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Adding Fuel to the Fire: The Climate Consequences of Arctic Ocean Drilling

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2012 was supposed to be a banner year for Royal Dutch Shell, as the company planned to embark on the first Arctic offshore exploratory drilling activity in decades and set itself up to make billions of dollars prospecting for oil in the far-flung region off Alaska's North Slope. But that's not how things turned out.

Instead, beginning with efforts to prepare for operations, the company experienced one setback after another.[1] Shell struggled to meet the government's safety requirements for its oil spill response equipment, experiencing multiple technical failures and permit violations.[2] Mother Nature weighed in and kept the drilling sites choked with sea ice. Yet despite these setbacks and others, Shell received permits from the federal government in August to begin preparatory drilling, albeit not deep enough to actually strike oil in Alaska's Beaufort and Chukchi Seas.[3]

The coup de grace came on New Year's Eve when Shell's Kulluk rig ran aground near Kodiak, Alaska—a fiasco that required a 500-plus person response effort, led by the Coast Guard, working for more than a week in dangerous conditions to secure the rig.[4] This final calamity prompted the Obama administration to launch a high-level 60-day review of Shell's entire Arctic drilling program, and after assessing its equipment and determining that both Arctic drilling rigs were too damaged to operate in 2012, caused Shell to announce on February 27 that it would not seek to drill in the remote and challenging region in 2013.[5]

In presenting the results of the Department of the Interior's review on March 14, outgoing Secretary of the Interior Ken Salazar admitted, "The government still has a lot to learn. The Arctic is a very difficult environment to operate in. … Shell is one of the most resource-capable companies in the world (and) they encountered a whole host of problems in trying to operate up there."[6] The review concluded that Shell would have to develop a "comprehensive plan" for its operations before it would be allowed to move forward. This begs the question: What exactly did the permit process consist of before all these mishaps?[7]

Shell spent seven years[8] and an estimated $5 billion[9] getting ready for its chance to tap the reserves of fossil fuels thought to be stashed beneath the Arctic seabed, and the result was irrefutably a failure. Neither the oil and gas industry nor its regulators are adequately prepared for Arctic offshore drilling operations.

Furthermore, climate change is already wreaking havoc in the region, melting it at an alarming rate and setting off a domino effect that will ripple through the entire global system. The trends so plainly on display in the Arctic are merely a preview of what awaits the rest of the planet if serious action isn't taken soon to aggressively curb our carbon emissions. If we allow corporate interests to tap the reserves of additional fossil fuels that have been exposed by the rapid onset of global climate change, we're missing the clear message about the future of our environment on a planetary scale. Slowing the devastating steamroll of climate change requires slashing the amount of greenhouse gases we put into the atmosphere, not opening up vast new sources of carbon.

In President Barack Obama's most recent State of the Union address, he reiterated his commitment to addressing the urgency of climate change for the sake of future generations.[10] The president's will, however, is matched by the utter intransigence of Congress and what has been called the most antienvironmental House of Representatives in history.[11] Looking forward, the Obama administration will face some big decisions early on in the second term: the fate of the controversial Keystone XL pipeline,[12] regulating pollution[13] from existing coal-fired power plants, and whether or not to move forward with offshore drilling in the fragile Arctic.

America's Arctic outer continental shelf will be undisturbed by drilling rigs in 2013, but the battle over oil and gas exploration in its frigid waters is far from over. Shell made clear that it sees this latest announcement to pause operations as a hiatus, not a cancellation of its plans to tap the Arctic Ocean's reserves. Marvin Odum, Shell's director of Upstream Americas, said, "Our decision to pause in 2013 will give us time to ensure the readiness of all our equipment and people following the drilling season in 2012."[14]

The Obama administration will also need to decide on ConocoPhillips' applications to begin exploratory drilling in 2014. The company said its plans remain on track and it will submit remaining information to the Department of the Interior this spring, despite Shell's problem-filled year.[15]

As CAP's John Podesta and Carol Browner articulated in a recent Bloomberg op-ed, Shell's string of mishaps and failures provide overwhelming evidence that the oil and gas industry is not prepared for the enormous challenge and incalculable risk that accompanies any operations in the Arctic. In light of that reality, they wrote, "The Obama administration shouldn't issue any new permits to Shell this year and should suspend all action on other companies' applications to drill in this remote and unpredictable region."[16]

Below we examine in further detail the risks and potential consequences of offshore drilling in the Arctic region.

