



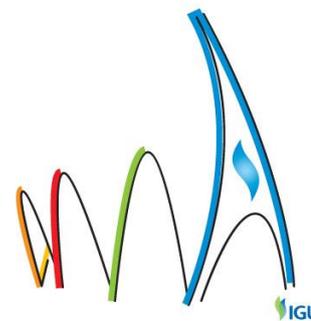
Stakeholders Collaborate for Environmentally Responsible Shale Gas Resource Development

The Center for Sustainable Shale
Development

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"GROWING TOGETHER TOWARDS A FRIENDLY PLANET"



26th World Gas Conference | 1-5 June 2015 | Paris, France

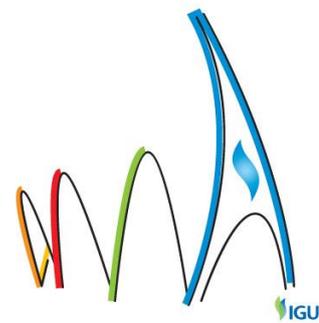
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In 2011, the Center for Sustainable Shale Development (CSSD) was organized as an unprecedented, collaborative effort of environmental organizations, philanthropic foundations, energy companies and other stakeholders committed to safe, environmentally responsible shale resource development in the Appalachian Basin of the United States. Former New Jersey Governor Christine Todd Whitman, a former Administrator of the United States Environmental Protection Agency and a CSSD Board Member, described the CSSD as an initiative "which will help to ensure that our country's natural gas resources are developed in a way that is most protective of the environment as well as public health and safety."

Background

In 1859, the world's first commercially successful well was drilled for oil production in Venango County, near Titusville, Pennsylvania. More than 350,000 oil and gas wells have been drilled in Pennsylvania since that time. Since the first recorded natural gas hydraulic-fracturing event in 1947, the innovative technologies of horizontal drilling and hydraulic fracturing have allowed exploration and production operating companies to access and develop shale gas resources that were not economically reachable in the past.

The Marcellus Shale region includes Pennsylvania, eastern Ohio, West Virginia, Maryland, and New York, which are all located in a geographical area known as the Appalachian Basin. The Marcellus Formation is black shale rock. Like most shale, it splits along the bedding easily, a property known as fissility. The ability to penetrate the shale to allow the release of gas was made possible with the advancement of hydraulic fracturing. Hydraulic fracturing involves the pumping of liquids into the well at extremely high pressures that fracture the resource formation, allowing more of the resource to reach the well. This technology has been used with various rates of success throughout the years, however, in the mid 1990's the practice became much more advanced with the invention of superior fluid mixes. The fluids are water or petroleum-based and are mixed with several molecular compounds to create an extremely heavy, viscous, and stable material. Shale reservoirs were previously not considered producible because they were impermeable.

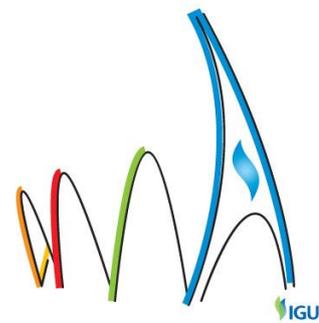
The significant improvements in technology and the continued learning have changed the industry dramatically. The Marcellus Region is a prime example of this change.

According to the Ohio Department of Conservation, the Marcellus Shale development began when Range Resources Inc., drilled a well through the Marcellus down to the Lower Silurian in Washington County Pennsylvania. The targeted reservoirs were not productive, but the Marcellus showed promise and a production well was successfully completed in 2004.

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Range drilled additional wells, experimenting with drilling and hydraulic fracturing techniques first used in Texas, and began producing Marcellus gas in 2005. Competitors took note, followed suit, and began the play. Soon there was a buzz in the industry.

The Marcellus Shale area is currently the most developed shale region in the United States. According to the U.S. Energy Information Administration, natural gas production in the Marcellus Shale region has grown from just over 1 billion cubic feet per day (Bcf/d) in 2007 to over 16 Bcf/d as of March 2015. The growth continues and, although the fall in energy prices has reduced the number of active rigs, new wells are being drilled and brought in to production each month.

A typical Marcellus well is completed between 5,000 and 9,000 feet vertically and up to 10,000 feet horizontally. Estimates of technically recoverable gas within the Appalachian Basin have been up to 500 trillion cubic feet (Tcf). According to the Pennsylvania Department of Environmental Protection, the state's shale gas wells produced over 4 Tcf of gas in 2014, enough to satisfy over 15% of the nation's annual natural gas demand.

