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Oil and water can mix
Moving toward water stewardship in the oil and gas industry

Deloitte Center *for* Energy Solutions

Contents

A case for water stewardship

Concerns about water stewardship are spilling into public awareness, largely due to increased competition for water and prolonged droughts in several regions of the world. As a result, nearly every industry sector is being scrutinized with regard to how it withdraws, uses, transports, and treats water. While water-intensive industries such as power generation and agriculture have been under pressure to conserve water and protect its quality for some time, stakeholders are now placing similar demands on less water-intensive industries. For instance, the oil and gas sector, which uses much less water than its power generation counterpart, has nonetheless found itself under a critical lens concerning the potential impact of hydraulic fracturing upon both water availability and quality. And this production technique is not alone. Others are also coming under scrutiny both from the public and from company stakeholders concerned about the long-term viability of operating in water-stressed areas.

Furthermore, this intensifying "water pressure" is unlikely to dissipate soon, since it can largely be linked to the inherent nexus between water and energy: It takes water to produce energy, and it takes energy to extract, transport, and treat water.[1] The conundrum, based upon projections, is that the world will increasingly need more of both.

According to the International Energy Agency (IEA), global water withdrawals for the energy industry, including fossil-fuel extraction and electricity generation, were 439 billion gallons per day in 2000.[2] Of the energy-related water withdrawals, fossil fuel extraction (i.e., coal, oil, and gas) accounted for 2.3 percent of the total. By 2035, the IEA anticipates total energy-related water withdrawals to increase to more than 500 billion gallons per day, with fossil-fuel extraction accounting for about 4 percent of this expanded pool. The main reason for this anticipated increase is that world energy demand, primarily for fossil fuels, is expected to grow at a compound annual growth rate of 1.27 percent through 2030.[3]

Meanwhile, over the same period, the 2030 Water Resources Group projects a 40 percent shortfall in water supply by 2030.[4] This expected shortfall is being driven by population and economic growth, increased demand for food and energy, the rise of the middle class, and the impact of droughts and climate change. Already, many countries are extracting water faster than it can be replenished. Mexico is exceeding its groundwater supplies by 20 percent, China by 25 percent and India by 56 percent.[5]

As water withdrawals exceed the pace of replenishment, water scarcity, particularly in arid and semi-arid areas, will become an increasing concern. Rising public awareness of industrial water usage, and the emotionally-charged issues of water availability and quality, will likely impel the oil and gas sector to demonstrate that "oil and water can mix" by devising strategies for the long-term management of this vital and finite resource — not only to mitigate risks but also to support growth.

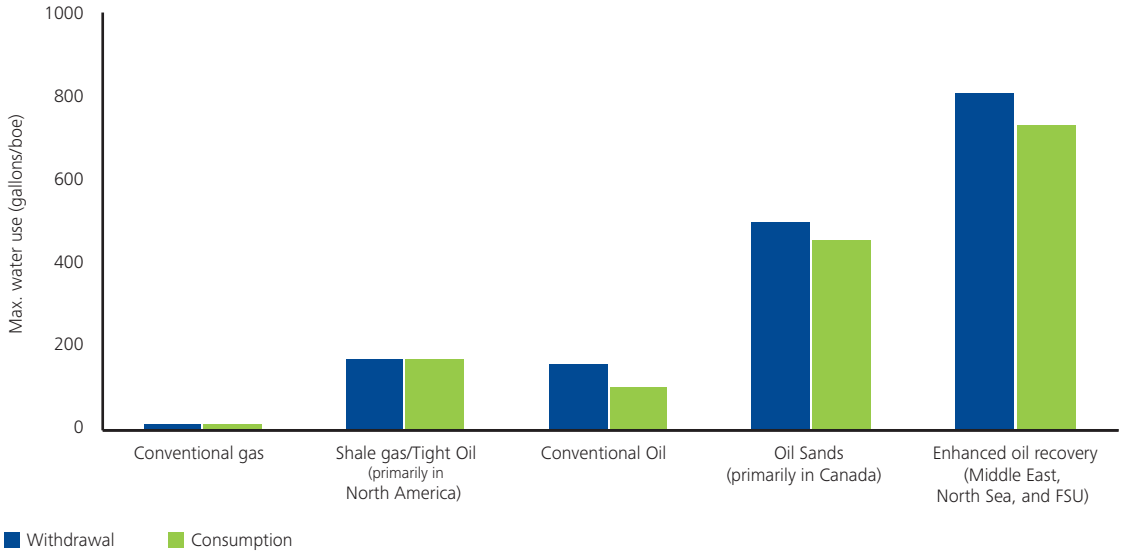
Water management and the oil and gas industry