The multiple risks of Arctic offshore drilling

Regardless of the company and its individual preparations, there are multiple risks inherent in industrializing one of the few remaining unspoiled corners of the planet.

Infrastructure

The area around planned drilling sites in the Beaufort and Chukchi Seas lacks even the basic infrastructure necessary to mount a large-scale response to an oil spill or other major incident—such as roads, major airports, ports, hospitals, and adequate facilities to house and feed responders. The nearest permanent Coast Guard facility is more than 1,000 miles away in Kodiak, Alaska, and the United States currently operates just one functional icebreaking vessel, used mainly for scientific missions.[17]

Not only does the Arctic have inadequate infrastructure to deal with an oil spill, but also response technologies in such extreme environmental conditions remain untested and unproven. A 2012 independent report by the Government Accountability Office identified a slew of environmental, logistical, and technical challenges associated with Arctic offshore drilling and concluded that Shell's "dedicated capabilities do not completely mitigate some of the environmental and logistical risks associated with the remoteness and environment of the region."[18]

Weather

Extreme and unpredictable weather conditions complicate transportation, preparedness, operations, and cleanup of spilled oil to an even greater degree. As the National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling stated in its January 2011 final report:

> *The Alaskan Arctic is characterized by extreme cold, extended seasons of darkness, hurricane-strength storms, and pervasive fog—all affecting access and working conditions. The Chukchi and Beaufort Seas are covered by varying forms of ice for eight to nine months a year. These conditions limit exploratory drilling and many other activities to the summer months. The icy conditions during the rest of the year pose severe challenges for oil and gas operations and scientific research. And oil spill response efforts are complicated year-round by the remote location and the presence of ice, at all phases of exploration and possible production.*[19]

Scientific knowledge

Largely untouched by industrial activity, much of the Arctic region remains a mystery. The area is home to numerous indigenous communities that have subsisted for centuries in the harshest surroundings our planet has to offer. It also serves as a habitat for some of the most rare and fragile species on the planet. Any drilling activity in the region would be operating without sufficient scientific knowledge to determine the potential effects of operations on the already fragile ecosystem. A 2010 report released by the U.S. Geological Survey identified major gaps in Arctic science and research, emphasizing that "significant questions" remain regarding the scientific and technical information needed to adequately prepare for drilling in the challenging Arctic environment.[20] An independent review commissioned by the Pew Environment Group and Ocean Conservancy in 2011 took the Geological Survey analysis a step further, recommending concrete next steps—such as developing a comprehensive research and monitoring plan and setting aside significant areas for protection—that should be taken before moving forward with potentially damaging industrial activity in the region.[21]

Responding to these risks

The inaccessibility and incomparably harsh weather conditions add a major liability to potential operations, and the private sector has taken notice. Insurance giant Lloyd's of London issued a report warning companies that responding to an oil spill in a region "highly sensitive to damage" would present "multiple obstacles, which together constitute a unique and hard-to-manage risk."[22] German bank WestLB also announced last year that it would refuse financing to any offshore oil and gas drilling in the region because "the risks and cost are simply too high."[23] And Total S.A., the fifth-largest oil and gas company in the world, announced that it wouldn't seek to drill in the Arctic because an accident there would be a "disaster."[24]

Despite these concerns, and after multiple delays due to the erratic weather and failure to receive Coast Guard certification of its oil spill response barge, Shell received approval from the Department of the Interior to drill two preparatory wells in the Arctic Ocean last summer. Though the two "top holes" were completed without incident, the operations surrounding Shell's Arctic program were nothing short of a disaster. The company twice lost control of its Arctic drilling rigs,[25] had its oil spill response equipment "crushed like a beer can" in tests in Puget Sound,[26] and was cited for multiple safety and environmental violations—now the subject of an investigation that the Coast Guard handed over to the Department of Justice to assess potential civil or criminal charges.[27]

After watching Shell's string of mishaps from the sidelines, Norway-based oil and gas company Statoil said two weeks ago that it would consider walking away from its Arctic offshore leases if exploration proves too risky and expensive.[28] Tim Dodson, Statoil's

executive vice president of global exploration, acknowledged the numerous challenges associated with Arctic offshore drilling and reiterated his company's cautious approach to exploration in the region, saying, "We've [said] we wouldn't drill before 2015. Whether that means we drill in 2015, or maybe not until 2016 or whether we'd drill at all, I think maybe the jury's still a little bit out on that."

