Trashing the Planet for Natural Gas: Shale Gas Development Threatens Freshwater Sources, Likely Escalates Climate Destabilization

Karen Charman

All that is solid melts into air, all that is holy is profaned, and man is at last compelled to face with sober senses his real conditions of life, and his relations with his kind.

—Karl Marx, Communist Manifesto

As the large, easy reservoirs of fossil fuels are exhausted, the capitalist machine is now scouring the earth in a frenzy to exploit sources that are much more difficult, risky, ecologically damaging, and expensive to extract. Natural gas from coalbed methane, shale, and tight gas sands; oil from tarsands or increasingly deep wells far below the ocean floor; and thin coal seams that are only "economic" for companies to exploit by blowing up whole mountaintops define the new era of fossil fuel extraction. All of these activities are destroying ever-larger swathes of land, ecosystems, and the communities that depend on them, greatly escalating the global ecological crisis that, if it continues unabated, will make the earth uninhabitable for life as we know it.

Evidence and public awareness of the ecological threats—particularly the use of fossil fuels—have been mounting for some time. But so far, global fossil fuel consumption has only increased, and several forecasts expect substantial rises in energy consumption in the coming decades.[1] Although the explosion in the availability of environmentally friendly products over the last several years indicates that strong support for non-polluting, renewable energy sources does exist, private energy corporations use every means at their disposal to prevent the widespread adoption of alternatives that would threaten their enormous profits.[2] Energy corporations and their proponents manipulate the public sphere by engaging in sophisticated propaganda campaigns to both strengthen the perceived need for fossil fuels and confuse public debate by distorting facts about the environmental harm of extracting and burning them.[3] Energy corporations have also been supremely successful at manipulating the political process, which supports them with massive public

---

[1] See, for example, "International Energy Outlook 2010 – Highlights," U.S. Energy Information Administration, May 25, 2010, online at: http://www.eia.doe.gov/oiaf/ieo/highlights.html. Concurrent with its expected increases in energy consumption, the EIA Outlook forecasts a 43 percent rise in world CO_2 emissions between 2007 and 2035. Also see Todd Woody, "Fossil Fuel Use in 2034? Not Much Different," *The New York Times*, January 16, 2010; and S. Ansolabehere, et al., "The Future of Nuclear Power: An Interdisciplinary MIT Study," Massachusetts Institute of Technology, 2003.

[2] See Daniel Tanuro, "Marxism, Energy, and Ecology: The Moment of Truth," *Capitalism Nature Socialism*, Vol. 21, No. 4, December 2010, p. [tk].

[3] See for example, Margot Roosevelt, "Billionaire Koch Brothers Back Suspension of California Climate Law," *Los Angeles Times*, September 2, 2010, online at: http://latimesblogs.latimes.com/greenspace/2010/09/koch-brothers-global-warming-prop-23-climate-change.html; James Hogan and Richard Littlemore, *Climate Cover-Up: The Crusade to Deny Global Warming* (Edmond, OK: Greystone Press, 2009); Naomi Oreskes and Erik M. Conway, *Merchants of Doubt: How a Handful of Scientists Obscured the Truth on Issues from Tobacco Smoke to Global Warming* (London: Bloomsbury Press, 2010); Ross Gelbspan, *The Heat is On: The Climate Crisis, The Cover-up, The Prescription*, Updated edition (Reading, MA: Perseus Books, 1997/1998); Fred Pearce, *With Speed and Violence: Why Scientists Fear Tipping Points in Climate Change* (Boston: Beacon Press, 2007).

subsidies and laws that ensure their profitability while limiting liability for the direct and indirect harm they cause.[4]

Reports of "peak oil" and predictions that we will run out of energy supplies combined with wild fluctuations in oil prices over the last few years against a backdrop of escalating political instability in the Middle East have stoked fears in the developed world that basic needs for heating and transportation could become prohibitively expensive. At the same time, worldwide discoveries of massive amounts of natural gas, much of it in shale formations, have been announced.[5] Advanced Resources International, Inc., a U.S.-based research and consulting firm specializing in shale and other unconventional sources of natural gas, describes the "new understanding of the size and availability" of these new gas supplies as a "paradigm shift" that began quietly in the U.S. a decade ago and is now poised to go global "with Australia, China and Europe in the lead."[6] Significant shale gas basins are also noted in Central Asia, the Middle East, North Africa, Russia, and South America.[7]

