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STRONG

CSC

# EXPLORATION AND PRODUCTION (E&P) INDUSTRY PERSPECTIVE

This document represents the observations and predictions of our experts in the upstream oil and gas industry, referred to as the E&P segment. We discuss our view of market conditions over the next six months and the IT opportunities that this market view represents. This is based on our consulting work for major upstream companies, our independent research and our own research services group's analysis. Much of the data cited is sourced from the U.S. Government Energy Information Administration ([www.eia.doe.gov](http://www.eia.doe.gov)) public web site.

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## Overview

The global E&P market is focused on the search for and exploitation of oil and gas reserves around the planet. The United States does not produce enough oil to meet current consumer demand, and must therefore import 60 percent of our domestic needs, in many cases from dangerous and unfriendly regimes, though most of our imports are from Canada and Mexico. In contrast, the United States has a vast supply of coal and natural gas that could be converted, with the right technologies and distribution changes, along with “green” and “unconventional sources” to make the country energy independent – starting in 2030 and lasting until the end of the century and perhaps beyond. With the right incentives, we remain optimistic that the United States can greatly expand our use of renewable sources in the mid term, while advanced research programs can lay out the future from 2050 onward. However, the global E&P industry will have to be the agent of rational change over the next 30-50 years, not just the producer of black crude oil and natural gas.

In 2009, the global E&P industry is seeking a period of relative stability after severe price volatility. Oil will likely bounce between \$50 and \$75 per barrel, about where prices were from 2005 to 2007, though prices may spike up as summer approaches. Even with growing demand, gas prices will remain low as well, since some estimates show that with recent mega-discoveries in Louisiana, the United States may have as much as a 100-year supply of natural gas at current use rates. The Henry Hub spot price (a pricing point for natural gas futures contracts traded on the New York Mercantile Exchange) averaged \$3.62 per one thousand cubic feet (Mcf) in April, \$0.46 per Mcf below the average spot price in March, and down from an average price of about \$7 through much of 2006 to 2008.

Huge new gas fields have also been found in Texas, Arkansas and Pennsylvania. One industry-backed study estimates the United States has more than 2,200 trillion cubic feet of gas waiting to be produced, enough to satisfy nearly 100 years of current U.S. natural gas demand. The discoveries have spurred energy experts and policy makers to start looking to natural gas in their pursuit of a wide range of goals; easing the impact of energy price spikes, reducing dependence on foreign oil, lowering “greenhouse gas” emissions and speeding the transition to renewable fuels.

Meeting such goals would require quickly moving away from coal-fired power plants, which account for substantial carbon emissions. President Obama wants the United States to rely more on renewable energy, such as wind and solar power, but those technologies aren't ready to shoulder more than a tiny fraction (2 percent) of the nation's energy burden – perhaps as much as 9 percent by 2030 according to the Energy Information Administration (EIA),<sup>1</sup> though some experts say the percentage could be as high as 20 percent. Advocates for natural gas argue that the fuel, which is cleaner than coal, would be a logical quick fix. In addition, billionaire energy investor T. Boone Pickens has been touting compressed natural gas (CNG) as an alternative to gasoline and diesel for cars and trucks.

Figure 1. Shale Gas Plays, Lower 48 States

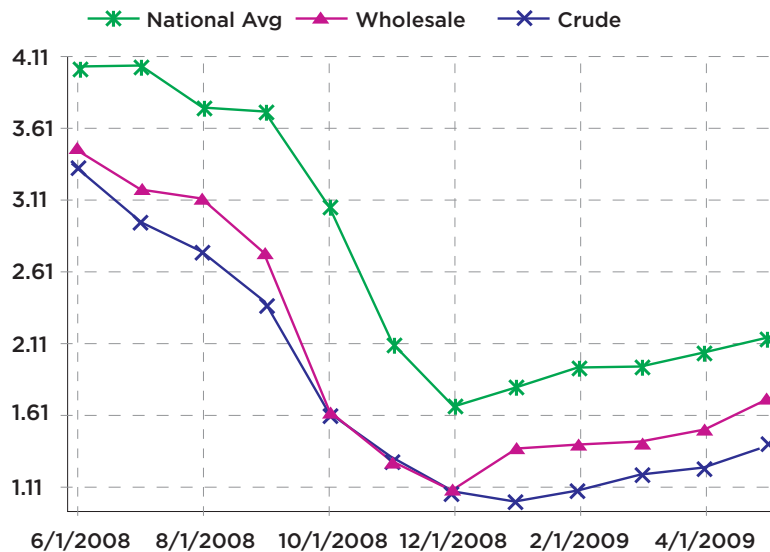


Source: Energy Information Administration based on data from various published studies. Updated: May 28, 2009  
[http://www.eia.doe.gov/pub/oil\\_gas/natural\\_gas/analysis\\_publications/maps/maps.htm](http://www.eia.doe.gov/pub/oil_gas/natural_gas/analysis_publications/maps/maps.htm)