Shell's multiple failures and the concern expressed by fellow corporations illustrate how the current level of risk in Arctic offshore drilling outweighs the potential reward. The amount of time and money Shell has invested so far is just a down payment on the massive investment that would be required to build the infrastructure necessary to get the oil to market and turn a profit on estimated reserves.[29] This has led analysts to wonder whether the current boom in production of natural gas and its subsequent effect on energy prices will render Arctic offshore prospects uneconomic in the near future.[30] Nick Butler, former group vice president of strategy and policy development at BP, wrote in the *Financial Times* last September that regardless of Shell's investment, "No amount of technical excellence can transform the economics of a project which is at the outer limit of commercial viability." If Shell were to abandon its Arctic project, Butler continues, it "would not be an admission of technical failure, nor an act of submission to the environmentalists. It would be a statement of commercial common sense."[31]

The climate factor

The prospect of industrializing the fragile Arctic becomes even riskier when examined in the context of climate change. The Arctic region is feeling the devastating effects of climate change more than anywhere else on the planet, undergoing an alarming transformation as it warms at about twice the rate of the rest of the globe.[32] The rapid rate of change means our baseline of scientific knowledge about the region is constantly shifting, further complicating the ability to make informed decisions regarding industrial activity in the region, including oil and gas development, fishing, shipping, and tourism.

The National Oceanic and Atmospheric Administration's 2012 Arctic Report Card documented a very grim year for the region and found "strong evidence of widespread, sustained change driving Arctic environmental system into new state," including record-low sea ice extent, record ice sheet surface melting in Greenland, record-high permafrost temperature, and record-low snow extent.[33]

Moreover, the region's rapid loss of snow and ice has a snowball effect that speeds melting: The decrease in sea ice cover, snow cover, glaciers, and Greenland ice sheet means that the bright, white surfaces that reflect summer sunlight are being replaced by darker surfaces—ocean and land—that absorb sunlight. These conditions increase the capacity to store heat within the Arctic system, which induces more melting—a positive feedback.

Another feedback response exists in the thawing tundra—melting permafrost also accelerates warming by releasing a frozen cache of carbon into the atmosphere that will likely add 0.4 degrees Fahrenheit to 1.5 degrees Fahrenheit to total global warming by 2100.[34] According to a November 2012 United Nations Environment Programme report, the frozen organic matter that exists in permafrost contains almost twice as much carbon than is currently present in the atmosphere.[35] If that organic material were to thaw, then it would subsequently decay, releasing large amounts of carbon dioxide and methane into the atmosphere and amplifying the warming already underway.

Black carbon, a component of fine particle pollution that is emitted through a variety of combustion processes, has also been identified as a significant factor contributing to observed and projected rates of Arctic climate change.[36] As an aerosol, black carbon absorbs incoming solar radiation, heating the atmosphere and contributing to overall global and Arctic warming. When deposited onto Arctic ice and snow, it darkens the surface, increasing the absorption of radiation. While countries in close proximity to the Arctic have used better controls on air pollution to reduce black carbon emissions, increased industrial activity in the Arctic could reverse this trend.[37]

Lastly, the current rate of carbon dioxide emissions from human activity promises—in addition to its effect on climate—to drastically change the biological and chemical processes that occur in our oceans. Confirming this trend, the Intergovernmental Panel on Climate Change's 2007 report concluded that if carbon dioxide emissions are not constrained, we can expect the average acidity of our oceans to increase by 100 percent to 150 percent by 2100.[38]

The Arctic is particularly vulnerable to ocean acidification due to its cooler water and low salinity. Cooler water allows for carbon dioxide to be dissolved more quickly into the Arctic Ocean, while lower salinity reduces the ability of the ocean to buffer against acidification. Because of these factors, if current rates of carbon dioxide emissions are left unconstrained, the acidity of the Arctic Ocean will rise sharply.[39]

Accelerating the feedback loop

Ironically, the dramatic changes experienced throughout the Arctic—many of which are the result of man-made climate change—are unlocking massive fossil-fuel reserves which, when burned, would only accelerate the destructive cycle of unchecked emissions and warming.

