

# The climate responsibilities of industrial carbon producers

Peter C. Frumhoff<sup>1</sup> · Richard Heede<sup>2</sup> · Naomi Oreskes<sup>2,3</sup>

Received: 25 December 2014 / Accepted: 8 July 2015

© The Author(s) 2015. This article is published with open access at Springerlink.com

**Abstract** Responsibility for climate change lies at the heart of societal debate over actions to address it. The United Nations Framework Convention on Climate Change established the principle of “common but differentiated responsibilities” among nations, suggesting that industrialized nations that had produced the greatest share of historic emissions bore particular responsibility for preventing dangerous interference with the climate system. But climate responsibilities can be attributed in other ways as well. Here, we explore the conceptual territory of responsibility. We consider the distinctive responsibilities of the major investor-owned producers of fossil fuels, assessing the actions these companies took and could have taken to act upon the scientific evidence of climate change. We conclude that major investor-owned fossil energy companies carry significant responsibility for climate change. It is still possible for these companies to effectively contribute to a solution. Significant progress in reducing emissions and limiting climate change could be achieved if companies 1) unequivocally communicate to the public, shareholders, and policymakers the climate risks resulting from continued use of their products, and therefore the need for restrictions on greenhouse gas emissions consistent with the 2 °C global temperature target; 2) firmly reject contrary claims by industry trade associations and lobbying groups; and, 3) accelerate their transition to the production of low-carbon energy. Evidence from history strongly suggests that a heightened societal focus on their climate responsibilities will be needed to hasten such a transition.

---

**Electronic supplementary material** The online version of this article (doi:10.1007/s10584-015-1472-5) contains supplementary material, which is available to authorized users.

✉ Peter C. Frumhoff  
pfrumhoff@ucsusa.org

<sup>1</sup> Union of Concerned Scientists, Cambridge, MA 02138-3780, USA

<sup>2</sup> Climate Accountability Institute, Snowmass, CO 81654, USA

<sup>3</sup> Department of the History of Science, Harvard University, Cambridge, MA, USA

## 1 Introduction

As the impacts of anthropogenic climate change have become increasingly evident (IPCC 2014), the issue of responsibility for these impacts has come to the fore. The concept of responsibility is central to the United Nations Framework Convention on Climate Change (UNFCCC), adopted at the Rio Earth Summit in 1992. Parties to that convention agreed that the industrialized nations—which had produced the lion’s share of greenhouse gas emissions—should take the lead in combating climate change “on the basis of equity and in accordance with their common but differentiated responsibilities” (United Nations 1992).

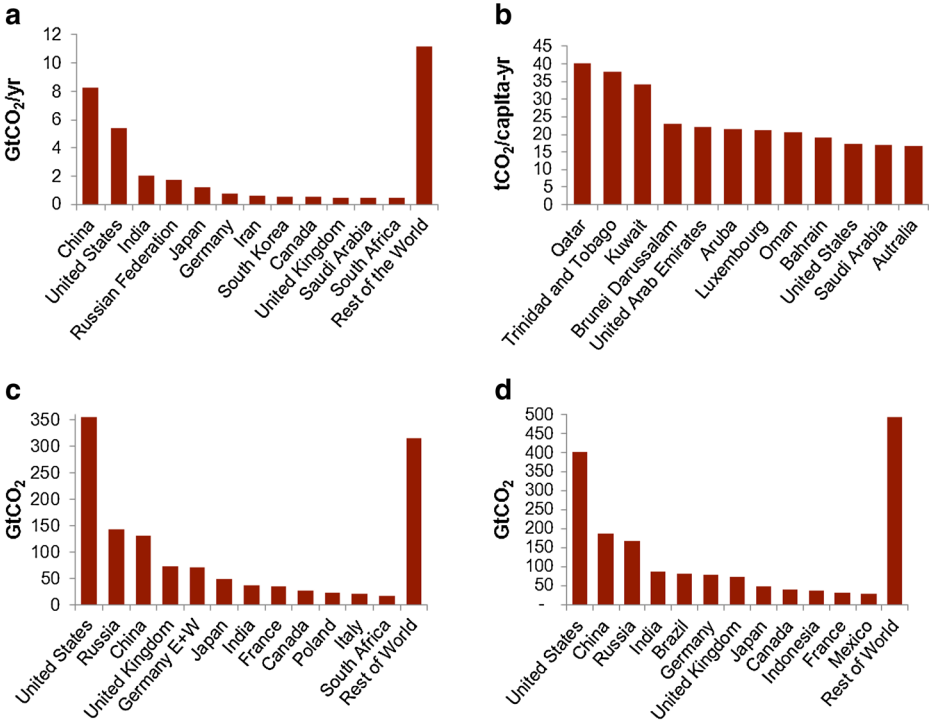
The concept of “differentiated” responsibility signaled the recognition both that industrialized (Annex I) nations had produced most of the emissions, and that their wealth was intimately linked to the economic activities that produced those emissions (Shue 1999). The Kyoto Protocol thus focused attention on emission cuts by Annex I nations.

This focus was consistent with the general ethical principle, as well as the common sense of daily life, that responsibility for a problem is assumed to fall on those who create it, particularly if they do so knowingly (Rawls 1971). Definitions of responsibility become intricate as people have divergent interpretations of what exactly the problem is, how to assess its costs, how to identify the responsible party or parties (particularly if many individuals or groups contributed), how fully they apprehended the consequences of their actions, and whether reasonable alternative actions were available to them. In the context of climate change, several competing views have been put forward about the allocation of responsibilities. The Brazilian Proposal, for example, analyzed by the UNFCCC Subsidiary Body for Scientific and Technical Advice (SBSTA), suggested that the burden of addressing climate change should be apportioned on the basis of cumulative historic emissions (Rive et al. 2006), rather than annual ones, because it is the former that drive global climate change. Differing allocation schemes dramatically alter the ranking of the most responsible nations (Fig. 1a–d).

The nation-state framework for climate policymaking via the UNFCCC and scientific assessment via the IPCC has tended to obscure other ways at looking at the question of climate responsibility. One option is to focus on individuals. Noting that nations with similar total emissions (e.g., USA and China) may have very different *per capita* emissions (Baer et al. 2000), some commentators have proposed the concept of equal *per capita* allocation over time, with convergence toward a common per capita emission rate (Höhne et al. 2006). Others have suggested that the wealthiest individuals in the world, regardless of nationality, should bear a larger share of the burden (Chakravarty et al. 2009).

