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COMMENT

The Marcellus Shale: Bridge to a Clean Energy Future or Bridge to Nowhere? Environmental, Energy and Climate Policy Considerations for Shale Gas Development in New York State

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INTRODUCTION

The United States consumes approximately twenty percent of the world's energy resources, but is home to roughly five percent of the world's population.[1] As global climate change and competition for energy resources continue to grow, access to clean and reliable energy supplies is increasingly critical to economic prosperity, national security, and a healthy environment. America's transportation sector is nearly wholly dependent on oil, the majority of which is imported,[2] while the electricity

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1. WORLD POPULATION BALANCE, http://www.worldpopulationbalance.org/population_energy (last visited Oct. 11, 2011).

2. While America's electricity generation fuels are nearly one hundred percent domestically-supplied, we import over sixty percent of our oil. In 2010, the United States imported 4.25 billion barrels of oil (a little over 11.5 million barrels per day), sending approximately $337 billion to foreign countries. TeamPickins, *U.S. Imported 4.25 Billion Barrels of Oil in 2010, Spending $337 Billion*, PICKINSPLAN BLOG (Jan. 19, 2011, 9:24 AM),

generation sector, which is the largest contributor of greenhouse gas emissions in the country, is largely dependent upon domestic coal.[3] The need to find alternatives to these energy supplies is heightened in the face of climate change and instability in the major oil producing regions of the world. In 2010, the transportation sector alone accounted for approximately seventy percent of the oil consumed in the United States[4] and nearly forty-five percent of electricity consumed was generated by coal.[5] Importantly, coal and oil are the "dirtiest" fossil fuels available[6] and developing cleaner alternatives to them would be a significant step toward reducing oil imports and the environmental impacts of energy production and power generation. With vast amounts of natural gas trapped in shale becoming technologically and economically recoverable, some argue that natural gas, and shale gas in particular, represents a domestic fuel source that could bridge the transition from a high-carbon fossil fuel powered economy to a renewable fueled green energy economy.[7]

Extracting natural gas from shale formations requires the use of a process known as "hydraulic fracturing," also called "hydrofracking" or "fracking." Depending on the well size, the fracking process can involve injecting millions of gallons of water combined with thousands of gallons of proprietary chemical slurries into the well bore at extremely high pressure to break the

http://www.pickensplan.com/news/2011/01/19/us-imported-425-billion-barrels-of-oil-in-2010-spending-337-billion/.

3. *U.S. Greenhouse Gas Inventory*, U.S. ENVT'L PROT. AGENCY, http://www.epa.gov/climatechange/emissions/usgginventory.html (last visited Nov. 30, 2011).

4. *Petroleum* INSTITUTE FOR ENERGY RESEARCH, http://www.instituteforenergyresearch.org/energy-overview/petroleum-oil/ (last visited Nov. 30, 2011).

5. U.S. ENERGY INFO. ADMIN. [EIA], 2011 ANNUAL ENERGY OUTLOOK: EARLY RELEASE OVERVIEW 1 (2010) (hereinafter EIA, OUTLOOK).

6. *See Natural Gas and the Environment*, NATURALGAS.ORG, http://www.naturalgas.org/environment/naturalgas.asp (last visited Nov. 27, 2011) (describing how coal produces more carbon dioxide, carbon monoxide, nitrous oxide, sulfer dioxide, particulates and mercury than oil or natural gas).

7. *See, e.g.*, JOHN PODESTA & TIMOTHY WIRTH, NATURAL GAS: A BRIDGE FUEL FOR THE 21ST CENTURY, CENTER FOR AM. PROGRESS (2009).

shale.[8] The fracturing creates fissures that are propped open by the injection of sand, which allows the gas to migrate to the well bore to be pumped to the surface.[9] The Marcellus Shale formation remains the largest shale gas formation in the United States and possibly the largest in the world,[10] and is among the most rapidly developing formations in the country.[11]

Because hydraulic fracturing allows for the recovery of trillions of cubic feet of natural gas, natural gas is increasingly considered a "bridge fuel" that could be utilized to transition from coal and oil to a cleaner, renewable energy-powered economy.[12] However, there are many environmental consequences of industrial scale shale gas development[13] that invoke important policy considerations about the role that natural gas will play for national and regional energy and climate change strategies. These concerns are compounded by a federal and state regulatory patchwork that critics argue does not provide sufficient environmental protection, particularly water and air resources.[14]

8. *Hydraulic Fracturing: Fact Sheet*, CHESAPEAKE ENERGY (Sept. 2011), http://www.chk.com/Media/Educational-Library/Fact-Sheets/Corporate/Hydraulic_Fracturing_Fact_Sheet.pdf.

9. *Id.*

10. NEW YORK STATE DEP'T OF ENVTL. CONSERVATION DRAFT SUPPLEMENTAL GENERIC ENVTL. IMPACT STATEMENT ON THE OIL, GAS AND SOLUTION MINING REGULATORY PROGRAM 9-2 (Sept. 2009) [hereinafter DSGEIS]; *see also*, NEW YORK STATE DEP'T ENVTL. CONSERVATION REVISED DRAFT SUPPLEMENTAL GENERIC ENVIRONMENTAL IMPACT STATEMENT ON THE OIL, GAS AND SOLUTION MINING REGULATORY PROGRAM 9-2 (Sept. 2011) [hereinafter REVISED DSGEIS].

11. U.S. ENERGY INFO. ADMIN., *Today in Energy: Pennsylvania Drives Northeast Natural Gas Production Growth* (Aug. 30, 2011), http://www.eia.gov/todayinenergy/detail.cfm?id=2870 (last visited Dec. 5, 2011) [hereinafter EIA, *Pennsylvania Drives Northeast Natural Gas Production Growth*].

12. *See, e.g.*, PODESTA & WIRTH, *supra* note 7, at 1; *see also* Barack Obama, President, United States of America, State of the Union Address (Jan. 25, 2011), *available at* http://abcnews.go.com/Politics/State_of_the_Union/state-of-the-union-2011-full-transcript/story?id=12759395.

