Trends in Responsible Natural Gas Development

Colorado State University

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Contents

Introduction

When we think about America's ideal future – greater security, economic stability, sustainable prosperity and a healthy environment – we confront an inescapable fact: we cannot get there without transitioning to a clean energy economy. This is not a philosophical or partisan issue. It is a physical and economic reality driven by an array of factors, from the risks of global climate change to the rapid changes underway in domestic and global energy markets. America's intricate power system has been called the greatest engineering achievement of the 20th century.[1] The modernization of that system to integrate cleaner, more sustainable and more distributed energy production will be one of the most important achievements of the 21st century.

Clean energy is arguably the biggest market opportunity in the world today – a market opportunity that includes a major role for natural gas. The size and duration of that role depends, however, on some forces the oil and gas industry cannot fully control, including government policies, the maturation of carbon capture technology, and the market penetration of competitive carbon-free energy resources. But natural gas market share also depends on factors the industry can control, including practices and policies that win the confidence of the American people and sustain the industry's social license to operate.

This paper addresses the several issues that have emerged from the boom in natural gas production and that affect the industry's social license to operate. The paper is a result of four symposia organized by Colorado State University's Energy Institute over the past four years, plus a roundtable of industry leaders convened by the Institute's Center for the New Energy Economy (CNEE) in the summer of 2013. The most recent symposium took place in September 2014 in Denver, Colorado, with more than 700 industry leaders and stakeholders in attendance.[2]

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[1] The National Academy of Engineering, *Greatest Engineering Achievements of the 20th Century*, 2000. www.mae.ncsu.edu/eischen/courses/mae415/docs/GreatestEngineeringAchievements.pdf

[2] The symposium website, www.naturalgas.colostate.edu, also received more than 2,600 page views during the week of the conference. The other four meetings with the industry and its stakeholders were annual symposia in 2011, 2012 and 2013, and a roundtable organized by CNEE in 2013 with

All of the meetings included leaders from the environment, academic and NGO communities to encourage a frank and open discussion of whether it is possible to find common ground on what "responsible" gas production means in a carbon constrained world. More specifically, the industry and its stakeholders discussed their shared concerns about the boom in gas production; if and how these issues can be resolved; and whether Colorado's experience in natural gas production and regulation offers replicable lessons on how to build greater collaboration among policy makers, regulators, environmental leaders and industry organizations.

The Situation

Era of Abundance

> "We are in an era of abundant natural gas, energy efficiency and renewable energy. Economists tell us that humans make better decisions during times of abundance – than we do when we have scarcity. We need to make a plan – in this time of abundance – that will serve future generations well. In the future, we won't have as much abundance, we won't have the same opportunity to make the right decisions – resource scarcity will limit our thinking."
> ~ Paula Gant, DAS for Oil and Natural Gas
> U.S. Department of Energy, Office of Fossil Energy

Looking ahead to 2040, the U.S. Energy Information Administration (EIA) projects in its latest reference case that the United States will become a net exporter of natural gas by 2017 and imports of all fuels will end by 2030. Domestic crude oil from tight formations will experience strong growth through 2020, and then begin to decline. EIA predicts that natural gas production will continue steady growth, increasing 56% between 2012 and 2040. The growth of domestic crude oil and natural gas production vary significantly across regions and cases, "leading to shifts in crude oil and natural gas flows between regions, requiring infrastructure adjustments, such as new builds and pipeline flow reversals."

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the assistance of the Aspen Institute and at the encouragement of the White House. The roundtable was part of CNEE's *Powering Forward* project, which produced more than 200 recommendations for presidential leadership on five energy topics including responsible natural gas production.

Long-term prices for natural gas will rise, helping electric generation from renewable fuels grow by 72% between 2013 and 2040. Because of improved energy efficiency, slow growth in energy consumption, and a shift away from more carbon-intensive fuels, the nation's carbon dioxide emissions will remain below their 2005 level through 2040. By 2040, 33% of U.S. primary energy consumption will be from petroleum and other liquids; natural gas will provide 29% while coal's contribution will be 18%, the same as in 2013. Renewable resources will make up 10% and nuclear fuels 8%.[3]

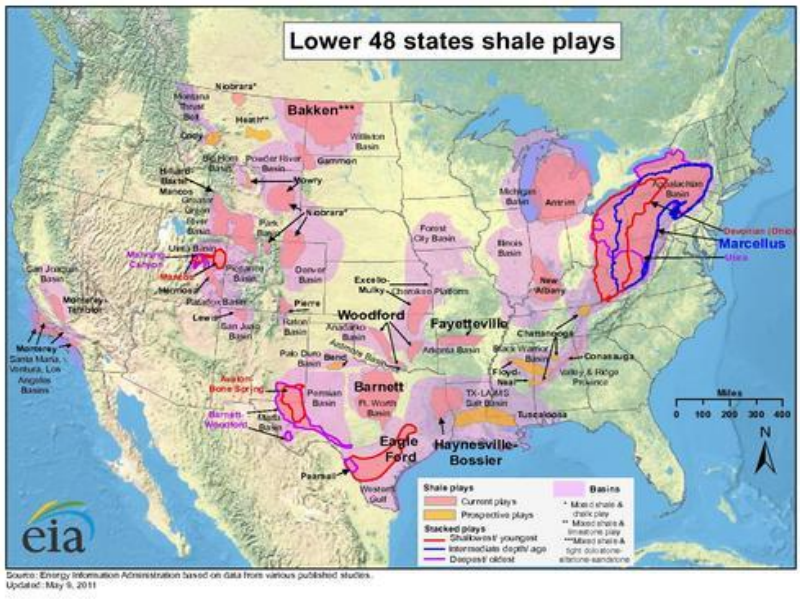

Figure 1: This map show U.S. shale gas plays in the lower 48 states, www.eia.gov/oil_gas/rpd/shale_gas.pdf

There are several reasons to keep natural gas in the energy mix indefinitely. Composed mostly of methane, it produces far less carbon dioxide, sulphur dioxide, nitrogen oxides and particulates than coal or oil. Much of the capital investment to continue using it already has been made. More than 1.5 million miles of natural gas pipelines criss-cross the lower 48 states today, delivering the fuel to virtually every part of the country. Nearly six in every 10 American households get some of their energy from natural gas. It is an

[3] EIA, *Annual Energy Outlook 2015*, April 2015. http://www.eia.gov/forecasts/aeo/pdf/0383(2015).pdf. The reference case assumes that current laws and regulations remain unchanged and GDP grows an average of 2.4% annually from 2013 to 2040. EIA's analyses do not include the possible impacts of the EPA's proposed Clean Power Plan.

important resource for commerce and industry. Natural gas generated 27% of the nation's electricity in 2013, second only to coal (39%).[4]

Colorado is the eighth largest oil producing state and fifth highest in natural gas.[5] Much of Colorado's oil production now and in the future is from tight formations of which shale is one type. The easily extracted supplies of natural gas are virtually exhausted, however. What remains are pockets of "unconventional gas" trapped in rock and coal formations (Figure 1)[6].

Until recently these deposits have been technically and/or economically unreachable. Now, two extraction techniques have led to a production boom. With the first technique, hydraulic fracturing, producers inject a pressurized mixture of water, sand and chemicals deep underground to crack rock formations and free the gas. The second technique, horizontal drilling, allows producers to reach out horizontally in all directions deep underground from a single vertical well to access unconventional gas deposits with minimal surface land disturbance.

In less than a decade, the country has gone from a period of resource constraint to resource abundance due to technological advances. The U.S. is now the world's No. 1 gas producer. Industry analysts declare that we have entered "the age of gas."[7] Technically recoverable

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[4] EIA, *What is U.S. electricity generation by energy source*?, March 2015. www.eia.gov/tools/faqs/faq.cfm?id=427&t=3

[5] 24/7wallstreet, *The 10 Most Oil Rich States*, July 2014.247wallst.com/special-report/2014/07/28/the-10-most-oil-rich-states/

[6] There currently are six main types of unconventional gas: deep gas, gas-containing shales, coal-bed methane, geo-pressurized zones, Arctic and subsea hydrates, and tight gas.

[7] GE, *The Age of Gas and the Power of Networks*, Peter C. Evans & Michael F. Farina. www.ge.com/sites/default/files/GE_Age_of_Gas_Whitepaper_20131014v2.pdf

reserves are said to be sufficient to last at least 90 years at current consumption rates.[8] To keep pace with this production, the Interstate Natural Gas Association of America (INGAA) says that the investment in midstream infrastructure needs to be on the order of $313 billion through 2035.[9]

The Industry's Social License to Operate

Several challenges have developed with the boom in gas production, however, including the real and perceived social and environmental impacts of the fuel's value chain. While industry leaders feel that some public concerns are not justified, they recognize that other concerns are legitimate and that the industry must address them to maintain its "social license to operate." The issues range from the public concerns about the chemicals used in hydraulic fracturing fluids, to methane leaks in the industry's infrastructure, to shareholder worries about the industry's climate-related risks. During the Energy Institute's 2014 symposium, one panel included stakeholders who developed the list of common concerns show in Figure 2.

