in three children in this country goes to school within areas described by industry as “vulnerable” (CEG 2014). While these risks are wide reaching, the families that live in the most vulnerable zones are disproportionately poor, African American, or Latino (Orum et al. 2014).

For example, Chevron’s Richmond, California, refinery faced criticism in a 2014 report for exposing communities of color to past and potential chemical catastrophes. Some 80 percent of the population living within a mile of the refinery were people of color and a quarter were below the poverty line (Orum et al 2014). The facility experienced several recent safety problems, with significant fires at the plant both in 2012 and 2014 (Chemical Safety Board 2014; Chaudhuri, Samanta, and Seba 2014). In the 2012 fire, 15,000 residents near the refinery sought treatment for respiratory problems.

In addition to the health risks that communities face from their proximity to refineries, they are vulnerable to the same climate risks as companies. When oil and gas facilities are damaged in floods or have resulting spills, surrounding communities can be contaminated as well. After Hurricane

Katrina, the Meraux refinery (then owned by Murphy Oil, now Valero-owned) spilled 25,000 barrels of oil from damaged tanks. City canals, over a square mile of neighborhood, and approximately 1,700 homes were contaminated with oil (EPA 2006). Damages to the community cost Murphy Oil \$330 million to settle 6,200 claims, buy contaminated property, and perform cleanups (MNS 2006; FEMA 2005).



Smoke from a huge fire at Chevron’s Richmond, CA refinery billows into surrounding communities. The 2,900 acre petroleum refinery is located in Contra Costa County on San Francisco Bay, an area plagued by industrial accidents. Some 80 percent of the population living within a mile of the refinery are people of color and a quarter are below the poverty line.

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conditions; rather, its guidance suggests that good disclosure identifies past and potentially future events or conditions and analyzes company-specific consequences in a narrative form (Ceres 2012; SEC 2010; SEC 2003).

In response to such demands from shareholders and the SEC, some companies have chosen to carefully analyze and publicly disclose their climate risks. The Hess Corporation, an oil and gas company with refining operations, has performed better than many other oil and gas companies in this regard. In its voluntary climate reporting to CDP (formerly the Carbon Disclosure Project), Hess described how climate-induced changes in storm severity could disrupt its operations and result in substantial costs:

“Increased storm severity could materially affect our operations in the Gulf of Mexico. The financial im-

pact of recent storms is an indicator of potential future implications. In 2013 Tropical Storm Karen hit the Gulf of Mexico, requiring Hess to shut-in its Baldpate Production Platform. Total gross lost production was approximately 130 thousand barrels of oil equivalent, with a market value of about \$9 million” (CDP 2014).

To date, the five companies featured in this report have not disclosed careful analysis of their climate risk in their reporting to the SEC. In their Form 10-K filings, these companies have provided little to no disclosure of physical risk from climate change for any of their facilities. Shareholders have taken note of this, however, and they continue to file resolutions requesting greater disclosure of physical climate risks (See Box 8, p. 18).

Methodology

This report focuses on the top five U.S. energy companies with respect to their total crude-refining capacity: Valero, Phillips 66, Exxon Mobil, Marathon Petroleum, and Chevron (Brelsford, True, and Koottungal 2013). One coastal refining facility for each of the five companies was chosen for analysis based on perceived risk, which was determined by vulnerability of location and historical storm damage. (See the table, and Figure 3, p. 8).

The capacity information for each petroleum refinery is reported by the U.S. Energy Information Administration (EIA) as of January 1, 2014 (EIA 2014e). Capacity was listed in barrels per calendar day (b/cd), which is a measure of the

amount of input that a distillation unit can process in a 24-hour period under usual operating conditions; this measure takes into account both planned and unplanned maintenance (EIA 2014c).

Refinery property lines were determined by county-level parcel-ownership data, when available. Digital Elevation Model (DEM) data were obtained from the U.S. Geological Survey National Map.

The extent to which each company disclosed—i.e., how thoroughly it considered the physical impacts of climate change itself—was assessed using (a) the SEC’s EDGAR database; (b) targeted keyword searches in the Ceres/CookESG

Facility Statistics and Company Disclosure for Refineries Analyzed

U.S. Refining Rank of Company by Crude Capacity	Global Refining Rank of Company by Crude Capacity	Company	Site Location	Crude Capacity at Facility Analyzed (Barrels per Calendar Day)	Company Disclosure of Physical Climate Risk
1	6	Valero	Meraux, LA	125,000 b/cd	None
2	10	Phillips 66	Linden, NJ	238,000 b/cd	Poor
3	1	Exxon Mobil	Baytown, TX	560,500 b/cd	None
4	13	Marathon Petroleum	Texas City, TX	84,000 b/cd	None
5	9	Chevron	Pascagoula, MS	330,000 b/cd	None

Refineries from the top five U.S.-based refiners were chosen to assess risks the companies face from climate change impacts. Global rankings and crude capacities were based on 2013 SEC filings (Brelsford, True, and Koottungal 2013) and company disclosure assessments were characterized using tools developed by Ceres (2012).

These companies have provided little disclosure of climate change risk for their coastal refinery locations.

SEC Climate Disclosure Search Tool; and (c) 2013 SEC Form 10-K filings, which note all of the companies' disclosed material risks (for the most recent year for which data were available) (Ceres CookESG 2014; SEC 2014). Specifically, each company was assigned a disclosure score for its reporting on physical risk to the SEC (in its 2013 Form 10-K filings), based on methodology established in the Ceres 2012 report referenced below. Ceres—a nonprofit that mobilizes investors, companies, and public interest groups around sustainable business practices—defines good disclosure of physical risks from climate change this way:

“Provides a detailed analysis of the physical climate risks the company faces (including in its supply

chain), the operational segments and/or specific company facilities that might be impacted, the magnitude and timeframes of the anticipated impacts (quantified, when feasible), and how the company plans to respond. Includes an assessment of whether these physical risks ‘will have, or are reasonably likely to have, a material impact on the company’s liquidity, capital resources, or results of operations’ (SEC 2003) and the basis for the company’s conclusions. Discusses past physical impacts, if material” (Ceres 2012).