13. *See, e.g.*, CRAIG MICHAELS ET AL., FRACTURED COMMUNITIES: CASE STUDIES OF THE ENVIRONMENTAL IMPACTS OF INDUSTRIAL GAS DRILLING 4 (2010); AMY MALL, DRILLING DOWN: PROTECTING WESTERN COMMUNITIES FROM THE HEALTH AND ENVIRONMENTAL EFFECTS OF OIL AND GAS PRODUCTION (2007); GASLAND: A FILM BY JOSH FOX (Int'l WOW Co. 2011), *available at* http://www.gaslandthemovie.com.

14. Hydraulic fracturing raises many other environmental and human health concerns beyond air and water impacts. This article focuses on a narrow selection of air and water impacts associated with hydraulic fracturing.

Without comprehensive federal and state regulations backed with adequate enforcement, natural gas, and shale gas in particular, may not be the "bridge to a clean energy future" unless these environmental impacts are adequately addressed.

Part I of this comment provides a brief overview of recent shale gas developments in the United States. Part II discusses the potential role of domestic natural gas, with a focus on shale gas, as a bridge fuel from coal and oil to cleaner renewable resources. Part III discusses some of the water and air resource pollution concerns arising from hydraulic fracturing and shale gas development. Part IV highlights the proposal to develop the Marcellus Shale in New York State and argues that the decision on whether to develop the Marcellus marks a crossroads in terms of energy and climate policy and environmental leadership. This Part argues that a decision to postpone development would allow the State more time to promulgate adequate shale gas regulations and fund a robust enforcement regime. Part V concludes that while natural gas has some significant benefits over coal and oil, the environmental tradeoffs of shale gas development are not adequately mitigated under New York's current regulatory structure and a decision to postpone or forego development of the Marcellus Shale actually furthers New York State's long-term climate and energy policy goals.

I. THE SHALE GAS BREAKTHROUGH

Shale gas formations are tight rock formations containing vast amounts of natural gas. The Energy Information Administration's (EIA) 2011 Annual Energy Outlook estimates that the technically recoverable unproved natural gas reserves locked in shales in the United States are 827 trillion cubic feet.[15] This figure was revised from the 347 trillion cubic feet estimated in the 2010 Annual Energy Outlook.[16] The report attributes the dramatic increase in estimated reserves to new information gained through increased drilling activity in both existing and new shale formations such as the Marcellus, Haynesville, and

15. EIA, OUTLOOK, *supra* note 5, at 8.
16. *Id.*

Eagle Ford.[17] The shale gas formations represent a large portion of America's natural gas potential as development has become technologically and economically feasible through horizontal drilling, hydraulic fracturing, and until recently, high natural gas prices.[18]

The EIA however, has indicated that these projections will be reduced dramatically in light of new information.[19] In August 2011, the United States Geological Survey (USGS) estimated the Marcellus Shale contains approximately 84 trillion cubic feet of natural gas, as opposed to the earlier EIA estimates of approximately 410 trillion cubic feet.[20] While significantly lower than the EIA estimates for the Marcellus, the USGS 2011 estimate is an increase from its 2002 estimate of two trillion cubic feet.[21]

Despite these revisions, shale gas plays an important role in the United States' energy portfolio. In 2010, shale gas comprised twenty-three percent of the United States natural gas supply at 4.87 trillion cubic feet of gas.[22] By 2035, it is estimated that shale gas production will account for approximately forty-six percent of all United States natural gas production.[23] The Department of Energy notes that "three factors have come together in recent years to make shale gas production economically viable: (1) advances in horizontal drilling; (2) advances in hydraulic fracturing; and, perhaps most importantly, (3) rapid increases in

17. *Id.*

18. *See, e.g.*, EIA, *Pennsylvania Drives Northeast Natural Gas Production Growth*, *supra* note 11 (Pennsylvania has experienced rapid growth in natural gas production from hydraulic fracturing in the Marcellus Shale).

19. *See* JAMES L. COLEMAN ET. AL., ASSESSMENT OF UNDISCOVERED OIL AND GAS RESOURCES OF THE DEVONIAN MARCELLUS SHALE OF THE APPALACHIAN BASIN PROVINCE, FACT SHEET, U.S. GEOLOGICAL SURVEY (2011), *available at* http://pubs.usgs.gov/fs/2011/3092; *see also* Ian Urbina, *Geologists Sharply Cut Estimates of Shale Gas*, N.Y. TIMES, Aug. 24, 2011, at A16, *available at* http://www.nytimes.com/2011/08/25/us/25gas.html?_r=1&ref=ianurbina.

20. Urbina, *supra* note 19.

21. *Id.*

22. U.S. ENERGY INFO. ADMIN. *Today in Energy: Shale Gas is a Global Phenomenon* (Apr. 5, 2011), http://www.eia.gov/todayinenergy/detail.cfm?id=811# [hereinafter EIA, *Shale Gas is a Global Phenomenon*].

23. *Id.* (However, as noted earlier, the EIA has indicated that it will revise its Marcellus Shale estimates in accordance with the USGS estimates. It is not clear how this revision will affect the EIA long-term outlook).

natural gas prices in the last several years as a result of significant supply and demand pressures."[24]

Some of the largest shale gas deposits in the United States include the Barnett formation in Texas, the Fayetteville in Arkansas, the Haynesworth in Oklahoma, and the Marcellus in the mid-Atlantic.[25] The most developed formation is the Barnett, producing over six percent of all United States natural gas in the lower forty-eight states.[26] Production in the Barnett increased from less than 200 billion cubic feet in 1998 to over one trillion cubic feet in 2007. Over 1,100 permits were issued to drill the Barnett in 2004 and by 2008 the Texas Railroad Commission was on track to issue over 4,000.[27]

The Marcellus formation is also rapidly developing but production has been largely limited to Pennsylvania.[28] Between 2008 and 2010, gas developers drilled 2,349 Marcellus wells in Pennsylvania, with 1,386 of those wells drilled in 2010 alone.[29] The more recent exploration and development of the Marcellus formation and the continuing development of other formations such as the Haynesville and Eagle Ford led the Energy Information Administration to almost double its technically

24. U.S. DEP'T OF ENERGY, OFFICE OF FOSSIL ENERGY, NATIONAL ENERGY TECHNOLOGY LABORATORY: MODERN SHALE GAS DEVELOPMENT IN THE UNITED STATES: A PRIMER, at ES-1 (2009), *available at* http://www.eogresources.com/responsibility/doeModernShaleGasDevelopment.pdf. (However, since 2009 natural gas prices and forecasts have been significantly below the 2009 forecast).