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[8] EIA estimates that technically recoverable reserves in the U.S. will last 92 years at the rate of consumption in 2011. Other analysts estimate the North American reserves are sufficient to supply Canada and the United States for 150 years at current consumption rates. Technically recoverable reserves are those that are "proved" and "unproved". Proved reserves are those that can reasonably be expected to be produced under existing economic and production conditions. Unproved reserves are recoverable with current technology, but without considering current economics.

[9] INGAA, prepared by ICF International, *North American Midstream Infrastructure through 2035: Capitalizing on Our Energy Abundance*, March, 2014. www.ingaa.org/file.aspx?id=21498
This investment figure includes new mainlines, natural gas storage fields, laterals to/from storage, power plants and processing facilities, gas lease equipment, processing facilities, and LNG export facilities needed through 2035, averaging about $14 billion per year.

Common Stakeholder Concerns with O&G Development

- Impacts of development on land values, recreation, and wildlife
- Operators out-bidding local farmers for water rights
- Ozone levels out of attainment
- Role of local governments and communities in regulating production
- Availability of adequate resources to enforce regulations
- Enforcing penalties for violations of regulations
- Role of regulations in market certainty and transparency for the public
- Production-related noise, odor, traffic, and spills
- Role of memoranda of understanding between local governments and industry
- Timely and effective way for permits to be processed
- Avoiding the "one size fits all" in locating production sites
- Increasing the quantity and quality of peer-reviewed studies of local health impacts
- The state's capacity to host oil and gas industry production
- More robust civic engagement

Figure 2. Common stakeholder concerns with oil & gas development, generated during the 2014 Energy Institute's NG Symposium.

In the national arena, the most prominent issues include these:

Jurisdictional Disputes: Gas producers and landowners can and do disagree because of "split estates," where one party owns surface land rights and another party owns subsurface mineral rights. Split estate issues are complicated further where the federal government owns the subsurface rights. That is the case with more than 57 million acres of federal land, 90% of which is in Montana, Wyoming, New Mexico, Arizona, North Dakota, Idaho and Colorado.

Another jurisdictional dispute is whether communities have the right to ban or restrict gas production within or near their borders. In general, the regulation of oil and gas production is a state responsibility, but voter referenda to ban hydraulic fracturing have been approved either statewide or by individual communities in California, Colorado, Ohio,

Texas, and Vermont.[10] The state of New York is among the most recent to join this list.[11] Production bans imposed by communities have ended up in the courts. In Colorado, Governor John Hickenlooper appointed a commission to resolve the state vs. local jurisdictional issues. The commission completed its recommendations in February 2015, though it remains unclear whether the commission's recommendations will be implemented either legislatively or by the state's regulatory body.

Environmental Impacts: Several environmental issues are causing concern. The most controversial is whether the chemicals in hydraulic fracturing fluids are contaminating fresh water supplies. The industry explains that the fluids are injected far below the level of aquifers; nearby communities are concerned that the chemicals can make their way into aquifers through improperly or incompletely sealed well casings. Public worries have been exacerbated by the reluctance of oil and gas companies to disclose the chemicals in their fracking fluids early on, asserting that the chemicals are trade secrets. The industry says its disclosure practices are improving; one major fracking company, Baker Hughes, has announced it will disclose 100% of the chemicals in its fluids.[12] In contrast, North Carolina has passed a law making it a misdemeanor to disclose the chemicals. In any case, the lack of transparency has undermined public support for production in some areas of the country.

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[10] Food & Water Watch, *The Anti-Fracking Movement*, www.foodandwaterwatch.org/water/fracking/anti-fracking-map/
Food & Water Watch estimates that more than 450 states and localities in the U. S. have approved measures to ban hydraulic fracturing.

[11] The New York Times, *Citing Health Risks, Cuomo Bans Fracking in New York State,* December 17, 2014. www.nytimes.com/2014/12/18/nyregion/cuomo-to-ban-fracking-in-new-york-state-citing-health-risks.html?_r=0
Governor Cuomo's Administration banned fracking, citing health risks to the public.

[12] On March 27, 2015, shareholders from Baker Hughes and Halliburton voted in favor of a $35 billion merger. The merger was expected to be finalized in the second half of 2015 subject to the approval of anti-trust regulators and other issues.

Methane emissions are another prominent environmental issue. Methane is a powerful greenhouse gas – 25 times greater than CO_2 over a 100 year period.[13] Oil producers often vent it into the air intentionally at well sites. Unintentional leaks have been found in wells, pipelines, storage tanks and vehicle fueling sites. A World Resources Institute (WRI) study concluded that methane escape represents a significant source of global warming pollution and that reducing leakage to less than 1% of total production is necessary to ensure that the climate impacts of natural gas are lower than those from coal or diesel fuel over any time horizon. Other researchers have concluded that methane emissions should not exceed 3.2% of total production.[14] WRI estimates that methane emissions can be cut by one-half to two-thirds with current, proven, cost-effective technologies.[15]

Other environmental issues include the industry's land management and wastewater handling practices, as well as evidence that the industry's practice of injecting wastewater back into the earth has caused earthquakes in some parts of the U.S. DOE and the U.S. Geological Survey are evaluating the science of this "induced seismicity" problem.[16]

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[13] Environmental Protection Agency, *Overview of Greenhouse* Gases. http://epa.gov/climatechange/ghgemissions/gases/ch4.html

[14] Center for American Progress, *Reducing Methane Pollution from Fossil-Fuel Production on America's Public Lands*, October 2013. www.americanprogress.org/issues/green/report/2014/10/06/98326/reducing-methane-pollution-from-fossil-fuel-production-on-americas-public-lands

[15] World Resources Institute, *Clearing the Air*, April 2013. www.wri.org/publication/clearing-air

[16] LiveScience, *Fracking Linked to More Ohio Earthquakes,* 2014. www.livescience.com/48294-fracking-caused-ohio-earthquakes.html
The Utica in OH and Barnett in TX have reported seismic events.

The Texas Tribune, *Mayors: Texas Must Act Faster on Earthquake Study*, 2014. www.texastribune.org/2014/05/12/mayors-say-texas-slow-act-earthquakes/

Aging Infrastructure: When the American Society of Civil Engineers (ASCE) conducted its quadrennial evaluation of the nation's energy infrastructure in 2013, it gave the electric grid and oil and gas pipelines a D+. The ASCE noted that aging or neglected pipelines have caused "deaths, injuries, significant property damage, and environmental impacts" in recent years. In addition, much has changed since many of our pipelines were built, from more severe weather events to the threat of cyber-attack. In April 2015, the U.S. Department of Energy issued its first-ever Quadrennial Energy Review (QER), which looked exclusively at the nation's energy infrastructure.[17] It mentioned the changing factors that affect if, where and how infrastructure should be improved, including the nation's 2.6 million miles of interstate and intrastate pipelines, 414 natural gas storage facilities, 330 ports handling crude petroleum and refined petroleum products, and more than 140,000 miles of railways that carry crude petroleum, refined petroleum products and liquefied natural gas as well as coal. Nearly 50% of the nation's gas transmission and gathering pipelines were built in the 1950s and 1960s, the QER said.

"Natural gas and oil TS&D infrastructures have not kept pace with changes in the volumes and geography of oil and gas production," the QER reported. "The Nation's ports, waterways, and rail systems are congested, with the growing demands for handling energy commodities increasingly in competition with transport needs for food and other non-energy freight. Although improvements are being made, much of the relevant infrastructure—pipelines, rail systems, ports, and waterways alike—is long overdue for repairs and modernization." The cost of repairs and modernization will be as high as $3.5 billion annually between 2015 and 2030 while the total cost of replacing cast iron and bare steel pipes in the distribution systems is estimated at $270 billion, it said.

Environmental Issues: One changing factor is the environment. "Energy TS&D infrastructure has always been shaped not only by the mix of energy supply technologies and end-use patterns, but also by the characteristics of the environment where the infrastructure must operate, including, for example, terrain, vegetation, soil and seismic conditions, and climate," the QER observed. "It has long been true, as well, that choices

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[17] U.S. Department of Energy, *Quadrennial Energy Review: Energy Transmission, Storage and Distribution Infrastructure*, April 2015. http://energy.gov/sites/prod/files/2015/04/f22/QER_Summary_0.pdf

about TS&D infrastructure have had to take into account the need to limit that infrastructure's adverse impacts on the environment. By far the most important environmental factor affecting TS&D infrastructure needs now and going forward is global climate change."