Note that the 2012 Ceres report and this report focus on disclosure, rather than assessing how well companies are actually managing and preparing for these risks, given that transparency provides incentives for companies to improve performance and reduce risks (Ceres 2012).

Methods used in this report draw from the best practices established by the NOAA Coastal Services Center and laid out in the “Mapping Coastal Inundation Primer” (NOAA 2012). The extent of future sea level rise was mapped for the years 2030, 2050, and 2100 using recently published, localized sea level rise projections (Kopp et al. 2014). Maps featured in this

FIGURE 3. Map of U.S. Coastal Refineries of the Five Companies Analyzed



The five companies analyzed have refineries along the Gulf, East, and West Coasts, as well as in Hawaii. Some of these facilities face risks, now and in the future, from sea level rise and storm surge. The oil and gas infrastructure in the Gulf of Mexico is especially vulnerable because of rising seas, sinking land, and frequent tropical storm systems.



© FEMA/Patsy Lynch

St. Bernard Parish, just outside of New Orleans, was contaminated with oil when the then Murphy Oil-owned Meraux refinery was severely damaged by storm surge during Hurricane Katrina. After the incident, Murphy Oil disclosed that the facility faced climate-related risks, but Valero has yet to disclose the same since it acquired the Meraux facility in 2011.

report show the Representative Concentration Pathway (RCP) 4.5 scenario from the Intergovernmental Panel on Climate Change Fifth Assessment report (IPCC 2013b). The RCP 4.5 can be viewed as a moderate mitigation policy scenario that has emissions peaking around 2040 and then declining (Kopp et al. 2014; IPCC 2013b).

Inundation from storm surge was estimated using the National Weather Service Sea, Lake, and Overland Surges from Hurricanes (SLOSH) model's maximum of maximums (MOMs) at Gulf and East Coast sites. The storm surge maps produced from SLOSH MOMs show worst-case-scenario flooding given all possible storm paths for a hurricane of a particular strength. It is unlikely that any singular storm could produce all of the flooding shown in these storm surge inundation maps for a particular category; rather, the maps demonstrate the areas at risk for damage from storm surge at refineries, now and in the future, from Category 1–5 hurricanes.

SLOSH MOMs are often used for emergency management and coastal planning (NYC OEM 2009). During the

key days preceding landfall of a major storm, the uncertainty associated with the final storm path is high. Thus it is essential for communities and emergency managers not only to know and plan for the worst-case scenario but also to prepare for multiple possibilities of where damage might occur.

To examine specific effects sea level rise might have on storm surge, a SLOSH MOM model of a hurricane category that already affects each facility was selected in order to compare how risk today changes with estimated sea level rise in 2030, 2050, and 2100.

For a more detailed description of the methodology for this report, see Appendix A.

The next five sections address in turn the five companies analyzed in this report. Each section identifies the company's place in the industry, specifies the coastal refinery examined, gives a brief synopsis of the company's history of weather and climate-related damages, summarizes how well the company publicly discloses climate change risks to all its coastal refineries, and provides a sense of shareholder actions pressing the company to recognize that need.

Results

Valero Energy Corporation

Valero Energy Corporation is the sixth-largest refining company in the world, and its nine refineries on U.S. coasts help make it the largest refiner in the United States. Several of these facilities sit in low-lying areas on the coast of the Gulf of Mexico and thus face significant risks from sea level rise and storm surge.

After Hurricane Katrina in 2005, the then Murphy Oil-owned Meraux refinery (modeled in Figure 4), which sits below sea level in southern Louisiana, spilled 25,000 barrels of oil and was shut down for several months (DOE 2009; EPA 2006). Meraux city canals and more than a square mile of neighborhood were contaminated with oil, resulting in a \$330 million settlement for Murphy Oil (EPA 2006; MNS 2006). The Meraux facility again saw damages from the 2008 hurricane season and was shut down for many days (DOE 2009). Following these adverse

After Hurricane Katrina, the Meraux refinery spilled 25,000 barrels of oil. Meraux city canals and more than a square mile of neighborhood were contaminated.

BOX 3.

Valero Refining Statistics

Physical climate risk disclosure to SEC: No disclosure

Total U.S. crude refining capacity: 2,096,500 b/cd

Near-coast facilities in the U.S.: Meraux, LA (125,000 b/cd); St. Charles, LA (205,000 b/cd);* Corpus Christi, TX (200,000 b/cd); Houston, TX (88,000 b/cd); Texas City, TX (225,000 b/cd); Benicia, CA (132,000 b/cd); Wilmington, CA (78,000 b/cd)

* Valero Refining New Orleans LLC

events, Murphy Oil disclosed in its 2010 SEC Form 10-K that “the physical impacts of climate change present potential risks for severe weather (floods, hurricanes, tornadoes, etc.) at our Meraux ... refinery in southern Louisiana and our offshore platforms in the Gulf of Mexico” (Murphy Oil 2011).

