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Balancing Environmental Tradeoffs Associated with Low Impact Drilling Systems to Produce Unconventional Natural Gas Resources

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Abstract

An environmental scorecard has been developed to determine the tradeoffs associated with implementing low impact drilling technology in environmentally sensitive areas. The scorecard assesses drilling operations and technologies with respect to air, site, water, waste management, biodiversity and societal issues. Low impact operations reduce the environmental footprint of operations by the adoption of new methods to use in (1) getting materials to and from the rig site (site access), (2) reducing the rig site area, (3) using alternative drilling rig power management systems, and (4) adopting waste management at the rig site. The scorecard enables a dialog to be established and maintained among all interested, concerned and affected stakeholders. In this manner, the industry has a new way of seeing itself within the larger network. The scorecard that will be presented in the paper provides the means to demonstrate the connectivity between energy production and the affected ecosystem. The Houston Advanced Research Center (HARC) is leading a consortium effort to investigate the development of low impact drilling systems. The work originated in 2005 and funding was obtained by the U.S. Department of Energy for 2006 – 2009. Additional funding for the effort was obtained through the Research Partnership to Secure Energy for America (RPSEA), industry and environmental organizations. The goal of this project is to reduce the environmental impact of rig operations through integration of low-impact site access and site operations. The paper discusses the scorecard that is being developed. The scorecard methodology presents an ecological understanding of the tradeoffs associated with producing energy. The scorecard methodology was developed through a series of workshops being held with ecologists, botanists, wildlife management experts and others in addition to oil and gas industry experts.

Introduction

An environmental scorecard has been developed to determine the tradeoffs associated with implementing low impact drilling technology in environmentally sensitive areas. The scorecard assesses drilling operations and technologies with respect to air, site, water, waste management, biodiversity and societal issues. This paper is based on the Scorecard Reference Guide.[1]

The overall objective of the scorecard is to have a means of measuring the environmental and societal tradeoffs associated with an energy development project. Industry has done an effective job of making safety a core value within each and every employee. The goal of the scorecard is to assist in the development of a mindset within industry that environmental stewardship is a core value. In addition, the scorecard enables all stakeholders to understand the balance between energy development and the impact on the environment.

What Does 'Environmentally Friendly' Mean?

'Environmentally Friendly' has become the shorthand term for the concept of developing energy resources in such a manner as to minimize the impact on the environment. The concept goes beyond environmental impact and takes into consideration societal issues as well as ensuring that technologies are cost effective.

Why Use the Scorecard?

Development of energy resources is important to the economic development and security of our nation. The scorecard enables a methodology to be employed that documents the environmental and societal tradeoffs associated with energy development. The scorecard enables operating companies to make use of the principle of ***what gets measured, gets done***.

Environmentally Friendly Drilling (EFD) practices can substantially reduce negative environmental impacts and promote balance between nature and energy development. In addition, EFD practices may be cost effective, enhance public relations, increase worker productivity and reduce potential liabilities.

Having an operation certified through the use of the Scorecard can demonstrate how an operating company successfully manages operations. In addition, using EFD practices may reduce overall costs, enhance public image, increase productivity and reduce potential liability issues. EFD practices have environmental, economic, and social elements that benefit all stakeholders, including operating companies, service companies, suppliers, contractors, regulators, landowners and the general public.

Who Should Use the Scorecard?

The EFD scorecard ***process*** is designed to document how environmental and societal issues are addressed. The scorecard is an adaptive ecosystem services management tool that can assist operating companies in planning and implementing practices to manage operational risks. Land owners, regulators and the general public can use the scorecard to objectively access operators' environmental performance.

The Environmentally Friendly Drilling System Scorecard

The environmental scorecard was developed to determine the tradeoffs associated with implementing low impact drilling technology in environmentally sensitive areas. The scorecard assesses drilling operations and technologies with respect to air, site, water, waste management, biodiversity and societal issues. Low environmental impact drilling and completion operations may reduce the environmental footprint of operations by the adoption of new methods to use in (1) getting materials to and from the rig site (site access), (2) reducing the rig site area, (3) using alternative drilling rig power management systems, and (4) adopting waste management at the rig site.

