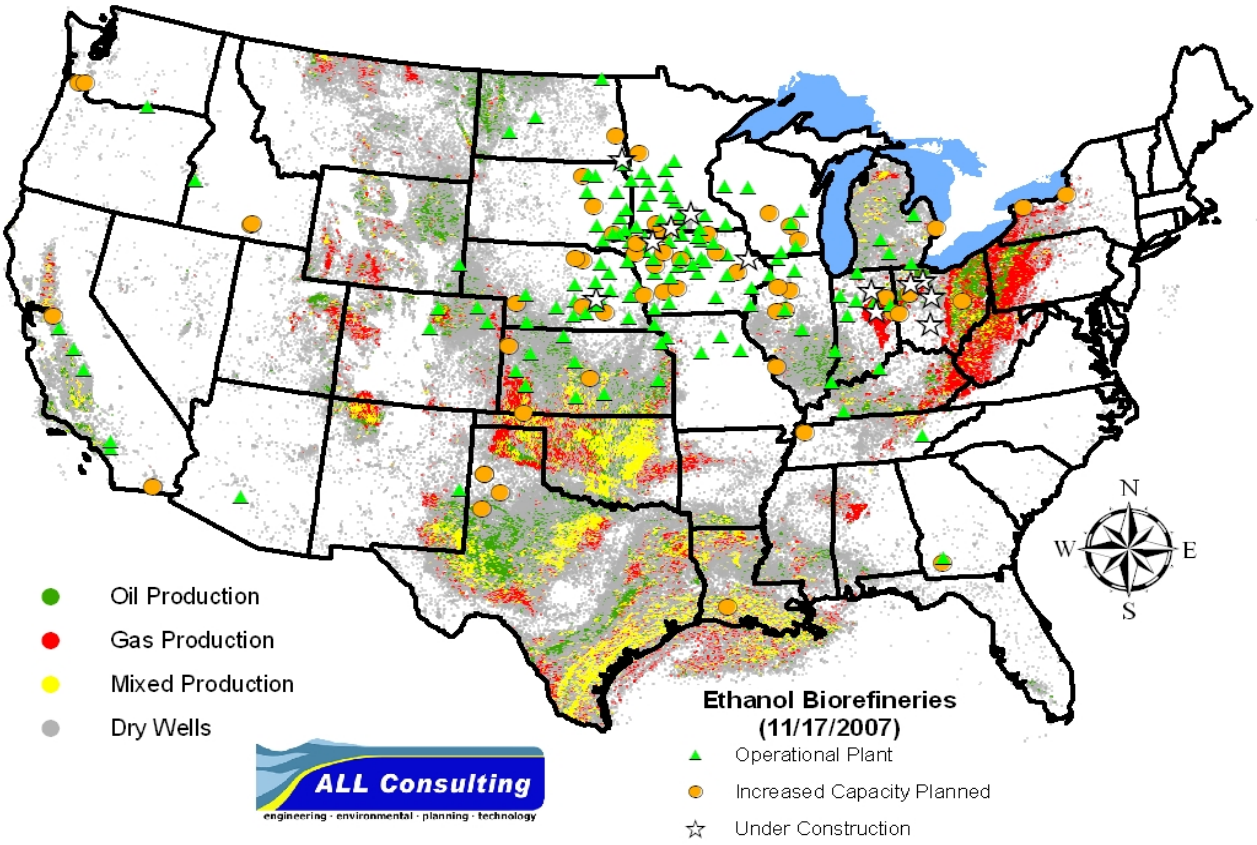
Technical Paper

Applying a Synergistic Approach to Sustainable Energy Development



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Abstract

Energy demands worldwide are growing and outpacing supply in many areas. The growing disparity between supply and demand for fossil fuels, combined with oil and gas production levels that are estimated to peak and begin a decline, perhaps as much as 5-7 percent annually, has also lead to the development of a growing number of alternative energy plants worldwide. Furthermore, in many areas of the United States, the development of oil and gas resources is impeded due to the lack of economic and reasonable water management alternatives, while a lack of sustainable water is also limiting or impeding several types of industrial developments, including alternative energy plants. Upon analyzing the many issues involving water throughout many of the western states, the idea of creating a sustainable approach to energy development is clearly on the horizon. This paper addresses sustainable approaches of leveraging the technologies of the oil and gas industry to explore new beneficial alternatives for produced water management while also providing solutions to key issues facing the alternative energy industry, especially in the area of Biofuels. Details in this paper stem from research conducted by ALL Consulting and numerous cooperators and contributors through research conducted for the U.S. Department of Energy's National Energy Technology Laboratory.

Introduction

As developing countries emerge and urban population centers grow, the global market for energy demand rises. The energy demand is outpacing supply in multiple countries worldwide, and the United States is no exception. As such, developing sustainable alternative energy sources has become a necessity to ensure domestic energy demands can be met in the future. The development of Biofuels, commonly referred to as ethanol, is one alternative energy source that already has the infrastructure in place (pipelines and gasoline