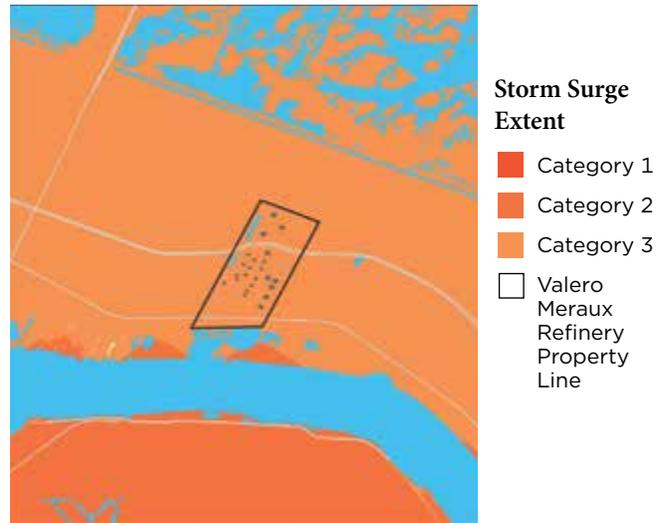
Yet Valero has not disclosed such climate risks since it acquired the Meraux facility from Murphy Oil on October 1, 2011. Valero’s 2013 SEC filing noted only that there could be “weather conditions that disrupt the supply of and demand for refined products,” mentioning Hurricane Sandy as an example. Direct discussion of climate change concerns was limited to the impacts of climate-related regulations. Valero wrote, “Compliance with and changes in environmental laws, including proposed climate change laws and regulations, could adversely affect our performance” (Valero Energy 2014).

FIGURE 4. Valero’s Meraux, LA Refinery

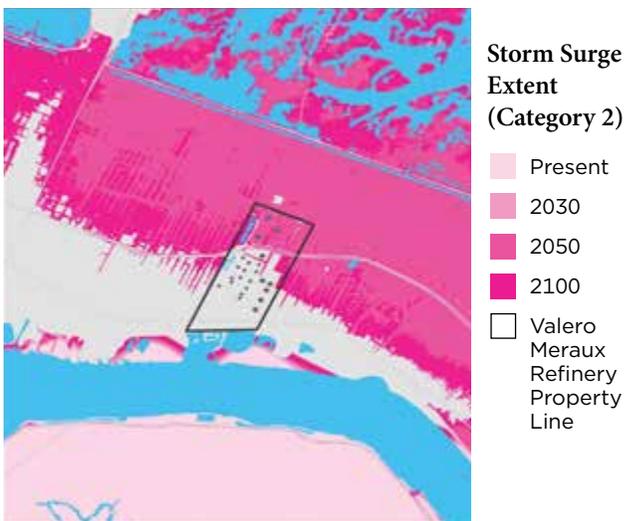
a. Aerial Image Showing Refinery Property Line



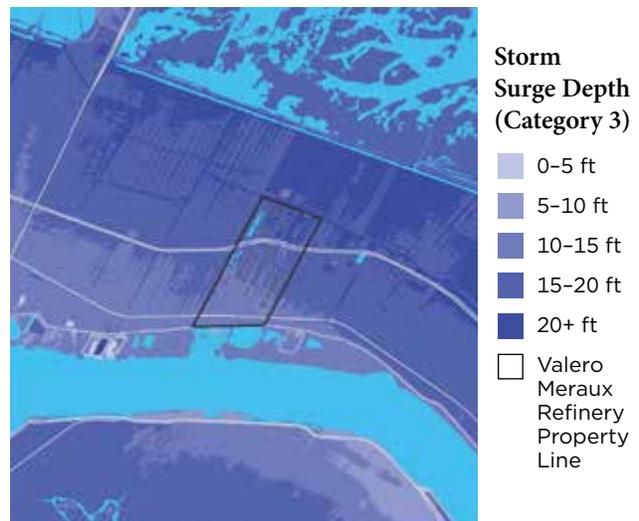
b. Extent of Storm Surge Flooding Today from Category 1–3 Hurricanes



c. Projections for Storm Surge Extent from a Category 2 Hurricane Today and with Sea Level Rise by 2030, 2050, and 2100



d. Depth of Storm Surge Flooding Today from a Category 3 Hurricane



Valero’s Meraux, LA, refinery (125,000 b/cd) sits 10 miles east of New Orleans and has risks both from sea level rise and storm surge. SLOSH MOM modeling shows that by 2050, sea level rise will make the facility vulnerable to Category 2 hurricanes (Figure 4c), which are not currently projected to flood the facility at all (Figure 4b). With sea level rise to date, a Category 3 storm could put parts of the facility under 10 feet of water (Figures 4d).

Phillips 66

Phillips 66, formed in 2012 when ConocoPhillips spun off its refining, marketing, chemical, and transportation operations, is the 10th-largest refiner in the world. The company has 15 refineries worldwide—11 in the United States, with three of them on coasts. Phillips 66 has only limited disclosure of climate-related risks, including sea level rise and storm surge. After Superstorm Sandy hit in 2012, some 7,800 gallons of oil spilled at its Bayway refinery in Linden, NJ (modeled in Figure 5). The refinery was shut down for three weeks because of flood damage and power outages from the storm (Reuters 2012). But despite the obvious vulnerability of this and other facilities, the company has not fully reported its physical risks from climate impacts.

Phillips 66 SEC filings contain only minimal consideration of such risks, as exemplified by the following: “To the extent there are significant changes in the Earth’s climate, such as more severe or frequent weather conditions in the markets we serve or the areas where our assets reside, we could incur increased expenses, our operations could be materially impacted, and demand for our products could fall” (Phillips 66 2014). The company has made no reference to the vulnerability of its coastal facilities to climate-related sea level rise and storm surge, nor has it provided any significant discussion on how, or if, it is preparing for those risks.

Meanwhile, investors are taking notice. For the 2015 shareholder season, Phillips 66 shareholders, led by Calvert Investment Management, have filed a resolution asking the

BOX 4.