The 2009 Copenhagen Accord, supported by the United States and more than 100 other nations, formally recognized that global warming must be held below 2 degrees Celsius, requiring "deep cuts in carbon emissions" in order to do so.[40] Recent studies, however, show that the current global rate of emissions has us on a trajectory to blow past that

threshold, exposing humanity to the most calamitous consequences of climate change. A World Bank report released late last year, for example, carried the dire warning that we're on track for a 4 degrees Celsius warmer world by as soon as 2060—a catastrophic scenario "marked by extreme heat-waves, declining global food stocks, loss of ecosystems and biodiversity, and life-threatening sea level rise."[41]

As climate activist Bill McKibben wrote in a must-read *Rolling Stone* piece last year, to put this level of warming in context:

> *So far, we've raised the average temperature of the planet just under 0.8 degrees Celsius, and that has caused far more damage than most scientists expected. (A third of summer sea ice in the Arctic is gone, the oceans are 30 percent more acidic, and since warm air holds more water vapor than cold, the atmosphere over the oceans is a shocking five percent wetter, loading the dice for devastating floods.)*[42]

The November iteration of the International Energy Agency's annual World Energy Outlook report made headlines for projecting that the United States could become the world's largest oil producer by 2020.[43] The much bigger story, however, was their warning that more than two-thirds of the world's proven fossil-fuel reserves need to still be in the ground in 2050 in order to limit global warming to 2 degrees Celsius and prevent catastrophic climate change.

The Arctic region is believed to contain 13 percent of the world's undiscovered oil and 30 percent of its natural gas, according to the U.S. Geological Survey.[44] Developing these reserves—and unlocking the massive "carbon bomb" they represent—is an irrational and dangerous response to the reality of global climate change. Not only does it put the remote and undeveloped region at risk for a potentially devastating oil spill, but it feeds the positive feedback loop of carbon emissions and climate destruction.

In a recent Ecofys report ranking the planned fossil fuel projects that would be most dangerous for the climate, oil and gas drilling in the broader Arctic region came in at number three, with the potential to add more than 31 billion metric tons of additional CO2 into the atmosphere by 2050.[45] In the Alaskan Arctic alone, U.S. Geological Survey estimates of the oil and gas recoverable there equate to nearly 16 billion metric tons of CO2 when burned—approximately double China's entire 2009 greenhouse gas emissions. [46]

And the potential climate impacts aren't limited to just oil and gas consumption. A recent report from the Clean Air Task Force found that substantial climate impacts could come from the production stage as well, unless companies take meaningful steps to minimize them.[47] Otherwise, methane and black carbon will likely be emitted in significant amounts if drilling in the Arctic proves as lucrative as many oil companies hope it will be.

In order to avoid the catastrophic consequences of climate change, enormous fossil-fuel reserves will need to remain in the ground untouched. Quite simply, serious climate action is incompatible with expanding fossil-fuel production.

Why the melting Arctic matters

The ramifications of the melting Arctic aren't contained in that faraway part of the world. Instead, the devastating impact of climate change in the Arctic has tremendous ripple effects throughout the entire global system. As Jane Lubchenco, the administrator of the National Oceanic and Atmospheric Administration in President Obama's first term, succinctly put it, "What happens in the Arctic doesn't stay in the Arctic."[48]

The unprecedented melting of the Greenland ice sheet, for example, has extremely serious implications for global sea-level rise. The summer melt from Greenland in 2012 alone added a millimeter to global sea level.[49] As journalist Chris Mooney explains, "Not only is that millimeter felt around the globe, but it is felt in specific places. For instance, it rode atop the wall of water that Superstorm Sandy pushed inland at New York and New Jersey." If Greenland continues its rapid melting, it could wreak havoc on coastal communities around the globe in the form of coastal flooding and storm surges.[50]

What's more, the "Arctic amplification" explained above not only accelerates warming within the region, but it may also be increasing the frequency of extreme weather events in the United States. A recent report led by the National Oceanic and Atmospheric Administration found that enhanced warming of the Arctic alters the jet stream, and these shifts in winds not only affect weather patterns throughout the Arctic, but are also thought to influence weather in Greenland, the United States, and Western Europe. The researchers stated that "With more solar energy going into the Arctic Ocean because of lost ice, there is reason to expect more extreme weather events, such as heavy snowfall, heat waves, and flooding in North America and Europe."[51]