25. *Id.* at ES-2

26. *Id.* at ES-1.

27. AL ARMENDARIZ, EMISSIONS FROM NATURAL GAS EMISSIONS IN THE BARNETT SHALE AREA AND OPPORTUNITIES FOR COST EFFECTIVE IMPROVEMENTS 3 (2009) *available at* http://www.edf.org/sites/default/files/9235_Barnett_Shale_Report.pdf.

28. *See* EIA, *Pennsylvania Drives Northeast Natural Gas Production Growth*, *supra* note 11. While significant portions of the Marcellus also underlie New York State, development has been limited to vertical drilling because horizontal drilling combined with hydraulic fracturing is effectively banned until the issuance of the Final Supplemental Generic Environmental Impact Statement (FSGEIS).

29. Office of Oil & Gas Mgmt., *Permit Drilled Maps,* PA. DEP'T OF ENVTL. PROT. (last updated Nov. 9, 2011), http://www.dep.state.pa.us/dep/deputate/minres/oilgas/2011PermitDrilledmaps.htm.

recoverable reserves forecast, as indicated above.[30] Despite the USGS downward revision of the EIA estimate, the long-term price projections remain low and stable. Current forecasts estimate wellhead prices will remain under five dollars per thousand cubic feet through 2022 and gradually increase to just over six dollars and fifty cents by 2035.[31] This is a change from recent years when the national average prices for natural gas reached nearly fourteen dollars per thousand cubic feet.[32]

II. NATURAL GAS AS A BRIDGE FUEL

The demand for energy resources continues to grow worldwide and the strategic development of natural gas in the United States represent an opportunity to make important advances in the future of America's energy security and climate initiatives. New discoveries and advances in technology make it more likely that natural gas, and particularly shale gas, will play a critical role in America's energy future.[33]

Natural gas is a versatile energy source that is used in electricity generation and transportation sectors, and in residential, commercial and industrial sectors.[34] Because of this versatility, low natural gas prices could impact long-term investment trends in electricity generation and the transportation sector, two areas where there has been much interest in utilizing more natural gas.[35]

In 2009, forty-five percent of the United States' electricity was generated by coal.[36] However, while coal is "cheap," it contributes twice as many greenhouse gas emissions and more nitrogen oxides, particulate matter, and sulfur dioxide than

30. EIA, OUTLOOK, *supra* note 5, at 8.

31. *Id.* at 4.

32. *Residential Natural Gas Prices: What Consumers Should Know*, U.S. ENERGY INFO. ADMIN. 1 (2007), http://www.puc.state.mn.us/portal/groups/public/documents/pdf_files/011724.pdf.

33. *See, e.g.*, *id*; PODESTA & WIRTH, *supra* note 7, at 1.

34. EIA, OUTLOOK, *supra* note 5, at 4-5.

35. *Natural Gas Demand*, NATURALGAS.ORG, http://www.naturalgas.org/business/demand.asp (last visited Nov. 29, 2011).

36. EIA, OUTLOOK, *supra* note 5, at 1.

natural gas at the point of combustion.[37] Transitioning from coal-fired generating capacity to renewable generation sources such as wind and solar is imperative to meeting long-term greenhouse gas emission reduction goals and providing cleaner energy resources. While this transition will take time, market and regulatory policy frameworks incentivizing renewable energy integration will likely favor natural gas as a transition fuel.[38]

Natural gas-fired electric generation is more efficient than coal-fired generation and natural gas power plants are a viable firming resource for intermittent sources such as wind and solar.[39] The Center for American Progress notes that ten gigawatts of natural gas-powered generation capacity was installed over the past two decades but currently only about two-fifths of that capacity is used.[40] The implication is that excess natural gas-fired generating capacity exists sufficient to substitute for much of the United States' present coal fired generation without the construction of new infrastructure.[41]

While the United States electricity sector is currently largely dependent upon coal, natural gas and nuclear power—all of which are largely domestically sourced—the United States transportation sector is not so similarly positioned in terms of diversity or availability of domestic resources. Nearly fifty percent of the petroleum products consumed in the United States were imported in 2010,[42] with the transportation sector consuming over seventy percent of all oil used.[43] Unstable political regimes in the heart of the world's oil producing regions,

37. PODESTA & WIRTH, *supra* note 7, at 1.

38. *See e.g.*, NEW YORK STATE ENERGY PLAN, NATURAL GAS ASSESSMENT 2009, NYSERDA 22 (Dec. 2009).

39. PODESTA & WIRTH, *supra* note 7, at 3; *see also* OTTINGER ET AL., ENVIRONMENTAL COSTS OF ELECTRICITY (1991).

40. PODESTA & WIRTH, *supra* note 7, at 3.

41. *Id.*; *but see Natural Gas Key to Backing up Renewable Power*, ELECTRICENERGYONLINE.COM (Mar. 16, 2011), http://www.electricenergyonline.com/?page=show_news&id=151053 (recognizing significant installed generating and transportation capacity exists, but highlighting other issues such as firm transportation capacity and grid reliability concerns).

42. *How Dependent are we on Foreign Oil?*, U.S. ENERGY INFO. ADMIN (June 24, 2011), http://www.eia.gov/energy_in_brief/foreign_oil_dependence.cfm.