Unexpected events like terror attacks or regional conflicts will cause unexpected spikes, but demand seems to be declining as people have adjusted to cost-saving lifestyles. OPEC is not likely to drop production but will ride out the low prices in hopes of seeing demand increase as economies recover. There is still a strong likelihood that when the recovery is underway, severe and unexpected economic and political decisions will cause dips in prices. The impact of coming tax increases, which have yet to hit the U.S. economy, will likely dampen any momentum in terms of economic growth.

The real unknown that outweighs many other market factors is how President Obama's energy policies will affect the supplies of petroleum products and the costs to produce them. It is clear that the administration favors higher prices to force people to cut back the use of fossil fuels, but it is as yet unclear what steps they will take to limit offshore drilling. The "Drill Here-Drill Now" lobby is biding their time and if gas pump prices hit \$4 per gallon again, they will be back. Pump prices recently (5/12/2009) in Chicago hit \$2.90, but on the average, gas prices are about \$2.30 nationwide, about \$1.50 less than they were a year ago.

Figure 2. Crude Oil Prices, 2008-09



Source: Energy Information Administration

While there is considerable uncertainty in the world oil market, the range of prices is seen to be unexpectedly bounded. "They could spike up, they could spike down, but I think if you look through that volatility, they're pretty range bound where they are now until you see a significant turnaround in the economy," Exxon/Mobil CEO Rex Tillerson told Reuters at the World Economic Forum on Latin America. "They are going to be in this range for a while."

The other major component of Obama's energy policy is the carbon cap and trade scheme, which would be employed to help reduce the nation's carbon footprint by 80 percent by the year 2050, in line with what some other nations like the U.K.

have pledged.<sup>2</sup> Interestingly, the hue and cry over “global warming” has undergone a subtle shift to become “climate change” since the evidence released by NASA on average global temperature reported by satellites show a definite cooling trend over the past 10 years.<sup>3</sup> This fact is not being widely reported and most people think the planet is growing ever hotter.

Unless the average person’s perception of this problem changes, it seems likely that the administration and Congress will implement some form of this scheme — which will incur huge costs, burdensome regulations and great opportunities for fraud and mismanagement. The number of people in the United States who think “global warming” is a more serious problem than the economy continues to decline, standing at about 34 percent according to the Rasmussen poll. But, about one-quarter of oil and gas companies in North America, including companies such as Chevron, are already



trading on voluntary regional carbon markets. A mandatory nationwide cap and trade program will be delayed due to the weakness in the economy, but widespread support by the Obama administration will bring in cap and trade legislation as financial indicators improve. Oil and gas companies will look at shoring up their carbon trading capabilities, including enhancing carbon inventory and forecasting capabilities through IT. Current indications are that a limited cap and trade system will be enacted at a slower pace than had been originally proposed, based on a compromise between environmentalist and business advocates.

Speaking at the 2009 Offshore Technology Conference in Houston, the head of oil giant Chevron Corp, David O’Reilly, called on President Obama to create a national energy policy that promotes efficiency, opens up new areas for oil production and sets a clear policy on carbon dioxide emissions.

“The new administration has an opportunity to make realistic changes to our approach to energy and to create a comprehensive energy policy,” O’ Reilly said in a speech to the Council on Foreign Relations. “And we need the new energy policy to be addressed as a strategic economic priority as well as a national security priority,” he said in a prepared text.

Pressure on the global oil industry to find new sources of crude and imminent fear of “peak oil” is slightly lessened due to lower demand from the current global recession. However, the struggle of managing production declines in aging fields does not go away. Many companies like Saudi Aramco and PEMEX are continuing to invest in developing new fields and reservoirs since their countries’ prosperity is so tied to oil exports.

Cuts to capital budgets during a downturn could hinder the industry’s ability to ramp up supply when demand returns, so many companies like Chevron and Royal Dutch Shell have maintained the same level of capital spending as last year — citing the need to continue to invest for future demand. They are also taking advantage of lower services costs.