The North American shale gas revolution has brought increased attention to the oil and gas industry with regards to water. On one hand, the industry is being praised for bringing the United States closer to energy independence; on the other hand, it is being scrutinized for how it is managing water resources, both in terms of withdrawal and consumption. Defined herein, *water withdrawal* is the total amount of water removed from a lake, river, or aquifer for use in any purpose, while *water consumption* is the portion of that water that is "lost" as a result of transmission, evaporation, absorption or chemical transformation. Notably for the oil and gas sector, any water remaining downhole is considered consumed water since it is no longer available to the hydrologic cycle.

The amount of water withdrawn within the oil and gas sector varies according to production processes employed. For instance, enhanced oil recovery (EOR) is the most water-intensive production process since it uses hydro-flooding and steam injection techniques that require approximately 800 gallons of water per barrel of oil equivalent.[6] EOR is also the largest consumer of water per barrel since most of the water remains downhole. Conventional gas production uses the least amount of water in the sector. In comparison, shale production, either for gas or tight oil, uses approximately ten times the amount of water as conventional gas. While its water withdrawal is still comparable to conventional oil production, shale production consumes water more heavily than many other conventional production processes since most of the injected water is left downhole. New water management techniques focus on recycling much of this water, which is recovered along with naturally occurring formation water, for use in the next fracture.[7]

The delineation between water that is injected into a well and the water that naturally exists within the rock formations is hard to maintain in an aqueous mixture. The industry attempts to distinguish the two by defining them as "produced water" and "flowback water." Produced water is naturally occurring water locked in underground oil and gas formations that is brought to the surface during exploration and production. It includes a mixture of liquid and gaseous hydrocarbons as well as dissolved and suspended solids such as sand and silt. Produced water is generally saline with some traces of hydrocarbons, and it requires proper treatment before disposal or re-use. The salinity of produced water in the U.S. ranges from 100 mg/liter to over 400,000 mg/liter. In comparison, the salinity of seawater is 35,000 mg/liter.

Figure 1: Maximum water withdrawal by oil and gas resource



Source: International Energy Agency, "Water for Energy – Is energy becoming a thirstier resource?", World Energy Outlook 2012. http://www.worldenergyoutlook.org/media/weowebsite/2012/WEO_2012_Water_Excerpt.pdf

Flowback water is water introduced into the underground formation as part of the production process, which then returns to the surface during extraction. Flowback water contains injected fluids and additives that entered the formation as part of production. Given the difficulty in differentiating the two, flowback water is generally included by the sector as part of produced water. However, the Commonwealth of Pennsylvania has recently collected data that illustrates the differences. The data showed that the volume of flowback water in the Marcellus was three times the amount of produced water.[8] As more of the Marcellus is developed and enters production, the proportion of produced water to flowback water is expected to increase since wells naturally tend to produce more water than hydrocarbons over the course of their lifespans.

While water usage per well varies by production field, operating company, and well depth, as well as the number of fracking stages in the case of shale production, IHS estimates that the cost of water management — including acquisition, storage, transportation, and disposal — can comprise as much as 10 percent of the total capital expenditure for a shale well.[9] Local water conditions play a critical role in determining the cost and availability of water for the oil and gas sector, but so does public support. This points to the importance of developing a water stewardship strategy as a means of reducing not only near-term operating expenses but also long-term regulatory costs.