Natural gas forms as a result of the anaerobic decay of organic material. "Conventional" natural gas pools in permeable places, such as sandstone formations, which can be tapped with vertical wells, while shale gas is typically found in separate, tiny bubbles throughout the shale.[8] Relatively small amounts of gas have been extracted from shallow fractured shale formations in the U.S. for decades. But the idea of creating "a permeable reservoir"[9] to get at these small but plentiful pockets by shattering a large area of the shale made these previously unattainable gas deposits accessible. The infamous American oil services corporation, Halliburton, combined two existing technologies—hydraulic fracturing and horizontal drilling—to make this possible.

When burned for fuel, natural gas emits about half of the greenhouse gas emissions as coal.[10] This new source of gas is now being sold to the American public as a home-grown source of plentiful, "clean" energy that will go a long way toward making the U.S. energy independent.[11] However, a look at the U.S. experience so far and likely future impacts indicates a different reality.

Gas vs. Water

---

[4] See, for example: Doug Koplow, Cynthia Lin, Anna Jung, Michael Thöne, and Lucky Lontoh, "Untold Billions: Fossil-Fuel Subsidies, Their Impacts, and The Path to Reform," The Global Subsidies Initiative of the International Institute for Sustainable Development, Geneva, August 2010. For a discussion of natural gas subsidies in the U.S., see: "Hancock & the Marcellus Shale: Visioning the Impacts of Natural Gas Extraction Along the Upper Delaware," a report by the Columbia University Urban Design Research Seminar, Spring 2009, pp. 30-31.

[5] See: http://nat .com/map-shale-gas-around-the-globe.htm.

[6] Vello A. Kuusdraa and Scott H. Stevens, "Worldwide Gas Shales and Unconventional Gas: A Status Report," Advanced Resources International, Inc., December 7, 2009.

[7] *Ibid.* and Peter Staas, "The Future of Shale Gas is International," *Investing Daily*, July 11, 2010, online at: http://www.investingdaily.com/tes/17542/the-future-of-shale-gas-is-international.html.

[8] Mark Zoback, Saya Kitasei, and Brad Copithorne, "Addressing the Environmental Risks from Shale Gas Development," Briefing Paper 1, Natural Gas and Sustainable Energy Initiative, Worldwatch Institute, July 2010, p. 2.

[9] Kuuskraa and Stevens, "World Wide Gas Shales and Unconventional Gas," December 7, 2009.

[10] Burning natural gas averages 13.7 grams C of CO_2 per million joules of energy compared to 18.6 for gasoline, 18.9 for diesel fuel, and 24.0 for bituminous coal. Robert W. Howarth, "Preliminary Assessment of the Greenhouse Gas Emissions from Natural Gas Obtained by Hydraulic Fracturing," Department of Ecology and Evolutionary Biology, Cornell University, April 1, 2010 draft.

[11] See, for example: http://geology.com/news/2010/worldwide-shale-gas-assessment.shtml.

As the United Nations notes in its backgrounder on the "Water for Life" Decade (2005-2015): "Water is essential for life. No living being on planet Earth can survive without it."[12] Earth has an essentially closed hydrological cycle. This means virtually all of the water that has ever existed on our planet is all the water that will ever exist here. And it's the same water, just recycled over and over, down through time.

The last two decades have brought mounting evidence that globally, fresh water supplies—which comprise only about 3 percent of all water on the planet—are in crisis.[13] Aquifers are being drawn down faster than they can naturally replenish, lakes are shrinking, wetlands are disappearing, and glaciers and ice caps—the largest "bank" of freshwater on Earth—are melting into the salty oceans. Much of the remaining freshwater supplies are being contaminated with all manner of chemicals and toxins, by-products of the industrialized culture that have reached virtually everywhere on the planet.

