Environmentally Friendly Production of Unconventional Natural Gas Resources

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ABSTRACT

Clean burning natural gas begins with producing the gas in an environmentally friendly manner. Industry has made great strides in protecting the environment while increasing natural gas production in the U.S. Producers, however, still face daunting challenges to effectively produce more natural gas in environmentally sensitive areas. The Environmentally Friendly Drilling (EFD) program combines new low-impact technologies that reduce the footprint of drilling activities, integrates light weight drilling rigs with reduced emission engine packages, addresses on-site waste management, optimizes the systems to fit the needs of a specific development sites and provides stewardship of the environment. In addition, the program includes industry, the public, environmental organizations, and elected officials in a collaboration that addresses concerns on development of unconventional natural gas resources in environmentally sensitive areas. The EFD program provides the fundamentals to result in greater access, reasonable regulatory controls, lower development cost and reduction of the environmental footprint associated with operations for unconventional natural gas.

Keywords: low-impact operations, environmental stewardship, technology transfer

1 PROGRAM OVERVIEW

The US has an abundant supply of natural gas, almost a 100 year supply of this clean energy source. However much of it is a "non-permitable" resource. The question is how to develop these resources without impacting the environment. The EFD program takes a systematic approach to develop and integrate new, low-impact, cost-effective technologies that reduce the footprint of drilling and production activities. The program provides technologies to successfully produce shale gas and tight gas sands, Figures 1 and 2, while appropriately addressing environmentally sensitive issues throughout the U.S.

Working together is a partnership (7 universities, one research center, 2 National Laboratories, 11 O&G companies, and 3 environmental organizations) to develop EFD technologies that reduce the impact in environmentally sensitive ecosystems. Partners have regional expertise that they bring together in a synergistic manner to address the needs across the U.S.

To inform the public of the industry's environmental advancements in technology, the EFD program is developing a computer based model to select complementary environmentally friendly technologies for E&P operations along with an EFD Scorecard to measure performance. The model and the scorecard are important tools that allow industry and regulators to measure performance. The Scorecard concept engages all stakeholders, including industry, academia and environmental organizations, to identify technologies and systems that can be used to recover unconventional natural gas reserves with the lowest possible environmental footprint. The Model and the Scorecard are based on the principles of what gets measured gets done and what gets identified gets dealt with.

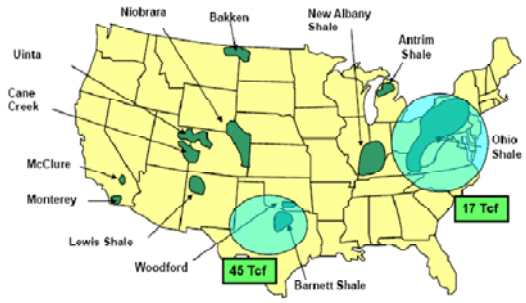

Figure 1. Shale Gas – 69 Tcf Technically Recoverable

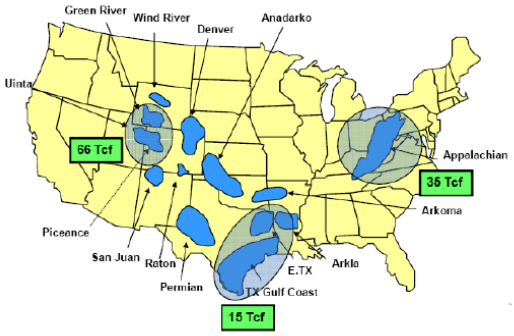

Figure 2. Tight Gas Sands – 159 Tcf Technically Recoverable

2 PROGRAM FOCUS - ACCESS

The EFD program addresses access to domestic resources, which are either off limits or are restricted. Exploration and production companies face restrictions, and in some cases complete prohibitions, that prevent operations in sensitive areas in the continental United States. Environmental constraints, including laws, regulations, and implementation procedures, can limit natural gas development and production on both federal and private lands. More than 30 environmental policy and regulatory impediments to domestic natural gas production have been identified and documented. Yet U.S. stakeholders are united in the desire to improve the energy independence of the country and to understand the environmental tradeoffs necessary to secure energy for America. Actions that eliminate or reduce the impacts can help the nation meet its natural gas demands.