Why water stewardship matters

Water scarcity is becoming increasingly prevalent in the United States. In many areas, shortages stemming from increased water competition and droughts have triggered mandated conservation programs and higher water prices. For example, U.S. water prices have increased by 25 percent since 2010, rising approximately 6 to 7 percent annually.[10] The amount Americans pay for water is rising faster than U.S. inflation and faster than the amount paid for any other utility service.[11] As the cost of water continues to rise, it is becoming a "pocketbook" issue for many Americans, which increases its political salience and emotional impact. The new level of attention being paid to the availability of water and its price to consumers and businesses affects both real and perceived risks in the oil and gas industry.

A report from Columbia University's Water Center shows that between 2000 and 2010 water rates charged to consumers by water utilities increased 23 percent.[12] These costs can be attributed to a number of factors, including maintenance expenses and the need for infrastructure upgrades. In addition, a number of water utilities are taking on more debt in order to fund infrastructure expansions, which in turn requires higher water rates to service the debt. In essence, this creates a vicious cycle. As higher water rates are passed on to consumers, they often begin to cut back on their water usage, which requires water utilities to increase rates even further to make up for the reduced revenue.[13]

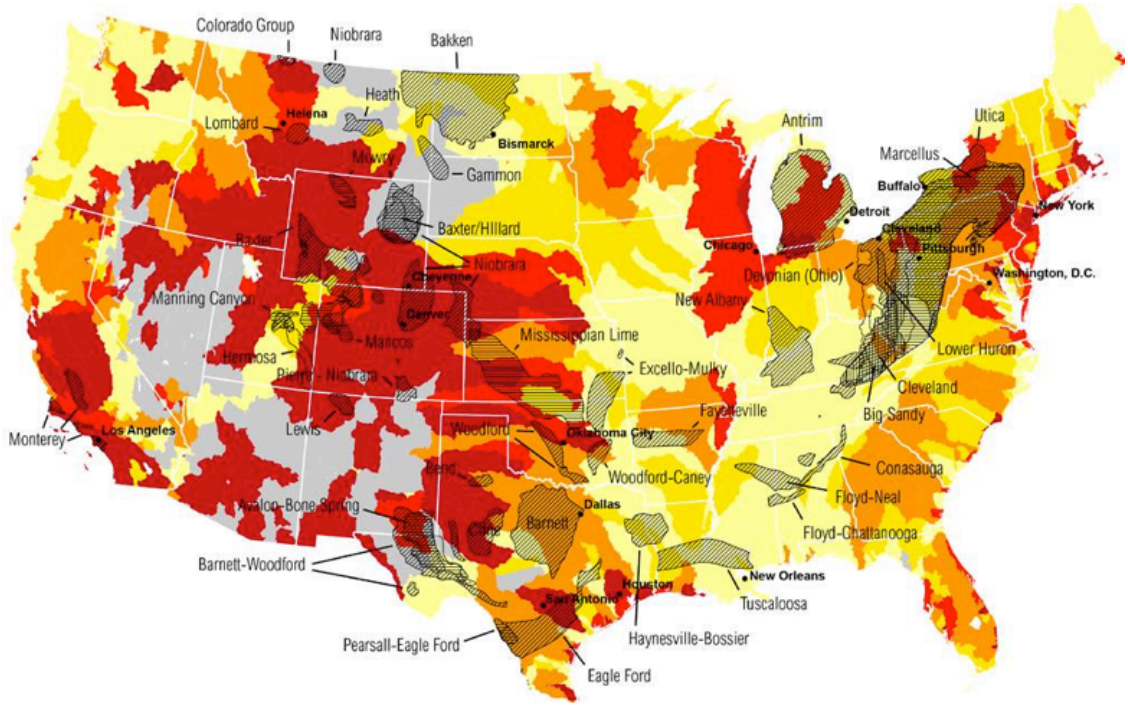
In addition to greater maintenance and infrastructure requirements, water scarcity is also contributing to rising water rates. Large water utilities located in areas with low annual precipitation often pursue source diversity strategies, which can result in higher costs for the water utility and thus higher costs for the consumer.[14]