Among the variables related to climate change is the growing interest in carbon-funded tax cuts[18] and emerging concerns about the world's "carbon budget". The IEA and the Intergovernmental Panel on Climate Change (IPCC), among other institutions, accept findings by climate scientists that we cannot keep global warming at or below 2°C unless 60% to 80% of the world's proved global fossil fuel reserves remain unburned between now and mid-century.[19] This finding puts trillions of dollars of the industry's assets as risk. Former Secretary of the Treasury Henry Paulson is among those who warn that the world's carbon budget (the remaining amount of greenhouse gases the world can emit and still keep warming to no more than 2°C) has produced a carbon bubble – an overvaluation of fossil energy companies comparable to but with much greater potential economic disruption than the real estate bubble that preceded the Great Recession.[20]

A related issue is the right-sizing of the oil and gas infrastructure to avoid "committed carbon." Pipelines, power plants and other energy infrastructure are built to last decades. If environmental, policy and market changes constrain the use of oil and gas in the future,

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[18] Partnership for Responsible Growth, *Our Mission*.
http://www.partnershipforresponsiblegrowth.org/about/

[19] IEA, *World Energy Outlook 2014, Executive Summary*.
www.iea.org/Textbase/npsum/WEO2014SUM.pdf
and
IPCC, *Summary for Policy Makers*, report.mitigation2014.org/spm/ipcc_wg3_ar5_summary-for-policymakers_approved.pdf

[20] Secretary Henry Paulson, *The Coming Climate Crash*, June 2014.
www.nytimes.com/2014/06/22/opinion/sunday/lessons-for-climate-change-in-the-2008-recession.html?_r=0

one of two things will happen. Either the investment in infrastructure will be stranded or the desire to get full value from the investment will lead to a de facto commitment to continued carbon emissions. Stephen Davis of the University of California-Irvine and Robert Socolow of Princeton University estimate that because of sunk capital worldwide committed carbon has increased approximately 4% per year since 2000, two thirds of it from investments in coal. By 2012, Davis and Socolow report, 27% of the world's committed carbon was attributed to power plants fired by natural gas.[21]

Public Health: Oil and gas production is a perceived public health issue in communities near production sites. Current epidemiology studies are insufficient to assess the risks of human exposure to development. In terms of occupational health, the National Institute for Occupational Safety and Health (NIOSH), a division of the Center for Disease Control, has managed a program since 2005 that looks at risks of worker fatality from natural gas development. NIOSH finds that the primary cause of fatalities is actually motor vehicle accidents around worksites. It is also important to note that, when assessing occupational health, that the natural gas work force is very transient and tends to move with the gas booms (North Dakota, South Texas, Northeastern Colorado, etc.). A great deal of data is being collected, but there is no common entity that coordinates and analyzes it. More work is needed in this area.

Saving Water: The federal government as well as many state and local jurisdictions are increasingly concerned about the availability of and competition for fresh water supplies. The adequacy and cost of water supplies are already becoming influential factors in the nation's energy choices. In Colorado, for example, operators are outbidding farmers for access to water.[22] In parts of the U.S., electric generation has been curtailed because of inadequate supplies of cooling water for power plants. The oil and gas industry, as well as

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[21] Stephen Davis & Robert Socolow, *Commitment accounting of CO_2 emissions*. iopscience.iop.org/1748-9326/9/8/084018/article?fromSearchPage=true

[22] New York Times, *For Farms in the West, Oil Wells are Thirsty Rivals.* www.nytimes.com/2012/09/06/us/struggle-for-water-in-colorado-with-rise-in-fracking.html?pagewanted=all

thermoelectric power plants, will have to respond with better technologies and practices to conserve, recycle and prevent the contamination of fresh water resources. Some of these new practices such as dry cooling in power plants will increase the cost of energy production and those costs are likely to be passed on to consumers.[23]

Competition with Cleaner Energy Resources: Leaders in the solar and wind power industries worry that competition from natural gas will slow down the transition to their energy resources. While abundant supplies of gas could keep its price lower than that of renewable resources, several other developments could raise the cost of energy from fossil fuels while the price of energy from solar and wind technologies continues to fall. Among those developments, as noted above, are water conservation measures and the use of Carbon Sequestration and Storage (CCS) at power plants. The DOE's National Renewable Energy Laboratory (NREL) says its analysis shows that with technologies commercially available today, the U.S. could obtain as much as 80% of its electricity from renewable resources by mid-century if we make the necessary changes in the electric grid.[24] Whatever the energy mix turns out to be, the carbon-based resource most likely to provide the balance of the nation's fuel is natural gas.[25]

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[23] Union of Concerned Scientists, *How it Works: Water for Natural Gas*. www.ucsusa.org/clean_energy/our-energy-choices/energy-and-water-use/water-energy-electricity-natural-gas.html#.VIt3f6TF9TR

[24] NREL, *Renewable Electric Futures Study*. http://www.nrel.gov/analysis/re_futures

[25] NREL's assumption is that the balance of electric generation would come from nuclear power, natural gas, clean coal and energy efficiency. However, clean coal technology (carbon capture and sequestration) is not yet commercial viable; if and when it becomes commercially viable, it will raise the price of coal-fired electricity.

Moving Forward

Participants in Energy Institute's dialogues identified four factors that will help the gas industry find a sustainable path forward: forward thinking; thoughtful public policy; securing a social license to operate and technology advancements. These factors must function simultaneously and in balance (Figure 3):

Forward Thinking – Fossil energy industries can strengthen their social license if they anticipate and are proactive in helping the nation confront environmental challenges. Recent public opinion research shows consistently that a sizeable majority of Americans across party lines acknowledge that climate change is real and that we must do something about it. In a recent poll conducted by the New York Times, Stanford University and Resources for the Future, 78% of American's polled believed that the Federal Government should take measures to limit greenhouse gases, one of the leading causes of climate change.[26]

> *"Coal has been the MVP in lifting the world out of poverty. Natural gas will play a similar role in lifting millions more out of poverty. "*
> ~ Chris Wright, CEO Liberty Resources

Thoughtful Public Policy: A consistent theme among industry leaders has been that natural gas producers welcome reasonable regulations and government oversight. The key word is "reasonable." Reasonable oversight creates greater market certainty, which leads to investment; screens out the industry's bad actors; reduces the chances that companies within the energy sector will obtain unfair advantage by engaging in irresponsible practices; and strengthens public confidence in the industry's practices. On the other hand, excessive, ineffective, unnecessary or constantly changing regulations constrain gas production, increase development costs, impede the adoption of

> *"The question isn't what the next regulation should be, it's always – where has the market failed? Where has an externality not been internalized? How can new public policy address that market failure?"*
> ~ Dan Grossman
> Rocky Mountain Director, EDF

[26] New Your Times, *Global Warming: What Should Be Done?*, January 29, 2015. http://www.nytimes.com/interactive/2015/01/29/us/global-warming-poll.html

environmental improvements, and delay the fuel's environmental benefits. To score well on the "forward thinking" element of sustainability, leaders in the natural gas industry should become advocates of climate risk reduction as well as proactive in addressing other social and environmental issues with possible impacts on the future role of natural gas. One place to start: working with state and federal officials on a national methane leak reduction plan. The industry argues that regulations must be well-matched to legitimate risks associated with the gas value chain. The challenge for government and the oil and gas industry is to find the sweet spot that protects people and the environment while capturing the benefits of the nation's gas resources.

At the same time, reasonable government regulations cannot enhance public trust if they are not enforced. States must train and hire adequate numbers of qualified inspectors and fund them sufficiently to keep up with the boom in gas production and the construction of pipelines and other infrastructure.[27]

Social License to Operate: Producers are understandably concerned that the industry is judged by the actions of its worst operators. They acknowledge that the production boom raced ahead of regulations that might have increased the public's confidence in the industry's operations. Industry leaders want to build greater trust and a sense of joint mission with government agencies, the environmental community, public-interest organizations and the general public.

The industry wants the public to appreciate that it creates jobs, improves public health by replacing dirtier fuels, and produces fewer greenhouse gas emissions. For example, the EIA reports that jobs in the oil and gas sector rose 40% between 2007 and 2012 – including the Great Recession years – compared to 1% in the private sector over all.

> *"I think we should be bullish about natural gas, but stubborn about developing it in the very best way."*
> ~ Bill Ritter, Jr., 41st Governor of Colorado and Director of the Center for the New Energy Economy

[27] This recommendation on inspectors was one of scores of proposals submitted to the Obama Administration in CNEE's Powering Forward report. See Pages 87-104 for the full list. cnee.colostate.edu/graphics/uploads/CNEEPoweringForwardFullReport.pdf

Advocates of a major role for natural gas argue that it is not realistic to prohibit drilling or pipeline development and still enjoy the quality of life we have today. Natural gas has reduced power plant pollution, lowered electricity prices, fueled transportation, and has been crucial in the manufacturing myriad consumer goods.[28] Noted energy expert Daniel Yergin contends that the extraction of tight oil in Colorado, North Dakota and Texas allowed the United States to avoid an oil crisis that would have occurred with the recent supply disruptions from Libya, Iraq and Iran (EIA Energy Conference, 2014).