Phillips 66 Refining Statistics

Physical climate risk disclosure to SEC: Poor disclosure

Total U.S. crude refining capacity: 2,060,200 b/cd

Near-coast facilities in the U.S.: Linden, NJ (238,000 b/cd); Belle Chasse, LA (247,000 b/cd); West Lake, LA (239,400 b/cd); San Francisco, CA (120,000 b/cd); Los Angeles, CA (139,000 b/cd)

company for better disclosure of risk from the physical impacts of climate change. The resolution states, “Diminished refining utilization rates, potential downtime or closure of facilities due to direct damage to facilities, danger to employees, disruption in supply chains, and power supply [outages] due to storm surges or sea level rise could have a material impact on the company’s production and related cash flows. This was made evident when the company’s Bayway refinery lost power after Superstorm Sandy, was shut down for several weeks due to flood damage from the storm, and incurred significant maintenance and repair expenses” (Calvert Investment Management 2014).

Phillips 66 shareholders, led by Calvert Investment Management, have filed a resolution asking the company for better disclosure of risk from the physical impacts of climate change.



Phillips 66’s Bayway refinery in Linden, New Jersey, is part of the “Chemical Coast” of industrial facilities situated on Arthur Kill—the waterway between New Jersey and New York’s Staten Island. The geography of the New York bight puts the region at greater risk from storm surge associated with storms affecting the greater New York City area.

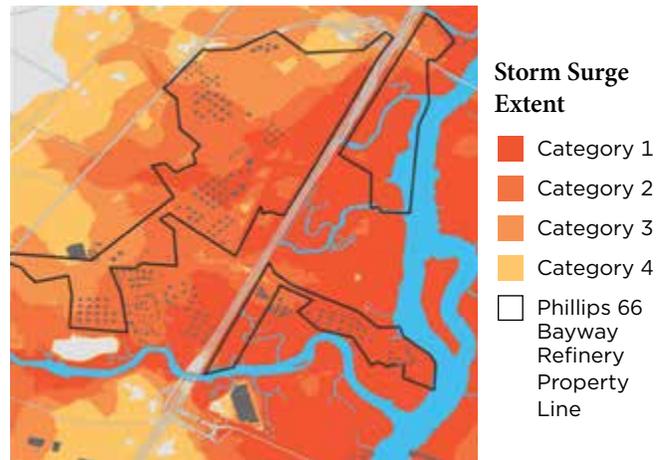
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FIGURE 5. Phillips 66's Linden, NJ Refinery

a. Aerial Image Showing Refinery Property Line



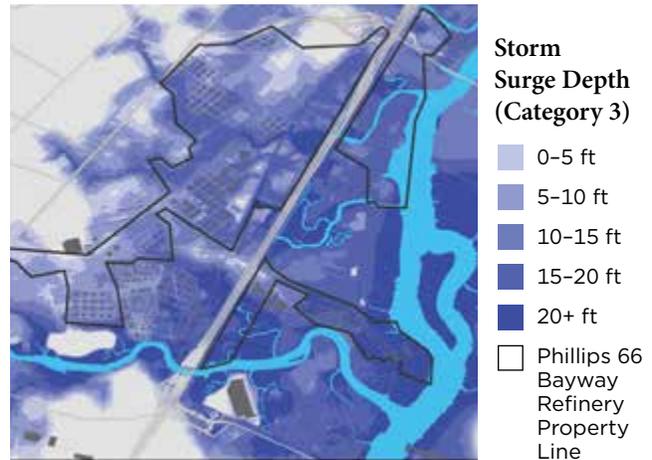
b. Extent of Storm Surge Flooding Today from Category 1–4 Hurricanes



c. Projections for Storm Surge Extent from a Category 2 Hurricane Today and with Sea Level Rise by 2030, 2050, and 2100



d. Depth of Storm Surge Flooding Today from a Category 3 Hurricane



Phillips 66's Bayway refinery (238,000 b/cd) in Linden, NJ, sits within the New York metropolitan area and faces risks from climate change. SLOSH MOM modeling shows that with sea level rise to date, a Category 1 hurricane could put parts of the facility under water (Figure 5b). If a Category 3 storm hit, the facility could be inundated, with potential for parts of the refinery to be under 10 feet of water (Figure 5d). Sea level rise, along with changes in hurricane intensity, could worsen storm impacts in the future (Figure 5c). The refinery could also be vulnerable from storm surge as a result of nor'easter storms occurring at high tide.

Exxon Mobil Corporation

Boasting more than 5 million b/cd in crude-refining capacity, Exxon Mobil Corporation is the largest refiner in the world. With three major refining facilities (Baytown, Chalmette, and Beaumont) along the Gulf of Mexico, the company has undisclosed risks from climate change impacts, including sea level rise and storm surge. Its Baytown complex (modeled in Figure 6) is the largest petroleum and petrochemical complex in the United States (Exxon Mobil Corporation 2014a). In 2005, Hurricane Rita caused both the Baytown and Beaumont facilities to shut down (Reuters 2005). Hurricane Katrina also caused major damage to the Chalmette refinery, causing it to shut down for many months (DOE 2009; EIA 2005). With continued sea level rise as well as potential increases in storm intensity as the climate warms, future shutdowns are likely.

Despite the vulnerable placement of these facilities, Exxon Mobil has not reported physical risks from climate change impacts to the SEC. Though the company's 2013 SEC filing noted that "hurricanes may damage our offshore production facilities or coastal refining and petrochemical plants in vulnerable areas," the only direct reference to climate-related risks discussed how



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As climate change continues, it is likely that more intense hurricanes will occur more often in the North Atlantic basin. Wind speeds in Category 4 hurricanes reach up to 156 miles per hour, snapping trees and ripping off roofs and walls, like these in Baytown after Hurricane Ike.