stations), and is already utilized for consumption. However, the absence of a sustainable source of water can limit the ability of a Biofuel plant to refine consumable ethanol. Meanwhile, the development of domestic oil and gas resources is limited, in some areas, due to the lack of economic and reasonable produced water management alternatives. This paper briefly addresses the idea of creating sustainable approaches to domestic energy development by leveraging the technologies of the oil and gas industry to explore new beneficial uses for produced water, while also providing synergistic solutions to the alternative energy industry, especially in the area of Biofuels.

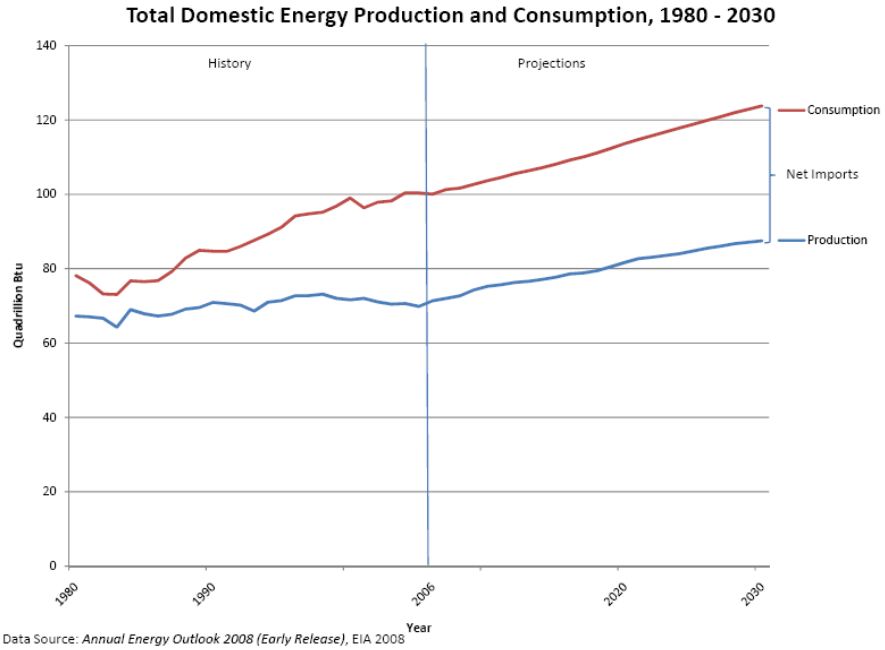
United States Domestic Energy Demand

The oil and gas extraction industry plays an important role in the energy supply for the United States. Crude oil and natural gas supply 65 percent of the energy consumed in the United States, and domestic producers supply approximately 40 percent of the crude oil and 90 percent of the natural gas. Neither natural gas nor crude oil supplies are keeping up with demand in the United States. Of our current natural gas supply, research suggests that as much as 50 percent is provided by wells drilled within the last five years. A growing number of oil industry experts are also endorsing the idea that the world is approaching a practical limit to the number of barrels of crude oil that can be pumped every day. The disparity between energy production and consumption in the United States is also growing (see insert[1]). Recent legislation to encourage energy independence and to ease growing concern over global warming has

[1] Source: Energy Information Administration, 2008

included President Bush signing a new energy bill that ramps up production of ethanol use to 36 billion gallons per year. Also, there appears to be growing momentum for America to produce 25 percent of the total energy consumed in the United States from renewable resources (solar, biomass, wind, geothermal, new hydropower) by 2025 (Salazar, 2006).