Operators have invested in more efficient and environmentally friendly dual-fuel drilling rigs using compressed natural gas or line gas and have expanded the average number of wells per pad. Drilling and completions efficiencies have reduced the average cost per well by approximately 10%ⁱ and reduced the time to drill a Marcellus well by approximately 40%ⁱⁱ. The US Energy Information Administration (EIA) reports indicate that although the total drilling rig count in the Marcellus region is down since it peak in 2012, gas production per rig continues to increase. In 2007, one rig averaged roughly 422 mcf/d. The latest data in 2014 shows that producers are averaging nearly 8,000 mcf/d.

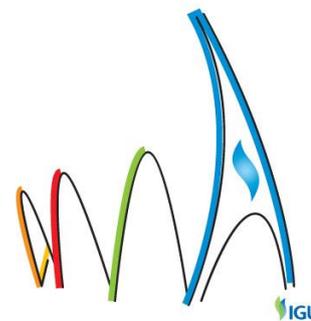
Investments in equipment, employment, and host community improvements (e.g., infrastructure, education and medical facilities) have revitalized active shale gas regions, while tax and impact fees have generated significant government fiscal benefits.

More than 200,000 Pennsylvanians are employed within or support the natural gas industry with the average annual pay of an oil and gas worker in Pennsylvania at \$71,220ⁱⁱⁱ. Roadway and infrastructure investments by oil and gas companies were reported at over \$411 million between 2008 and 2011. The U.S Department of Commerce has ranked Williamsport, Pennsylvania, located near the center of the states shale gas region, as the seventh fastest growing metropolitan region in the nation.

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In Pennsylvania, Act 13 of 2012 established an "impact fee" on every well drilled for natural gas in the Marcellus Shale formation. The fee is updated annually and is based on natural gas prices and the Consumer Price Index. In 2013, exploration and development companies paid \$50,000 for each new horizontal well or \$10,000 for each new vertical well drilled. Through Pennsylvania's 2013/2014 fiscal year, the impact fee has brought in \$630 million to Pennsylvania (\$204 million in 2011, \$202 million during 2012, and \$224 million in 2013). Sixty percent of the impact fee revenue remains in counties and municipalities hosting natural gas production. The remainder is distributed to various state agencies regulating drilling activity and to the Marcellus Legacy Fund for statewide environmental and infrastructure projects.

New leadership in Pennsylvania, and ongoing political debates, argue the merit of retaining the impact fee structure or adopting the Governor's proposed 5% severance tax on natural gas production. Industry groups contend that shale gas development in the state has generated over \$2.1 billion U.S. dollars in state taxes through 2013 and \$700 million in royalties from energy-development on public lands. The outcome of the debates and ultimate taxing environment will likely have a direct effect on future investments in unconventional development in the region.

The environmental impacts of hydraulic fracturing and shale gas resource development are the subject of controversial scientific, political and social discussions. Pennsylvania's northern neighbour and another beneficiary of the shale gas geological resources, New York State, has banned high volume hydraulic fracturing because of the potential environmental concerns. Although most politicians and citizens doubt their sincerity, some New York state residents and local government officials have threatened to secede from New York State over the ban in favour of joining the Commonwealth of Pennsylvania where hydraulic fracturing is permitted.

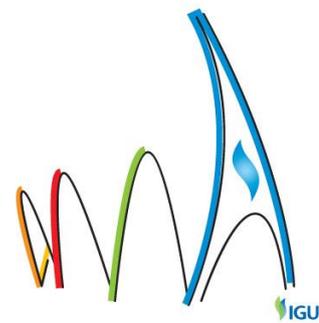
Aim

The CSSD was formed to encourage, document and recognize best practices implemented by exploration and development companies to reduce environmental impacts and secure social license. The CSSD promotes continuous improvement of operating practices and attainment of its fifteen environmental performance standards to protect water resources and air quality during unconventional natural gas exploration and production.

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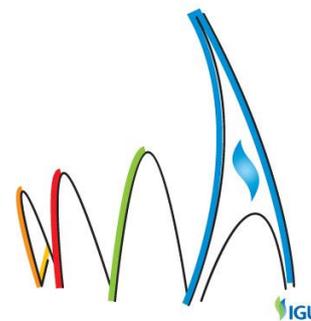
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For example, CSSD standards require that 90% of the water used in fracturing is to be recycled, pre- and post-drilling groundwater quality monitoring is required, and there is a public disclosure requirement for fracturing fluids used in drilling (see fracfocus.org). Conformance to the CSSD standards requires a level of environmental performance which exceeds most regulatory requirements of the United States federal government and the state governments of Ohio, Pennsylvania and West Virginia. Several standards significantly exceed regulatory requirements.