New York—the plight of the PCB-laden Hudson River and other trashed waterways immediately within and surrounding New York City notwithstanding—is famous for the abundance and purity of its fresh water supplies. Relying primarily on the natural cleansing processes of its largely rural and forested 1,969-square-mile watershed to purify the water,[14] New York City boasts the largest unfiltered surface water supply in the world.[15] Ninety percent of New York City's water comes from the Catskill Mountains, a little over a hundred miles north and west of Manhattan.[16] This system serves 8 million people in New York City and another million in adjacent upstate communities—approximately half of the state's residents.[17] Though the system is old, deteriorating, and in need of repair, it is 95 percent gravity fed, still considered an engineering marvel, and often described as New York State's single most valuable asset. Overall, New York City has invested or allocated $1.5 billion to protect its drinking water.[18] A key element in keeping the New York City water supply clean is the fact that much of upstate New York is not industrialized or intensively developed.

In a stunning irony of capitalist greed, the new era of dirty fossil fuel extraction now threatens the water supply of the financial capital of the world. That's because most of the bottom third of New York State—including the New York City watershed west of the Hudson River—sits atop the Marcellus Shale, a vast expanse of sedimentary rock several thousand feet below the surface

---

[12] See http://www.un.org/waterforlifedecade/background.html.

[13] See, for example, Sandra Postel, *Last Oasis: Facing Water Scarcity* (New York and London: W.W. Norton and Co./Worldwatch, 1992, 1997); Maude Barlow and Tony Clarke, *Blue Gold: The Fight to Stop the Corporate Theft of the World's Water* (New York and London: The New Press, 2002); and Marc Reiser, *Cadillac Desert: The American West and Its Disappearing Water* (New York: Viking Penguin, 1986).

[14] Tawna Mertz, "New York City Depends on Natural Water Filtration," in "Nature's Services," Rand Corporation report, n.d., online at: http://www.rand.org/scitech/stpi/ourfuture/NaturesServices/sec1_watershed.html, accessed September 20, 2010.

[15] See "New York's Water System," New York City Department of Environmental Protection," online at: http://www.nyc.gov/html/dep/html/news/a_watershed_moment_restoration.shtml, accessed September 20, 2010.

[16] Ten percent of New York City's water comes from the Croton system east of the Hudson River and is now filtered.

[17] "New York City Watershed and Drinking Water," New York League of Conservation Voters Education Fund, Environmental Issues fact sheet, n.d., online at: http://www.nylcvef.org/guide/new_york_city_watershed_and_drinking_water.

[18] "NYC to Acquire 1,323 Acres of Land for Watershed Protection," press release, New York City Department of Environmental Protection, August 25, 2010, online at: http://www.nyc.gov/html/dep/html/press_releases/10-83pr.shtml.

of the land extending into eight states.[19] In 2008, the amount of natural gas in the Marcellus was estimated at as much as 516 trillion cubic feet,[20] up from previous U.S. Geological Survey estimates in 2002 of just 1.3 trillion cubic feet.[21] The new estimate has prompted some to dub the Marcellus "the Saudi Arabia of natural gas."

To access the widely distributed small bubbles of gas, the extraction companies must drill horizontal wells. These go several thousand feet down into the shale and then run horizontally up to another 10,000 feet. A mixture of water, chemicals, and sand is pumped into the well at enormous pressure, which forces open cracks in the rock to let the gas flow back up to the wellhead.[22] This procedure is known as horizontal hydraulic fracturing, or "fracking."