43. *Energy Independence*, AMERICAN ENERGY INDEPENDENCE.COM, http://www.americanenergyindependence.com/ (last visited Nov. 29, 2011).

oil embargoes, supply disruptions resulting from natural disasters such as hurricane Katrina, and accidents such as the BP oil spill have led every American President since Richard Nixon to proclaim the need to reduce America's dependence on foreign oil.[44] While there are many ideas of how to wean America off the "oil addiction," the basic premises of Texas oil baron, T. Boone Pickens' "Pickens Plan" have gained significant attention from Congress and the Obama Administration.[45] Pickens argues that the United States can reduce dependence on OPEC oil by half in seven years by switching the United States' heavy vehicle fleet to run on natural gas.[46]

In the electric generation sector, utilizing natural gas as an alternative fuel to coal is attractive because natural gas emits less carbon than coal at the point of combustion. In the transportation sector, the Pickens Plan is appealing in the face of high oil prices and relatively abundant domestic natural gas supplies. However, there are significant tradeoffs. The climate benefits become less attractive after the life cycle analyses of natural gas derived from hydraulic fracturing are compared to those of conventionally derived natural gas. Some reports indicate that combined greenhouse gas emissions released though shale gas production and subsequent combustion may be greater than the emissions released from coal.[47]

The recent boom in shale gas production has exposed other environmental and human health impacts associated with

44. *Energy Independence*, PICKENSPLAN, http://www.pickensplan.com/energy_independence/ (last visited Oct. 10, 2011).

45. Dave Michaels, *Obama Endorses Pickens Plan for Natural Gas Vehicles*, THE DALLAS MORNING NEWS (Mar. 30, 2011), http://www.dallasnews.com/business/energy/20110330-obama-endorses-pickens-plan-for-natural-gas-vehicles.ece.

46. Texas Propane Fleets, *T. Boone Pickens Takes on OPEC*, RAILROAD COMMISSION OF TEXAS PUBLIC OUTREACH & EDUCATION BLOG (Sept. 20, 2010), http://blogs.rrc.state.tx.us/TPF/?p=777.

47. RUTH WOOD ET AL., THE TYNDALL CTR., SHALE GAS: A PROVISIONAL ASSESSMENT OF CLIMATE CHANGE AND ENVIRONMENTAL IMPACTS 8 (2011), *available at* http://www.tyndall.ac.uk/sites/default/files/tyndall-coop_shale_gas_report_final.pdf; ROBERT W. HOWARTH ET AL., METHANE AND GREENHOUSE GAS FOOTPRINT OF NATURAL GAS AND SHALE FORMATIONS 9 (2011), *available at* http://www.sustainablefuture.cornell.edu/news/attachments/Howarth-EtAl-2011.pdf; *see generally*, TOM M. L. WIGLEY, COAL TO GAS: THE INFLUENCE OF METHANE LEAKAGE (2011).

hydraulic fracturing as well.[48] These impacts have resulted in opposition to hydraulic fracturing in communities across the country and raised questions about natural gas' "clean" credentials.[49] In a recent interview on the "Daily Show," Jon Stewart spoke with T. Boone Pickens about hydraulic fracturing, asking: "[i]t sounds too good to be true so it must be. Is it horribly unsafe; is that what this fracking is? Is [it] that we can't do it without poisoning the country? What is it that is keeping us from doing it?"[50] While T. Boone Pickens maintains that he has never seen fracking damage "anything,"[51] critics of hydraulic fracturing reference increasing environmental damage to air, water and land resources as well as human health impacts related to the practice.[52]

III. WATER AND AIR POLLUTION

As noted above, the EIA's long-term projections estimate that over forty-five percent of all natural gas produced in the United States by 2035 will come from shale gas. Experience in shale gas-producing states reveals that hydraulic fracturing has significant impacts on water and air resources; with nearly half the country's natural gas supply expected to come from shale, the long-term consequences must be considered and addressed now. Reports of shale gas development in Colorado, Wyoming, Texas, and Pennsylvania highlight numerous water and air contamination problems that have arisen from shale gas production.[53] Improper

48. *See e.g.* MICHAELS ET AL., *supra* note 13; MALL, *supra* note 13; GASLAND, *supra* note 13.

49. *See e.g. id.*; *see also* WOOD ET. AL., *supra* note 47; HOWARTH ET AL., *supra* note 47; WIGLEY, *supra* note 47.

50. Interview with T. Boone Pickens, founder and chairman of BP Capital Management, The Daily Show (Jan. 27, 2011), *available at* http://www.thedailyshow.com/watch/thu-january-27-2011/t--boone-pickens.

51. *Id.*

52. S*ee, e.g.*, MICHAELS ET AL., *supra* note 13; MALL, *supra* note 13; GASLAND, *supra* note 13; KATE SINDING, PROTECTING NEW YORKERS' HEALTH AND THE ENVIRONMENT BY REGULATING DRILLING IN THE MARCELLUS SHALE 9, 14 (2009).

53. S*ee, e.g.*, MICHAELS ET AL., *supra* note 13, at 5; MALL, *supra* note 13; SINDING, *supra* note 52 at 9, 14 (2009); GASLAND, *supra* note 13; Ian Urbina, *E.P.A Steps up Scrutiny of Pollution of Pennsylvania Rivers*, N.Y. TIMES, Mar.

well casing, lax on-site wastewater storage practices and perhaps even the hydraulic fracturing process itself, can allow natural gas constituents to migrate into and permanently contaminate underground aquifers and private wells.[54] The dumping of flowback waters into streams and onto roads contaminates surface waters and improperly treated fracking wastewater at sewage treatment plants (often defined as publicly owned treatment works or "POTWs") damage streams and drinking water supplies, putting human and ecological health at risk.[55]

Air pollutants in the form of volatile organic compounds (VOCs) and nitrous oxides (NOx), which are precursors to ground level ozone, a respiratory hazard, arise from the concentrated operation of diesel pumps, truck traffic, and on-site generators.[56] Methane gas, a highly potent greenhouse gas, and other pollution constituents are released through the drilling, fracturing, venting, flaring, condensation, and transportation processes of a well's lifecycle.[57]

A. Water Pollution

The New York State Department of Environmental Conservation (NYS DEC or DEC) estimates that the hydraulic fracturing process requires anywhere from 2.9 million to 7.8 million gallons of injected water combined with chemicals and sand to fracture a single well, depending on the depth of the well and geology of the area.[58] DEC estimates that over the next thirty years, "there could be up to 40,000 wells developed with the high volume hydraulic fracturing technology."[59] Reports from hydraulic fractured wells in northern Pennsylvania indicate that between nine and thirty-five percent (or 216,000 to 2.8 million

8, 2011, at A12, *available at* http://www.nytimes.com/2011/03/08/ science/earth/ 08water.html?ref=ianurbina.