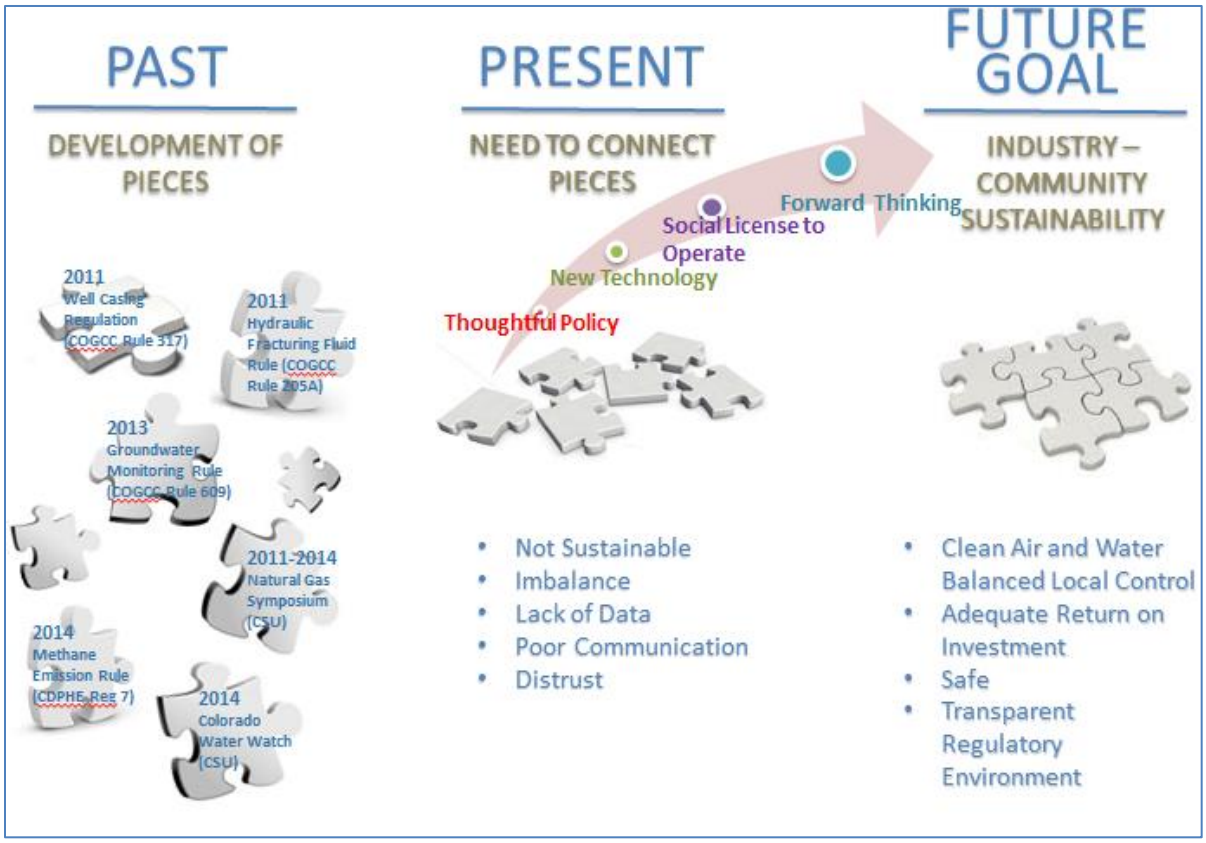

Figure 3. Participants in the Denver symposium discussed four success factors – or pillars- to successful oil and gas development: forward thinking, thoughtful policy, social license and technical advances.

[28] Natural Gas Supply Association, *The Stuff of Everyday Life.* http://www.ngsa.org/download/issues/TheStuffOfEverydayLife.pdf

Technological Advances: Technical innovation continues in the oil and gas industry as well as in university and government-sponsored research programs. New devices are making it easier for gas companies to detect leaks over thousands of miles of pipeline. At the same time, the industry can make better use of existing technologies. For example, more producers could capture methane and use it to fuel their equipment rather than flaring or venting the gas.

The Role of Public Policies: The Colorado Story

The questions that federal, state and local policy makers should be asking include these: Are the issues surrounding gas production so intractable that we should discount this resource as a bridge to a clean energy economy? Or should we redouble the efforts of industry, government and civil society to find and implement solutions?

The evolution of public policies in Colorado is demonstrating that the oil and gas industry, environmental protection advocates and citizens can collaborate to solve problems associated with the production and distribution of natural gas. Colorado has a long tradition of oil and gas production; it sits atop ample shale gas formations. It is among the states expected to provide a significant part of America's natural gas supplies in the future.

In 2007, Bill Ritter Jr. became Colorado's 41st governor. Among his top priorities were to create a clean energy economy in Colorado, including the production of natural gas in ways that did not jeopardize the state's natural beauty or quality of life. With the support of the state legislature, he appointed new members of the Colorado Oil and Gas Conservation Commission (COGCC) with expertise in the social and environmental dimensions of energy production.

The oil and gas industry initially resisted this change. Over time, however, the Ritter Administration and industry leaders began working together. In 2010 for example, the legislature passed and Governor Ritter signed Colorado's Clean Air-Clean Jobs Act. It directed the Public Utilities Commission (PUC) to accelerate the retirement of 900MW of coal generation (or 50% of the coal fleet, whichever was less) and replace it with natural

gas, renewable energy and energy efficiency. The PUC has now approved plans from regulated utilities that will reduce greenhouse gas emissions 28% by 2020 compared to 2000 with natural gas playing a central role.

In 2011, under Governor John Hickenlooper, the COGCC unanimously approved a requirement that oil and gas producers disclose the chemical families of the agents in fracking fluids.[29] At the time, it was the toughest such rule in the country.

In 2013, the state began requiring groundwater monitoring at production sites. Before drilling can begin, producers are now required to collect baseline water samples; after drilling, producers must take additional samples to determine whether there has been any contamination.

In February 2014, the Colorado Air Quality Control Commission, supported by the Anadarko Petroleum Corp., Noble Energy Inc., and DCP Midstream Denver, approved the nation's first regulation to limit methane emissions from oil and gas operations – a rule that has the added benefit of reducing the emissions of volatile organic compounds responsible for smog.[30]

The state's educational institutions are involved, too. *Colorado Water Watch*[31] is a program led by CSU researcher Dr. Ken Carlson at the Center for Water and Energy Sustainability

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[29] The COGCC's Hydraulic Fracturing Chemical Disclosure Rule (2011) calls for the disclosure of chemicals intentionally added to hydraulic fracturing fluids on FracFocus, the national chemical registry site.

[30] Colorado Department of Public Healt*h & Environment, REGULATION NUMBER 7 CONTROL OF OZONE VIA OZONE PRECURSORS AND CONTROL OF HYDROCARBONS VIA OIL AND GAS EMISSIONS (EMISSIONS OF VOLATILE ORGANIC COMPOUNDS AND NITROGEN OXIDES)* sos.state.co.us/CCR/GenerateRulePdf.do?ruleVersionId=5670&fileName=5%20CCR%201001-9

[31] CWES, *Colorado Water Watch Project*. waterwatch.colostate.edu

(CEWS). The intent of the project is to monitor aquifers in close proximity to hydraulic fracturing operations and then to provide the public with real-time information about water quality at these oil and gas sites.

Today, Colorado is an example of the important mix of natural gas, energy efficiency and renewable resources.

This is not to imply that production is without controversy in Colorado. In recent years, several communities have put fracking bans in place. By the fall of 2014, the courts had struck down three local bans and citizen groups were preparing to force a statewide ballot initiative designed to give communities the authority to ban the practice. To try to find a compromise, Governor Hickenlooper established an oil and gas commission comprised of representatives from local government, civic organizations, environmental interests, agriculture, and affected industries. Its main focus is to identify how to most reasonably and effectively balance land use issues so that community interests and private mineral rights are both protected.[32] The commission has now produced several recommendations, some of which can be implemented through Colorado Oil and Gas Commission (COGCC) rule making.

Policy Trends in Other States

Two developments in the years immediately ahead will influence policy trends in the U.S. The first are the policies established by state legislatures and regulators; the second is the U.S. Environmental Protection Agency's use of the Clean Air Act to regulate carbon emissions from new and existing power plants.

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[32] Colorado.gov, *Oil and Gas Task Force*, 2014. dnr.state.co.us/ogtaskforce/pages/home.aspx

State Natural Gas Policy Activity

State legislatures are active in other policies that affect natural gas demand. While most enforcement is done by state agencies, legislatures oversee, fund and delegate authority to regulators. CNEE maintains an Advanced Energy Legislation Tracker, which catalogues all introduced and enacted advanced energy legislation in the 50 states. From this database, CNEE has tracked and analyzed state legislative trends in 2013 and 2014 related to three phases in the natural gas value chain: upstream production, midstream distribution and downstream consumption.[33]Figure 4, below, shows the distribution of introduced bills by year across the supply chain.

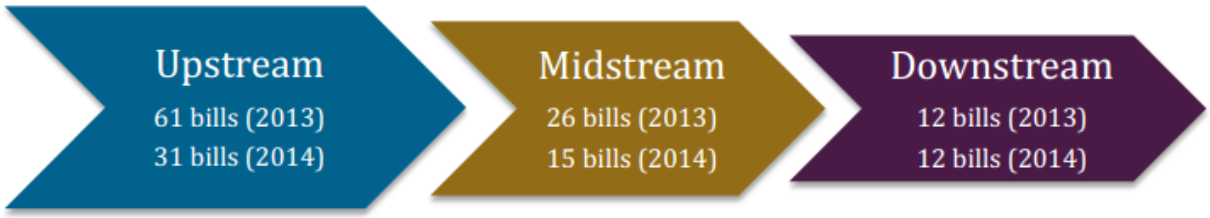

Figure 4. 2013 & 2014 frequency of introduced state legislation impacting the natural gas supply chain (CNEE).