James L. Northrup, a 30-year veteran of the oil and gas industry, describes horizontal hydrofracking of shale as "effectively the explosion of a massive pipe bomb underground."[23] In order to break up the rock, the fracking pressure in a shale gas well must be extreme—15,000 pounds per square inch, which he notes has three times the explosive pressure of a thermobaric air bomb that can be heard up to 100 miles away.[24] The horizontal orientation of the wells is particularly problematic for drinking water sources, since horizontal wells are much more likely to go under aquifers, lakes, streams, springs, and rivers.[25] Furthermore, horizontal wells are fracked numerous times. This increases the chances of hitting and expanding fault lines, which will carry to aquifers and groundwater sources naturally occurring toxic chemicals such as pyrite; radioactive elements such as radium[26] and uranium[27] that are common in dark shales like the Marcellus; the methane gas itself; and the additional chemicals ("fracking fluids") the companies use to maximize gas production of the wells.[28] Intensive gas drilling has taken place in Garfield County, in northwestern Colorado, since 2000.[29] A 2009 hydrogeologic study of the area, which like the southern tier of New York has

---

[19] The Marcellus stretches from New York south and west through much of Pennsylvania into the eastern third of Ohio, and down through western Maryland into most of West Virginia. A sliver runs along most of Virginia's western border. It encompasses a tiny portion of Kentucky at its easternmost point, and a very thin finger reaches into eastern Tennessee. See Nat Gillespie, Map, "Marcellus Shale Formation," in Morgan Lyle, "Fractured Landscape: The Appalachians' Energy Development Rush, *Trout*, Winter 2009, p. 37. For New York's portion of the Marcellus, see http://www.dec.ny.gov/energy/46381.html.

[20] Penn State University geoscientist Terry Engelder, who made the estimate, quoted in "Unconventional Natural Gas Reservoir Could Boost U.S. Supply," PennState Live, January 17, 2008, online at: http://live.psu.edu/story/28116, accessed September 21, 2010.

[21] "Hancock & the Marcellus Shale," Spring 2009, p. 2.

[22] See http://geology.com/articles/marcellus-leases-royalties.shtml.

[23] James L. Northrup, "Potential Leaks from Hydro-Fracking of Shale," comments to the U.S. Environmental Protection Agency, September 8, 2010. Northrup is former planning manager with Atlantic Richfield (ARCO) and owner of onshore and offshore drilling rigs.

[24] *Ibid.* Northrup notes that the pressure is powerful enough to produce earthquakes. As an example, he cites one registering 2.8 on the Richter Scale on June 2, 2009 in Cleburne, Texas in the heart of drilling operations in the Barnett Shale. Prior to this event, earthquakes had never been recorded in that area.

[25] *Ibid.*

[26] Abrahm Lustgarten and ProPublica, "Natural Gas Drilling Produces Radioactive Wastewater," *Scientific American*, November 9, 2009, online at: http://www.scientificamerican.com/article.cfm?id=marcellus-shale-natural-gas-drilling-radioactive-wastewater, accessed September 22, 2010.

[27] Phillips Energy Partners, "Currently Targeted Areas: Marcellus Shale," online at: http://phillipsenergypartners.com/buying-mineral-rights/marcellus-shale/, accessed September 27, 2010.

[28] Northrup, "Potential Leaks from Hydro-Fracking Shale," September 8, 2010.

[29] The number of wells increased from 200 in 2000 to more than 1,300 in 2008, and there are plans for a total of 7,000. Geoffrey Thyne, "Review of Phase II Hydrogeologic Study, Prepared for Garfield County," December 20, 2009, p. 5, online at: http://www.garfield-county.com/Index.aspx?page=1143.

active faults and fractures, found that both methane and wastewater from gas drilling was contaminating drinking water sources, and that methane contamination increased with the number of gas wells.[30]

Toxic Mystery Chemicals

The fracking process itself requires 3-8 million gallons of water per well,[31] and the fracking fluid mixed into the water includes a wide range of chemicals and compounds, many of which are known to be harmful at very low doses.[32] Because gas drilling was specifically exempted from the Safe Drinking Water Act in the George W. Bush/Dick Cheney-era U.S. Energy Policy Act of 2005, the formulas are considered proprietary information and, as of this writing, are not publicly available.