BOX 5.

Exxon Mobil Refining Statistics

Physical climate risk disclosure to SEC: No disclosure

Total U.S. crude refining capacity: 2,043,500 b/cd

Near-coast facilities in the U.S.: Baytown, TX (560,500 b/cd); Chalmette, LA* (192,500 b/cd), Beaumont, TX (344,600 b/cd); Torrance, CA (149,500 b/cd)

*Joint venture with Petróleos de Venezuela; Exxon is the operating partner

climate regulation could affect the company's finances. The company wrote, "greenhouse gas restrictions could make our products more expensive, lengthen project implementation times, and reduce demand for hydrocarbons, as well as shift hydrocarbon demand toward relatively lower-carbon sources..." (Exxon Mobil Corporation 2014c).

Exxon Mobil has undisclosed risks from climate change impacts, including sea level rise and storm surge.

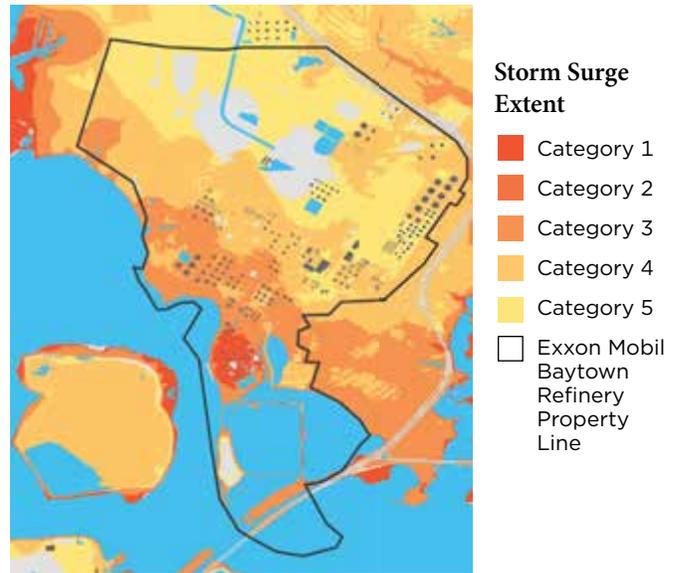
But Exxon Mobil shareholders are concerned about these risks. In 2013, a shareholder resolution was filed by the Christopher Reynolds Foundation, requesting that the company "review the exposure and vulnerability of [its] facilities and operations to climate risk and issue a report that ... estimates the costs of the disaster risk management and adaptation steps the company is taking, and plans to take, to reduce exposure and vulnerability to climate change and to increase resilience to the potential adverse impacts of climate extremes" (Christopher Reynolds Foundation 2013a). In response to other shareholder demands, Exxon Mobil produced a report on energy and climate in 2014. The report noted that the company's risks from climate impacts, such as sea level rise and Gulf Coast hurricanes, "are carefully assessed and considered;" however, Exxon Mobil has not yet disclosed details of this assessment in this report or to the SEC (Exxon Mobil Corporation 2014b).

FIGURE 6. Exxon Mobil's Baytown, TX Refinery

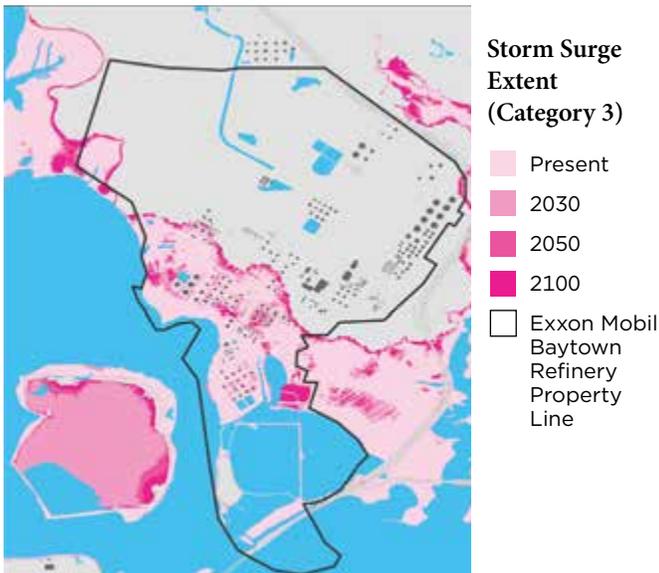
a. Aerial Image Showing Refinery Property Line



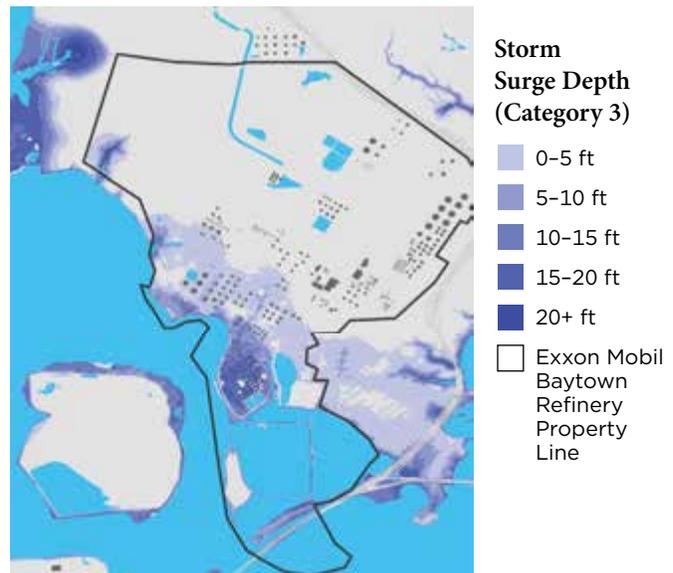
b. Extent of Storm Surge Flooding Today from Category 1–5 Hurricanes



c. Projections for Storm Surge Extent from a Category 3 Hurricane Today and with Sea Level Rise by 2030, 2050, and 2100



d. Depth of Storm Surge Flooding Today from a Category 3 Hurricane



Exxon Mobil's Baytown, TX, refinery (560,500 b/cd) sits at the north end of Galveston Bay, 25 miles east of Houston. SLOSH MOM modeling shows that with sea level rise to date, the facility faces risks from storm surge associated with stronger storms (Figure 6b). A Category 3 hurricane, for example, could inundate parts of the property (Figure 6b) and has the potential to leave some structures under 15 feet of water (Figure 6d). Sea level rise and increases in the proportion of more intense storms could make such storms more damaging to this facility in the future (Figure 6c).