The costs for E&P had risen substantially (about 50 percent) over the last five years, and super majors were facing high expenses for new projects that are highly technology dependent for smaller reserves. However, many companies have quietly renegotiated their service contracts with the large service providers, reducing costs to them, but putting service contractors under a big strain.



Oil service companies must find ways to lower costs by making changes to their own supply chains — including profiting from cheaper materials and establishing new relationships with suppliers in Asian countries, according to industry experts. These companies must strive above all to avoid the mass layoffs that crippled the industry in past oil busts of the mid 1980s and 1990s. The operators depend on the expertise of the service companies to achieve the advances in drilling and production performance that they have enjoyed over the past ten years.

### ***National Oil Companies (NOC)***

The NOCs of many countries have taken over more control of the E&P activities in their countries, instead of following past practices where they ceded control to large global E&P companies, such as Shell or Exxon. Part of this is a realization that their national sovereignty and prosperity are tightly linked to their success in managing these national resources. Another element is the fact that they have acquired more confidence and ability to plan and operate their fields over the years through education and training of their workforces. Since the NOCs now control about 77 percent of global petroleum resources, their ability to produce from their fields has a huge impact on the availability of product. In addition to continuing to invest in oil field equipment and services, the NOCs are also investing in new IT applications and systems. Most NOCs do not permit data on their oil and gas production or reserves to leave the country, so their use of local IT has increased.

### ***Alternative Energy***

The development and deployment of alternative energy sources, such as wind, solar and bio-fuels, were a centerpiece of the Obama campaign. But alternative energy sources contribute only a small fraction (2 percent) of the nation's energy needs. Even with federal and commercial R&D this fraction is not likely to product more than 20 percent of our requirements by 2030.

Biofuels have turned out to be problematic as the world tries to feed its growing population using the same resources that could be used for fuel. Ethanol has been oversold by lobbyists from agricultural states and possesses only 67 percent of the energy content of gasoline. While we expect that the use of biofuels will grow, it won't escalate at rates earlier believed when ethanol was thought to be a silver bullet. Research and development of alternative sources must be supported. However, it's not realistic to expect a sudden transition to these sources. While the United States should develop alternative energy, such as wind and solar, experts estimate that the world will still get about 80 percent of its energy from nuclear, oil, natural gas and coal in 2030.<sup>4</sup>

### ***Nuclear Energy***

Nuclear power is becoming an increasingly attractive option, though regulatory processes to approve new plants are still slow and cumbersome. Nuclear power plant technology has advanced far beyond the dangerous days of Three Mile Island and Chernobyl, and is far safer, smaller, and more efficient. The French produce most of their power from safe nuclear power, and even export it to the UK. The UK is planning to build tens of new plants between now and 2050, with the government recognizing that the carbon reduction goals cannot be met without nuclear power.

During his campaign, President Obama said he favored the continued use of nuclear power and saw it as an integral and inevitable part of any effective U.S. energy policy, especially in light of concerns about global warming.

Nevertheless, he believes the United States must not increase its reliance on nuclear energy until other critical issues, such as national security and nuclear waste disposal, have been adequately addressed. Obama has said, “I don’t think that nuclear power is a panacea” for America’s energy problems.<sup>2</sup> Nuclear waste disposal may be the Administration’s brake on accelerating nuclear power plant, since the Yucca Mountain, Nevada site has not been approved for full use and is tied up in courts. Interests in Nevada are fighting against having the waste stored there, citing inadequacies in the site characteristics.

“Nuclear power represents more than 70 percent of our non-carbon generated electricity,” according to the Obama energy plan.<sup>2</sup> “It is unlikely that we can meet our aggressive climate goals if we eliminate nuclear power as an option. However, before an expansion of nuclear power can be considered, key issues must be addressed including: security of nuclear fuel and waste, waste storage, and proliferation.”

### Business and IT Initiatives in Upstream Oil and Gas

In response to these economic and political pressures, companies have identified a number of related business initiatives, many of which have a large IT component. Under the generalized banner of the “Digital Oil Field (DOF),” E&P companies are investing in new processes, organizational models and new IT tools that enable better and faster decision making, as well as reducing costs and risks. The fundamental idea behind the DOF is to tightly integrate a continual process of gathering and analyzing real-time field data, updating and running simulations of reservoir models, subsurface and surface facility operations, and defining a production operations plan that optimizes both short-term production and the ultimate life of the reservoir.