The scorecard enables a dialog to be established and maintained among all interested, concerned and affected stakeholders. In this manner, the oil and gas industry has a new way of seeing itself within the larger network. Environmental sensitivities and other factors vary between various ecosystems. The EFD scorecard process takes this into consideration and enables operating companies to document how environmental factors are addressed for the different ecosystems.

History of the Scorecard

The Houston Advanced Research Center (HARC) and Texas A&M University through the Global Petroleum Research Institute (GPRI) have been collaborating with industry and environmental organizations to integrate and demonstrate current and new technology into land-based drilling systems for compatibility with environmentally sensitive or off-limits areas. The **Environmentally Friendly Drilling Systems** (EFD) Program (www.efdsystems.com) is taking a systems approach to the integration of currently known but unproven or novel technology in order to develop drilling systems that will have very limited environmental impact and enable moderate to deep drilling and production operations and activity with reduced overall environmental impact.

The EFD Program is identifying and providing the technology to successfully produce shale gas and tight gas sands while appropriately addressing environmentally sensitive issues. The project focuses on developing drilling technologies that can be used throughout the U.S., in particular, unconventional natural gas resources.

Why create something called "Environmentally Friendly Drilling"? Because new technology will help meet the U.S. energy needs for the next century at the same time we reduce the environmental "footprint" of oil and gas operations.

Exploration and production companies are aware that minimizing their environmental footprint is crucial to reducing environmental liabilities, controlling operational costs, and encouraging public acceptance for the sustainable development of the U.S. natural resources. There are certain restrictions for habitat protection and in some cases complete prohibitions that prevent drilling in many sensitive areas in the continental United States.

Sustainable development of petroleum resources requires careful planning, monitoring and measurement of operations over the life cycle of a development, from the initial planning through decommissioning and site restoration. An onshore drill site has decreased in size from over 10 acres to less than 1 acre per well over the last 20 years. Other environmental tradeoffs also need to be measured and tracked.

While there may be technologies available to accomplish environmentally acceptable drilling, technologies have to be proven to be accepted. In response to this need, the EFD project team works with government, industry, academia and public organizations to identify, develop, and provide industry with the tools to develop needed energy supplies. Many of these new and emerging technologies and methodologies can be applied to reduce environmental tradeoffs associated with oil and gas operations.

Having a program that has the potential to "lighten the impact" of drilling in environmentally sensitive areas such as coastal margins, National Forests and Parks and other public lands is extremely important. Leases beneath many of state and national parks and public lands are owned by private companies, not the government. Only by setting environmentally responsible standards can park managers protect the environment while providing access to these resources.

THE MORE YOU KNOW, THE LESS YOU NEED

The drilling process is considered a complex activity composed of a set of processes interrelated by purpose, sequence, and time. Millheim[2] defined the drilling process as a system in the mid 1980's. The systems themselves are made up of sub systems. The rig and the surface equipment is a complex subsystem of the drilling process. Pedersen and Essendrop defined the drilling system (Millheim's rig subsystem) as being comprised of six subsystems[3]: drilling control system, drilling machine, pipe handling, blow-out-preventer (BOP) and handling system, mud supply, and mud return[4]. Though defined for the offshore jack up design environment, many of the concepts have transitioned to the onshore rig design.

As knowledge has increased, technology has allowed the industry to contact almost 60 times the volume of subsurface rock material that could be accessed in 1970 while occupying only one third the surface area.[5] Today's technology associated with drilling and production can be unobtrusive and highly efficient if the technologies are used concurrently on the same well. In the past 20 years, technology has been able to significantly reduce the impact that drilling operations have on the environment. According to the Natural Gas Supply Association, some of the key technology developments over this time period have enabled the following.