Another option is to focus on industry. Recent lawsuits have drawn attention to the responsibilities of major emitting industries, particularly in transportation and electric power generation (Osofsky 2012). Shareholder resolutions and calls for institutional and individual divestment from the primary producers of coal, oil, and natural gas are giving rise to growing public discourse on the climate responsibilities of these fossil fuels companies (Lubber 2012; Oreskes 2013; Rockefeller Brothers Fund 2014).

This paper focuses on the distinctive responsibilities of the investor-owned fossil fuel producers. First, we explore the conceptual territory of responsibility and the historical evidence that social change has resulted when notions of corporate responsibility have shifted in response to changing social values. We then present empirical evidence for the role of specific fossil fuel corporations, including many of the 90 largest industrial carbon producers whose products are responsible for nearly two-thirds of all known industrial greenhouse gas emissions since 1751 (Heede 2014). We emphasize that more than half of all industrial



**Fig. 1** Under allocation schemes based on current annual CO<sub>2</sub> emissions from fossil fuels and cement production, China leads the pack, followed by the U.S. and India (a). Analysis of current per capita emissions brings small oil-producing states into the top tier (b). Analysis based on historic emissions (without land use changes) places the U.S. first, followed the USSR/Russia, China and Germany (c). Including historic land use changes brings Brazil and Indonesia into the top tier (d). (Boden et al. 2013; Matthews et al. 2014)

emissions of carbon dioxide have occurred since 1988: after the establishment of the IPCC, after leading scientists had stated publicly that anthropogenic climate change was underway, and after a vigorous and visible public discussion of its causes and risks had begun.

We highlight producers for five reasons. First, a relatively small number of corporations have produced the fossil energy that has contributed a large proportion of the total historic emissions that drive disruptive climate change. Second, as major corporations with a high level of internal scientific and technical expertise, they were aware of and in a position to understand the available scientific data. Third, an alternative was available to them: they could have adjusted their business models to anticipate policies motivating a transition to low-carbon energy by substantially investing in low-carbon energy technologies, constructively engaging in policy design, and taking other steps to reduce the adverse impact of their products. But they did not. Even today, they continue to explore for new and increasingly more carbon-polluting sources of fossil fuels, encouraging the expanded use of the products that they know to be responsible for disruptive climate change. Fourth, fossil fuel producers, particularly in the United States but also in Australia, Canada, and the United Kingdom, have sought to discredit and disparage the scientific evidence, and to deny, diminish, or discount the reality and significance of climate change as a problem (Gelbspan 2005; Ward 2006; Oreskes and Conway 2010). Many companies lobbied to prevent policies that would encourage the

transition to low-carbon energy and continue to do so today, including through the influential industry trade associations on whose boards of directors many of the largest companies sit (Wieners 2014).

Finally, we focus on producers because there has been strikingly little attention paid in academic and policy spheres to their climate responsibilities. Society at large has been unaware of, or perhaps unwilling to confront, this issue. This paper seeks to open up the question of their responsibilities to academic and policy analysis.

## 2 What is responsibility?

The concept of responsibility is central to the question of obligation to act. One familiar notion of responsibility involves damages: individuals and groups can sue for damages if they believe another party has injured them. But there are many other ways in which society holds both individuals and institutions accountable for the consequences of their actions. In the private sector, shareholders may divest from a corporation that has engaged in inappropriate business practices or behavior; consumers may decline to buy products. When parties are found responsible for engaging in illegal activities, they may be subject to governmental sanction, through restrictions on the sale or marketing of harmful products, civil fines, or criminal penalties. Ultimately, if consumers, regulators, legislatures, shareholders, or the public at large disapprove sufficiently of an activity, it may become impossible for a firm to remain in business, or at least to continue business as usual.

Changing notions of corporate responsibility have played an important role in social change (Gunningham et al. 2004). The most well-documented example involves tobacco. For decades, the tobacco industry argued—with considerable success—that responsibility for the ills of smoking rested with the smoker: individuals made a choice to smoke, and any resulting illness was their responsibility. However, as the evidence of the harms of tobacco became known, this argument was increasingly rejected by a society that concluded that manufacturing a product that killed people, even if legal, was morally problematic. In 1995 the U.S. Department of Justice concluded that the industry was legally culpable for knowingly spreading disinformation, bringing charges against the industry under the Racketeer Influenced and Corrupt Organizations (RICO) act (Eubanks and Glantz 2012).

The story of tobacco is not unique: history is replete with examples of products and activities that were once accepted but later rejected. Often this shift has hinged on scientific knowledge. Asbestos for example, was a legal product, viewed by many as a miracle material that saved lives. But when the scientific evidence became clear that asbestos caused asbestosis and mesothelioma, both its primary producers and the manufacturers of products containing it found themselves facing tens of thousands of lawsuits (Bowker 2003; Michaels 2008). Plaintiffs won many suits, particularly if their exposure occurred after the scientific evidence of the risks was established (Castleman 2005). The fact that asbestos was a legal product did not absolve corporations of their responsibility to protect workers and consumers from its adverse effects. A parallel story has been told about lead. While lead in paint was a legal product, companies have nevertheless been held liable for the damage it has caused (Markowitz and Rosner 2013).

Changing notions of corporate responsibility within civil society gain traction through shareholder resolutions, consumer boycotts, protests, lawsuits, and media (including social media) and divestment campaigns; these, in turn, can drive changes in regulation

(Gunningham et al 2004). Corporations engaged in mining, pulp and paper manufacturing and the marketing of soy, beef and palm oil have responded to such pressures to go beyond compliance with legal standards for environmental and social sustainability (Gunningham et al. 2004; Prno and Slocombe 2012; Nepstad et al. 2014). In effect, these companies have recognized that they must have a social license to operate.