- Upstream Production - Legislative changes related to exploration and production have been the most frequently enacted to date, with a total of 92 bills becoming law over the course of two years. This legislation tends to be concentrated in states that overlie oil and gas resources. Most new laws have to do with split estates and changes to severance and property taxes.
- Midstream Distribution – Pipeline safety issues have dominated this phase or production, including leaks and leak reporting, inspections and penalties, licensing conditions for pipeline technicians, and excavation notification requirements.
- Downstream Consumption - The use of natural gas in the transportation sector have been the most frequently enacted changes in this category.

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[33] CNEE, *2013/14 Trends in State Natural Gas Supply Chain Legislation,* September 2014. www.aeltracker.org/graphics/uploads/2013--2014-Trends-in-State-Natural-Gas-Supply-Chain-Legislation.pdf

Taking a closer look at the 38 enacted bills from the 2014 state legislative sessions, the following trends emerge (see Figure 5, below for a complete breakdown by policy type):[34]
1. Similar to 2013, bills related to severance and property taxes, split property and mineral estate, and local impacts of natural gas development were the most frequently enacted.

2. New laws addressing local impacts covered a handful of topics including liability for spill remediation and funding for state-managed remediation programs. Wyoming's HB 102 creates a Sage Grouse task force and California's SB 1281 creates new water use reporting requirements.

3. North Carolina's SB 786 was perhaps the most high profile bill in the category this year. As noted in CNEE's September natural gas policy brief, the new law revises several sections of the state's oil and gas statutes and lifts the state's moratorium on hydraulic fracturing.

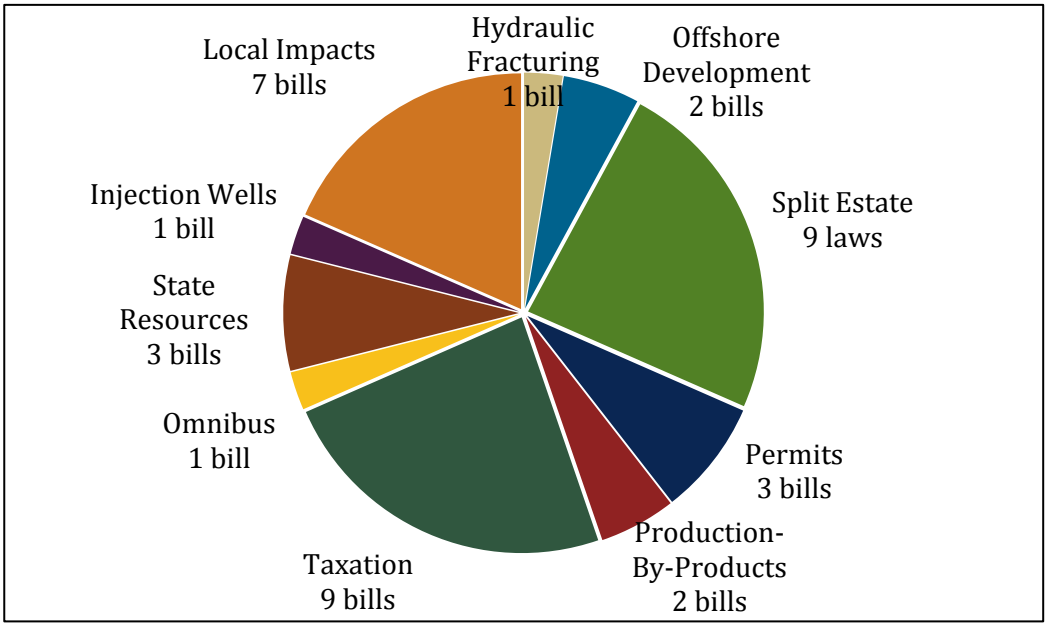

Figure 5. Breakdown of enacted natural gas legislation in 2014 by policy type (Source: CNEE AEL Tracker, www.aeltracker.org/graphics/uploads/CNEE-2014-Advanced-Energy-Legislation-End-of-Year-Summary.pdf).

[34] CNEE, *2014 Advanced Energy Legislation End of Year Summary*, December 2014,

Policy Trends at the Federal Level

BLM Rule on Hydraulic Fracturing

In March 2015, the Department of the Interior released long-awaited final standards[35] for hydraulic fracturing operations on public and American Indian lands. The standards are designed to update regulations to protect groundwater with new requirements for well-bore integrity, wastewater disposal and public disclosure of the chemicals used in fracturing agents. States and Tribes can request variances when they have equal or more protective regulations in place.

Among other things, the standards require a validation of well integrity and strong cement barriers between the wellbore and water zones through which it passes; disclosure on FracFocus of chemicals used in fracturing, within 30 days of completing fracturing operations; higher standards for storing recovered waste fluids from fracturing operations; and procedures to lower the risk of cross-well contamination.

Methane Emission Rules

In January 2015, the White House announced an executive action by the President to reduce methane leaks from oil and gas operations.[36] The President's goal is to cut methane emissions from oil and gas wells 40-45% by 2015 compared to 2012. In the summer of 2015, EPA will issue the first-ever regulations that directly engage the oil and gas industry in reducing methane emissions. The rule is expected to cover methane and Volatile Organic Compound (VOC) emissions from new and modified oil and gas production sources, along with natural gas processing and transmission sources. EPA will issue the final rule in 2016. In addition, it will create guidelines to help states reduce ozone-forming pollutants from existing oil and gas systems in areas of the country that do not meet the ozone health standard or that are in the Ozone Transport Region. The Bureau of Land Management,

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[35]Department of the Interior, *Federal Register*, March 2015. http://www.gpo.gov/fdsys/pkg/FR-2015-03-26/pdf/2015-06658.pdf

[36]The White House, *FACT SHEET: Administration Takes Steps Forward on Climate Action Plan by Announcing Actions to Cut Methane Emissions*. https://www.whitehouse.gov/the-press-office/2015/01/14/fact-sheet-administration-takes-steps-forward-climate-action-plan-anno-1

meanwhile, will update its decades-old standards on venting and flaring, as well as on leaks of natural gas from wells. Other elements of the President's initiative include a requirement for all segments of the oil and gas industry to participate in EPA's Greenhouse Gas Reporting Program.

Clean Power Plan - Existing Source Performance Standards under Section 111(d) of the Clean Air Act

In regard to federal policy developments impacting natural gas markets, on August 3rd President Obama and EPA released the Clean Power Plan, which included the final Existing Source Performance Standards rule under Section 111(d) of the Clean Air Act[37]. The final rule sets a national target of 32% reduction in CO_2 emission from the U.S. electric power sector by 2030, against 2005 levels. It also establishes a compliance timeframe of 2022 to 2030 for states with interim steps building to 2030.

The individual state emissions targets were derived by EPA using three 'building blocks'. Building block one is comprised of heat rate improvements assumed possible at existing coal-fired steam generating plants. These plant efficiency targets are applied regionally and range from 2.1% to 4.3%. Building block two represents a shift in generation from coal-fired steam units to cleaner burning, existing, combined cycle natural gas units (NGCC). In building block 2, EPA assumes a phased generation increase from these plants between 2022 and 2024 of up to 75% of net summer capacity (as opposed to a 70% nameplate capacity assumed in the draft rule). Building block three includes new renewable energy, built after 2012, based on projected growth rates for various renewable sources including wind and solar. This new zero emissions generation is also assumed to result in reduced generation from both sub categories of fossil sources.

The three building block assumptions are then applied to the three interconnection regions in the U.S. grid, as opposed to the state-by-state approach taken in the draft rule. These regions are the Eastern Interconnection, the Western Interconnection and Texas (ERCOT).

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[37] Clean Power Plan for Existing Power Plants, http://www2.epa.gov/cleanpowerplan/clean-power-plan-existing-power-plants

EPA then calculates resulting adjusted national uniform performance rates, which represent the Best System of Emissions Reduction (BSER), for two subcategories of fossil fuel electric generating units – electric steam units (coal-fired) and combustion turbines (natural gas-fired). The resulting 2030 performance target rates for these two categories are 1305 lbs of CO_2 per MWh and 771 lbs of CO_2 per MWh respectively. The 2030 subcategory rates represent both the potential for coal-fired generation shift to NGCC as well as the potential to shift generation from both fossil sources to renewable energy.

The Clean Power Plan is expected to open new markets for low-carbon resources including natural gas, solar energy, wind energy, energy efficiency and other alternatives. While it is too early to tell exactly what state plans will include, there are a number of ongoing regional dialogues that are bringing state air and energy decision makers together around 111(d) planning.