New analysis by researchers from Cornell University and Rutgers University confirms this theory, finding the confluence of events that created the unprecedented superstorm Sandy may not have been a freak occurrence, but one fueled by the record-breaking Arctic sea ice melt. According to a summary of the research:

> *… the severe loss of summertime Arctic sea ice—attributed to greenhouse warming—appears to enhance Northern Hemisphere jet stream meandering, intensify Arctic air mass invasions toward middle latitudes, and increase the frequency of atmospheric blocking events like the one that steered Hurricane Sandy west into the densely populated New York City area.*[52]

The combination of increased sea levels and altered weather patterns as a result of the rapid melting of the Arctic carries severe consequences for densely populated areas, including our own backyard. As top NASA climatologist James Hansen bluntly explained, "If the world allows a substantial fraction of the Greenland ice sheet to disintegrate, all hell breaks loose for eastern North America and Europe."[53]

Conclusion

Climate change is permanently altering the Arctic region, and the results are startling. As ecosystems unravel, fragile species such as polar bears are struggling to survive, shorelines are eroding, waters are becoming increasingly acidic, snow and ice are vanishing at an alarming rate, and storms are more severe and unpredictable than ever before.

At the heart of the problem, however, lies human activity—our addiction to fossil fuels. As Jason Box, Greenland expert at the Byrd Polar Research Center, explains, "Those who claim it's all cycles just don't understand that humans are driving the cycle right now, and for the foreseeable future."[54]

Rather than respond to this crisis with serious policies to significantly and swiftly reduce our carbon emissions, governments with jurisdiction over the Arctic have taken the reckless approach of moving forward with plans to exploit the newly accessible fossil fuels and accelerate the destruction. Decisions regarding whether to allow potentially destructive industrial activity, such as oil and gas development, in this fragile environment cannot be examined independently from the climate crisis they will perpetuate.

Taking serious action to curb the devastating effects of climate change means we must aggressively deploy clean technologies, internalize the actual price of pollution by putting a price on carbon, and make major investments in climate resiliency. The time for piecemeal solutions has passed and there is no room in the equation for major expansions in fossil-fuel production.

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Endnotes

1 Kiley Kroh and Michael Conathan, "Timeline: Documenting Shell's 2012 Drilling Debacle," Climate Progress, January 4, 2013, available at http://thinkprogress.org/climate/2013/01/04/1399891/timeline-documenting-shells-2012-arctic-drilling-debacle/.

2 Kiley Kroh, "Shell's Failed Arctic Oil Spill Equipment: 'Breached Like A Whale' And 'Crushed Like A Beer Can,'" Climate Progress, December 5, 2012, available at http://thinkprogress.org/climate/2012/12/05/1284301/shells-failed-arctic-oil-spill-equipment-breached-like-a-whale-and-crushed-like-a-beer-can/.

3 John M. Broder and Clifford Krauss, "Shell Gets Tentative Approval to Drill in Arctic," *The New York Times*, August 4, 2011, available at http://www.nytimes.com/2011/08/05/us/05shell.html?_r=2&.

4 Kiley Kroh, "Shell Runs Its Arctic Drilling Rig Aground; Coast Guard Prepares for 'Possible Spill-Response,'" Climate Progress, January 2, 2013, available at http://thinkprogress.org/climate/2013/01/02/1383901/shell-runs-its-arctic-drilling-rig-aground-coast-guard-prepares-for-possible-spill-response/.

5 Kiley Kroh, "Breaking: Shell Oil Announces It Will Not Drill in The Arctic Ocean In 2013," Climate Progress, February 27, 2013, available at http://thinkprogress.org/climate/2013/02/27/1649531/breaking-shell-oil-announces-it-will-not-drill-in-the-arctic-ocean-in-2013/.

6 Jennifer Dlouhy, "Feds release findings from Arctic drilling probe," FuelFix, March 14, 2013, available at http://fuelfix.com/blog/2013/03/14/feds-release-findings-from-arctic-drilling-probe/.