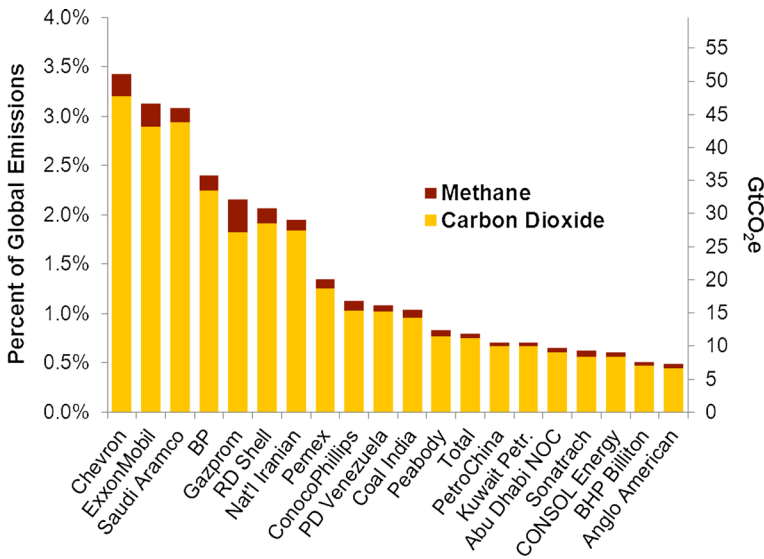
Turning to fossil fuels, some producers acknowledge that their ability to conduct business also requires a social license. Royal Dutch Shell, for example, has recently affirmed that “*real or perceived failures of governance or regulatory compliance could harm our reputation. This could impact our licence to operate, damage our brand, harm our ability to secure new resources and limit our ability to access the capital market.*” Shell has also claimed to embrace the principle of sustainable development, which, they suggest “*is a licence to operate imperative*” (Royal Dutch Shell plc 2010, 2014). Shell implicitly acknowledges that the fiduciary requirement of returning value to shareholders does not absolve corporations of broader ethical responsibilities. History affirms that conclusion. A corporation’s ability to return value to shareholders is influenced by, and in the long run depends upon, social license.

### 3 Quantifying the responsibility of industrial carbon producers

An enormous quantity of emissions can be traced to a relatively small number of fossil fuel producers. Heede (2014) analyzed historic production records of the ninety largest producers of coal, oil, and natural gas, as well as cement, from 1854 to 2010, calculating the carbon content of their marketed fuels (subtracting for non-energy uses), process CO<sub>2</sub> from cement manufacturing, CO<sub>2</sub> from direct flaring, venting, and fuel use, and fugitive or vented methane. Of total emissions of industrial CO<sub>2</sub> and methane from 1751 to 2010, 63 % were traced to 83 of the world’s largest producers of coal, oil and natural gas, and seven largest manufacturers of cement. That is to say, only 90 entities have produced all the fossil energy and cement responsible for 63 % of the world’s industrial emissions of CO<sub>2</sub> and methane; 29 % of these emissions have been traced to just 20 investor and state-owned companies (Fig. 2).

### 4 Response of industrial carbon producers to the evidence of anthropogenic climate change

Sustained scientific discussion of anthropogenic climate change can be traced to the 1950s, with a number of reports in the 1960s and 1970s suggesting that it could become a significant social and economic problem (NRC 1979; Oreskes 2004; Fleming 2005). In 1988, climate change went from a prediction to an observation, when NASA scientist James Hansen testified in the U.S. Congress that the human signal in climate change had been detected (Hansen et al. 1988). Hansen’s testimony was reported on the front page of *The New York Times*, which concluded that the “issue of an overheating world had suddenly moved to the forefront of public opinion” (Wilford 1988). Members of the U.S. Congress introduced H.R. 5380, The National Energy Policy Act of 1988, intended to “establish a national energy policy that will quickly reduce the generation of carbon dioxide and [other] trace gases as quickly as is feasible in order to slow the pace and degree of atmospheric warming...to protect the global environment.” Then-Vice President George H.W. Bush ran for president of the United States pledging to combat the “greenhouse effect with the White House effect” (New York Times Editorial



**Fig. 2** Cumulative emissions from 1854 to 2010 traced to historic fossil fuel production by the largest investor-owned and state-owned oil, gas, and coal producers, in percent of global industrial CO<sub>2</sub> and methane emissions since 1751. Data source: Heede (2014)

Board 1990). 1988 was also the year in which the world nations joined together to create the Intergovernmental Panel on Climate Change (IPCC) to provide a scientific basis for policy action. Fossil fuel corporations might have begun to take steps to limit the damages their products caused to the global environment.

Instead, leading investor-owned fossil fuel corporations, including ExxonMobil, Shell, and British Petroleum, created the Global Climate Coalition (GCC) to oppose greenhouse gas emission reduction policies. From 1989 to 2002, the GCC led an aggressive lobbying and advertising campaign aimed at achieving these goals by sowing doubt about the integrity of the IPCC and the scientific evidence that heat-trapping emissions from burning fossil fuels drive global warming. They worked successfully to prevent the United States from signing the Kyoto Protocol after it was negotiated in 1997. When the GCC disbanded, they stated that they had achieved their goals (Mooney 2005). A similar pattern of activities was undertaken in the early 1990s by a group known as the “Greening Earth Society,” funded by a consortium of U.S. coal corporations (Oreskes 2010).

An alternative was possible. In 1997, British Petroleum CEO John (later Lord) Browne gave a major speech at Stanford University pledging to move BP to a new business model that went “beyond petroleum.” Invoking the scientific consensus on climate change described in the IPCC Second Assessment report (Houghton et al. 1995), he said:

“[W]e are all citizens of one world, and we must take shared responsibility for its future and for its sustainable development...[T]here is now an effective consensus among the world’s leading scientists and serious and well-informed people outside the scientific community that there is a discernible human influence on the climate and a link between the concentration of carbon dioxide and the increase in temperature .[I]t would be unwise and potentially dangerous to ignore the mounting concern. We in BP... alone

could not resolve the problem. But that does not mean we should do nothing. ... We have a responsibility to act [and] BP accepts that responsibility..." (Browne 1997)

Browne's speech was a major departure from the prevailing industry pattern. The *Los Angeles Times* concluded it was akin to the Liggett Group's acknowledgment earlier that year that smoking caused cancer and heart disease, the first major tobacco company to do so (Gerstenzang 1997). It was met with public praise and anticipation of action. The *Financial Times* reported that "BP's stance sets a higher standard against which to judge other companies' readiness to cooperate with governments to fight climate change" (Allen and Bach 2011).

Following the speech, BP and several other companies took steps in the direction that Browne envisaged (Kolk and Levy 2001). In 1997, BP became the first company to leave the Global Climate Coalition; Shell Oil (U.S.) left the following year. In 1998, BP established an internal cap-and-trade system reducing internal emissions by ten percent over the next 4 years, and began to invest in solar energy, forming BP Solar in 1999. These measures were touted in a major advertising campaign launched in 2000 to rebrand BP as "Beyond Petroleum." Shell and Chevron also made targeted investments in renewable energy, totaling as much as 2.5 % of each company's annual expenditures during the past decade (Juhasz 2013). In 2007, BP, ConocoPhillips, and Shell became charter members of the U.S. Climate Action Partnership (USCAP), a coalition of business and environmental groups seeking to shape U.S. federal legislation to reduce greenhouse gases. In short, alternative paths were possible, and some leading companies took initial steps along them.