Our Digital Oil Field assessment model (Figure 3) helps assess a company’s level of achievement and ongoing or planned activities in each of the five levels.

Figure 3

<i>Maturity</i>	<i>Actors</i>	<i>Key Questions</i>	<i>Frequency</i>	<i>Value</i>
<b>Business Optimization</b>	Marketing, Transport and Field Operations	Are we producing the right petroleum products at the right volumes given market conditions?	Monthly, Weekly	\$M/Week
<b>Well/Field Optimization</b>	Reservoir and Production Engineering	Are we managing drilling and production operations to maximize overall field productivity and life?	Weekly	>\$K/Week
<b>Equipment Optimization</b>	Field Operations and Maintenance	Is all the equipment working normally and are we optimally planning downtimes for maintenance and repairs?	Daily	\$K/Week
<b>Data Optimization</b>	Field IT and Operations	Are we changing raw data from multiple E&O source systems into useful information?	Real-time	Outlay
<b>Field Optimization</b>	Field IT and Operations	Have we instrumented the wells and field equipment that will provide the base data needed for effective decisions?	Real-time	Outlay

The model is based on a view across the industry to understand where the leaders are and where the laggards stand with regard to the implementation of the DOF. The progression from the bottom of the table to the top of the table depends on the integration of the data that each level produces into useful information and effective decisions. There are companies that are doing what they believe is well/field optimization by running advanced planning and analytic tools, but the data is not integrated with the real-time data stream, so it is not as accurate and current as it could be.

The progression from the lowest level begins with the instrumentation of wells and field equipment to gather real-time data. Most companies have achieved this level. The data optimization level deals with the effective management,

analysis and visualization of all the real-time and simulation data that is created. Some companies have accomplished this level, and many companies are working to achieve this level. Equipment optimization depends on the integration of the real-time data with equipment reliability predictions and field asset scheduling to produce a maintenance plan that optimizes available production and minimizes costs.

Well/field optimization is the end-to-end optimization of all the reservoir, subsurface and surface facilities through the integration of real-time data with the results from the reservoir and field processing equipment. In enhanced recovery operations, the workflow takes into account the limitations in the capacity of the field, like steam available for steam floods. This process depends on the amount of fuel gas available, which is dependent on the amount of gas produced by the field and the capacity of the gas pipelines leading to the field. A field like Chevron's San Joaquin Valley may spend \$800 million a year on heating gas to produce steam to warm the heavy oil and pressurize the reservoir, so opportunities for savings based on optimizations are significant.

Business optimization adds the capability to further optimize the business by integrating trading operations, risk management, field logistics and supplier management to the portfolio. There are very few companies operating at this level of maturity, but this is the ultimate vision for which many strive. This vision was created by a number of contributing organizations, for example the IHS Cambridge Energy Research Association (CERA), and the Norwegian Oil Industry (OLF).

While efforts over the past six years have been heavily focused on field automation and new technologies, the industry now believes that the problems to be solved need to focus more on new workflows, new organizational capabilities, improved management of enterprise information, and collaboration and knowledge sharing.

### ***Workflow Transformation***

Speaking at the 2009 Society of Petroleum Engineers (SPE) Digital Energy Conference in Houston, Chevron ETC CEO Melody Meyers defined "Digital Energy" as a blending of integrated surface and subsurface modeling, collaboration across disciplines and optimized, transformed workflows for key operational processes. She said the objective is the "right information in real time," and the real prize is the optimized workflows across different disciplines. This means workflows of information and knowledge that span the domains of real-time data analysis, drilling and logging, production operations, and reservoir management that connect the people who need to collaborate to make effective decisions on an appropriate timescale.



### ***Culture and Organizational Change***

As these new workflows are deployed, they will bring changes in operating processes, employee interaction patterns and accountabilities, and these effects will be difficult for employees to adapt to. Every E&P company is highly dependent on the knowledge and expertise of these senior workers. Success hinges on the active participation and buy-in of this key group with the new concepts and the capture of their knowledge in a way that is easily transferable. Oil companies that are implementing similar concepts, in particular Chevron's iField, have even taken the approach that this transition

in technology, process and organization must be driven from field demand and should not be a top-down initiative. BP's enterprise approach seeks to capitalize on the many benefits of the "Field of the Future" concept in as many locations as feasible, while at the same time carefully addressing the non-technical "people" issues that will fundamentally decide whether or not the transformation is successful.