Marathon Petroleum Corporation

In 2011, Marathon Oil spun off its refining, pipeline, and other downstream operations, thereby creating Marathon Petroleum. With seven refineries in the United States and a 1.7 billion b/cd U.S. capacity, Marathon Petroleum now stands as the fifth-largest refiner in the world. The company's three coastal U.S. refineries face climate-related risks from sea level rise and storm surge; indeed, they have suffered storm damages in the Gulf of Mexico in the past.

In the wake of Hurricane Isaac in 2012, Marathon Petroleum's Garyville, LA, refinery—one of the world's largest—experienced a significant reduction in operating capacity. The company took a loan of one million barrels of crude oil from the federal government's emergency reserves to support its refining operations after the storm (Gardner and Schneyer 2012).

Despite such incidences, Marathon Petroleum has not disclosed any risks at its facilities from climate change impacts, including sea level rise and storm surge. The company does note in its 2013 SEC filing the potential for severe "local weather conditions" and "natural disasters such as hurricanes and

BOX 6.

Marathon Petroleum Refining Statistics

Physical climate risk disclosure to SEC: No disclosure

Total U.S. crude refining capacity: 1,714,000 b/cd

Near-coast facilities in the U.S.: Texas City, TX (84,000 b/cd); Galveston Bay, TX (451,000 b/cd); Garyville, LA (522,000 b/cd)

tornadoes"; however, its only direct discussion of climate change impacts is from regulation. The company states, "We believe the issue of climate change will likely continue to receive scientific and political attention, with the potential for further laws and regulations that could affect our operations" (Marathon Petroleum 2014).



As sea levels rise, hurricanes will be riding on the back of elevated water levels, increasing their inland reach and putting more people and infrastructure at risk from tropical storm systems.

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FIGURE 7. Marathon Petroleum’s Texas City, TX Refinery

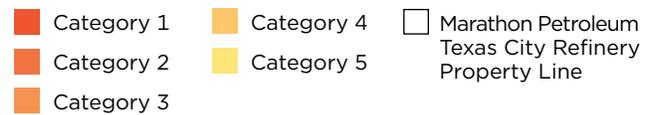
a. Aerial Image Showing Refinery Property Line



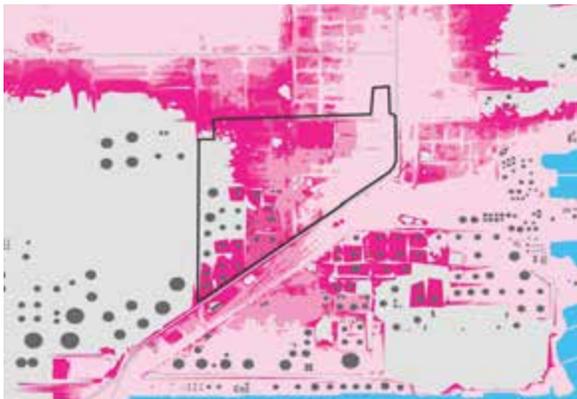
b. Extent of Storm Surge Flooding Today from Category 1–5 Hurricanes



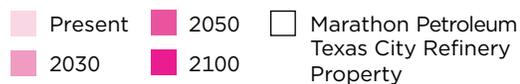
Storm Surge Extent



c. Projections for Storm Surge Extent from a Category 3 Hurricane Today and with Sea Level Rise by 2030, 2050, and 2100



Storm Surge Extent (Category 3)



d. Depth of Storm Surge Flooding Today from a Category 3 Hurricane



Storm Surge Depth (Category 3)



Marathon Petroleum’s Texas City refinery (84,000 b/cd) sits adjacent to its Galveston refinery to the west and Valero’s Texas City refinery to the south. SLOSH MOM modeling shows that with sea level rise to date, the Marathon Petroleum Texas City refinery and those around it could see storm surge impacts from a Category 3 storm or higher (Figure 7b), with operations closest to the coast being inundated (Figure 7d). In the future, sea level rise and changes in storm intensity could put the facility at greater risk for storm damages (Figure 7c). The close proximity of refineries in this area means that damage at one facility could also affect operations at others.

Chevron Corporation

With 14 refineries worldwide and a crude capacity of 2,540,000 b/cd, Chevron is the eighth-largest actor in the global refining industry. As the maps in Figure 8 demonstrate, Chevron's Pascagoula refinery is at risk for current storm damage and future impacts both of sea level rise and storm surge. Of note, this facility has already seen costs associated with storm damage; Hurricane Katrina caused major problems and an extended shutdown of the facility (Reuters 2005).

Despite the vulnerable locations of such facilities, Chevron fails to publicly report their physical risk from climate change. In the company's SEC filings, it makes no disclosures of this kind, though it does note the possibility of "disruptions at refineries or chemical plants resulting from unplanned outages due to severe weather." However, Chevron does not consider these risks in the context of climate change. The only direct discussion of climate change in Chevron's risk reporting surrounds the political implications of climate-related regulations. The company states, "Continued political attention to issues concerning climate change, the role of human activity in it, and potential mitigation through regulation could have a material impact on the company's operations and financial results" (Chevron Corporation 2014).