Responsible climate action by these companies would have extended these initial steps to broader policies to become diversified energy corporations. This would have included unambiguous acceptance of the available scientific evidence demonstrating the role of fossil fuel production in driving dangerous climate change, encouraging public and corporate support for policies to avoid dangerous climate change; vigorous and sustained investments in low carbon energy technologies in anticipation of such policies; education and training for company employees to understand the reasons for the changes in their business model; and forthright communication with shareholders, banks and insurers, and the general public to explain their shift in company strategy.

Responsible action by the fossil energy companies would also have included vigorous investments to assess the feasibility of carbon capture and storage technologies. The oil industry had the capability to assess and develop CCS based on their experience since the 1970s in CO<sub>2</sub> injection as part of enhanced oil recovery (EOR), and the coal industry had a strong incentive to develop carbon capture and storage technology, perhaps in cooperation with coal-burning utilities—at or near sites of coal-fired power plants. By 1988, recognizing the need to reduce the risks of their products, these industries could have invested in adapting EOR technologies for the purpose of long-term carbon storage. But they did not.

## 5 What did the industrial carbon producers do instead?

The major investor-owned fossil fuel companies did not follow this path. On the contrary, they took essentially the opposite path, denying the reality of the problem of climate change, working to ensure that fossil fuels would remain central to global energy production and that

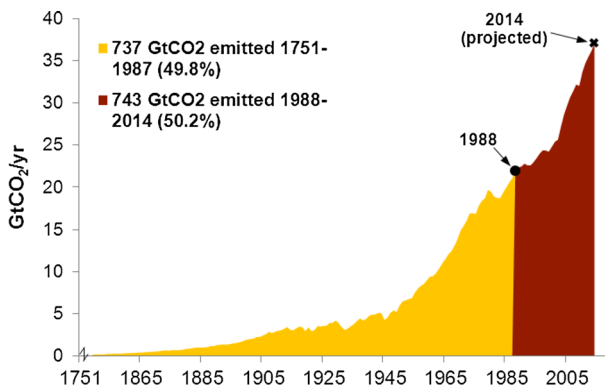


emissions would continue unabated. Indeed, *more than half* of all industrial emissions of CO<sub>2</sub> since the Industrial Revolution have been emitted since 1988. (Fig. 3).

Browne's call for corporate responsibility on climate was rejected by the major industrial carbon producers, and ultimately by BP itself. Instead, many of the largest fossil energy companies pursued a business model that coupled doubt-mongering about climate science with political advocacy against carbon regulations and in support of aggressive development of new sources of fossil fuels. Industry lobbying factored heavily in the 2001 rejection of the Kyoto Protocol by the U.S. administration under President George W Bush (Vidal 2005) and in the failure of the U.S. Senate to take up federal climate legislation after a comprehensive cap on emissions passed the U.S. House of Representatives in 2009 (Mackinder 2010; Grandia 2009; Oreskes 2010). In effect, the industry created a self-fulfilling prophecy: The absence of carbon regulation would ensure that fossil fuels would continue to be a good investment, and the companies would maximize profits for their shareholders to the detriment of the world at large by continuing to expand fossil fuel discovery and development.

Between 1988 and 2005, ExxonMobil invested over \$16 million in a network of front groups that spread misleading claims about climate science (leading to strong public condemnation from the British Royal Society: Ward 2006). It also exploited its close relationship with the administration of President George W. Bush to pressure the administration to remove top scientists from leadership roles in the IPCC and the US National Climate Assessment and to promote federal policies driving further reliance on fossil energy (UCS 2007; Brulle 2014). In 2009, Chevron provided transportation for its employees to attend faux "Energy Citizens" rallies organized by the American Petroleum Institute (API), purporting to demonstrate grassroots opposition to climate policies (Grandia 2009). As of 2010, many of the largest fossil energy companies were failing to comply with U.S. Securities and Exchange Commission guidance to disclose to their shareholders the material risks posed to their business by climate change (Coburn et al 2012). Several companies, including Chevron and BP, also ran misleading advertising campaigns highlighting their commitment to renewable energy (Juhasz 2013).

Major fossil fuel companies have maintained leadership roles in influential U.S. trade associations and lobbying groups, including API, American Coal Council, and the American Legislative Exchange Council (ALEC) that continue to cast doubt on climate science and



**Fig. 3** More than half of global CO<sub>2</sub> emissions (1751–2014) have been released since 1988. Data sources: Boden et al. (2013). Le Quéré et al. (2014)



oppose regulation of greenhouse gas emissions. As of 2012, Chevron, ExxonMobil, BP America, Shell, ConocoPhillips, Total, Anadarko, Occidental, Hess, Devon, Apache, and Marathon all served on the Board of Directors of API (American Petroleum Institute 2012).

In 2011 API brought suit with other parties against the EPA over its authority to regulate greenhouse gases, stating that “EPA professes to be 90 to 99 % certain that ‘anthropogenic emissions of greenhouse gases are primarily responsible for ‘unusually high planetary temperatures’, but the record does not remotely support this level of certainty” (Goldman and Rogerson 2013), a statement that flew in the face of the prevailing scientific consensus (IPCC 2007).

Peabody Energy and ExxonMobil serve on the corporate leadership “Enterprise Council “of ALEC, and Chevron, Shell, and ConocoPhillips are members of ALEC’s Energy, Environment and Agriculture Task Force. This task force is the source of ALEC’s model legislation aimed at repealing renewable energy standards and regional climate policy initiatives in US states. ALEC characterizes climate change on its website as “a historical phenomenon” for which “the debate will continue on the significance of natural and anthropogenic contributions” (American Legislative Exchange Council 2010, 2014; SourceWatch 2014).

Industrial carbon producers have done all this not only to be able to exploit existing reserves of oil, gas, and coal, but also to develop new ones. The depletion of older, accessible forms of oil and gas has led industry to develop new oil fields in technologically difficult and environmentally risky environments such as the deep Gulf of Mexico, the North Sea, and the Arctic. It has also led them to explore for and develop more carbon intensive unconventional fossil resources such as tight oil, with associated increases in emissions from flaring; thermal enhanced oil recovery, with increased emissions associated with producing steam, and oil sands, with increased emissions associated with extraction, upgrading and refining (Brandt et al. 2010). The oil and gas industry has also been dramatically expanding production of natural gas from shales in the United States, Canada, and elsewhere (Council of Canadian Academies 2014).