> *"I think there is a lot of room for both natural gas and renewables when we look at the targets and challenges before us in reducing CO_2 emissions we certainly see a lot of opportunity for more push on natural gas and at the same time a strong need for other forms of low carbon energy including renewables."*
>
> ~Robert LaCount, Executive Vice President, M.J. Bradley

Economic Factors & New Markets

Natural gas is a globally traded commodity in high demand. There has been wide consensus during the Energy Institute's Symposia that energy prices would be historically high today in the United States if we did not have the benefit of an abundant natural gas supply, especially when considering global events such as the political unrest in Ukraine and the Fukushima Daiichi Nuclear Power Plant disaster. By many accounts, the U.S. abundance of natural gas has put the nation, and our trading partners, on much more solid footing than it would be otherwise both economically and geopolitically.

Between 2000 and 2010, natural gas prices were volatile, reaching historic levels (Figure 7). The expectation of most participants in past symposia was that prices will be much lower and more stable in the 2010 to 2020 timeframe. While several panelists discussed the climate benefits of a shift to natural gas, most agreed that the primary motivation for the shift would be cost savings for nations and consumers. In this section we explore the domestic and international market drivers that could impact the price of natural gas in the next decade.

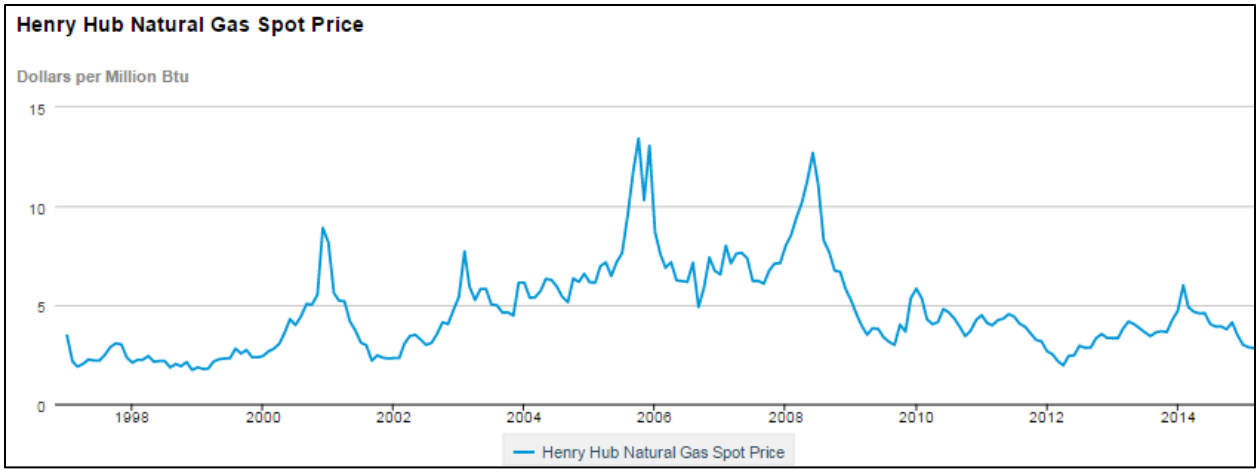

Figure 7. Henry Hub Natural Gas Spot Prices ($/MMBtu) from 1998 to 2014 (Source: EIA).

Recent events in Ukraine provide a poignant example of the geopolitics of natural gas. On the other hand, the boom in domestic natural gas production has brought tremendous benefit to the US and our trading partners. DOE has approved the export of 3.94 Bcf/day of

gas, which enables world consumers to exercise more buying power – particularly our allies.

Climate Agreements

At the subnational, national, multilateral and international levels, new commitments to reduce carbon emissions may lead to worldwide reductions in the use of fossil fuels, particularly those that are most carbon intensive. It remains to be seen whether natural gas will be considered a means to reduce carbon emissions or one of the fossil fuels whose consumption must be reduced and, if the latter, the timeframe over which reductions would be expected to occur. International negotiations on a global climate treaty are scheduled to culminate in the United Nation's 21st Conference of the Parties in Paris in December 2016.

China

China is the largest producer and consumer of energy in the world today. By some estimates, China is home to the largest shale gas resource in the world.[38] The U.S.-China Climate Agreement announced on November 11, 2014, commits the U.S. to cutting its carbon emissions 26% to 28% by 2025 compared to 2005 levels. In exchange, China has committed to a peak in its carbon emissions by 2030 and to obtain 20% of its energy from zero-carbon emissions sources by 2030.[39] A major domestic issue in China is poor air quality and related public health problems associated with its coal-fired power plants. Some cities in China have experienced fine particulates in their air as high as 500 or even 800$\mu g/m^3$. As such, China is very interested in increasing its natural gas-fired generation to improve air quality.

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[38] David Sandalow, Jingchao Wu, Qing Yang, Anders Hove and Junda Lin, Columbia Center for Global Energy Policy, *Meeting China's Shale Gas Goals*. energypolicy.columbia.edu/sites/default/files/energy/China%20Shale%20Gas_WORKING%20DRAFT_Sept%2011.pdf

[39] The White House, *U.S.-China Joint Announcement on Climate Change*, November 2014. www.whitehouse.gov/the-press-office/2014/11/11/us-china-joint-announcement-climate-change

LNG Exports

Yet another important factor in international gas markets will be the transfer of the fuel from producing to importing countries. Qatar is the biggest LNG exporter today and Japan is the largest importer. In general, Asia is by far the largest market, followed by Europe. There are currently 20 LNG exporting countries around the world and the U.S. is not among them. Plans are underway to build the facilities needed to export LNG from the U.S.[40] Once U.S. exports begin, they are expected to shave some of the peaks in domestic supply.

Russia is planning to export as much as 38 Bcm/year of natural gas from Siberia to China over the next 30 years by way of the Power of Siberia pipeline. The pipeline, which will deliver natural gas at a price of $12/MMBTu, will likely have an impact on global prices.[41] LNG has a compound annual growth rate (CAGR) of 5.6% though access to international markets is critical to maintaining its momentum.

Distributed Generation

Domestically, several technologies are expected to provide new markets for natural gas. Among them are decentralized power generation, CNG vehicles and more widespread use of combined heat and power systems. General Electric notes that the trend toward distributed power generation creates new opportunities for gas reciprocating engines, gas turbines integrated with micro-grids, and turbines integrated with solar and wind power systems to help mitigate the problems of intermittent production. GE estimates that investment in distributed power technologies of all kinds will grow to more than $200 billion during the 2012-2020 period.[42]

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[40] DOE, *Summary of Lower 48 Export LNG Terminal Applications*. energy.gov/fe/downloads/summary-lng-export-applications-lower-48-states

[41] Platts, *China-Russia pipeline deal to shape global LNG prices: Tokyo Gas official.* www.platts.com/latest-news/natural-gas/yuzhno-sakhalinsk/china-russia-pipeline-deal-to-shape-global-lng-27663702

[42] GE, *The Rise of Distributed Power*. eenews.net/assets/2014/02/25/document_gw_02.pdf

In August 2012, President Obama issued an executive order that establishes the goal of increasing the use of combined heat and power (CHP) 50% by 2020. The administration estimates that if the goal is achieved, it will save energy users $10 billion each year, result in up to $80 billion in new capital investment in manufacturing, and reduce emissions equivalent to taking 25 million cars off the road.

New Technologies

The oil and gas industry has experienced a series of incredible technology breakthroughs. In 1992, George P. Mitchell, drilled the first horizontal gas well in the Barnett. By 1997, he was experimenting with "light sand fracturing". Now operators are able to deploy horizontal drilling and fracturing techniques with a high degree of precision with horizontal well bores more than 2 kilometers in length and achieving an accuracy of less than 1 meter in a stratum of the target formation.

Though the degree of technological advancement in hydrocarbon extraction has been significant, hurdles still remain, particularly with respect to environmental and societal risks. To take advantage of new domestic and international market opportunities discussed above, participants in the 2014 Symposium identified four areas in which greater technological innovation is needed for "better, cheaper, safer, faster, cleaner, and more efficient" gas production. The most common theme was the need for technologies related to assessing, mitigating, and monitoring risks.

Figure 8. Importance of monitoring in closing the risk assessment and mitigation loop.

The four areas are:

1. Reducing lifecycle methane emissions with onsite detection and fixes. To understand and manage lifecycle methane emissions, we must first address the data gap. Data-driven approaches will drive change and may in fact be the first component of Figure 8 that will need to be completed. Monitoring to some extent will need to precede risk assessment and will in most cases be iterated in terms of timing and spatial coverage as best practices are developed.

Current estimates of lifecycle methane emissions range from 1% to 9% although more recent estimates are near the lower end of this range. In general, a small number of emission sources are responsible for the majority of methane emissions.

The Environmental Defense Fund (EDF) is coordinating 16 independent studies (CSU leads three of them) to more accurately assess methane leakage rates throughout the supply chain (Figure 5).[43] According to EDF, as much as 90% of the emissions opportunity is with existing infrastructure. As part of the EDF project, ICF International released a report[44] in March 2014 that a 40% reduction in onshore methane emissions can be achieved with existing technologies at a cost of $0.01/Mcf of gas produced – a cost that will actually save operators money.