7 U.S. Department of the Interior, "Review of Shell's 2012 Alaska Offshore Oil and Gas Exploration Program" (2013), available at http://www.doi.gov/news/pressreleases/upload/Shell-report-3-8-13-Final.pdf.

8 Juliet Eilperin and Steven Mufson, "Arctic drilling close for Shell, but still elusive," *The Washington Post*, July 20, 2012, available at http://articles.washingtonpost.com/2012-07-20/national/35488101_1_pete-slaiby-oil-spill-containment-system-noble-discoverer.

9 Associated Press, "Report says Shell unprepared for Arctic drilling," *Bloomberg Businessweek*, March 14, 2013, available at http://www.businessweek.com/ap/2013-03-14/report-says-shell-unprepared-for-arctic-drilling.

10 The White House, "Inaugural Address by President Barack Obama," available at http://www.whitehouse.gov/state-of-the-union-2013 (last accessed March 2013).

11 Suzanne Goldenberg, "Last Congress was most hostile to environmental causes, say activists," *The Guardian*, February 20, 2013, available at http://www.guardian.co.uk/environment/2013/feb/20/congress-low-score-league-of-conservation-voters?INTCMP=SRCH.

12 Kate Gordon and Daniel J. Weiss, "Keystone XL Isn't the Key: Pipeline Project Won't Improve Energy Independence" (Washington: Center for American Progress, 2011), available at http://www.americanprogress.org/issues/green/news/2011/12/16/10748/keystone-xl-isnt-the-key/.

13 Danielle Baussan and Daniel J. Wise, "Cleaning up Carbon Pollution 101" (Washington: Center for American Progress, 2012), available at http://www.americanprogress.org/issues/green/news/2012/12/13/47962/cleaning-up-carbon-pollution-101/.

14 Royal Dutch Shell, "Shell announces pause in Alaska drilling programme," Press release, February 27, 2013, available at http://www.shell.com/global/aboutshell/media/news-and-media-releases/2013/shell-announces-pause-in-alaska-drilling-programme.html.

15 Alan Bailey, "ConocoPhillps' strategy for Chukchi Sea drilling in 2014 takes shape," *Anchorage Daily News*, March 17, 2013, available at http://www.adn.com/2013/03/17/2829377/conocophillips-strategy-for-chukchi.html.

16 Carol Browner and John Podesta, "Why We Now Oppose Drilling in the Arctic," *Bloomberg News*, January 17, 2013, available at http://www.bloomberg.com/news/2013-01-17/why-we-now-oppose-drilling-in-the-arctic.html.

17 Kiley Kroh, Michael Conathan, and Emma Huvos, "Putting a Freeze on Arctic Ocean Drilling: America's Inability to Respond to an Oil Spill in the Arctic" (Washington: Center for American Progress, 2012), available at http://www.americanprogress.org/wp-content/uploads/issues/2012/02/pdf/arcticreport.pdf.

18 Government Accountability Office, "Interior Has Strengthened Its Oversight of Subsea Well Containment, but Should Improve Its Documentation" (2012), available at http://www.eenews.net/assets/2012/03/30/document_gw_04.pdf.

19 Oil Spill Commission, "Deep Water: The Gulf Oil Disaster and the Future of Offshore Drilling" (2011), available at http://www.oilspillcommission.gov/sites/default/files/documents/DEEPWATER_ReporttothePresident_FINAL.pdf.

20 Phil Taylor, "Report Finds Gaps in USGS Study on Offshore Drilling in Arctic Ocean," *The New York Times*, September 27, 2011, available at http://www.nytimes.com/gwire/2011/09/27/27greenwire-report-finds-gaps-in-usgs-study-on-offshore-dr-18866.html.

21 Pew Environment Group, "An Independent Review of USGS Circular 1370: 'An Evaluation of the Science Needs to Inform Decisions on Outer Continental Shelf Energy Development in the Chukchi and Beaufort Seas, Alaska" (2007), available at http://www.pewenvironment.org/uploadedFiles/PEG/Publications/Report/USGS-Report-Review-Sept2011.pdf.