These activities are consistent with the assumption that there will be no substantial constraints on the production and use of fossil fuels in the near to medium term, and with the determination to ensure that there will be no such constraints.

If the industrial carbon producers had accepted the need for a substantial price or cap on carbon, they would have made different business bets. Instead, they engaged in a set of activities designed to prevent the implementation of any substantial constraint on carbon, and they did so in part by repeatedly misrepresenting the state of scientific knowledge.

## 6 What are the industrial carbon producers doing now?

Some fossil fuel companies continue today to reject the scientific evidence—to insist that the scientific jury is still out—and that their products represent a good solution to the world’s energy needs. Peabody Energy, for example, declares on its website that “the greatest crisis society confronts is not a future environmental crisis predicted by computer models, but a human crisis today that is fully within our power to resolve ... with coal” (Peabody Energy 2014).

Other companies are turning to climate science to help them design “climate resilient” measures to maintain and even expand production in the face of hazards posed by thawing permafrost, rising seas, changing storm patterns, and acidifying oceans (IPIECA 2013). They

use climate projections to identify new opportunities to exploit fossil resources that are becoming accessible as a result of melting sea ice and other consequences of global warming. Royal Dutch Shell's plans to drill in the Chuckchi Sea, for example, draw explicitly on IPCC projections for a lengthening period of open water in the Arctic (Skuce 2012).

Other companies claim to accept the core findings of climate science and the serious risks associated with continued reliance on their products, while acting in ways that belie that claim. Chevron acknowledges that the use of fossil fuels “is contributing to an increase in greenhouse gases ... in the Earth's atmosphere” and claims to “share the concern of governments and the public about climate change” (Chevron Corporation 2014). ExxonMobil (2014a) unequivocally declares that “rising greenhouse gas emissions pose significant risks to society and ecosystems.” BP (2014) goes even further: “According to the Intergovernmental Panel on Climate Change (IPCC), warming of the climate system is unequivocal, and is in large part due to an increase in greenhouse gas (GHG) emissions from human activities.” Yet, none of these companies has accepted the proposition that accepting the science and understanding the risks of climate change implies the need to change their business plans. On the contrary, they argue that the world needs more fossil fuels rather than less. ExxonMobil (2014b), for example, in its 2014 energy outlook, insists that oil and gas will continue to be our major energy sources for the foreseeable future; the terms “climate change” or “global warming” are nowhere to be found.

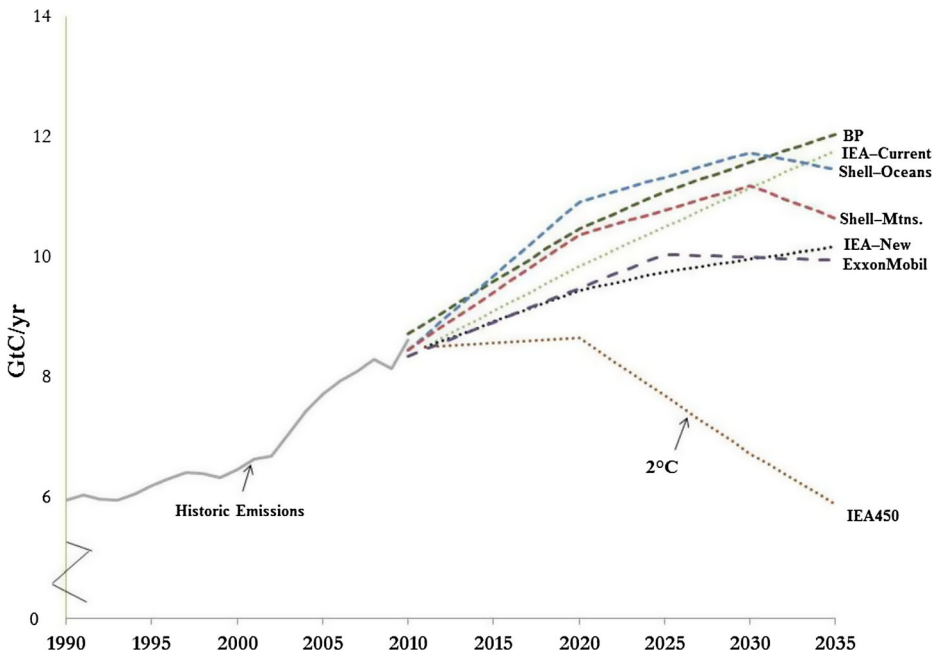
BP, Shell, and ExxonMobil have each developed detailed projections of future energy use. While they differ in their particulars, none anticipates a global price or cap or other strict regulatory limit on carbon for decades. On the contrary, these companies plan for a future in which the world will continue to rely on fossil fuels at levels that will lead to highly disruptive climate impacts. In *Energy Outlook: 2035*, BP envisions that global CO<sub>2</sub> emissions from energy use will continue to grow on average by 1.1 % per year, bringing emissions in 2035 to nearly double levels of 1990 and temperatures towards or above 4 °C by the end of the century, by their own admission “well above the path recommended by scientists...” (BP 2014). Shell explicitly acknowledges that the energy futures they envision will have highly disruptive consequences, “overshoot[ing] the trajectory for a 2 °C goal” (Royal Dutch Shell plc 2013). Yet, knowing this, they continue to bank on a high carbon future (Fig. 4).

Industry projections of future emissions that bring atmospheric carbon dioxide levels to concentrations well in excess of safe limits may turn out to be correct. But if so this will be in no small part because of the intensive efforts that industrial carbon producers have made—and continue to make—to prevent meaningful regulation of their products. The fossil fuel industry is knowingly participating in a pathway by which, in the words of Shell CEO Ben van Beurden, climate change “is just going to happen whether we like it or not” (Mufson 2014). They are actively creating the future that they claim to accept the need to avoid.