- 22,000 fewer wells are needed on an annual basis to develop the same amount of reserves as were developed in 1985.
- Had technology remained constant since 1985, it would take two wells to produce the same amount of oil and natural gas as one 1985 well.

- Drilling wastes have decreased by as much as 148 million barrels due to increased well productivity and fewer wells.
- The drilling footprint of well pads has decreased by as much as 70 percent due to advanced drilling technology.
- By using modular drilling rigs and slim hole drilling, the size and weight of drilling rigs can be reduced by up to 75 percent over traditional drilling rigs.
- Had technology, and thus drilling footprints, remained at 1985 levels, today's drilling footprints would take up an additional 17,000 acres of land.

Documented best practices and lessons learned have greatly reduced environmental issues associated with drilling operations. The oil and gas industry just needs to combine these practices into EFD systems, and then demonstrate their effectiveness in real applications.

REDUCE, REUSE, RECYCLE

The energy industry has progressed in taking into consideration environmental issues. Shell Exploration and Production Company established a Rig Waste Reduction Pilot Project in 2001 to identify potential waste reduction strategies.[6] Their preferential hierarchy that they developed is: *reduce, reuse, recycle, recover and dispose.* The majority of the total waste stream was found to be drilling discharges and non-hazardous oilfield waste. Mud use was reduced by 20% and mud component packaging was reduced by 90% through a combination of solids control efficiency, cuttings dryer technology and bulk mixing equipment. In addition, Shell implemented a sorting, compaction and recycling process for solid waste (consumables and trash) to reduce landfill disposal.

Schlumberger has introduced a total waste management program to mitigate rising quantities of landfill waste.[7] Benefits included an overall improvement in general housekeeping that reduced health and safety exposure and a general increase in environmental awareness and concern. As a result, the recommendation is made to ensure that the operator establishes a waste management program that covers all exploration, drilling and production activities.

Mobil implemented a waste management program for the Hugoton field operations.[8] The waste management system decreased overall waste-related costs while improving compliance assurance and reducing potential liability. The key element was a mechanical solids control system consisting of a semi-closed loop centrifuge flocculation dewatering process that removes solids for burial on location.

Chevron has published ten years of lessons learned concerning bio-treating exploration and production wastes.[9] They have successfully implemented bioremediation in diverse climates and in remote locations. The most common biological treatment techniques in the exploration and production industry are composting and land treatment. Land farming and composting have been successfully used for drilling wastes.[10]

There is currently an industry joint venture, sponsored by GPRI and the U.S. Department of Energy – National Energy Technology Laboratory to reduce waste volume of liquids at the rig site. This “Mud Pit Cleanup and Re-Use” project aims at recovering fresh water and solids-free brine at the rig site for re-use in drilling operations.[11]

RESTORE

Reducing, reusing and recycling are all important. For sustainability, more is required. The relationship between business and a healthy environment is critical to long-term sustainability. Paul Hawken has defined sustainability as a stable relationship between human culture and the living world.[12] Business practices need to address life on earth. Ecology and commerce need to be united. As industry weighs various business practices, a systematic methodology of understanding and guiding practices may be implemented to, first, develop an understanding of the tradeoffs. To develop an understanding of what is possible, an understanding of the current situation is required.

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.

WHAT GETS MEASURED, GETS DONE

The Nutrition Labeling and Education Act of 1990 mandated that food companies were required to use a new food label on most food products beginning in 1994. This label provides information to enable consumers to make educated decisions about what they eat.

The US Green Building Council (USGBC) has develop an analogous label for summarizing how a building measures up in their Leadership in Energy and Environmental Design (LEED) Green Building Rating System™. The LEED system encourages and accelerates the use of green building practices through the implementation of universally understood and accepted tools and performance criteria. Noble Corporation, for example, published an annual sustainability report documenting their performance year-over-year and, when they could, against their peers.

The EFD Scorecard, to measure tradeoffs concerning environmental issues related to oil and gas operations, used the nutrition label and the LEED system as analogies.