> *"Five years ago, if you wanted to look at methane emissions, you had to go back to an EPA/GRI study with look- up tables –very little data, very incomplete information. Now we have a wide range of tools on a wide range of scales – hand held devices, car sensors, fixed monitor, aerial monitors, satellite measurements – 'bottom up and top down' monitoring".*
> ~ Drew Nelson, Senior Manager for Natural Gas, EDF

[43] EDF, *Methane Studies Fact Sheet* http://www.edf.org/sites/default/files/methane_studies_fact_sheet.pdf. CSU is the lead on a downstream, local distribution mapping of pipeline methane emissions under city streets, and two midstream studies investigating transmission & storage and gathering & processing.

[44] ICF, *Methane Cost Curve Report*, March 2014. www.edf.org/icf-methane-cost-curve-report

As the first state to regulate the detection and reduction of methane emissions from oil and gas drilling, Colorado is a working example of data-driven policy change. The state's methane rule is expected to cut annual methane emissions by 65,000 tons.

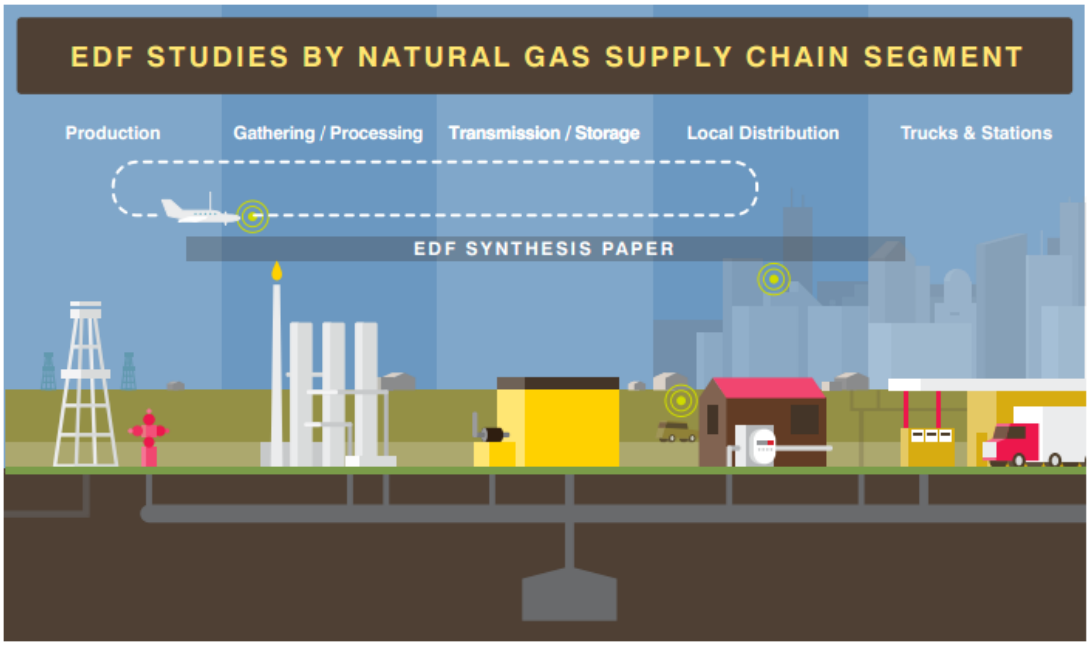

Figure 9. High-level schematic of EDF's independent methane studies (with permission)

2. Building sufficient infrastructure. Insufficient midstream infrastructure –the infrastructure that gathers, processes, transmits, and stores natural gas, as well as Liquefied Natural Gas (LNG) terminals – can lead to price volatility, stranded gas supplies, and loss in market share for the industry. This potential gas unavailability threatens the economic generation of electricity, especially given the "just-in-time" delivery of the resource. In order for the U.S. to transition to a power fleet dominated by cleaner energy, the nation must put a concerted technology (and policy) focus on infrastructure needs for natural gas. Infrastructure advancements for gas may go beyond traditional pipelines. GE, for example, is developing a strategy for extracting stranded gas, liquefying or compressing it, and

> *"Oil is worth ~ $100/barrel and it costs $10/barrel to move it. Natural gas is worth ~$10/mcf, but it costs $5/mcf to move it. Proximity to pipelines will play a huge role in the development of natural gas, due largely to the cost of moving the resource."*
>
> ~ Chris Wright, CEO, Liberty Resources

moving it to load centers. This LNG/CNG-to-electric generation is a "virtual pipeline" that is more versatile and rapidly deployable than underground pipelines. It may be one answer to the committed carbon problem.[45]

3. Giving the public access to real time monitoring. The *Colorado Water Watch*[46] project, mentioned earlier, provides the kind of transparency that builds trust. The project allows the public to see real-time information about water quality at oil and gas sites throughout the basin that underlies northeastern Colorado. Data from oil and natural gas well sites in the Denver-Julesburg Basin is transmitted to CSU servers where researchers employ algorithms to scan for anomalies or sudden shifts in water composition that could indicate contamination in a groundwater well. The data are analyzed and displayed as charts and graphs on a CSU website for the public to view, updated every hour. The project is in a "proof-of-concept"

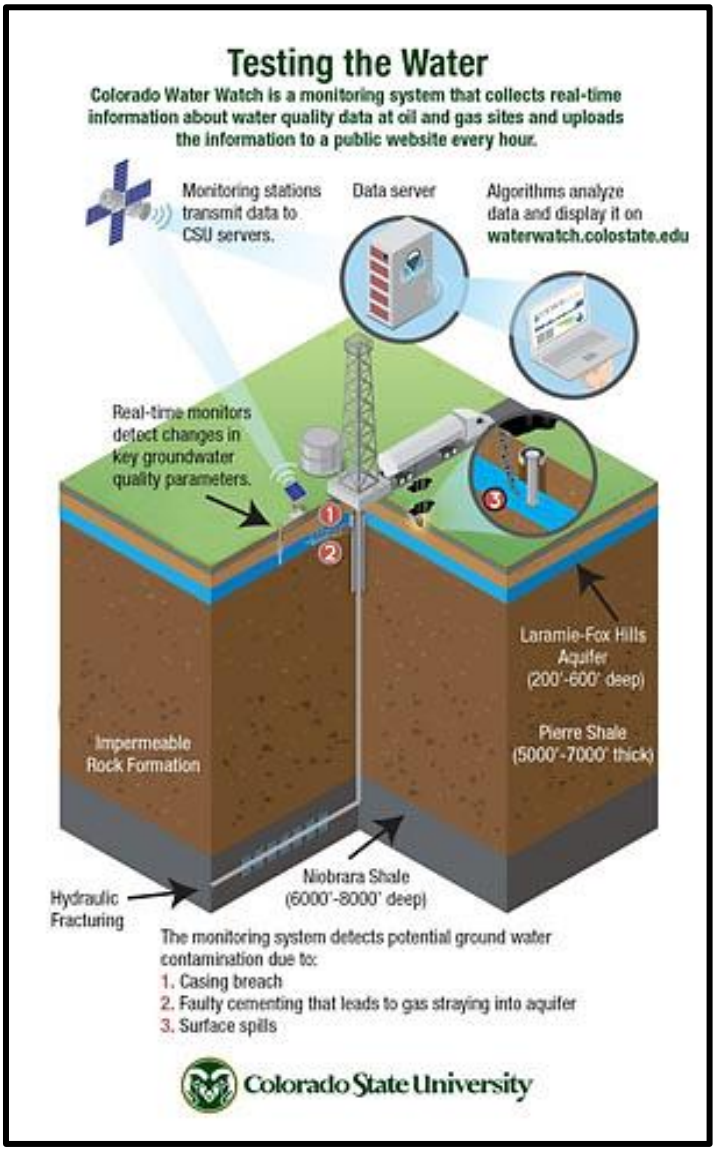

Figure 10. Schematic of the Colorado Water Watch Project (Source: CEWS).

[45] Hydrocarbon Processing, *GE unveils 'LNG In* *ket*. hydrocarbonprocessing.com/Article/3192932/GE-unveils-LNG-In-A-Box-technology-for-transportation-fuels-market.html

[46] CWES, *Colorado Water Watch Project*, waterwatch.colostate.edu

phase with expected expansion in the latter half of 2015.

4. Improvements in oil and shale gas recovery rates. Unconventional oil and gas production comes in various forms including coal bed methane, tight oil, and shale gas. Primary recovery from conventional oil and gas wells may yield only about 10% of the available hydrocarbon. With commonly applied secondary and enhanced oil recovery (EOR) techniques, recovery can exceed 60%. In contrast, estimates for shale oil and gas are in the 5% to 10% range, largely due to a high initial production decline rate. A high priority for the industry is technology that increases these recovery rates. By maximizing extraction for each "straw in the ground", producers need fewer "straws".

Carbon dioxide (CO_2) may be one resource for increasing recovery rates. Until recently, most of the CO_2 used for EOR has come from naturally occurring reservoirs. However, new technologies are being developed to capture CO_2 from industrial applications and transport it to where it would have the greatest benefit. One demonstration at the Dakota Gasification Company's plant in Beulah, ND, produces CO_2 and delivers it through a 204-mile pipeline to the Weyburn oil field in Saskatchewan, Canada. The Wyoming Pipeline Authority submitted plans for a set of corridors with more than 1,100 miles of pipeline that will allow CO_2 distribution throughout the state, potentially allowing an additional 800 million barrels of oil to be extracted. This type of arrangement could become part of regional CCS programs.