## 7 Conclusion

The analysis presented here suggests that the world's largest investor-owned fossil energy producers bear substantial responsibility for anthropogenic climate change. This is because:

- 1) They have produced a large share of the products responsible for dangerous anthropogenic interference in the climate system;



**Fig. 4** Historic and projected global CO<sub>2</sub> emissions. Historic emissions from Boden et al (2013). Projected emissions through 2035 from Royal Dutch Shell plc (2013), International Energy Agency (2013), BP (2014) and ExxonMobil (2014a, b). BP, ExxonMobil, and Shell project a continued high reliance on fossil energy, well above the pathway (IEA 450) that would result in a 50 % probability of keeping global temperatures below the 2 °C policy target. Shell’s “Oceans” scenario is one in which energy choices are shaped primarily by market forces, their “Mountains” scenario is one in which government policies play a more dominant role. IEA “current policies” scenario assumes policies and measures in place as of 2013; “new policies” scenario assumes additional policies and measures announced by governments but not fully enacted

- 2) They continued to produce them well after the danger was scientifically established and recognized by international policymakers;
- 3) They have worked systematically to prevent the political action that might have stabilized or reduced GHG emissions, including through unethical practices such as promoting disinformation; and
- 4) While ostensibly acknowledging the threat represented by unabated reliance on fossil fuels, they nevertheless continue to engage in business practices that will lead to their expanded production and use for decades to come.

The major investor-owned fossil energy producers companies have done all of this even while an alternative vision had been articulated and was possible. Through their actions, they have not only invested in, but sought to guarantee, a future that serves the interests of their shareholders, employees, and executives, but threatens the health, well-being and prosperity of virtually everyone else. Their power and influence on the global response to climate change is substantial. The fact that others—governments, emitting industries, and individuals—have responsibilities, too, does not obviate this point.

Much time has been lost since 1988, when an orderly transition to clean energy could and should have begun. Yet, it still may be possible for fossil fuel companies to make a transition

over the next two decades into energy companies that produce clean, low carbon energy at reasonable cost and reasonable profit.

It would be folly to assume that these companies will make such a transition of their own accord or in anticipation of the swift enactment of carbon regulations that they continue to thwart. Rather, evidence from history strongly suggests that a greatly intensified societal focus on their climate responsibilities will be needed to hasten it. Past shareholder actions, divestment campaigns, consumer boycotts of corporate “bad actors,” and litigation have proven effective in changing corporate behavior. Recently, public and shareholder pressure has helped drive BP America’s decision to stop funding the American Legislative Exchange Council (Page 2015), and BP and Royal Dutch Shell’s adoption of shareholder resolutions requiring them to report annually on their low-carbon energy research and development investments and their positions on climate policies (Farrell 2015).

These are modest first steps for companies whose core business model assumes and encourages our long-term reliance on fossil energy. But they are indicative of the potential for heightened civil society engagement to drive further change in company behavior.

We should make clear that these companies operate with a social license, and consider ways to revoke that license for carbon producers who fail to act on their social responsibility.

We should expect, for example, that companies stop supporting disinformation on climate change, including through lobbying groups and trade associations; unequivocally encourage and support state, federal, and international policies consistent with keeping warming below the 2 °C global temperature target; transparently report on and increase their investments in low carbon energy technologies and carbon capture and storage; and fully disclose the financial and physical risks of climate change to their business operations. And we should expect fossil fuel corporations to pay for a share of the harms resulting from the use of their products, both for the damages that have already occurred and the costs of preparing to limit the damages from further, now unavoidable impacts that responsible actions by these companies could have, and should have, helped to avoid.

The world’s essential transition to low carbon energy may hinge upon the scale and success of such efforts.

**Acknowledgments** We thank Michael MacCracken, Rebecca Henderson, Carroll Muffett, Ken Kimmell, Seth Shulman, Aaron Huertas, Gretchen Goldman, Dann Mitchell and three anonymous reviewers for constructive comments, and Jayne Piepenburg and Jennifer Guido for editorial assistance. Support for this work was provided by grants from the Grantham Foundation for the Protection of the Environment, Wallace Global Fund and Energy Foundation to the Union of Concerned Scientists, and the Wallace Global Fund and Rockefeller Brothers Fund to the Climate Accountability Institute.

**Open Access** This article is distributed under the terms of the Creative Commons Attribution 4.0 International License (<http://creativecommons.org/licenses/by/4.0/>), which permits unrestricted use, distribution, and reproduction in any medium, provided you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license, and indicate if changes were made.

## References

Allen D, Bach D (2011) BP: beyond petroleum? Available at: [http://openmultimedia.ie.edu/OpenProducts/British\\_Petroleum/British\\_Petroleum/pdf/DE1\\_153\\_I\\_NF.pdf](http://openmultimedia.ie.edu/OpenProducts/British_Petroleum/British_Petroleum/pdf/DE1_153_I_NF.pdf). Accessed 29 Sep 2014