By February 2009, independent scientist Theo Colborn compiled a list of 435 products containing 344 chemicals. However, since two-thirds of these products identified less than half of their ingredients with no way to find the contents elsewhere, the information on fracking products remains limited.[33] Abrahm Lustgarten, the reporter who first brought the toxic effects of horizontal hydrofracking to national attention in the U.S., adds that because so many of the chemicals used are "unstudied and unregulated," there is "a gaping hole in the nation's scientific understanding of how widespread drilling might affect our water resources."[34]

Some of the fracking chemicals identified include diesel, which contains the carcinogen benzene; ethylene glycol (automotive antifreeze); formaldehyde; kerosene; various salts and ammonia compounds; and biocides. Many of the chemicals Colborn was able to identify harm the nervous system, brain, respiratory system, gastrointestinal organs, skin, and eye.[35] Many are known to cause cancer, birth defects, developmental problems, reproductive disorders, immune system damage, kidney problems, cardiovascular and blood disease, and death.[36]

---

[30] Northrup, "Potential Leaks from Hydro-Fracking Shale," September, 8, 2010 and Thyne, "Review of Phase II Hydrogeologic Study, Prepared for Garfield County," December 20, 2009.

[31] Theo Colborn, quoted in "World-Renowned Scientist Dr. Theo Colborn on the Health Effects of Water Contamination from Fracking," *Democracy Now!*, April 14, 2010, online at: http://www.democracynow.org/2010/4/14/world_renowned_scientist_dr_theo_colborn, accessed September 21, 2010.

[32] The categories of chemicals include acids, biocides, breakers, clay stabilizers, corrosion inhibitors, crosslinkers, defoamers, emulsifiers, foamers, friction reducers, gellants, non-emulsifiers, polymers, pseudo-polymers, proppants, resins, solvents, surfactants, viscosifiers, and others that control fluid loss, iron, pH, and scale. See "Products and Chemicals Used in Fracturing," TEDX, The Endocrine Disruption Exchange, February 2009, online at: http://www.endocrinedisruption.com/chemicals.fracturing.php (link by "summary of the products and chemicals used to fracture natural gas wells (PDF)," accessed September 21, 2010.

[33] "Products and Chemicals Used in Fracturing," February 2009. Nine percent disclosed none. Less than 50 percent of the ingredients were disclosed in 24 percent of the products, 23 percent of the products listed 51-95 percent of its contents, and only 5 percent disclosed all ingredients. Even actual samples of contaminated soil and water from areas where accidents occurred won't provide a complete list of contaminants, since they don't come with labels, and unless a specific chemical is tested, it won't be found.

[34] Abrahm Lustgarten and ProPublica, "Drill for Natural Gas, Pollute Water: The Natural Gas Industry Refuses to Reveal What is in the Mixture of Chemicals Used to Drill for the Fossil Fuel," *Scientific American*, November 17, 2008, online at: http://www.scientificamerican.com/article.cfm?id=drill-for-natural-gas-pollute-water, accessed September 27, 2010.

[35] *Ibid.*

[36] Sandy Long, "What's in that Fracking Fluid? Pennsylvania Discloses the Chemicals Used by the Drilling Companies," *The River Reporter*, Vol. 34, No. 39, December 4-1-, 2009, online at: http://www.riverreporter.com/issues/08-12-04/news-fracking.html, accessed September 21, 2010.

The gas industry and drilling proponents maintain that gas wells go far enough below aquifers and surface water supplies in "tight," less permeable rock to prevent horizontal hydrofracking from contaminating drinking water sources. However, "more than 1,000 … cases of contamination have been documented by courts and state and local governments in Colorado, New Mexico, Alabama, Ohio and [more recently] Pennsylvania"[37] in areas where drilling is taking place.