Participants in the symposium felt that several other ongoing programs and technology demonstrations are worth noting:

- **EPA Natural Gas Star program.** This partnership, now more than 20 years old, encourages oil and natural gas companies to voluntarily adopt cost-effective technologies and practices that improve operational efficiency and reduce methane emissions.[47]

[47] Environmental Protection Agency, *Natural Gas Star Program*. epa.gov/gasstar/basic-information/index.html

- **GE Oil & Gas Technology Center.** Scheduled to open in 2015 in Oklahoma City, the Center will focus on accelerating mid- to later-stage oil and gas technologies developed in GE's Global Research labs, including production systems, well construction, water use optimization, CO_2 solutions, and energy systems.[48]

- **ARPA-E MONITOR Project.** This project supports the development of methane emission detection and measurement methods from the wellhead to the end-user.[49]

- **Southwestern Energy ECH2O, Energy Conserving Water Program.** Southwestern Energy launched this program in 2012. By 2016, the company will use conservation and innovative measures to replenish or offset each gallon of fresh water it uses in its operations.[50]

The National Conversation

Federal Leadership

In his last three State of the Union Addresses, President Obama has called upon natural gas as a vital component to economic growth, environmental protection, and international trade. The Administration has very clear direction from the President to reduce anthropogenic emissions of carbon. The President's Climate Action Plan[51] will develop a comprehensive, interagency methane strategy focusing on assessing current emissions

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[48] GE, *Oil & Gas Technology Center Groundbreaking*. geglobalresearch.com/news/oil-gas-technology-center-groundbreaking

[49] ARPA-E, *Funding Opportunity Announcements; Innovative Development in Energy-Related Applied Science*. arpa-e-foa.energy.gov

[50] Southwestern Energy, *Water Conservation and Safety*. swn.com/responsibility/pages/water.aspx

[51] The President's Climate Action Plan, 2013, *Reducing Methane Emissions*, www.whitehouse.gov/sites/default/files/image/president27sclimateactionplan.pdf

data, addressing data gaps, identifying technologies and best practices for reducing emissions, and identifying existing authorities and incentive-based opportunities to reduce methane emissions.

The DOE's natural gas areas of focus include: building up to 2 million miles of transport and pipeline infrastructure; making investments to create sustainable shale growth zones; thinking prudently about natural gas exports and evaluating, with the USGS, what science can tell us about "induced seismicity" resulting from re-injection of produced water in shallow resource fields.

Getting the Words Right

The Center for the New Energy Economy's *Powering Forward* roundtable in 2013 produced a comprehensive discussion on the need to change the national conversation about natural gas production.[52] Here are excerpts from CNEE's report of that discussion:

> *"Improving the conversation is as much about style and tone as it is our words.* ~ Patty Limerick Director and Chair, Center for the American West

"A key recommendation – perhaps THE key recommendation – had less to do with public policy and more to do with public discourse. It was the need to build greater trust and a sense of joint mission among government, the natural gas industry, the environmental community, other public-interest stakeholders, and the general public.

In one sense, the public conversation is trying to catch up with the technology. In just a few years, the United States has been transformed from a prospective natural gas importer to the world's biggest natural gas producer, with plans to export liquefied natural gas (LNG) in coming years.

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[52] CNEE, *Powering Forward*, Chapter 4 – Robust and Responsible Natural Gas Development, cnee.colostate.edu/graphics/uploads/CNEEPoweringForwardFullReport.pdf

Leaders in the natural gas industry have the principal responsibility for building trust in the rapidly increasing role of natural gas production. The industry's willingness to be transparent in its practices, frank about its challenges and proactive in addressing the environmental and social impacts of the natural gas system are key factors…

All stakeholders can improve the quality of the public dialogue about natural gas production by engaging more thoughtfully and frankly in the conversation. The industry can build public trust by acknowledging and addressing global, national and community concerns such as climate change and the challenges involved in responsible gas production; policy makers and public-interest groups can engage in fact-based, neutral communication that demonstrates they understand the industry and its role in ensuring the nation's energy and economic vitality. The public, and public policy, are best served by frank and honest discourse that leads to rational and thoughtful decision-making rather than emotional and polarized debate. Keys to thoughtful discourse include the following:

The current conversation about natural gas development is complicated by inaccuracies. Many industry-related terms are misused and create confusion. For example, the term "hydraulic fracturing" is regularly misconstrued to include every aspect related to resource development, rather than a specific step in the extraction process. To identify and address people's real issues, it is far more useful for them to focus their concerns about gas production than to condemn the entire production process.

Also, although "oil and gas" are virtually conjoined industries, the two fuels have very different carbon profiles that must be recognized to make sound public policy on issues such as global climate change.

"Another important distinction regards methane emissions in the oil and gas value chain. While most discussion is about "fugitive" emissions – a term whose negative connotation the industry does not like – intentional emissions (i.e., venting) also are a source of methane emissions.

Some of the issues associated with natural gas production arise from misunderstandings, some are the result of inadequate data, some are highly emotional, and some are legitimate.

All of them must be addressed to build public confidence that natural gas is being produced and transported responsibly.

Defining "responsible production": President Obama and members of his Administration can help the industry, state regulators and the public better understand what "responsible production" entails. There can be no reasonable argument against responsible production, but stakeholders may define "responsible" differently depending on their sensitivity to development timeframes, the government's role, consumer costs, community impacts and environmental concerns. What some consider responsible regulation, others may consider unnecessary constraints on the production of a critical national resource. The President can dispel confusion about his criteria for responsible production.

Highlighting progress as well as problems: Several industry leaders in the CNEE dialogue said that significant progress is being made in regard to disclosure of the chemicals used in fracturing fluids. While this remains an issue (during the 2013 legislative session, at least 16 bills were introduced on the subject), industry leaders say there is a clear trend today toward more disclosure.

In 2011, a subcommittee of the Secretary of Energy's Advisory Board (SEAB) issued a report that concluded, "There is no economic or technical reason to prevent public disclosure of all chemicals in fracturing fluids, with an exception for genuinely proprietary information." Today, a growing number of companies have voluntarily released information on the chemicals they use in their hydraulic fracturing operations. Many of these companies post their information on the non-governmental FracFocus website.

Meanwhile, the American Gas Association has issued a position statement on Responsible Natural Gas Resource Development, which says in part that disclosure is "vital to securing broad-based support for the continued development of natural gas resources."
Leaders in the gas industry expressed concern that the public's image of hydraulic fracturing does not reflect the improvements made in chemical disclosure. Industry participants believe that disclosure has been addressed in a significant way by state regulations. In fact, most states with oil and gas extraction have various disclosure requirements in place either through legislation or regulations. Environmental and public

interest organizations, meanwhile, remain active in encouraging more complete disclosure requirements.

Industry's role in the conversation: For its part in the conversation, production companies and the industry as a whole should be frank in acknowledging problems where problems exist and in being responsive to legitimate public concerns. As one participant in the CNEE process suggested, the message from the gas industry should be: "I know you are worried. Here are the things to be concerned about. Here are the things we are doing to address those concerns, and here is the information that will enable you to see how well we are doing."

Tell how we'll get there from here: The national dialogue can be improved by greater frankness from government officials on the challenges and directions of current energy policy. The President set an excellent example of communicating values, goals and specific actions during his climate-action speech in June 2013. Part of the Administration's message should be to acknowledge that there is no energy resource without some measure of environmental, energy and economic costs over its life cycle. Various fuels have different advantages based on their emissions profiles, production methods, the size and accessibility of supplies, location of the resources, transportability and social factors traditionally externalized in determining costs and benefits. The key to transparent and responsible energy policy is to recognize and quantify those factors for an informed evaluation of our energy choices.

Finally, the President can contribute to a more informed public dialogue about energy policy and his vision of a clean energy economy by addressing how we'll get there from here. What is the roadmap for the energy transition? What should the relative roles be of fossil energy, renewable energy and energy efficiency? As Center for Strategic and International Studies has noted: "Perhaps the most important goal for the executive branch is to set an energy vision for the country that allows stakeholders to gauge how the government views various fuel sources and technologies and the role they play in reaching that long-term vision."

Conclusion

Every energy choice has its costs, many of which are not born in the price. Even wind and solar energy produce carbon emissions when their hardware is manufactured. The key is whether the life-cycle benefits of an energy resource exceed its costs, and which resources produce the greatest benefits at least cost. As the cleanest fossil fuel, natural gas offers significant environmental benefits, job creation and other benefits mentioned in this paper. The social and environmental costs associated with its production and distribution are largely fixable with progressive policy, deploying all cost-effective available technologies, changes in industry practice and better communication with the public.

At the 2014 Energy Institute Symposium, Ted Brown of Noble Energy may have said it best:

"It's about leveraging technology and really wanting to find solutions. When we're at the table and having a conversation with everyone who has a willingness to help solve problems, that's when we advance and have breakthroughs in the Colorado rules."