Data collected in the previously funded EFD project shed insights on the way in which the public perceives environmentally friendly drilling technologies. These data reveal that the majority of citizens are either in favor of eliminating or relaxing current governmental regulations limiting the exploration and production of oil and natural gas in environmentally sensitive settings as the energy industry adopts and uses a more environmentally friendly approach. A significant majority of survey respondents indicated that as environmentally friendly approaches are implemented, current governmental regulations limiting the exploration and production of oil and natural gas should either be eliminated or relaxed. In environmentally sensitive areas such as coastal wetlands, desert ecosystems, and hardwood forests the large majority of respondents agreed that current regulations could either be eliminated or relaxed as the industry uses a more environmentally friendly approach (68, 72, and 63 percent, respectively).

According to the National Petroleum Council's (NPC's) recommendations, access to indigenous resources is essential for reaching North America's full supply potential. New discoveries in mature North American basins represent the largest component of the future supply outlook. However, the trend towards increasing leasing and regulatory land restrictions in the Rocky Mountain region and the Outer Continental Shelf (OCS) is occurring in precisely the areas that hold significant potential for natural gas production. The NPC evaluated the effect of removing the OCS moratoria and of reducing the impact of conditions of approval on the Rocky Mountain areas – a potential addition of 3 BCF/D by 2020.

3 PROGRAM HISTORY

Land-use policies of federal, state, and local governments have not kept pace with technological advances that allow for exploration and production while protecting environmentally sensitive areas. Technical advances have reduced the number and size of onshore drilling sites and production facilities. The federal government has continued to set federal lands off-limits to development through legislation, executive orders, and regulatory and administrative decisions. Moreover, an increasingly complex and costly maze of statutory and regulatory requirements effectively places additional lands off-limits to development, even though they are technically available for leasing.

The EFD program began in 2005. Our work has shown that the industry could achieve more than 90% reduction in the impact on the environment if low impact technology was combined into a complete system. EFD includes (a) commercialization of technology to treat and reuse produced water, (b) development of Alternate Rig Power to reduce operating costs and emissions, and (c) identification and testing of improved technologies and equipment that will reduce the footprint of access roads and well pads, to optimize EFD technologies in E&P activities. The program incorporates "disappearing roads" and light weight drilling rigs with reduced emission engine packages to reduce the footprint of drilling activities. The EFD system addresses on-site waste management (re-use of produced brine), and optimizes the system to fit the needs of a specific development sites using a systems engineering model developed previously. In addition the program offers a collaboration that addresses public concerns on development of unconventional natural gas resources in environmentally sensitive areas.

4 UNIVERSITY/NATIONAL LABORATORIES ALLIANCE

The EFD Program has initiated a partnership between National Laboratories and universities to develop critical new technologies to accelerate the development of domestic reserves in a safe and environmentally friendly manner. Historically the national labs have provided beneficial technologies to increase oil and gas production, but have not focused in the past few years on basic research aimed at providing clean fossil energy to the public in cost effective environmentally acceptable manner. We firmly believe that some of the science from research conducted at the Laboratories and Universities has had an environmental focus, but funded for downstream or other applications other than upstream oil and gas. This science has applicability we want to tap into through this initiative. The Alliance, managed by the Houston Advanced Research Center (HARC) combines the strong vision and strategic plan of a member led organization with the strengths of a network of highly skilled professionals and well equipped facilities having the talent to move ideas into operations. The objectives of the alliance are:

- To use HARC's information collection, synthesis, and dissemination organization.
- To tap into national laboratories scientific research capabilities by forging a partnership with universities, operators, services companies,

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environmental organizations and other laboratories to help meet the overall goals of industry.

- To bring highest level research capability to bear on the critical gap and basic research in technology needed to increase our energy reserves.
- To provide fundamental research that can be later incorporated into projects.
- To serve as a network link among the regional EFD partners and their constituencies.

Working with HARC will be Texas A&M University, University of Wyoming, University of Colorado, Utah State University, Sam Houston State University, University of Arkansas, West Virginia University, TerraPlatforms, LLC., Argonne National Laboratory and Los Alamos National Laboratory. We trust others will participate. The goal is to fund the development of and share the latest research findings with leaders of energy, academia, environmental organizations and government.

5 THE EFD SCORECARD

The oil and gas industry has made significant strides to reduce the impact oil and gas exploration, drilling and production operations have on the environment. Companies are aware that minimizing their environmental impact both onshore and offshore is crucial to reducing environmental liabilities, controlling operational costs, and enhancing public acceptance of the U.S. oil and gas exploration and production. As Congress addresses high energy prices, energy security and our dependency upon foreign imports, an option is to open new areas for leasing, most of which are off-limits because they are located in environmentally sensitive areas of the Outer Continental Shelf (OCS), Arctic and Western lands. While technology has advanced to the point where the drilling footprint has been significantly reduced, there is a legitimate concern that there is currently no way to assure the public that all of the oil and gas industry and their supply chain will be fully compliant to ensure minimum environmental impact of operations in these areas. A new government program would be slow to implement, impractical and expensive and could hinder the objective of increasing production in a timely manner, while protecting the environment.