22 Kiley Kroh and Michael Conathan, "Insurance Giant Lloyd's of London Warns of 'Unique and Hard-To-Manage Risk' of Arctic Ocean Drilling," Climate Progress, April 12, 2012, available at http://thinkprogress.org/climate/2012/04/12/463436/insurance-giant-lloyd-london-warns-of-unique-and-hard-to-manage-risk-of-arctic-ocean-oil-drilling/.

23 Kiley Kroh, "German Bank Won't Finance Arctic Ocean Drilling, Saying the "Risks and Costs Are Simply Too High,'" Climate Progress, April 23, 2012, available at http://thinkprogress.org/climate/2012/04/23/469076/german-bank-wont-finance-arctic-ocean-drilling-saying-the-risks-and-costs-are-simply-too-high/.

24 Kiley Kroh, "Shell Sending Arctic Vessels to Asia for Repairs, Casting Doubt Over 2013 Drilling," Climate Progress, February 12, 2013, available at http://thinkprogress.org/climate/2013/02/12/1581151/shell-sending-arctic-vessels-to-asia-for-repairs-casting-doubt-over-2013-drilling/.

25 Kroh, "Shell Runs Its Arctic Drilling Rig Aground; Coast Guard Prepares for 'Possible Spill-Response.'"

26 Kroh, "Shell's Failed Arctic Oil Spill Equipment: 'Breached Like A Whale' And 'Crushed Like A Beer Can.'"

27 Kim Murphy, "Coast Guard finds evidence of safety violations on Shell rig," *Los Angeles Times*, February 23, 2013, available at http://www.latimes.com/news/nation/nationnow/la-na-nn-shell-drilling-rig-20130222,0,3885011.story.

28 Kiley Kroh, "After Watching Shell, Statoil Considers Walking Away From Arctic Offshore Leases," Climate Progress, March 9, 2013, available at http://thinkprogress.org/climate/2013/03/09/1692061/after-watching-shell-statoil-considers-walking-away-from-arctic-offshore-leases/.

29 Christoper Helman, "Why Shell Should Just Quits Its Alaska Drilling Fiasco," *Forbes*, January 3, 2012, available at http://www.forbes.com/sites/christopherhelman/2013/01/03/why-shell-should-just-quit-its-alaska-drilling-fiasco/.

30 Alex DeMarban, "Will Arctic offshore oil drilling prove uneconomic in wake of US shale oil boom?", *Alaska Dispatch*, January 20, 2013, available at http://www.alaskadispatch.com/article/will-arctic-offshore-oil-drilling-prove-uneconomic-wake-us-shale-oil-boom.

31 Nick Butler, "Shell's Risky Play in the Arctic," *Financial Times*, September 19, 2012, available at http://blogs.ft.com/nick-butler/2012/09/19/shells-risky-play-in-the-arctic/?Authorised=false.

32 Intergovernmental Panel on Climate Change, "Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change" (2007), available http://www.ipcc.ch/publications_and_data/ar4/wg2/en/contents.html.

33 National Oceanographic and Atmospheric Administration, *Arctic Report Card: Update for 2012* (Department of Commerce, 2013), available at http://www.arctic.noaa.gov/reportcard/exec_summary.html.

34 Andy Skuce, "Carbon Feedback From Thawing Permafrost Will Likely Add 0.4°F-1.5°F To Total Global Warming By 2100," Climate Progress, October 6, 2012, available at http://thinkprogress.org/climate/2012/10/06/970721/carbon-feedback-from-thawing-permafrost-will-add-04f-15f-to-total-global-warming-by-2100/.

35 United Nations Environment Programme, "Policy Implications of Warming Permafrost" (2012), available at http://www.unep.org/pdf/permafrost.pdf.

36 Environmental Protection Agency, "Report to Congress on Black Carbon" (2010), available at http://www.epa.gov/blackcarbon/2012report/fullreport.pdf.

37 J.J. Corbett and others, "Arctic shipping inventories and future scenarios," *Atmospheric Chemistry and Physics* 10 (2010): 9689–9704.

38 Intergovernmental Panel on Climate Change, "Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change" (2007), available at http://www.ipcc.ch/publications_and_data/ar4/wg1/en/contents.html.

39 Oceana, "As Goes the Arctic, So Goes the Planet" (2008), available at http://oceana.org/sites/default/files/o/fileadmin/oceana/uploads/pacific/ArcticPetition-FINAL-lowres.pdf.