54. MICHAELS ET AL., *supra* note 13 at 3.

55. *Id.*; *see also* Urbina, *supra* note 53.

56. *See* REVISED DSGEIS, *supra note* 10, at 6-93 – 6-96.

57. *See, e.g.*, GASLAND, *supra* note 13; ARMENDARIZ, *supra* note 27, at 7.

58. DSGEIS, *supra* note 10, at 5-92 – 5-93 (while these are general estimates, the DSGEIS notes that applications on file with the DEC propose a water demand for single wells to be on the lower end of this range).

59. REVISED DSGEIS, *supra* note 10, at 6-6.

gallons) of the water-chemical solution used in fracking returns as "flowback" before a well begins to produce gas.[60] Handling and treating these high volumes of flowback water is a significant operational challenge of extracting shale gas and one that has not been met in some states.

The treatment of flowback waters has proven a persistent challenge in Pennsylvania, causing environmental damage that regulators in some areas have been slow to address.[61] Former Pennsylvania Department of Environmental Protection (DEP) Commissioner John Hanger said in a DEP press release in April 2010:

> The treating and disposing of gas drilling brine and fracturing wastewater is a significant challenge for the natural gas industry because of its exceptionally high total dissolved solid (TDS) concentrations. . . . Marcellus drilling is growing rapidly and our rules must be strengthened now to prevent our waterways from being seriously harmed in the future.[62]

However, the DEP has largely limited its regulatory oversight on the issue of wastewater disposal at POTWs to a request that shale gas producers "voluntarily" cease disposing of flowback water at some POTWs.[63]

The issue of improper treatment of hydraulic fracturing wastewater is compounded by specific exemptions for hydraulic fracturing from certain federal environmental laws. For example,

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60. DSGEIS, *supra* note 10, at 5-97.

61. *See, e.g.*, Don Hopey, *Bromide: A Concern in Drilling Wastewater*, PITTSBURGH POST-GAZETTE (Mar. 13, 2011), http://www.post-gazette.com/pg/11072/1131660-113.stm; Marc Levy, *Fracking Wastewater Disposal Process to be Altered in Pennsylvania*, HUFFINGTON POST (Apr. 19, 2011), http://www.huffingtonpost.com/2011/04/20/fracking-wastewater-disposal-pennsylvania_ n_851441.html.

62. Pa. Dep't of Envtl Prot., *PA Must Take Action to Protect Water Resources from Drilling Wastewater, Other Sources of TDS Pollution: Proposed Rules will Help Keep Drinking Water, Streams and Rivers Clean*, THE STREET (Apr. 6, 2010, 6:58 PM), http://www.thestreet.com/story/10719496/pa-must-take-action-to-protect-water-resources-from-drilling-wastewater-other-sources-of-tds-pollution.html.

63. Robbie Brown, *Gas Drillers Asked to Change Method of Waste Disposal*, N.Y. TIMES, Apr. 19, 2011, at A16, *available at* http://www.nytimes.com/2011/04/20/us/20gas.html.

the Energy Policy Act of 2005 amended the Safe Drinking Water Act (SDWA) to largely exempt gas drillers from the SDWA, from EPA regulation, and from disclosure of the chemicals used in hydraulic fracturing operations.[64] While some states such as New York would require drillers to meet higher standards,[65] industry has largely fought efforts to force public disclosure as well as federal efforts to study the impacts of chemicals used in hydraulic fracturing on drinking water.[66]

Independent analysis of products used in some western states for the production of oil and gas revealed more than 350 products containing hundreds of chemicals, the vast majority of which have known adverse effects on human health and the environment.[67] However, industry feet dragging on public disclosure has contributed to incomplete knowledge of the chemical makeup and concentrations used in fracturing fluids, and the full extent of the risk the chemicals pose to human and environmental health is unknown.[68] The NYS DEC advised in its Revised Draft Supplemental Generic Environmental Impact Statement (Revised dSGEIS) that:

> There is little meaningful information one way or the other about the potential impact on human health of chronic low level exposures to many of these chemicals, as could occur if an aquifer were to be contaminated as the result of a spill or release that is undetected and/or unremediated.[69]

Incomplete knowledge of the chemical constituents injected into wells during the fracturing process raise concerns about

64. 42 U.S.C. § 300h(d)(1) (2006).

65. *EFFECT OF FEDERAL SAFE DRINKING WATER ACT, CLEAN WATER ACT, AND EMERGENCY PLANNING AND COMMUNITY RIGHT-TO-KNOW ACT*, N.Y. DEP'T OF ENVTL. CONSERVATION, http://www.dec.ny.gov/energy/46445.html (last visited Nov. 29, 2011).

66. *See*, *e.g.*, Timothy Gardner, *EPA Subpoenas Halliburton*, REUTERS (Nov. 9, 2010), http://www.reuters.com/article/idUSTRE6A83YY20101109 (in November, 2010 the EPA requested nine fracking service companies to disclose the chemicals they use in hydrofracking operations. Eight responded voluntarily, however EPA had to subpoena Halliburton before it would cooperate.).

67. MALL, *supra* note 13, at 6.

68. REVISED DSGEIS, *supra* note 10, at 5-75.

69. REVISED DSGEIS, *supra* note 10, at 5-75.

understanding their effects on people and how to treat acute and chronic exposure. Further, as noted above, the fracturing fluids that return to the surface in flowback wastewaters create particularly daunting treatment challenges. The fracking solution pumped into the wells dissolves large quantities of salts, heavy metals such as barium and strontium, and radioactive materials.[70] When the water returns to the surface, it is stored for reuse, recycled, or treated and disposed. Currently, Pennsylvania is the only state that allows for the primary method for disposal of drilling wastewaters at POTWs.[71] Many POTWs are incapable of treating fracking wastewater and discharges of untreated fracking wastewater into surface waters create environmental and human health hazards.[72] The chemicals, radioactivity levels, and high salt concentrations pose difficulties for managers because most POTWs are not equipped to test for or treat all of these substances.[73] John H. Quigley, former Pennsylvania Secretary of the Department of Conservation and Natural Resources, stated:

> [w]e're burning the furniture to heat the house . . . [i]n shifting away from coal and toward natural gas, we're trying for cleaner air, but we're producing massive amounts of toxic wastewater with salts and naturally occurring radioactive materials, and it's not clear we have a plan for properly handling this waste.[74]

70. David Caruso, *Pennsylvania Allows Dumping of Polluted Waters from Natural Gas Hydrofracking*, POSTSTAR.COM (Jan. 3, 2011, 11:43 AM), http://poststar.com/news/local/article_ec61d5ce-175a-11e0-9b3c-001cc4c03286.html.