- American Legislative Exchange Council (2010) Memorandum to energy, environment and agriculture task force members. Available at: [http://www.commoncause.org/issues/more-democracy-reforms/alec/whistleblower-complaint/original-complaint/National\\_ALEC\\_Exhibit\\_4\\_EEA\\_2010\\_SNPS.pdf](http://www.commoncause.org/issues/more-democracy-reforms/alec/whistleblower-complaint/original-complaint/National_ALEC_Exhibit_4_EEA_2010_SNPS.pdf). Accessed 29 Sep 2014
- American Legislative Exchange Council Private Enterprise Advisory Council. In: ALEC - Am. Legis. Exch. Council. <http://www.alec.org/about-alec/private-enterprise-advisory-council/>. Accessed 29 Sep 2014
- American Petroleum Institute (2012) Form 990. [http://990s.foundationcenter.org/990\\_pdf\\_archive/130/130433430/130433430\\_201212\\_9900.pdf](http://990s.foundationcenter.org/990_pdf_archive/130/130433430/130433430_201212_9900.pdf). Accessed 29 Sep 2014
- Baer P, Harte J, Haya B et al (2000) Equity and greenhouse gas responsibility. *Science* 289:2287. doi:10.1126/science.289.5488.2287
- Boden TA, Marland G, Andres RJ (2013) Global, regional, and national fossil-fuel CO<sub>2</sub> emissions. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge
- Bowker M (2003) Fatal deception: the terrifying true story of how asbestos is killing America. Simon and Schuster
- BP (2014) BP energy outlook 2035. Available at: [http://www.bp.com/content/dam/bp/pdf/Energy-economics/Energy-Outlook/Energy\\_Outlook\\_2035\\_booklet.pdf](http://www.bp.com/content/dam/bp/pdf/Energy-economics/Energy-Outlook/Energy_Outlook_2035_booklet.pdf). Accessed 26 Sep 2014
- Brandt A, Plevin RJ, Farrell AE (2010) Dynamics of the oil transition: modeling capacity, depletion, and emissions. *Energy* 35:2852–2860. doi:10.1016/j.energy.2010.03.014
- Browne J (1997) Addressing global climate change. Available at: <http://www.bp.com/en/global/corporate/press/speeches/addressing-global-climate-change.html>. Accessed 29 Sep 2014
- Brulle RJ (2014) Institutionalizing delay: foundation funding and the creation of US climate change counter-movement organizations. *Clim Chang* 122:681–694. doi:10.1007/s10584-013-1018-7
- Castleman BI (2005) Asbestos: medical and legal aspects. Aspen Publishers, New York
- Chakravarty S, Chikkatur A, de Coninck H et al (2009) Sharing global CO<sub>2</sub> emission reductions among one billion high emitters. *Proc Natl Acad Sci* 106:11884–11888. doi:10.1073/pnas.0905232106
- Chevron Corporation (2014) Climate change | Global issues | Chevron. Available at: <http://www.chevron.com/globalissues/climatechange/>. Accessed 26 Sep 2014
- Coburn J, Salmon R, Grossman D (2012) Sustainable extraction? An analysis of SEC disclosure by major oil & gas companies on climate risk and deepwater drilling risk. Ceres and David Gardiner & Associates, Boston
- Council of Canadian Academies (2014) Energy prices and business decision-making in Canada: preparing for the energy future: the expert panel on Canadian industry's competitiveness in terms of energy use. Council of Canadian Academies, Ottawa
- Eubanks SY, Glantz SA (2012) Bad acts: the racketeering case against the tobacco industry. American Public Health Association, Washington, D.C.
- ExxonMobil (2014a) Global climate change. Available at: <http://corporate.exxonmobil.com/en/environment/climate-change>. Accessed 26 Sep 2014
- ExxonMobil (2014b) The outlook for energy: a view to 2040. Available at: <http://cdn.exxonmobil.com/~media/Reports/Outlook%20For%20Energy/2014/2014-Outlook-for-Energy-low-resolution.pdf>. Accessed 26 Sep 2014
- Farrell S (2015) Climate change dominates marathon Shell annual general meeting. *The Guardian*, 19 May 2015. <http://www.theguardian.com/business/2015/may/19/climate-change-shell-annual-meeting-oil-global-warming-resolution-shareholders>. Accessed 21 May 2015
- Fleming JR (2005) Historical perspectives on climate change. Oxford University Press, New York
- Gelbspan R (2005) Boiling point: how politicians, big oil and coal, journalists, and activists have fueled the climate crisis-and what we can do to avert disaster. Basic Books, New York
- Gerstenzang J (1997) Oil executive breaks with industry. *Los Angeles Times*, 21 May 1997. [http://articles.latimes.com/1997-05-21/news/mn-60912\\_1\\_oil-industry](http://articles.latimes.com/1997-05-21/news/mn-60912_1_oil-industry). Accessed 24 Sep 2014
- Grandia K (2009) Leaked memo: oil lobby launches fake “Grassroots” campaign. Available at: <http://www.desmogblog.com/oil-lobbys-%E2%80%98energy-citizens%E2%80%99-astroturf-campaign-exposed-launch>. Accessed 26 Sep 2014
- Gunningham N, Kagan RA, Thornton D (2004) Social license and environmental protection: why businesses go beyond compliance. *Law Soc Inq* 29:307–341. doi:10.1111/j.1747-4469-2004.tb00338.x
- Hansen J, Fung I, Lacis A et al (1988) Global climate changes as forecast by Goddard institute for space studies three-dimensional model. *J Geophys Res Atmos* 93:9341–9364. doi:10.1029/JD093iD08p09341
- Heede R (2014) Tracing anthropogenic carbon dioxide and methane emissions to fossil fuel and cement producers, 1854–2010. *Clim Chang* 122:229–241. doi:10.1007/s10584-013-0986-y
- Höhne N, den Elzen M, Weiss M (2006) Common but differentiated convergence (CDC): a new conceptual approach to long-term climate policy. *Clim Policy* 6:181–199. doi:10.1080/14693062.2006.9685594