A survey of 6,250 people in 17 states asked respondents to rank the importance of eight types of water use during periods of short-term scarcity.[15] Overwhelmingly, household use was ranked as a top priority, by over 30 percent of respondents. Irrigation for farmland was next, with over 20 percent. The third most popular choice was letting water flow to the natural environment. Industrial use was ranked fifth of the eight choices, above only private landscaping, municipal landscaping, and recreational use.

These findings are particularly important for the oil and gas sector when considering patterns of water scarcity, particularly relating to shale basins. The World Resources Institute (WRI) recently released a report that examines water availability in the development of global shale resources. The study found that 38 percent of shale plays are in arid regions or in locations that are under high to extremely high water stress.[16] In addition, 19 percent of shale plays are in regions that experience high or extremely high variability in water availability, while 15 percent are in locations with high to extremely high drought severity.[17] Limited water availability could play a big role in determining if the North American shale revolution can be duplicated elsewhere. It could also curtail shale production growth in the U.S. since some of the most prolific shale plays, such as the Niobrara, Permian, and Eagle Ford basins, are located in areas of high water stress. Parts of the Marcellus and Utica shales are also located in areas with constrained conditions.

Water stress in Texas, for instance, poses a challenge to the oil and gas industry. It accounts for the largest share of U.S. oil production and about 30 percent of the absolute water use in the oil and gas industry in the United States, at 843 million gallons per day.[18] Yet, drought conditions persist in more than 80 percent of the state.[19] Balancing the water requirements of oil and gas production with the needs of agriculture and the local citizenry is becoming more and more challenging as the drought persists and the sector's water requirements escalate in conjunction with production growth.

Figure 2: U.S. shale plays and baseline water stress (November 4, 2014)



Baseline Water Stress
withdrawals/available flow

- Low (<10%)
- Low to medium (10-20%)
- Medium to high (20-40%)
- High (40%-80%)
- Extremely high (>80%)
- Arid & low water use
- No data

Source: World Resources Institute - Global Shale Gas Development: Water Availability and Business Risks

The preservation of water quality is also an important issue for the oil and gas industry, and it has become a point of contention among opponents of fracking.

One area of concern is the disposal of flowback water, which is a mixture of produced water and injected water. Since produced water has been locked in the formation for millions of years, it reflects the chemical characteristics of the formation and associated hydrocarbons. Meanwhile, the injected water contains fracking fluids, any other chemical additives, clays, dissolved metal ions, total dissolved solids (TDS), and naturally occurring radioactive materials (NORM).[20] Uranium and thorium are not water-soluble, but they decay to radium, which is water-soluble. However, the concentrations vary by formation. The EPA estimates that 30 percent of U.S. oil and gas wells produce some NORM. These concentrations can typically be found in the scales and sludge byproducts of oil and gas production.

Safe and effective management of flowback water is presently one of the most important challenges facing the industry. Enhanced management of flowback water typically starts by reducing the amount of water that enters the well or that is brought to the surface. When water is brought to the surface, it is categorized and managed based on its quality, particularly relating to the amount of TDS it contains, which varies by basin and well.