These process changes will result in the creation of new roles and skills. The industry is discussing the concept of the “Digital Petroleum Engineer.” In a guest editorial in the Journal of Petroleum Technology, Mehrzad Mahdavi, SPE, Schlumberger, said that the industry now needs engineers with a balanced set of information technology skills, as well as specialized petroleum knowledge.<sup>5</sup> The IT skills would include networking, control automation, architecture, and data management. The University of Southern California has created a Master of Science Degree Program in Smart Oilfield Technologies. Skill changes will extend down to the operator level as well, as rather than reading round gauges and entering data in a “Big Chief” paper notebook, operators are looking at and interpreting computer screens and loading data from data historians. As Web 2.0 and Gen Z employees continue to enter the workforce, companies must adapt their personnel management policies, career development approaches, and even the technologies they use for communication and collaboration. New college graduates need ways to rapidly access the distilled knowledge of the company. One way they do this is by finding experts and mentors that will help educate them. One of the first questions they ask is, “where is the corporate Facebook site?” They expect to be able to connect with peers and experts, and collaborate in the ways that they have used since high school. They want to know who the approachable experts are, and they want to research future job assignments, e.g., “what’s it like to work in Nigeria?”



### ***Management of Enterprise Data***

The central problem for upstream oil and gas organizations is the effective management and use of data and information from various sources and systems. Since many of these systems have been historically based on vendor proprietary data formats, interoperability of data has been, and remains problematic. Petro-technical workers are frequently looking at information about a well that comes from several structured applications such as production histories, maintenance histories, well tests, electric logs and accounting information. It gets more complicated and difficult when the engineers must put together a cohesive study and investment recommendation consisting of both structured data and other related unstructured data from even more sources, e.g., reservoir management plans, business investment plans, or data in memos, emails and the ubiquitous spreadsheet. Unstructured data presents another issue — making sure the engineers and managers have the latest or “right” version of the data with which to start their analysis.

Having the ability to easily, consistently and accurately traverse from the data and definition of a well across multiple structured transactional database systems and the metadata associated with unstructured document types will be a requirement for success, or any possibility of a strategic advantage in the future.

In the recent past, master data management (MDM) in E&P was implemented as a single large data warehouse (Master Data Store) of physically integrated data. Efforts based on this interpretation (e.g., numerous Finder and MDM projects from Schlumberger and Landmark) failed in practice for a number of reasons — speed (design, implementation, usage), flexibility, comprehensiveness, adaptability and longevity, as well as the vendors desire to force proprietary models on their clients to extend their products’ penetration and lifetime. In the future, MDM solutions must be based on common industry data models, like the Public Petroleum Data Model (PPDM) and its sanctioned extensions, and an open, flexible, service-oriented approach to managing metadata, while leaving the data in established, well-maintained systems of record.

The top issues in enterprise data management (EDM) for E&P are similar to the issues facing many other organizations. All enterprises are facing an explosion in the sheer volume of digital information of all types that they must process and store. In one major company's experience, the volume of this data doubles every year. Like the E&P companies, many companies are processing an increasing volume of real-time data. We also observe the common need for the integration of data into modeling and analytical processes for optimizing key business processes. A discussion of the top three issues for EDM can be found in the foregoing pages. MDM plays into these topics by providing the processes and tools for managing these issues across the organization for the benefit of all business consumers of the data and information within the MDM.

### **Data Access**

Often, professionals scramble to find the most recent information or struggle between several versions or sources of data. Despite all the energy around building data stores (Master and Project) and migrating data between them, much important information remains locked away in application specific files, databases, spreadsheets, documents and file drawers. Engineers jealously guard these personal repositories of corporate knowledge. Also, efforts to integrate the data across applications have been weakened by lack of semantic integrity. And, while most companies have built thousands of web pages and numerous portals, trusted, shared information is still not readily accessible.

In recent years, users have discovered the power of using geographical interfaces like Google Earth to navigate their available data based on well or facility locations, and this type of data access has become a key capability. This now requires the data to be geographically and depth tagged, which necessitates a new type of metadata. Additionally, the power of web search tools such as Google have raised the expectations of users to be able to pull up all relevant data by entering a few search terms. This capability will be required for any type of data access tool, and the effective blending of geographic interfaces and search tools into user interfaces may greatly aid successful data access techniques.