Underground chemical drift isn't the only problem with horizontal hydrofracking, since "[t]ypically 30 to 40 percent of the water used for drilling and fracturing returns to the surface highly contaminated."[38] Gas drilling companies construct on-site pits, usually lined with plastic, where the wastewater evaporates in the open air. These pits are easily punctured, and spills often overflow during a heavy rain.[39] In New Mexico, state officials documented approximately 800 water contamination cases from oil and gas operations, "half of them from waste pits that had leaked chemicals into the ground."[40] Water sources are also at risk from spills of truckloads of chemicals transported on and off drilling sites, and there are increasing reports of drilling companies being fined for carelessness or deliberate dumping.[41] In New York, wastewater laden with high levels of radioactive elements released from deep underground present even more problems, because few if any water treatment facilities can handle radioactively contaminated water.[42]

Residents able to light their tap water on fire from methane seepage into their water supply is increasingly common in drilling areas. But the most dramatic impacts from the new gas drilling are the numerous well-documented cases of water wells, gas wells—and even a house in suburban Cleveland—that have blown up from the buildup of methane in drilling areas.[43] Based on the most recent estimate of 489 trillion cubic feet of natural gas—the equivalent of 81.5 billion barrels of oil[44]—Cornell University Professor of Civil Engineering Anthony Ingraffea says a maximum of

---

[37] *Ibid.* Though drilling for shale gas has now been taking place for approximately ten years, it's only in the last two years that calls for monitoring the environmental and health impacts have gained any traction. Thus far, there is very little hard scientific data on the environmental impacts. The multiple award-winning documentary, *Gasland*, investigated the effects of shale gas drilling around the U.S. and has been instrumental in raising awareness about the environmental contamination and plight of people who live in drilling areas.

[38] "Hancock & the Marcellus Shale," Spring 2009, p. 10.

[39] *Ibid.*

[40] Abrahm Lustgarten, "Setting the Record Straight on Hydraulic Fracturing," *ProPublica*, January 20, 2009, online at: http://www.propublica.org/article/setting-the-record-straight-on-hydraulic-fracturing-090112, accessed September 22, 2010.

[41] See for example, Michael Rubinkam (Associated Press), "Wells Near Gas Drilling Found Tainted," *The Philadelphia Inquirer*, September 17, 2010, online at: http://www.philly.com/inquirer/local/20100917_Wells_near_gas_drilling_found_tainted.html, accessed September 22, 2010; Sabrina Shenkman, "Gas Drillers Plead Guilty to Felony Dumping Violations, *ProPublica*, February 22, 2010, online at: http://www.propublica.org/article/gas-drillers-plead-guilty-to-felony-dumping-violations, accessed September 22, 2010; Abrahm Lustgarten, "Pennsylvania Orders Cabot Oil and Gas to Stop Fracturing in Troubled County," *ProPublica*, September 25, 2009, online at: http://www.propublica.org/article/pennsylvania-orders-cabot-to-stop-fracturing-in-troubled-county-925, accessed September 22, 2010.

[42] Abrahm Lustgarten, "Is New York's Marcellus Shale Too Hot to Handle?," *ProPublica*, November 9, 2009, online at: http://www.propublica.org/article/is-the-marcellus-shale-too-hot-to-handle-1109, accessed October 7, 2010.

[43] Abrahm Lustgarten, "Officials in Three States Pin Water Woes on Gas Drilling," *ProPublica*, April 26, 2009, online at: http://www.propublica.org/article/officials-in-three-states-pin-water-woes-on-gas-drilling-426, accessed October 7, 2010.

[44] Using a statistical calculation, Penn State University Professor of Geosciences Terry Engelder in 2009 estimated there was a 50 percent probability that the Marcellus will yield 489 trillion cubic feet of gas over its lifetime. This is down from his 2008 estimate with SUNY Fredonia geologist Gary Lash of 516 trillion cubic feet. See: Terry Engelder, "Marcellus

410,000 wells could be drilled throughout the entire Marcellus formation, 78,000 in New York State alone.[45] As drilling and gas pipelines expand, more explosions due to methane seepage are likely.

Full Steam Ahead!