Fossil Fuel Development and Produced Water Synergies



One barrier to domestic crude oil and natural gas production is successfully managing produced water in a sustainable manner. Produced water is water that has been trapped in underground formations and is brought to the surface through the production of crude oil or natural gas. This water can represent a significant issue for producers, with approximately 15 to 20 billion barrels of water produced every year in the United States from nearly a million wells (Argonne). ALL Consulting estimates that produced water comprises as much as 98 percent of all waste generated by oil and natural gas operations in the United States, with oil to water ratios approaching a nationwide average of 10 barrels of water per barrel of oil produced (ALL, 2006). This represents a significant quantity of produced water that must be dealt with by producers.

Management costs associated with produced water management have the potential to detrimentally impact the economic viability of oil and/or natural gas production and sometimes render production operations economically unviable. However, there are a growing number of alternatives that are becoming available to producers considering increased water demands, especially in the arid west, combined with technological advances in several key areas. A significant amount of research with regard to beneficially using produced water has also been conducted. Two key publications on the issue of managing produced water were the result of research funded by the U.S. Department of Energy's National Energy Technology Laboratory (NETL) and other state and federal agency cooperators. The first is the "Handbook on Coal Bed Methane Produced Water: Management and Beneficial Use Alternatives" (ALL, 2003) and the second is the "Guide to Practical Management of Produced Water from Onshore Oil & Gas Operations in the United States" (ALL, 2006). These research publications outline a variety of management alternatives and beneficial uses applicable to produced water. Further, these documents make note of produced water treatment technologies and management practices that can help to facilitate the use of produced water in a variety of ways, including for purposes of agricultural and industrial uses.

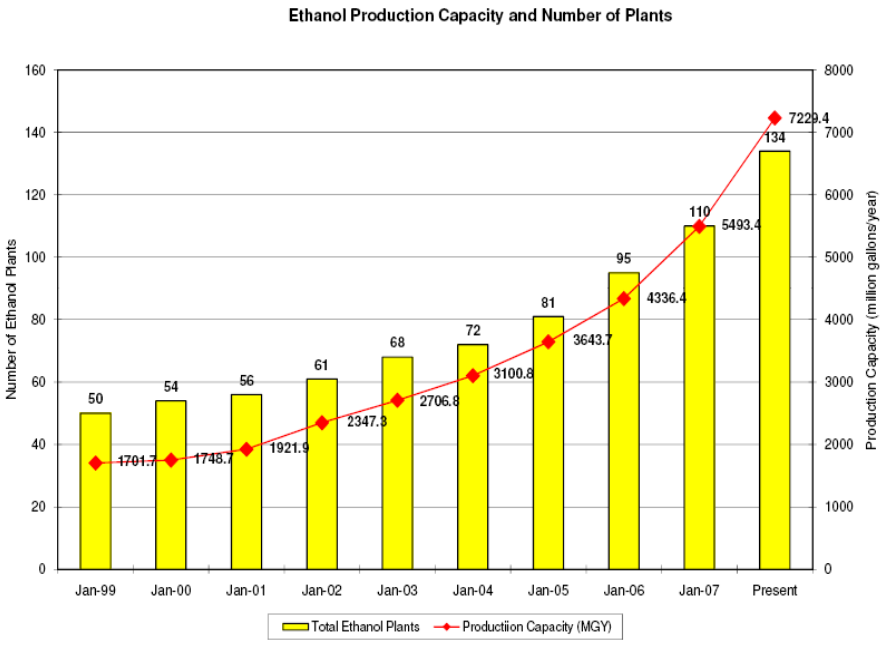
Produced water can vary in quality from very high quality (perhaps meeting state and federal drinking water standards) to water that is a much poorer quality (perhaps having elevated concentrations of various naturally occurring compounds, such as sodium chloride). Produced water production volumes can also vary from well to well and often increase or decrease over time. Assessing the feasibility for beneficially using produced water requires consideration be given to the quality of the water produced, the quantity of water involved (both produced and needed for beneficial use), whether treatment of the water is required