THERE IS ONLY ONE BUS

In 1963, Buckminster Fuller published his ***Operating Manual for Spaceship Earth***[13] where he discusses the limited supply of energy onboard the spaceship and the need to harness the energy being supplied by the sun. Another way of looking at it is to realize that everyone is on the same bus and that there is a limited amount of fuel in the tank. While technologies are being pursued to harness solar energy, technologies need to be developed and implemented to ensure that current energy supplies are being used efficiently and all new fuel supplies that are tapped are done in a manner that will not be detrimental to those onboard.

There are tradeoffs between energy needs and biodiversity values. Many areas that are potentially valuable for energy are also recognized for biodiversity values. Energy development can impact biodiversity. The energy industry needs to meet public demand for energy while at the same time meet society's expectations for corporate, social and environmental responsibility. Conservation organizations need to be a voice for biodiversity protection while appropriately partnering with industry and recognizing that there is a balance to be struck between/among economic development, energy production and the conservation of biodiversity.

The EFD program is aimed at tapping the fuel supplies in an environmentally sound manner. The scorecard methodology aims to measure and demonstrate its effectiveness.

Everyone on the bus has a vested interest in ensuring that sources of energy are produced using technologies that are not harmful. In developing the tradeoffs scorecard methodology, the decision was made to get as many stakeholders around the same table as possible, including industry producers and service companies, ecologists, botanists, toxicologists, zoologists, wildlife managers, endocrinologists, environmentalists, regulators, and others. An initial workshop was held with representatives from government, academia, non-profits, industry and environmental organizations with the objective of discussing the tradeoffs associated with producing energy.

The focus of the workshop was the drilling systems and operations, recognizing that there is a need to also consider other oil and gas systems and operations. Environmentally Friendly Exploration and Production scorecards could be developed, as a minimum, for:

- Exploration
- Drilling
- Completion
- Processing
- Refining
- Transportation
- Distribution
- Field Development
- Field Operations

An EFD scorecard for drilling systems and operations was selected as the first scorecard to be developed due to the ease at which a boundary can be established around the time and location for the systems and operations.

WHAT GETS IDENTIFIED, GETS DEALT WITH

The objective of the EFD scorecard is to have a methodology that is meaningful, simple and easy to implement and understand. Six attributes were identified as meaningful to evaluate: site (soil/sediment), water, air, waste management, biodiversity/habitat and societal issues. The scorecard process builds upon the remarkable safety improvements in a similar process. With safety, the industry reports through the International Association of Drilling Contractors and there is a commitment from each contractor to

have 0 recordable incidents. The scorecard provides a means to make environmental and societal issues core business values.

Each attribute has several layers or sub-attributes. As an example, within biodiversity, the potential threat to wildlife due to proximity or timing of operations could be assessed and minimized. Drilling activities have the potential risk of temporarily interfering with wildlife. The risk can be mitigated through proper planning and monitoring of operations.

The EFD scorecard has two point levels. First are the prerequisites – those activities that must be done. Second are optional credits – those activities that are considered best practices, going beyond minimum operating requirements.

Prerequisites for the various attributes include rules and regulations that govern the drilling locations. Within the United States, regulations vary by state and address various environmental issues by geographic location. Argonne National Laboratory, in conjunction with Marathon and Chevron, has developed an interactive website that summarizes state and federal regulations governing drilling waste. The website also provides descriptions of various technical options as well as case studies and other information.[14]

The optional credits include various practices that can reduce the environmental and societal tradeoffs associated with oil and gas operations. There are several references that provide information on various technologies and methodologies that may be employed to address the optional credits, including:

- *The Oil and Gas Industry from Rio to Johannesburg and Beyond*, IPIECA/OGP 2002.[15]
- *Integrating Biodiversity Conservation into Oil and Gas Development*, The Energy & Biodiversity Initiative.[16]
- *Reinventing the Well*, Conservation International.[17]
- *Environmental Management in Oil and Gas Exploration and Production*, Joint E&P Forum/UNEP Technical Publication.[18]
- *Drilling Rig Energy Inventory Engineering Report.*[19]
- *Environmental Impact of Standard Oil Drilling Installations Versus the LOC250.*[20]
- *Assessments of Technologies for Environmentally Friendly Drilling Project: Land Based Operations.*[21]
- *Clean Energy-Environment Guide to Action.*[22]
- *Annotated Bibliography of Waste Minimization Technology.*[23]
- *Waste Minimization in the Oil Field.*[24]
- *Guidelines for the Review of State Oil & Natural Gas Environmental Regulatory Programs.*[25]
- *Coal Bed Methane Best Management Practices.*[26]
- *Texas State Review of Oil and Natural Gas Environmental Regulations.*[27]
- *Manager's Guide to Environmental Regulations.*[28]
- *Considering Ecological Processes in Environmental Impact Assessments.*[29]
- *Environmental, Health, and Safety (EHS) Guidelines.*[30]
- *Environmental Management Systems and International Environmental Standards in the Offshore Oil and Gas Industry.*[31]
- *Summation of Potential Technologies for Environmentally Friendly Drilling in South Texas.*[32]
- *Modern Shale Gas Development in the United States: A Primer.*[33]

MAJOR ATTRIBUTES

There are six major attributes of the scorecard. For each there are prerequisites that must be addressed and then credits that may be earned by going beyond the prerequisites. A summary of the key points that are addressed in each attribute follows.

Air – Within this attribute, the prerequisites are related to complying with all regulations. Credit subattributes include implementing technologies and processes related to contractual obligations for logistics, site emissions, dust suppression, clean power and green completions.

Water – There are two prerequisites in the water attribute: developing/implementing a stormwater management plan and planning

and implementing integrity testing of the surface casing. Credit subattributes include technologies and processes related to developing/implementing a water management plan, setbacks from streams/sources, mitigation measures to protect waters, reducing water usage, and reuse of water and fluids.

Site – The site prerequisites include regulatory compliance as well as erosion and sedimentation control. Credit subattributes are related to the use of a pre-existing site, pad drilling, protecting/restoring habitat, providing contractor guidelines, site reclamation, well design considerations, living quarters, and other technologies and processes.

Waste Management – There are two prerequisites related to developing/implementing a waste management plan and performing a pre-site assessment of the drill site pad. Credit subattributes cover the drilling fluid handling system, handling of rig wastes, spill prevention systems and disposal of drill cuttings.

Biodiversity/Habitat – For this attribute, there are three prerequisites covering species protection, habitat protection/enhancement, and regulatory requirements. Credit subattributes include interim reclamation, reduction of surface disturbance, offsite mitigation, invasive species prevention, reintroduction of species/habitat and other issues.

Societal – There are two prerequisites covering regulatory compliance and the development/implementation of a communication plan. Credit subattributes are related to public outreach, noise/lighting, monitoring air quality, training local first responders, surface use plans, and programs related to dispute resolution and unintended consequences.

NEXT STEPS

The Environmentally Friendly Drilling team is now working with operators to prototype test the scorecard system. Once the scorecard has been tested and the appropriate number of points is determined for the various levels, a voluntary certification process will be introduced.

The EFD certification process will be a voluntary process based on existing, proven technologies. The process will evaluate environmental and societal issues associated with energy development based on accepted principles seeking a balance between energy development and all living systems.

The EFD scorecard will vary with various ecosystems. Practices and methodologies vary in importance from one ecosystem to another and the Scorecard takes this into consideration.

Companies interested in obtaining EFD Certification for their project will be requested to first register the project. Registration is an important step that establishes the primary contact between the project and the organization that will perform the certification. Once a project is registered, the company may begin to collect information to satisfy the prerequisite and credit submittal requirements.

Occasionally the company may encounter difficulties in applying an EFD prerequisite or credit to their project. These problems arise from instances where the Reference Guide may not sufficiently address a specific issue or where there is a conflict that requires resolution. To address such problems, there will be an EFD Interpretation process.

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