- Houghton JT, Meira Filho LG, Callander BA, Harris N, Kattenberg A, Maskell K ed Climate change 1995: the science of climate change. Contribution of Working Group I to the Second Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge UK
- International Energy Agency (2013) World energy outlook 2013. <http://www.iea.org/W/bookshop/add.aspx?id=455>. Accessed 29 Sep 2014
- IPCC (2007) IPCC fourth assessment report-climate change 2007: the physical science basis, summary for policy makers. <http://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-spm.pdf>. Accessed 20 Oct 2014
- IPCC (2014) Summary for policymakers. Cambridge University Press, Cambridge
- IPIECA (2013) Addressing adaptation in the oil and gas industry. [http://www.acclimatise.uk.com/login/uploaded/resources/Addressing\\_adaptation\\_in\\_oil\\_and\\_gas\\_2013\\_0.pdf](http://www.acclimatise.uk.com/login/uploaded/resources/Addressing_adaptation_in_oil_and_gas_2013_0.pdf). Accessed 26 Sep 2014
- Juhasz A (2013) Big oil's big lies about alternative energy. Rolling Stone, 25, June 2013. <http://www.rollingstone.com/politics/news/big-oils-big-lies-about-alternative-energy-20130625>. Accessed 29 Sep 2014
- Kolk A, Levy D (2001) Winds of change: corporate strategy, climate change and oil multinationals. *Eur Manag J* 19:501–509. doi:10.1016/s0263-2373(01)00064-0
- Le Quéré C, Peters GP, Andres RJ et al (2014) Global carbon budget 2013. *Earth Syst Sci Data* 6:235–263
- Lubber M (2012) Fossil fuel divestment is a timely issue for investors. *Forbes*, 17 Dec 2012. <http://www.forbes.com/sites/mindylubber/2012/12/17/fossil-fuel-divestment-is-timely-issue-for-investors/>. Accessed 29 Sep 2014
- Mackinder E (2010) Pro-environment groups outmatched, outspent in battle over climate change legislation. Available at: <http://www.opensecrets.org/news/2010/08/pro-environment-groups-were-outmatc/>. Accessed 26 Sep 2014
- Markowitz G, Rosner D (2013) Lead wars: the politics of science and the fate of America's children. Univ of California Press, Berkeley
- Matthews HD, Graham, TL, Keverian S, et al (2014) National contributions to observed global warming. *Environ Res Lett* 9:014010. doi:10.1088/1748-9326/9/1/014010
- Michaels D (2008) Doubt is their product: how industry's assault on science threatens your health. Oxford University Press, New York
- Mooney C (2005) Some like it hot. *Mother Jones*, May/June Issue. <http://www.motherjones.com/environment/2005/05/some-it-hot>. Accessed 29 Sep 2014
- Mufson S (2014) CEO of royal dutch shell: climate change discussion “has gone into la-la land.” *Washington Post*. 10 Sep 2014. <http://www.washingtonpost.com/blogs/wonkblog/wp/2014/09/10/ceo-of-royal-dutch-shell-climate-change-discussion-has-gone-into-la-la-land/>. Accessed 29 Sep 2014
- National Research Council (NRC) (1979) Carbon dioxide and climate: a scientific assessment: report of an Ad Hoc Study Group on Carbon Dioxide and Climate, Woods Hole, Massachusetts National Academy of Sciences, Washington, D.C.
- Nepstad D, McGrath D, Stickler C et al (2014) Slowing amazon deforestation through public policy and interventions in beef and soy supply chains. *Science* 344:1118–1123. doi:10.1126/science.1248525
- New York Times Editorial Board (1990) Some white house effect. *New York Times*. 21 April 1990. <http://www.nytimes.com/1990/04/21/opinion/some-white-house-effect.html>. Accessed 29 Sep 2014
- Oreskes N (2004) The scientific consensus on climate change. *Science* 306:1686–1686. doi:10.1126/science.1103618
- Oreskes N (2010) My facts are better than your facts: spreading good news about global warming. In: Howlett P, Morgan MS (eds) *How well do facts travel?*. Cambridge University Press, Cambridge pp 135–166
- Oreskes N (2013) Put government labs to work on climate change. *Wash. Post*
- Oreskes N, Conway EM (2010) *Merchants of doubt: how a handful of scientists obscured the truth on issues from tobacco smoke to global warming*. Bloomsbury Press, New York
- Osofsky HM (2012) Litigation's role in the path of US federal climate change regulation: implications of AEP v Connecticut. *Val UL Rev* 46:447–457. Available at: <http://scholar.valpo.edu/cgi/viewcontent.cgi?article=2233&context=vulr>. Accessed 29 Sep 2014
- Page S (2015) Oil and gas giant BP cuts ties with conservative group ALEC. Available at: <http://thinkprogress.org/climate/2015/03/24/3638181/bp-leaves-alec/>. Accessed 15 Jun 2015
- Peabody Energy (2014) Energy access for all with green coal. [www.peabodyenergy.com/content/224/Video-Gallery/Energy-Access-For-All](http://www.peabodyenergy.com/content/224/Video-Gallery/Energy-Access-For-All). Accessed 29 Sep 2014
- Promo J, Slocombe DS (2012) Exploring the origins of “social license to operate” in the mining sector: perspectives from governance and sustainability theories. *Resour Policy* 37:346–357. doi:10.1016/j.gloenvcha.2006.01.002
- Rawls J (1971) *A theory of justice*. Harvard University Press, Cambridge
- Rive N, Torvanger A, Fuglestad JS (2006) Climate agreements based on responsibility for global warming: periodic updating, policy choices, and regional costs. *Glob Environ Chang* 16:182–194. doi:10.1016/j.gloenvcha.2006.01.002



- Rockefeller Brothers Fund (2014) Divestment statement. Available at: <http://www.rbf.org/content/divestment-statement>. Accessed 29 Sep 2014
- Royal Dutch Shell plc (2010) Code of conduct: helping you live by our core values and our general business principles. Available at: <http://s06.static-shell.com/content/dam/shell/static/aboutshell/downloads/who-we-are/code-of-conduct/code-of-conduct-english2010.pdf>. Accessed 29 Sep 2014
- Royal Dutch Shell plc (2013) New Lens scenarios: a shift in perspective for a world in transition. Available at: [http://s01.static-shell.com/content/dam/shell-new/local/corporate/Scenarios/Downloads/Scenarios\\_newdoc.pdf](http://s01.static-shell.com/content/dam/shell-new/local/corporate/Scenarios/Downloads/Scenarios_newdoc.pdf). Accessed 29 Sep 2014
- Royal Dutch Shell plc (2014) Form 20-F. Available at: <http://s05.static-shell.com/content/dam/shell-new/local/corporate/corporate/downloads/pdf/investor/reports/2013/20f/2013-annual-report20fsec.pdf>. Accessed 29 Sep 2014
- Shue H (1999) Global environment and international inequality. *Int Aff* 75:531–545. doi:10.1111/1468-2346.00092
- Skuce A (2012) Big oil and the demise of crude climate change denial. Available at: Skept. Sci. <http://www.skepticalscience.com/bigoil.html>. Accessed 29 Sep 2014
- SourceWatch (2014) ALEC corporations. Available at: [http://www.sourcewatch.org/index.php/ALEC\\_Corporations](http://www.sourcewatch.org/index.php/ALEC_Corporations). Accessed 29 Sep 2014
- Union of Concerned Scientists (UCS) (2007) Smoke, mirrors & hot air: how exxonmobil uses big tobacco's tactics to manufacture uncertainty on climate science. Union of Concerned Scientists
- United Nations (1992) United Nations framework convention on climate change. New York
- Vidal J (2005) Revealed: how oil giant influenced Bush. *The Guardian*, 8 June 2005. <http://www.theguardian.com/news/2005/jun/08/usnews.climatechange>. Accessed 15 June 2015
- Ward R (2006) Letter from the Royal Society to ExxonMobil. [https://royalsociety.org/~media/Royal\\_Society\\_Content/policy/publications/2006/8257.pdf](https://royalsociety.org/~media/Royal_Society_Content/policy/publications/2006/8257.pdf). Accessed 28 Oct 2014
- Wieners B (2014) Leaked: the oil lobby's conspiracy to kill off California's climate law. In: *BusinessWeek Polit*. <http://www.businessweek.com/articles/2014-11-25/revealed-the-oil-lobbys-playbook-against-californias-climate-law>. Accessed 1 Dec 2014
- Wilford JN (1988) His bold statement transforms the debate on greenhouse effect. *New York Times*. 23 Aug 1988. <http://www.nytimes.com/1988/08/23/science/his-bold-statement-transforms-the-debate-on-greenhouse-effect.html>. Accessed 29 Sep 2014