and whether treatment is economically feasible, applicable regulatory constraints or requirements, and stakeholder preferences – to name a few. Considering the vast variability of produced water and produced water uses throughout the United States, implementing a sustainable process can be challenging. However, considering the potential benefits that produced water can provide combined with growing water demands and strains on remaining water resources should be sufficient justification to expand the use of produced water for beneficial uses that both promote sustainability and offer valuable synergies with the ongoing development of oil and natural gas.

Alternative Fuel Synergies

When considering options for alternative energy, common options might include wind power, solar energy, hydro power, geothermal power, and alternative fuels. Combined, these renewable energy sources make up approximately 14 percent of the world energy supply. Although this percentage is not expected to grow significantly, the domestic energy consumption is expected to rise some 60 percent by 2030. This translates into a substantial requirement for research into new energy sources and breakthroughs in areas currently under development. Currently, alternative fuels, specifically ethanol production, are receiving a great deal of attention.

The production of ethanol has been steadily increasing with most growth occurring since 2000. Most ethanol production relies on large amounts of corn to meet the feedstock requirements of the growing number of plants. According the Renewable Fuels Association (RFA, 2008) there is a rapid growth in both the number of ethanol plants as well as their capacity (see insert[2]).

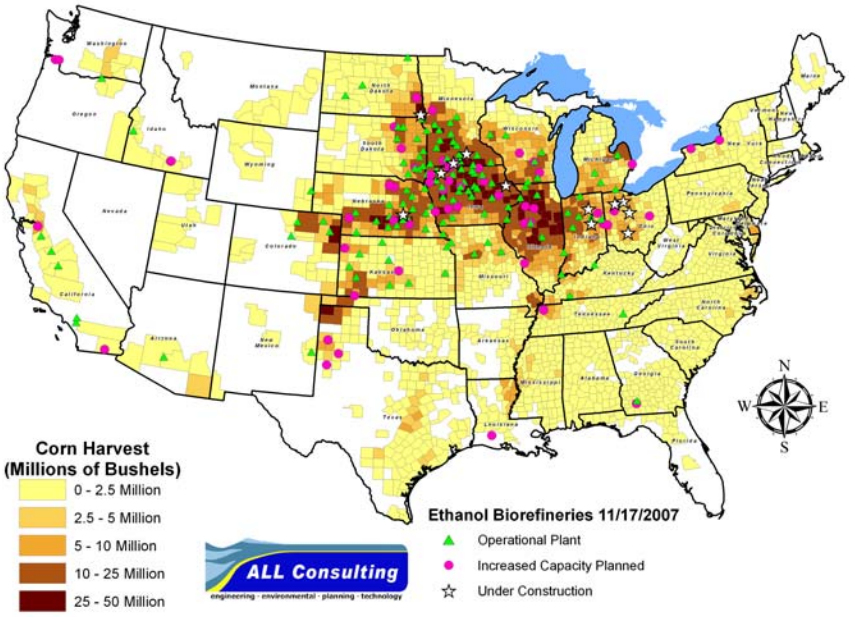


Most of these ethanol plants are being built or are planned near existing areas of historic corn production (see Map 1). The demand for corn ethanol has driven up the price of corn around the world. It will require vast amounts of grain and cellulosic biomass to meet the President's alternative energy goal of 36 billion gallons of ethanol produced per year. This goal represents a five-fold increase over today's levels. Until the use of cellulosic biomass as a feedstock can be perfected, the edible portion of a corn crop will continue to be relied upon to meet ethanol production requirements.