Despite increasing evidence of the danger and irreversible ecological damage in areas where horizontal hydrofracking for natural gas is taking place, governments around the world appear to be embracing this new method of resource exploitation. The United States encourages gas drilling with more than $13.5 billion of subsidies, most of which were authorized in the 2005 Energy Policy Act.[46] As a result, for five years prior to 2009, a typical U.S. gas company paid 0.3 percent tax on its profit instead of the standard corporate tax rate of 35 percent.[47] Though most of the subsidies apply to the exploration rather than the production phase of natural gas extraction, townships and residents don't collect taxes or royalties until gas production reaches a certain level. Gas companies, however, receive subsidies whether or not their wells produce, thus leasing land, exploration, and drilling are essentially risk-free activities—possibly even if companies abandon drilled wells without cleaning them up.[48] A 2004 law that deems oil and gas a "manufactured good" permits companies to claim billions of dollars in tax deductions, shifting much of the cost of gas production to American taxpayers.[49] Another subsidy allows companies to write off 70-100 percent of their outlay for equipment, supplies, and other costs of drilling.[50] Other subsidies guarantee that the gas industry pays almost nothing for the cost of gas distribution and gas pipelines.[51] Gas companies and their investors are also allowed to write off losses, enabling them to shelter other income.[52] Currently, efforts are underway in the U.S. Congress for substantial new subsidies to switch fuels in the transportation sector by encouraging the widespread adoption of cars and trucks that run on natural gas.[53]

The various subsidies and incentives were adopted ostensibly to boost domestic natural gas production to make the U.S. energy independent. However, as *Investing Daily* points out, "it's important to remember that energy markets are global."[54] A raft of recent international deals indicates that much of the gas drilled in the U.S. is intended for the international energy market. In November 2008, U.S.-based Chesapeake Energy, a major investor in the Marcellus Shale, sold the second largest supplier of natural gas in Europe, the Norwegian company StatoilHydro, a 32.5 percent stake in its Marcellus leases, a deal that could add the equivalent of 2.5 to 3 billion barrels of oil to StatoilHydro's reserves.[55] *Investing Daily* reports that also in 2008, Chesapeake joined BP in a $1.9 billion joint venture in the Fayetteville Shale in Arkansas. In early 2010, Chesapeake formed a

---

Shale Gas Play," *Geosciences Newsletter 2009*, Department of Geosciences, College of Earth and Mineral Sciences, PennState, 2009, p. 12.

45 Author telephone interview with Anthony Ingraffea, September 21, 2010.

46 "Hancock and the Marcellus Shale," Spring 2009, pp. 30-31.

47 *Ibid.*

48 *Ibid.*, p. 30.

49 *Ibid.*, p. 31.

50 *Ibid.*

51 *Ibid.*

52 *Ibid.*

53 Peter Staas, "Investing in Natural Gas Vehicles," *Investing Daily*, October 8, 2010, online at: http://www.investingdaily.com/tes/17859/investing-in-natural-gas-vehicles.html, accessed October 8, 2010.

54 Staas, "The Future of Shale Gas is International," July 11, 2010.

55 "Chesapeake Teams Up with Norway Supplier," *Toronto Star*, November 12, 2008, online at: http://www.thestar.com/business/article/535150, accessed October 7, 2010.

$2.25 billion joint venture with the French energy giant Total that gives Total a 25 percent stake in Chesapeake's assets in the Barnett Shale in Texas. India's largest company, Reliance, bought a 45 percent stake in Pioneer Natural Resources' gas leases in the Eagle Ford Shale in southern Texas after purchasing a 40 percent stake in Atlas Energy's Marcellus Shale holdings. Oil giants Royal Dutch Shell, ExxonMobil, and ConocoPhillips are also making significant investments in unconventional natural gas in the U.S. and elsewhere, as are Chinese companies.[56]