BOX 7.

Chevron Refining Statistics

Physical climate risk disclosure to SEC: No disclosure
Total U.S. crude refining capacity: 955,000 b/cd
Near-coast facilities in the U.S.: Pascagoula, MS (330,000 b/cd); El Segundo, CA (269,000 b/cd); Richmond, CA (245,271 b/cd); Kapolei, Hawaii (54,000 b/cd)

As a result, Chevron shareholders are raising concerns about the company's climate-related risks. A 2013 shareholder resolution filed by the Christopher Reynolds Foundation asked Chevron to "review the exposure and vulnerability of our company's facilities and operations to climate risk and issue a report ... that estimates the costs of the disaster risk management and adaptation steps the company is taking, and plans to take, to reduce exposure and vulnerability to climate change and to increase resilience to the potential adverse impacts of climate extremes" (Christopher Reynolds Foundation 2013b).

BOX 8.

An Investor Perspective on Climate-related Risk

*By Paul Bugala, senior sustainability analyst, Extractive Industries, Calvert Investment Management, Inc.
December 8, 2014*

In January 2010, the Securities and Exchange Commission (SEC) said that public companies should warn investors of any serious risks that climate change might pose to their businesses. Public companies must disclose any material consideration about their businesses anyway. So, the SEC's recognition that climate change is worthy of special attention was significant. This sort of thing doesn't happen every day.

What we do see every day are increasing signs of the impact of climate change on our lives and economy. Unfortunately, company disclosures of climate change risks are not where they should be. In fact, only 62 percent of S&P 500 companies and only half of Russell 3000 SEC filers said anything about climate change in their 2014 annual reports, according to Ceres (2014). And too often these comments did not include specifics on how companies are working to mitigate the causes and adapt to the effects of global warming.

In its 2010 disclosure guidance, the SEC called out physical impacts such as sea level rise and storm surges as climate change threats worthy of particular company and investor

attention. The impacts of sea level rise and storm surges are particularly challenging in industries such as oil and gas refining, which have large facilities close to coasts. So, the Union of Concerned Scientist's effort to disclose risks related to these topics, represented by this report, is quite welcome and, perhaps, overdue.

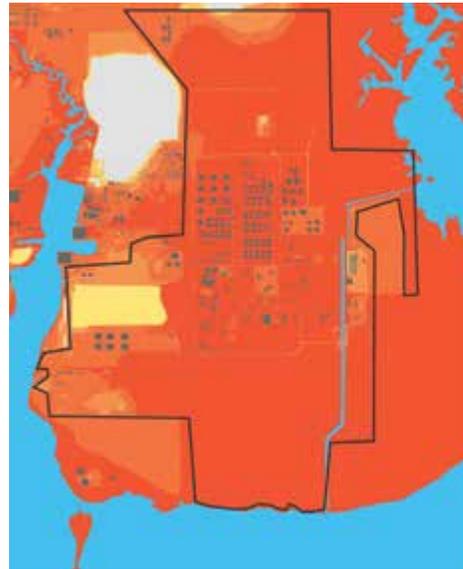
Calvert Investment Management has been filing shareholder resolutions and engaging in other advocacy on climate-related issues with companies in our portfolios since 2002. However, 2014 is the first year we have filed a shareholder proposal seeking disclosure of risks related to sea level rise and storm surge. Drawing on the information in this report, we filed a resolution with Phillips 66 asking for greater disclosure of its climate risks (Calvert Investment Management 2014). We hope this report draws more investor attention to these specific climate risks and results in corporate and public policies that better reflect the immediate and material threat of climate change.

FIGURE 8. Chevron’s Pascagoula, MS refinery

a. Aerial Image Showing Refinery Property Line



b. Extent of Storm Surge Flooding Today from Category 1–5 Hurricanes



Storm Surge Extent

- Category 1
- Category 2
- Category 3
- Category 4
- Category 5
- Chevron Pascagoula Refinery Property Line

c. Projections for Storm Surge Extent from a Category 1 Hurricane Today and with Sea Level Rise by 2030, 2050, and 2100



Storm Surge Extent (Category 1)

- Present
- 2030
- 2050
- 2100
- Chevron Pascagoula Refinery Property Line

d. Depth of Storm Surge Flooding Today from a Category 3 Hurricane



Storm Surge Depth (Category 3)

- 0–5 ft
- 5–10 ft
- 10–15 ft
- 15–20 ft
- 20+ ft
- Chevron Pascagoula Refinery Property Line

Chevron’s refinery (330,000 b/cd) in Pascagoula, MS, is vulnerable to storm surge impacts. SLOSH MOM modeling shows that given its location in the Gulf of Mexico, even a Category 1 hurricane could penetrate the facility (Figure 8b) and a Category 3 storm could leave parts of the facility under 10 feet of water (Figure 8d). Such storm impacts are likely to be worse in the future, as sea levels encroach upon the property (Figure 8c), subsidence in the Gulf continues, and storms become more intense.

Conclusion

Recommendations

In this report, five refineries—one from each of five major oil and gas companies—were found to face climate-related physical risks from sea level rise and enhanced storm surges. And these five sites are not unique. Many other U.S. oil refineries face similar climate change threats, which expose their investors to undue financial risks, expose the public to additional burdens at the pump and in its taxes, and expose nearby populations to potential harm from damage at these facilities.