71. *Id.*

72. Ian Urbina, *Regulation Lax as Gas Wells' Tainted Water Hits Rivers*, N.Y. TIMES, Feb. 27, 2011, at A1, *available at* http://www.nytimes.com/2011/02/27/us/27gas.html?ref=ianurbina.

73. *See id.*; Pam Kasey, *Gas Well Drilling Brine Challenges Water Treatment Plants*, TIMESWV (Dec. 15, 2008), http://timeswv.com/todaystopnews/x681691547/Gas-Well-Drilling-Brine-Challenges-Water-Treatment-Plants; *see generally* A.W. GAUDLIP ET AL., MARCELLUS SHALE WATER MANAGEMENT CHALLENGES IN PENNSYLVANIA (2008), *available at* http://s3.amazonaws.com/propublica/assets/monongahela/MarcellusShaleWaterManagementChallenges%2011.08.pdf (discussing the development of alternatives to POTWs for treating high volumes of heavily brine laden flowback water).

74. Urbina, *supra* note 72.

Former DEP Commissioner John Hanger stated that twenty-six miles of Dunkard Creek, located in Greene County, Pennsylvania, were destroyed by excessive TDS levels. TDS concentrations from drilling fluids can contain up to five times the salt as sea water.[75] These high levels, along with changes in temperature and nutrient concentrations, allowed a "golden algae to bloom" and created such an inhospitable environment that it destroyed aquatic life, including "at least sixteen species of freshwater mussels and eighteen species of fish."[76] These issues have not escaped the attention of the EPA, which noted particular concern over increased bromide levels resulting from improperly treated drilling wastewaters entering drinking water sources.[77] Bromides react with chlorine disinfectants used in drinking water treatment plants and create the disinfection by-product trihalomethane. EPA has labeled trihalomethane a potential hazard and set federal safe drinking water standards at 80 micrograms per cubic liter.[78]

Facing increasing scrutiny from the EPA, Pennsylvania DEP acknowledged that most POTWs are not capable of properly treating drilling wastewaters and requested fracking operators to cease taking drilling wastes to the fifteen treatment plants still accepting it.[79] While voluntary requests to cease common disposal practices have yet to become translated to enforceable regulations, drilling operators in Pennsylvania have begun

75. GUADLIP ET AL., *supra* note 73, at 5, 7 (noting that flowback waters can have concentrations of TDS, soluble salts, of up to 200,000 mg/l; compared to normal seawater which has a TDS concentration of about 40,000 mg/l).

76. *PA Must Take Action to Protect Water Resources from Drilling Wastewater, Other Sources of TDS Pollution: Proposed Rules will Help Keep Drinking Water, Streams and Rivers Clean*, PA. DEP'T OF ENVTL. PROT. (Apr. 6, 2010), http://www.portal.state.pa.us/portal/server.pt/community/newsroom/14287?id=10349&typeid=1.

77. David B. Caruso, *Pennsylvania wants to end Gas Drilling Wastewater Discharge*, ASSOCIATED PRESS (Apr. 19, 2011), http://nhjournal.com/2011/04/19/pa-wants-to-end-gas-drilling-wastewater-discharge/.

78. Hopey, *supra* note 61.

79. Levy, *supra* note 61.

developing alternative disposal methods, such as recycling and reusing flowback water; albeit to a limited extent.[80]

B. Air Pollution

Hydraulic fracturing also impacts air quality. Shale gas production requires thousands of trucks to both deliver the millions of gallons of water needed for the fracturing process and to haul hundreds of thousands of gallons of flowback wastewater for disposal.[81] The well drilling and fracking process, well completion, and gas production all require the use of generators, compressors, high powered mobile diesel engines, and condensate tanks, as well as flaring, and venting techniques.[82] These processes and techniques combine to release large amounts of methane, fine particulate matter and VOCs.[83] VOCs are ground level ozone precursors, and methane is a highly potent greenhouse gas.[84] Benzene, toluene, and formaldehyde are used in fracking and are some common VOCs that react with sunlight to create ground level ozone, which can cause respiratory diseases such as asthma, bronchitis or emphysema.[85]

Oil and gas production are among the largest sources of VOCs in the Rocky Mountain region.[86] Extremely high ozone levels in Sublette County, Wyoming—a town with a population of less than 9,000 people—have been attributed to the natural gas drilling boom there.[87] Ozone levels in Sublette County reached 143 parts per billion (ppb) on March 1, 2011 and 124 ppb on March 2, 2011.[88] In 2010, the worst ozone levels in Los Angeles

80. Ian Urbina, *Wastewater Recycling no Cure-All in Gas Process*, N.Y. TIMES, Mar. 1, 2011, at A1, *available at* http://www.nytimes.com/2011/03/02/us/02gas.html?pagewanted=all.

81. REVISED DSGEIS, *supra* note 10, at 6-302.

82. *See id.* at 6-187 – 6-190.

83. *See, e.g.* ARMENDARIZ, *supra* note 27, at 5-7.

84. MALL, *supra* note 13, at 8.

85. *Id.*

86. *Id.*

87. *EPA Chief Tours Wyoming Gas Field Known for Air Pollution*, BILLINGS GAZETTE (May 22, 2009, 12:00 AM), http://billingsgazette.com/news/state-and-regional/wyoming/article_9e2caa72-393e-56d6-847f-8720211f2462.html.