40 United Nations Framework Convention on Climate Change, "Copenhagen Accord" (2009), available at http://unfccc.int/meetings/copenhagen_dec_2009/items/5262.php.

41 World Bank, "Turn Down the Heat: why a 4°C Warmer World Must be Avoided" (2012), available at http://climatechange.worldbank.org/sites/default/files/Turn_Down_the_heat_Why_a_4_degree_centrigrade_warmer_world_must_be_avoided.pdf.

42 Bill Mckibben, "Global Warming's Terrifying New Math: Three simple numbers that add up to global catastrophe—and that makes clear who the real enemy is," *Rolling Stone*, July 19, 2012, available at http://www.rollingstone.com/politics/news/global-warmings-terrifying-new-math-20120719.

43 International Energy Agency, "World Energy Outlook 2012: Executive Summary" (2012), available at http://www.iea.org/Textbase/npsum/weo2012sum.pdf.

44 U.S. Geological Survey, "90 Billion Barrels of Oil and 1,670 Trillion Cubic Feet of Natural Gas Assessed in the Arctic," Press release, July, 23, 2008, available at http://www.usgs.gov/newsroom/article.asp?ID=1980.

45 Greenpeace, "Point of No Return: The massive climate threats we must avoid" (2013), available at http://www.greenpeace.org/international/Point-of-No-Return/.

46 The Arctic Ocean has 23.6 billion barrels of technically recoverable oil and 104.41 trillion cubic feet of technically recoverable gas. (See: Bureau of Ocean Energy Management, *Proposed Final Outer Continental Shelf Oil & Gas Leasing Program 2012-2017* (U.S. Department of the Interior, 2012), available at http://boem.gov/uploadedFiles/BOEM/Oil_and_Gas_Energy_Program/Leasing/Five_Year_Program/2012-2017_Five_Year_Program/PFP%2012-17.pdf.) One barrel of oil = 0.43 metric tons of CO2. (See: Environmental Protection Agency, "Green Power Equivalency Calculator Methodologies," available at http://www.epa.gov/greenpower/pubs/calcmeth.htm.) One cubic foot of gas = 0.0545kg CO2. (See: "Table 12.1 – U.S. Default Factors for Calculating CO2 Emissions from Fossil Fuel and Biomass Combustion, available at http://www.theclimateregistry.org/downloads/2012/01/2012-Climate-Registry-Default-Emissions-Factors.pdf.) Producing all reserves would result in 15.8 billion metric tons CO2 (10.1 billion from oil and 5.7 billion from gas).

47 Clean Air Task Force, "Best Practices for Reduction of Methane and Black Carbon from Arctic Oil and Gas Production" (2012), available at http://www.catf.us/resources/publications/files/20120713-Arctic_Best_Practices.pdf.

48 Brad Johnson, "Jane Lubchenco Exclusive: 'We Don't Fully Understand the Consequences' of Drilling the Arctic," ClimateProgress blog, October 25, 2011, available at http://thinkprogress.org/climate/2011/10/25/350682/jane-lubchenco-exclusive-we-dont-fully-understand-the-consequences-of-drilling-the-arctic/.

49 Chris Mooney, "Why Greenland's melting could be the biggest climate disaster of all," *The Grist*, January 24, 2013, available at http://grist.org/climate-energy/why-greenlands-melting-could-be-the-biggest-climate-disaster-of-all/.

50 Ibid.

51 James E. Overland and others, "The Recent Shift in Early Summer Arctic Atmospheric Circulation," *Geophysical Research Letters* 39 (19) (2012): 1–6.

52 Blaine Friedlander, "Arctic ice loss amplified Superstorm Sandy violence," *Cornell Chronile Online*, March 4, 2013, available at http://www.news.cornell.edu/stories/March13/GreeneSandy.html.

53 Bill Mckibben, "The Arctic Ice Crisis: Greenland's glaciers are melting far faster than expected," *Rolling Stone*, August 16, 2012, available at http://www.rollingstone.com/politics/news/the-arctic-ice-crisis-20120816.

54 Chris Mooney, "Why Greenland's Melting Could Be the Biggest Climate Disaster of All," Climate Desk, January 28, 2013, available at http://climatedesk.org/2013/01/why-greenlands-melting-could-be-the-biggest-climate-disaster-of-all/.