The Houston Advanced Research Center (HARC) and Texas A&M University have been leading an industry consortium effort to identify, coordinate, and document the development of low impact drilling systems. Our group has developed a scorecard to understand the tradeoffs associated with environmental and energy production issues. The methodology presents an ecological understanding of the tradeoffs associated with producing energy. This scorecard methodology is based on the recommendations of ecologists, botanists, wildlife management experts and others in addition to oil and gas industry experts. All stakeholders (government agencies, academia, industry, environmental NGO's and the general public) are active participants in the development of the process.

Today's industry is accepting costs of environmental stewardship. These costs must be reconciled with commercial interests. Environmental restoration, economic prosperity and social stability may co-exist and do not have to be in conflict. The EFD scorecard methodology can ensure that adequate operational safeguards are employed for a variety of ecosystems. The process facilitates the adoption of energy exploration, production and delivery practices that are environmentally responsible through the creation and implementation of universally understood and accepted tools, techniques and performance criteria that are specific to a given location.

6 WASTE MANAGEMENT

The EFD is exploring various technologies to reduce discharges associated with drilling and production operations. The objective is the integration of both wastewater treatment and reuse and solid waste treatment processes into a system that captures and treats all run-off and effluent fluids, drill cuttings, and other waste streams.

Sustainable development of petroleum resources requires appropriate management of all waste streams generated over the life cycle of a development beginning with initial planning of projects and operations through decommissioning and site restoration. Quality waste management approach is crucial to achieve this goal.

The principal aim of waste management is to ensure that waste does not contaminate the environment at such a rate or in such a form or quantity as to overload natural assimilative processes and cause pollution. Eliminating or minimizing waste generation is crucial, not only to reduce environmental liabilities but also operational cost.

The project is developing a small footprint, low-impact environmental treatment process that is adaptable to real-life drilling operations, based on sound engineering and biological principles that is capable of converting drilling wastes to a useable product.

7 ARCTIC OPERATIONS

The Alaskan North Slope possesses one, if not the greatest, opportunity to increase domestic oil and gas production. This region, however, faces some of the greatest environmental and logistical challenges to develop resources in the world. A number of studies have shown weather patterns in this region are warming and the number of days the tundra surface has adequate snow cover and frozen surface soils for tundra travel each year has declined. Operators are not allowed to openly explore in undeveloped areas until the tundra is sufficiently frozen and adequate snow cover is present. Using the best available methods, exploration in remote arctic areas can take up to three years to identify a commercial discovery, and then years to build the infrastructure to develop and produce. This makes new

exploration costly. It also increases the costs of maintaining field infrastructure, pipeline inspections and later environmental restoration efforts.

The EFD team has identified certain low-impact technologies suitable for operations to reduce the footprint and impact on the environment. *Additional improvements are needed for exploration and economic field development and end-of-field restoration.* The inland platform was identified as a potentially enabling technology. Future work is needed to incorporate this technology along with other technologies (mats, small modular rigs, waste management, alternative road technologies, along with other EFD technologies) into ***systems*** that are suitable for Arctic conditions. The inland platform may mitigate environmental risks associated with activities in environmentally sensitive areas. ***There are several potential applications that could be pursued***. As a next step, a detailed engineering study could be performed to develop a design for a site-specific staging area that could be used for logistical support. Then, a prototype for a specific application could be developed. This would enable various engineering and scientific data to be obtained that could be used in more complex applications. We are currently seeking partners and funds to pursue this next step.

8 SYSTEMS ENGINEERING

In choosing a system of low impact technologies to drill a well, many choices are available. The selection process is complex and needs to be based on a logical approach. The EFD Team has developed a systems approach, an established solution to optimize decisions and ensure that the program selected satisfies chosen criteria (called attributes). Recently this statistical approach has been proposed for locating infill wells in a developed field. It is being used in the EFD program to arrive at the optimum system for a given site. The entire matrix of technologies is being transferred to the web where sponsors can access the tool to select low impact options among the many configurations of drilling systems.

The Systems Engineering Design Methodology is currently specific for the coastal margins of Texas. The EFD team is in the process of generalizing the methodology to provide a framework into which play specific information (regional requirements for environmental compliance, etc.) could be placed. This would enable the regional partners to more quickly and efficiently "stand-up" an equivalent informational site.

9 RELATED PUBLICATIONS

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