88. Cory Hatch, *Sublette Ozone Near Double Health Limit*, JACKSON HOLE DAILY (Mar. 4, 2011), http://www.jhnewsandguide.com/article.php?art_id=7055;

reached 114 ppb.[89] With ozone levels at times reaching over twice the federal limit of 75 ppb[90] and regularly exceeding that limit in areas of Wyoming with small human populations, there appears to be a direct relationship between gas drilling and air quality.

A 2009 study of oil and gas activities in the Barnett shale in Texas provides a useful breakdown of different point sources of air pollution resulting from shale gas production processes.[91] The study broke down emissions from compressor engine exhaust, oil and condensate tanks, well drilling, hydraulic fracturing and well completions, natural gas processing, and transmission fugitives.[92] All of these emission source categories were predicted to have increases in VOCs and greenhouse gas emission levels in 2009 from 2007 levels.[93] One striking statistic from the report was that oil and gas ozone precursor emissions in the Barnett formation would exceed the mobile source ozone precursor emissions of the Dallas-Fort Worth Metropolitan area by more than thirty tons per day.[94]

While natural gas is widely hailed as the cleaner alternative to oil and coal, this characterization does not account for the air emissions impacts from the production stages of natural gas obtained through hydraulic fracturing. This observation is particularly important considering the upward trends in estimated shale gas production over the long-term.[95] Accounting for shale-derived natural gas' full air quality impacts requires analysis of the emissions produced from the production stage all the way through the combustion stage—a full life-cycle

Mead Gruver, *Wyoming Air Pollution Worse than Los Angeles Due to Gas Drilling*, HUFFINGTON POST (Mar. 8, 2011), http://www.huffingtonpost.com/2011/03/08/wyoming-ait-pollution-gas-drilling_n_833027.html.

89. Gruver, *supra* note 88.
90. Hatch, *supra* note 88.
91. *See* ARMENDARIZ, *supra* note 27.
92. *Id.* at 21-24.
93. *Id.* at 22.
94. *Id.* at 25.
95. EIA, *Shale Gas is a Global Phenomenon*, *supra* note 22.

analysis.[96] As noted earlier, preliminary life-cycle analyses of shale gas production indicate that air quality climate impacts are significantly greater than the impacts from the point of combustion alone, and could contribute as much—or more—greenhouse gas emissions than coal.[97] These findings and the increasingly high environmental costs of hydraulic fracturing indicate that natural gas' "clean credentials" are not what they appear and begs the question whether natural gas is really the clean alternative that can be a "bridge fuel" to a clean energy future.[98]

IV. CONSIDERATIONS FOR NEW YORK STATE

Identifying the environmental and human health impacts associated with shale gas development are an essential component of crafting regulations and policies that recognize regional and local impact variability and the overall cumulative impacts of industrialized natural gas development in New York State. The NYS DEC's Revised dSGEIS discusses many of these impacts,[99] but does not sufficiently address how it will mitigate these impacts in light of the experience of other shale gas developing states.

In New York State, permit applicants must have a plan for wastewater disposal before a permit to drill can be issued. Title Six of the New York Code of Rules and Regulations (NYCRR) section 554.1(c)(1) requires submission and approval of a fluid disposal plan "prior to the issuance of a well drilling permit for any operation in which the probability exists that brine, salt water or other polluting fluids will be produced or obtained during drilling operations in sufficient quantities to be

96. Life cycle analysis is already required for biofuels to meet federal renewable fuel standards. *See* JAMES VAN NOSTRAND & ANNE MARIE HIRSCHBERGER, BIOFUELS 21 (2010).

97. *See generally* WOOD ET AL., *supra* note 47; HOWARTH ET AL., *supra* note 47; WIGLEY, *supra* note 47.

98. *See e.g.*, PODESTA AND WIRTH, *supra* note 7.

99. REVISED DSGEIS, *supra* note 10. In conjunction with the release of the revised dSGEIS, NYS DEC also released proposed regulations for high volume horizontal hydraulic fracturing. *See High Volume Hydraulic Fracturing Proposed Regulations*, N.Y. STATE DEP'T OF ENVTL. CONSERVATION, http://www.dec.ny.gov/regulations/77353.html.

deleterious to the surrounding environment . . ."[100] The DEC identifies three primary methods of disposing of flowback waters: treatment at POTWs, underground injection wells, and industrial treatment plants.[101] Pennsylvania POTW operators' experience treating flowback waters indicates that DEC's reliance on POTWs as a viable, large scale treatment option is not well-founded.

Further, DEC's own assessments of New York States' POTW capabilities show this option should be largely unavailable to drillers because the State's drinking water resources cannot be protected if POTWs accept the anticipated high volume of drilling wastewater that will be produced from 40,000 new wells.[102] There are currently 610 POTWs in operation in New York State.[103] The DEC reports that one quarter of those POTWs are operating beyond their useful life capacity and "many others are using outmoded, inadequate technology, increasing their likelihood of tainting our waters."[104] Of these 610 facilities, DEC listed only 135 as having the ability to treat flowback fluid.[105] ProPublica, a nonprofit journalism group, contacted 109 of the 135 plants and found that operators from only three have any interest in accepting flowback water.[106] Additionally, ProPublica reported that of the dozen out-of-state plants listed by DEC, nine would not take any more flowback fluid because they have already reached their capacity.[107]

DEC also notes that no POTWs in New York currently have TDS specific treatment technologies.[108] This is important in light of the experience of POTWs in Pennsylvania and indicates that

100. 6 N.Y.C.R.R. 554(c)(1) (2011).

101. DSGEIS, *supra* note 10, at 5-119.

102. REVISED DSGEIS, *supra* note 10, at 6-6.

103. NEW YORK STATE DEP'T OF ENVTL. CONSERVATION, *A GATHERING STORM: NEW YORK WASTEWATER INFRASTRUCTURE IN CRISIS* (2011), http://www.dec.ny.gov/chemical/48803.html.

104. *Id.*

105. Joaquin Sapien & Sabrina Shankman, *Drilling Wastewater Disposal Options in N.Y. Report Have Problems of Their Own*, PROPUBLICA (Dec, 29, 2009), http://www.propublica.org/article/drill-wastewater-disposal-options-in-ny-report-have-problems-1229.