### **Data Quality**

The creation of trusted or credible data stores has always been an issue in petroleum data management. Numerous factors contribute to data cacophony or lack of data transparency, making it difficult to get the data together to do quality assurance. Factors playing into this situation are:



- Focus on getting the analytics accomplished, rather than making sure the information generated is usable by the next step or the next business process
- Difficulty getting operational personnel who really know the data to focus on data management as part of their job, while not providing enough support for them to do data management as well as their “real jobs”
- Lack of a consistent viewpoint of managers that EDM is part of their job and is of extreme value to them personally
- Dependency on mountains of data and information (generated by a wide portfolio of applications) by E&P professionals to analyze, create and store data and information

All E&P enterprises have real data or just folklore about the percent of time that engineers spend just finding and preparing data sets for analysis. At Chevron, estimates of these numbers range between 30 percent and 70 percent, depending on who you ask. Some strategic business unit organizations are clearly better than others. By illustrating the value of having the right data at the right time within the business, not to mention the added value of NOT having data- driven disasters, a good enterprisewide MDM policy can be an asset to business managers and engineers — rather than just more work of dubious value.

### ***Identification of Primary Data Sources***

With so many applications in use within organizations, often with multi-terabyte databases, maintaining a reference of the database of record or primary source for a particular data type is very important. It is not uncommon for the drilling/exploration/reservoir management organizations to use 40-60 different applications on Windows, UNIX and LINUX. Information on the most common business object, the WELL, is generally kept in multiple systems depending on whether the data is facility, engineering, E&P rights, financial or production-related information. Recent projects on electronic well files have aided in solving this problem but it is still an issue for many companies.

It can be difficult deciding on standards for the reference data, then preparing and communicating standard transformations that are required for business use of the data within single and multiple business processes. Companies need a “universal translator” that can intelligently move data between applications and processes, doing semantic conversions where required.

### ***Collaboration and Knowledge Sharing***

For many years, the E&P industry has been a global leader in the development and effective use of collaboration processes, organizational models and technology. Virtually all large E&P companies have small, dedicated organizations that focus on knowledge management and sharing. Most track the business impact of these programs to the bottom line. In technology, there is an industry direction to reduce the number of different content and document management systems that most companies still employ, in favor of Microsoft Office SharePoint Server. E&P companies are looking at how to leverage the Microsoft stack to replace legacy portals, data repositories and collaboration tools.

Since 2000, we have led an industry community called the Energy Knowledge Management Network (EnKMN, pronounced “In Common”). In 2009, leadership of this group was assumed by BP, Shell and ConocoPhillips. We are proud of our contributions to this group and wish them well as they have matured into a truly cross-company community. We have dedicated resources that provide collaboration and knowledge sharing consulting to federal and commercial organizations, including dedicated SharePoint and Content Management practices.



### **Final Thoughts**

The world is at a breath-holding tipping point with regard to our smart use of the globe’s energy resources. The West must unearth ways to increase energy efficiency and generate more energy from renewable and long-term sources. We need a rational and fact-based view of the green debate, about “global warming” and “climate change.” This has a huge impact on the future of the energy industry, not just the E&P companies. Leaders must innovate to take the lead in providing and distributing energy, regardless of the source. Underdeveloped and developing nations must take on their burden of being ecologically responsible. America has made huge advances in cleaning up the air and water, and we can help other nations apply these processes and technologies.

With its global presence and its practical, pragmatic, engineering-based approach to solving some of the world’s most complex problems, America can develop an engagement approach with those global agencies and governments to understand a strategy to apply our expertise to assist them. At stake may be the prosperity and health of the global community.

## About CSC's Chemical, Energy and Natural Resources Group

Our Chemical, Energy and Natural Resources Group is singularly qualified to help you achieve strategic business objectives by employing industry-specialized capabilities, innovative business solutions leveraging leading edge technology, world-class program management, and unrivalled excellence in delivery to your growth agendas. Learn more at [www.csc.com/CENR](http://www.csc.com/CENR) or contact us at [poweryourperformance@csc.com](mailto:poweryourperformance@csc.com).

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## About CSC

*The mission of CSC is to be a global leader in providing technology enabled business solutions and services.*

*With the broadest range of capabilities, CSC offers clients the solutions they need to manage complexity, focus on core businesses, collaborate with partners and clients, and improve operations.*

*CSC makes a special point of understanding its clients and provides experts with real-world experience to work with them. CSC is vendor-independent, delivering solutions that best meet each client's unique requirements.*

*For 50 years, clients in industries and governments worldwide have trusted CSC with their business process and information systems outsourcing, systems integration and consulting needs.*

*The company trades on the New York Stock Exchange under the symbol "CSC."*

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