David L. Porges, CEO of EQT Corporation has described the CSSD certification as “a voluntary, independent evaluation and certification process to recognize companies that achieve and maintain high standards of [environmental] performance.” According to Fred Krupp, President of the Environmental Defense Fund, “The CSSD has an important role to play in the ongoing process of continuous advancement of industry practices that must improve to protect neighbours of oil and gas development and the environment we all share”. The Christian Science Monitor reported in October 2013 that the “Center’s aim is to imitate the success of the independent certification regime for green buildings known as the Leadership in Energy and Environmental Design or LEED.”

The CSSD conducted a survey of its members, academia, government regulatory agencies and executive offices, and non-affiliated oil and gas companies and environmental organizations. Respondents indicated that the top three challenges facing the shale gas industry are 1) Minimizing risk to the environment and local communities, 2) The extremism in public discourse and 3) Obtaining and/or maintaining social license to operate. The goals of the CSSD include contributions toward each of these challenges. The survey response also indicated that the certification program could improve 1) The industry’s overall environmental performance, 2) Providing transparent access to information, and 3) Building public awareness on excellence in industry performance.

Four significant shale gas producing companies in the region today have been active participants in the formation of the CSSD and development of its environmental performance standards. Three of the companies have demonstrated conformance with the full complement of the CSSD’s fifteen environmental performance standards and attained certification while the fourth continues to improve its performance.



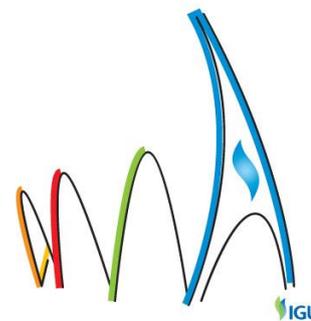
Methods

The CSSD's rigorous and verifiable standards took approximately 18 months to develop in a collaborative manner. A technical working committee of environmental non-governmental organizations (NGOs) and industry representatives authored and adopted the fifteen standards only when all committee members agreed upon the wording and intent of each standard. The CSSD Board of Directors, who is also made up of individuals from academia, environmental NGOs, industry, regulatory bodies and consumer advocates, were given the complete suite of standards for review and approval (see Board of Directors at sustainable shale.org).

Since initial adoption of the standards and the first audit and certification of an operating company, the standards have been reviewed and Standard 1, relating to wastewater treatment and discharge, has been revised to reflect technological improvements and increase protection of water resources.

Operators may seek certification to the CSSD standards for the eight Water Performance Standards, the seven Air Performance Standards or full certification to all fifteen standards. The CSSD approach requires operating companies to demonstrate conformance to each of the standards for which it seeks certification through a rigorous audit process. The assessment of conformance is conducted by an independent third-party firm using accredited auditors with upstream oil and gas experience. The audit firm is retained by the CSSD to maintain impartiality.

Operators undergo a pre-audit to evaluate their readiness for certification and to determine the scope of applicable operations, appropriate audit sample size and locations and the anticipated schedule. The certification audit is conducted within approximately two weeks of the pre-audit and includes both a desk-top office review of documentation and databases as well as interviews with operator data owners, managers, engineers, geologists and other responsible persons. The field portion of the audit includes visits to a sample suite of operators' well pad locations and assets to observe operations and equipment relevant to each performance standard. Field visits are representative of geographies and stages of well development and production/transmission, including well pads, active drilling and hydraulic fracturing operations, producing wells (wet and dry gas wells), compressor stations and impoundments. Generally, 50% of active drilling operations and well completions are observed during the initial certification audit.



Upon completion of its desktop and field review, the audit firm prepares a written report and recommendation for or against certification. Next, CSSD's Certification Decision Committee evaluates the audit report and is given the opportunity to pose and receive response to questions relating to the audit findings prior to making its decision. The Certification Decision Committee consists of five members including two CSSD officers, two board members who are not affiliated with an operator or non-governmental organization or environmental group, and one non-aligned individual appointed by the Board. The latter three make the final decision whether to grant certification.

Operators are evaluated via an annual review within 9 to 15 months of the first date of certification to assure continued conformance with the performance standards. The annual review includes a smaller sample set of visits to operating locations, encompassing approximately ten to twenty percent of the initial sample size. A full re-certification audit is required every two years including a sample of up to 50% of activities and locations.

Upon certification, the operator and CSSD issue press releases providing some details on the audit and certification process and CSSD posts on its website a summary of the desktop document review and field verification visits.