106. *Id.*

107. *Id.*

108. REVISED DSGEIS, *supra* note 10, at 6-62.

POTWs in New York are at risk of violating safe drinking water standards by accepting non-pretreated drilling wastewater.[109] The implications of this issue are significant considering DEC's reliance of POTWs as a potential disposal option for drilling wastewater in New York, particularly when certified POTW infrastructure is currently unavailable.

While New York State does require a wastewater disposal plan as a prerequisite for permit issuance, ProPublica and DEC's POTW analysis, coupled with cutbacks in the DEC staff and budget, raise questions about the ability of the State to enforce environmental regulations.[110] The wastewater treatment issues associated with hydraulic fracturing are one example of the impacts that large-scale development of the Marcellus Shale can have on the environment and it highlights an important point. Gas drilling has unintended consequences and hidden costs such as declining surface water quality, increased road maintenance as a result of dramatic increases in heavy truck traffic and increased air emissions to name only a few. These costs are not necessarily borne by drilling companies or landowners, but instead by towns, counties and states hosting the drilling. The longer term consequences include the cumulative impacts of these costs and also the consequences of path dependency resulting from industrial scale shale gas production, and are not in line with New York State's long-term climate and energy goals.

New York State has pronounced progressive policy goals of reducing climate impacts and dependence on fossil fuels. These initiatives have led to energy efficiency improvements, the promotion of new renewable energy investment, and reduced greenhouse gas emissions.[111] The New York State Climate

109. *See* Urbina, *supra* note 53.

110. *See generally* Edward McAllister, *Insight: New York at Risk from Lack of Natgas Inspectors?*, REUTERS (Jul. 29, 2011), http://www.reuters.com/article/2011/07/29/us-newyork-shale-drilling-idUSTRE76S5FA20110729.

111. *See e.g.*, *New York State Climate Action Plan Interim Report*, NEW YORK STATE CLIMATE ACTION COUNSEL (Nov. 9, 2010), *available at* http://nyclimatechange.us/InterimReport.cfm [hereinafter *Climate Action Plan*]; PAUL J. HIBBARD ET AL., THE ECONOMIC IMPACTS OF THE REGIONAL GREENHOUSE GAS INITIATIVE ON TEN NORTHEAST AND MID-ATLANTIC STATES (Nov. 15, 2011), *available at* http://www.analysisgroup.com/uploadedFiles/Publishing/Articles/Economic_Impact_RGGI_Report.pdf.

Action Plan outlines the aggressive goal of reducing greenhouse gas emissions by eighty percent by 2050.[112] Because New York is moving toward dramatic reductions in greenhouse gas emissions through the Climate Action Plan,[113] a decision to put off drilling in the near-term to develop regulatory mechanisms to address the environmental impacts would be reasonable and in line with state climate goals.

Development of the Marcellus Shale will also not significantly impact New York State's natural gas imports or supply forecasts. The state has long been a net importer of natural gas[114] and full scale development of the Marcellus would only reduce those imports by approximately six percent.[115] A decision to delay drilling would also allow New York State regulators to learn more about the impacts of hydraulic fracturing on air and water resources as well as the myriad other impacts associated with the practice. A decision to delay would also allow the State time to craft comprehensive regulations and time to structure, staff and fund a robust shale gas regulatory compliance regime.

V. CONCLUSIONS

Advances in hydraulic fracturing technology and horizontal drilling have made trillions of cubic feet of natural gas trapped in tight shales technologically and economically recoverable. Long-term projections estimate that shale gas resources will comprise over forty-five percent of the United States' natural gas production by 2035.[116] It is clear that shale gas reserves in the United States are an important domestic energy resource. It is less clear, however, that shale gas should be considered a cleaner alternative to coal or oil. Current regulatory frameworks governing shale gas production have failed to prevent recurring

112. *Climate Action Plan*, *supra* note 111, at ES1.

113. *Id*.

114. *See* NYSERDA, NATURAL GAS ASSESSMENT NEW YORK STATE ENERGY PLAN 2009 14 (Dec. 2009), *available at* http://www.nysenergyplan.com/final/Natural_Gas_Assessment.pdf (noting that 95 percent of New York State's current natural gas supply comes from out of state.).

115. *See id.* at 30.

116. EIA, *Shale Gas is a Global Phenomenon*, *supra* note 22.

and persistent environmental damage to air and water resources, putting ecological and human health at risk. These impacts indicate that shale-derived natural gas is not an environmentally sound alternative to coal or oil and raises questions about whether it should be considered a "bridge fuel."

The collective experience of shale gas development around the country shows that current hydraulic fracturing practices come with unacceptable environmental impacts. When considered from a life-cycle perspective, shale gas production can release more greenhouse gas emissions than traditional gas production and according to some studies, potentially as much as coal.[117] Other environmental impacts such as water and air pollution are major drawbacks of shale gas development. The environmental impacts of shale gas production reveal that without revisions to the regulatory frameworks governing hydraulic fracturing, environmental and climate problems will only worsen as shale gas production increases in the coming decades. National and regional energy and climate strategies that rely on shale gas as a key fuel source to transition from high-carbon fossil fuels to clean renewable sources should be closely scrutinized and revised to account for these climate and environmental impacts.

It is the duty of government to be the steward of public resources. It is my hope that the discussion surrounding shale gas development in New York State will be elevated to include a thorough accounting of the impacts to New York's other natural resources. A decision about whether to develop the Marcellus Shale should be made within the context of industry's ability to meet the highest standards of environmental compliance and New York's long-term energy and climate policy goals. As it currently stands, New York does not have the infrastructure or regulations needed to ensure that shale gas development will be conducted in a manner that is protective of the environment. New York also lacks the necessary policy framework to ensure that development of the Marcellus will further long-term energy and climate policy goals. If the State

117. *See e.g.*, WOOD ET AL., *supra* note 47; HOWARTH ET AL., *supra* note 47; WIGLEY, *supra* note 47.

addresses these issues, it could realize the benefits of the Marcellus Shale while ensuring environmental protection. However, if New York State permits development without implementing stricter environmental regulation, the Marcellus Shale will become a bridge to nowhere.