Yet most fossil fuel energy companies are failing to report their physical risks from climate change, despite the real dangers involved and despite guidance from the SEC and demands from shareholders. Investors, community groups, and the public, which have a right to know about companies' climate-related risks, can help hold them accountable for recognizing and preparing for these climate impacts.²

- **Companies** should be more transparent about their risks from—and contributions to—climate change. They should fully accept climate science and integrate it into their business plans, including their plans for emissions

reduction and risk mitigation. Such plans should not only reflect climate change's physical impacts but also include the necessary measures—remedial and preventive alike—for protecting facilities, employees, shareholders, and communities against damages.

- **The Securities and Exchange Commission** should push companies to follow its guidelines for disclosing climate change risks, while also educating them about how to comply and on what full disclosure looks like. Further, the SEC should go beyond guidance and issue a rule that requires companies to report annually whether climate change impacts—including sea level rise and enhanced storm surges—pose risks to their business and to list any such risks specifically.
- **Investors** who have previously pressed companies to seriously consider any business risks posed by the physical impacts of climate change should continue to do so, and also ask companies to document these risks in their SEC Form 10-K, as part of their responsibility to investors and

Investors, community groups, and the public, which have a right to know about companies' climate-related risks, can help hold them accountable for recognizing and preparing for these climate impacts.

² For letters sent to companies from the Union of Concerned Scientists regarding these issues and related shareholder resolutions, see Appendix B.



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Hurricane force winds make waves larger and storm surge brings these pounding waves further inland, exposing structures to the destructive battering power of the ocean (water weighs approximately 1,700 pounds per cubic yard). As a result, it is essential that companies, communities, and governments fully consider and prepare for the impacts of climate change.

to the rest of society. Investors new to these issues should (a) focus squarely on the financial effects that climate change could have on companies, and (b) press companies and the SEC to improve their responses to these risks and sharpen their recognition of attendant opportunities.

- **Refineries**, in order to minimize the damage that climate change impacts could have on coastal facilities and surrounding communities, should:
 - conduct facility specific risk assessments and adapt their facilities to withstand climate impacts or consider alternative investments;
 - reduce the global warming emissions of their operations by, for example, improving energy efficiency, implementing combined heat and power, and using lower carbon fuels;
 - use safer inputs and processes, including safer chemical alternatives, whenever possible;

- be prepared to adequately respond to accidents when they occur;
- and be transparent about the chemicals and processes used, safety records, and any preventive measures in place. Public access to information is key to enabling communities to hold facility owners and operators accountable for reducing risks as much as possible, and for emergency responders to have unfettered access to information during crises.
- **States** should enact laws to enhance safety, transparency, and preparedness for climate impacts at refineries.
- **The public** should demand that companies not only consider physical risks associated with climate change but also take appropriate steps to ensure that communities surrounding facilities are adequately protected from potential climate-related risks and accidents.

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[APPENDIX A]

Detailed Methodology

Appendix A is available online at www.ucsusa.org/risingrisks.

[APPENDIX B]

Letters to Companies from UCS and Recent Shareholder Resolutions regarding Climate Risk Disclosure

Appendix B is available online at www.ucsusa.org/risingrisks.

Stormy Seas, Rising Risks

*What Investors Should Know About
Climate Change Impacts at Oil Refineries*

Though many large refining operations are in vulnerable coastal areas less than 10 feet above the high tide line, many companies fail to disclose risks from climate impacts such as sea level rise and storm surge.

Sea level rise and storm surge already pose great threats to our nation's coasts. As climate change continues, these risks will only grow. Coastal oil and gas refineries face tremendous risks from these climate change impacts. Yet most companies do not publicly disclose these vulnerabilities, even though the U.S. Securities and Exchange Commission (SEC) asks all publicly traded companies to consider the climate-related risks they face and to disclose those that are material. Damaged or destroyed facilities have wide-reaching financial implications and can also endanger nearby communities. Hurricanes Rita and Katrina, for example, shut down 23 percent of the nation's oil refining capacity and caused numerous spills, affecting nearby communities and taxpayers everywhere.

When companies neglect to disclose and prepare for these risks, they face greater potential for spills and other damages caused or made worse by climate impacts. Investors, taxpayers, and fence line communities should not have to bear the burden of this failure. Companies should be held accountable for fully considering and managing these risks. Shareholders, decision makers and the SEC should push companies to fully consider and prepare for climate change impacts. Greater transparency about the future of our fossil fuel energy infrastructure, and about risks associated with it, allows us to make more informed decisions on our energy choices.

**Union of
Concerned Scientists**

FIND THIS DOCUMENT ONLINE: www.ucsusa.org/risingrisks

The Union of Concerned Scientists puts rigorous, independent science to work to solve our planet's most pressing problems. Joining with citizens across the country, we combine technical analysis and effective advocacy to create innovative, practical solutions for a healthy, safe, and sustainable future.

The Center for Science and Democracy at UCS works to strengthen American democracy by advancing the essential role of science, evidence-based decision making, and constructive debate as a means to improve the health, security, and prosperity of all people. More information about UCS and the Center for Science and Democracy is available on the UCS website: www.ucsusa.org.

NATIONAL HEADQUARTERS

Two Brattle Square
Cambridge, MA 02138-3780
Phone: (617) 547-5552
Fax: (617) 864-9405

WASHINGTON, DC, OFFICE

1825 K St. NW, Suite 800
Washington, DC 20006-1232
Phone: (202) 223-6133
Fax: (202) 223-6162

WEST COAST OFFICE

500 12th St., Suite 340
Oakland, CA 94607-4087
Phone: (510) 843-1872
Fax: (510) 843-3785

MIDWEST OFFICE

One N. LaSalle St., Suite 1904
Chicago, IL 60602-4064
Phone: (312) 578-1750
Fax: (312) 578-1751