Proponents argue unconventional natural gas is clean and needed as a "bridge fuel" that will help reduce greenhouse gas emissions to help curb global climate destabilization until we can transition away from coal. But this claim neglects to account for both the energy required and the resulting emissions from extracting, processing, and distributing the gas—i.e., the use of fossil fuels to build pipelines, truck the enormous amounts of water needed for hydrofracking, drill wells, manufacture the chemicals for the fracking fluids, run the compressors, and treat and transport the wastewater.[57] Nor does it consider the loss of carbon sinks from forests cleared for drilling.[58] No scientific peer-reviewed analyses of greenhouse gas emissions measuring the entire fuel cycle for shale and other unconventional gas sources have yet been completed and published. Cornell ecologist Robert W. Howarth is analyzing total greenhouse gas emissions from Marcellus Shale gas development. His preliminary data suggest that because of the difficulty of obtaining the more diffuse shale gas, these additional emissions are likely to be at least three times the greenhouse gas emissions for extracting, processing, and transporting diesel fuel and gasoline.[59]

Much more of a concern, however, is the leakage of methane into the atmosphere during all stages of drilling, processing, transporting and burning the gas. Methane, which is 72 times more powerful a greenhouse gas per molecule than CO_2,[60] is the major component of natural gas. Howarth notes that the numerous incidents of explosions and contaminated wells in shale gas drilling areas in Pennsylvania, Wyoming, and Ohio in recent years reveal pathways for methane to escape into the atmosphere: "The concentrations of methane necessary for an explosion are at least 10,000-fold higher than those normally in the atmosphere, and this leakage from contaminated groundwater is probably quite significant in terms of the greenhouse-gas footprint of shale gas."[61] Although Howarth's study is not yet complete, his preliminary results indicate that the greenhouse gas footprint of Marcellus Shale gas is "probably at least twice as great as the emissions from just

---

[56] Staas, "The Future of Shale Gas is International," July 11, 2010.
[57] Robert W. Howarth, "Preliminary Assessment of the Greenhouse Gas Emissions from Natural Gas Obtained by Hydraulic Fracturing," April 1, 2010 (draft); and Robert W. Howarth, "Statement for the EPA Hydraulic Fracturing Public Informational Meeting," Binghamton, NY, September 15, 2010.
[58] *Ibid.*
[59] *Ibid.* Howarth estimates the greenhouse gas emissions for drilling, processing, and transporting shale gas at 4.5 grams C of CO_2 per million joules of energy compared to 1.5 grams C of CO_2 per million joules of energy for diesel and gasoline. As shale gas and other fossil fuel sources become more difficult to extract, he says both the energy required and the emissions will increase significantly.
[60] P. Forster, V. Ramaswamy, P. Artaxo, T. Berntsen, R. Betts, D.W. Fahey, J. Haywood, J. Lean, D.C. Lowe, G. Myhre, J. Nganga, R. Prinn, G. Raga, M. Schulz and R. Van Dorland, "Changes in Atmospheric Constituents and in Radiative Forcing," in S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.), *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* (Cambridge and New York: Cambridge University Press, 2007), Table 2.14, "Lifetimes, Radiative Efficiencies and Direct (except for CH4) GWPs Relative to CO_2."
[61] Howarth, "Statement for the EPA Hydraulic Fracturing Public Informational Meeting," September 15, 2010.

burning the gas. That is, shale gas is not a clean fuel and appears to be a poor choice as a transitional fuel over the coming decades if the U.S. is serious about addressing global climate disruption."[62]

Two California scientists, Mark Jacobson from Stanford University and Mark Delucchi from the University of California at Davis, have laid out a plan to eliminate fossil fuel use in every country on the planet and replace it with clean, renewable energy—currently existing wind, solar, geothermal, tidal and hydroelectric power technologies—in just ten years.[63] Their plan calls for "millions of wind turbines, water machines, and solar installations."

While they acknowledge the numbers are large, they point out that massive societal transformations have taken place before, for example when the U.S. retooled its automobile manufacturers during World War II to build 300,000 aircraft, and other countries produced another 486,000. They also acknowledge some technical hurdles, but none that seem insurmountable. The biggest roadblock appears to be the juggernaut of capitalist ideology and power that in the face of escalating ecological catastrophe refuses to give up its short-term profit-driven death grip on the planet.

---

[62] *Ibid.*

[63] Mark Z. Jacobson and Mark A. Delucchi, "A Path to Sustainable Energy by 2030," *Scientific American*, November 2009, pp. 58-65.