[2] Source: Renewable Fuels Association, 2008

The large water demands to grow corn is already unnecessarily stressing our Nation's fresh water aquifers. A typical ethanol plant requires an average of approximately 15 gallons of water to produce a gallon of ethanol. However, when the water it takes to grow the corn is added, about 1,700 gallons are needed to produce every gallon of ethanol (Jenkins, 2007). Considering this substantial need for water combined with the surplus of water produced in association with oil and natural gas, use of produced water to meet the demands of the Biofuels industry could be significant. Further, the potential mutual benefits that this type of approach to sustainability meeting energy demands are unprecedented.

Map 1 – Ethanol Plant Location - Corn Production



Responding to current and anticipated demand, the ethanol industry is aggressively increasing its production through new construction, expansion of current facilities and increased utilization of existing facilities. An EIA report (Reynolds, 2002) suggests that there is sufficient transportation and retailing infrastructure to support the ethanol distribution and marketing of 5.1 billion gallons. To meet the Presidential future alternative energy targets and to lower our dependence on foreign sources of fossil energy, America must find cost effective and sustainable ways to produce alternative fuels. A big step in attaining this goal would be to utilize cellulose biomass and other bio-refinery feed stocks that do not compete as a food sources and to consider alternatives that have the potential to increase economic viability, improve environmental sustainability, and address public concerns over issues such as potential detrimental impacts to local public water supply sources. For example, the United States ethanol industry is directly or indirectly releasing 6 million tons of CO_2 per year to the atmosphere (Shewbert, 2001). Based upon the latest United States energy legislation, ethanol production (and associated CO_2 emissions) is projected to increase five-fold by the year 2022. Considering potential beneficial uses for CO_2, such as supplying CO_2 for tertiary oil recover projects, the synergies between the Biofuels industry and the oil and gas extraction industry should be more closely examined.

Conclusions

The synergies between the oil and natural gas extraction industry and the bio-fuels industry are evident. These synergies have the potential to offer an approach to alternative energy development that is both sustainable and mutually beneficial with the oil & gas extraction industry. Potential benefits to the oil and natural gas industry include, but are not necessarily limited to, offering a beneficial use alternative for managing produced water, increasing the economic viability of a producing oil or natural gas field, access to an economical source of high-quality CO_2 for enhanced recovery or pressure maintenance, enhancing terrestrial carbon sequestration, reducing overall environmental impacts and disturbances associated with development and operations, and enhancing multiple uses for land and resources in an area of operations. For the Biofuels industry, leveraging oil and gas industry resources has the potential to increase the economic viability of a plant, provide an independent and drought resistant water supply, decrease demand on local ground or surface water resources, supplement water for livestock to reduce fertilizer

demands, provide additional options for waste management, offer a sequestration option for greenhouse gas emissions, and create a highly sustainable approach to alternative energy development that minimizes undesirable and unnecessary environmental impacts. For the United States, this approach has the potential to positively influence alternative energy development while also enhancing fossil fuel development in an effort to meet the growing energy needs of the United States in a sustainable and environmentally prudent manner.

Lead Researcher Bio

Mr. Arthur is a registered professional petroleum engineer specializing in oil and gas, underground injection, and environmental/sustainability issues. He has over 25 years of diverse experience that includes work in industry, government and consulting. Mr. Arthur is a founding member of ALL Consulting and has served as the company's President since its inception in 1999.

Mr. Arthur has gained experience in an assortment of technical areas, including, but not limited to, beneficially using produced water; produced water management; water treatment technologies; industrial water usage; engineering design; regulatory permitting and environmental work; extensive hydrogeological and geochemical analysis of monitoring and operating data; natural resource and environmental planning; natural resource evaluation; regulatory analysis; restoration and remediation/waste management and minimization; environmental planning, design, and operations specific to the energy industry in environmentally sensitive areas; and data management of oil and gas producing and related injection well data and information.

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