Results

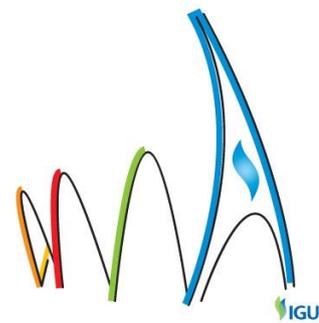
All four of CSSD's participating natural gas producing companies in the Marcellus Shale region have committed to becoming certified to the standards, and by the first quarter of 2015, three operating companies have been certified and a fourth is preparing and planning for their initial certification conformance audit. Operators have made measurable improvements in environmental performance and investments in equipment to achieve conformance with the standards and attain certification. Many of the performance standards have been incorporated into operator's internal environmental standards, management processes and decision making.

To conform with Water Performance Standards, operators have improved containment and leak detection and monitoring of water impoundments, recycled a minimum of 90% of waste water from operations, utilized closed-loop drilling systems, thoroughly evaluated risks to prevent adverse migration of drilling fluids to groundwater, and conducted pre- and post-drilling groundwater monitoring for potential water quality impacts.

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Certification to Air Performance Standards has required operators to reduce emissions from drilling, fracturing and motor vehicle engines, and pneumatic controllers on gas process units as well as reduce, document and control gas flaring activity. Documented equipment maintenance and leak inspections are also required on a regular schedule to minimize air emissions.

The companies involved view the standards and the independent third-party certification process as a way to demonstrate their commitment to managing the environmental aspects and impacts related to their shale gas production activities in the Marcellus Shale region.

Joe Osborne, Legal Director for the Group Against Smog and Pollution (GASP) said that "natural gas producers and environmental organizations managed to work together to produce a meaningful set of standards to reduce the risks and environmental impacts of shale gas production. It's a particularly remarkable accomplishment given how contentious and polarizing the public conversation about shale gas tends to be."

CSSD survey results indicate that the CSSD faces challenges with gaining public trust and recognition of independence from the oil and gas industry. Respondents encourage CSSD engagement of the public to obtain and maintain credibility while also encouraging greater participation by oil and gas operators and environmental groups. These apparently opposing goals present an opportunity for continued collaboration among the participants.

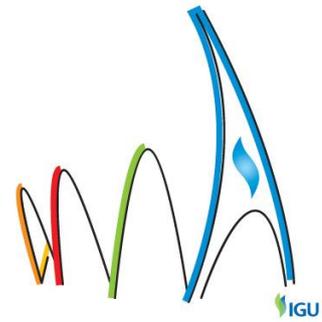
Conclusions

Davitt Woodwell, President of the Pennsylvania Environmental Council, has stated that "the opportunity to participate in the CSSD with other leading NGOs and members of the gas industry committed to go beyond regulation has helped us to further our understanding of the technical process and to help put in place standards that will continue to evolve and provide enhanced protections for Pennsylvania's citizens and natural resources." A participating oil and gas company has expressed a hope that CSSD certification would help make them a preferred partner of choice for development of the natural gas resource in the Appalachia region. Mr. Fred Krupp, President of the Environmental Defense Fund, has said "perhaps one of the largest benefits is actually being at the table, sharing ideas and developing performance standards which are then quickly put into operation in the field".

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CSSD's environmental performance standards are currently applicable to shale gas development impacts to water and air quality within the Appalachian Basin, however, interest has been expressed by stakeholders to expand the program beyond the Marcellus region. The CSSD standards were conceived to be "evergreen" as a commitment to continuous improvement across the full range of operational practices^{iv}. Some changes to the standards are being considered to enable implementation by users from other shale gas producing regions of the United States and internationally. Version 2.0 of the CSSD standards is currently being drafted and may be published in early 2015. Additional environmental performance standards may be considered along with possible health and safety standards.

The CSSD has received requests from international representatives of several countries expressing an interest in the CSSD program and has been in active discussions with those parties.

Authors:

Randy Daugharthy, Bureau Veritas Certification, Inc.

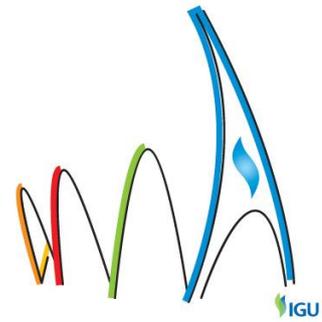
John Stangline, Bureau Veritas North America, Inc.

Bureau Veritas Certification is accredited by the CSSD as its initial independent certification auditing firm.

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ⁱⁱⁱ Pittsburgh Post-Gazette, Michael Sanserino, September 17, 2014

^{iv} Andrew G. Place, Corporate Director, Energy & Environmental Policy, EQT Corporation