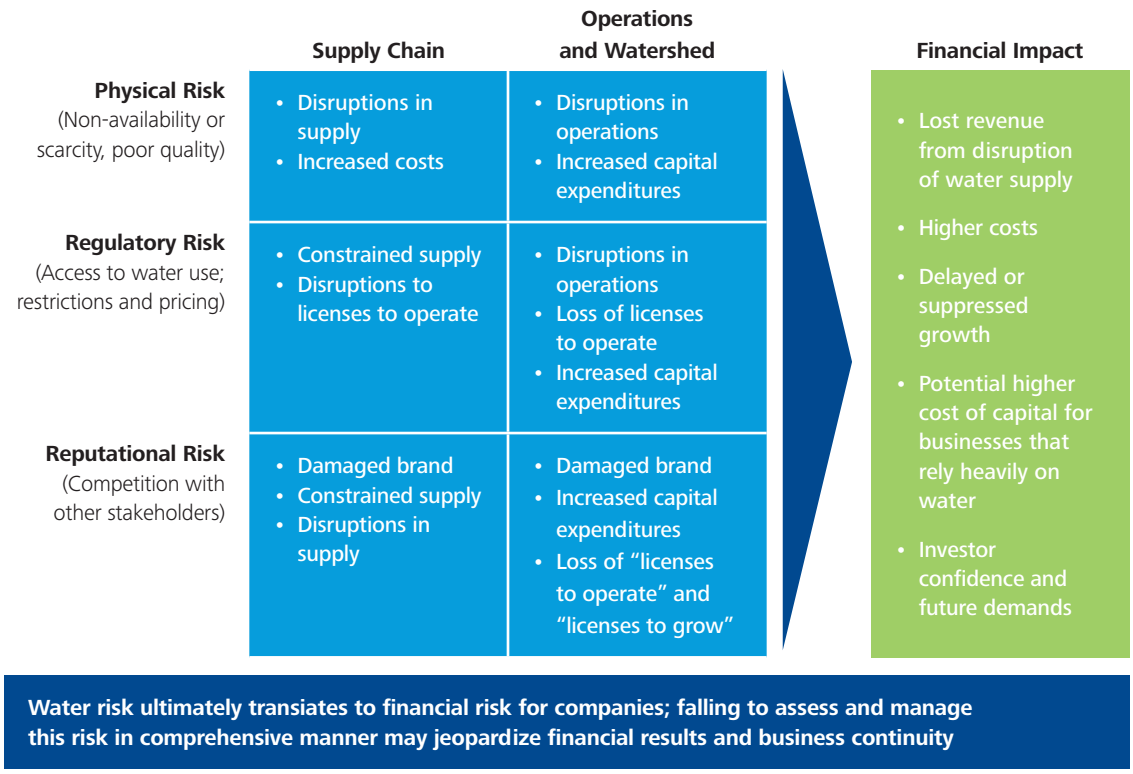
Managing risks — From water management to water stewardship

Developing effective water stewardship programs in collaboration with stakeholders and local communities is particularly critical given the importance of water to everyone. According to a recent Gallup poll, 56 percent of the public views the oil and gas industry negatively — just slightly better than the U.S. Federal Government — while only 29 percent view the industry positively.[21] By getting ahead of the curve on water stewardship, the oil and gas industry has an opportunity to avoid conflicts over water usage before they become acute as well as to improve its image as a whole. Other industries have already illustrated the power of water stewardship as a risk mitigation strategy.[22]

Given that water is vital to oil and gas production, exploration and production (E&P) companies are beginning to move from the immediate necessity of water management to the forward-thinking realm of water stewardship. Industry organizations such as the International Petroleum Industry Environmental Conservation Association have developed guidance for water stewardship, and several global oil and gas companies actively participate in water stewardship programs such as the the World Business Council for Sustainable Development. All of these programs, whether led by companies, industry or non-governmental organizations (NGOs), are designed to address the three major types of water-related risks: physical, regulatory, and reputational, the latter of which is driven by stakeholder perceptions (Figure 3). Thus, the actual amount of water used by a company can be less important than how stakeholders perceive its withdrawal and consumption patterns.

Water stewardship programs essentially assess these three types of risks to determine the business value that is at stake. By nature these programs are broad, spanning the entire enterprise. They often consider how water competition could affect business operations, brand value, and the social license to operate, along with analyzing the potential implications of upstream and downstream activities upon water quality, withdrawal, and consumption.

Figure 3: Physical, regulatory, and reputational water risk dimensions



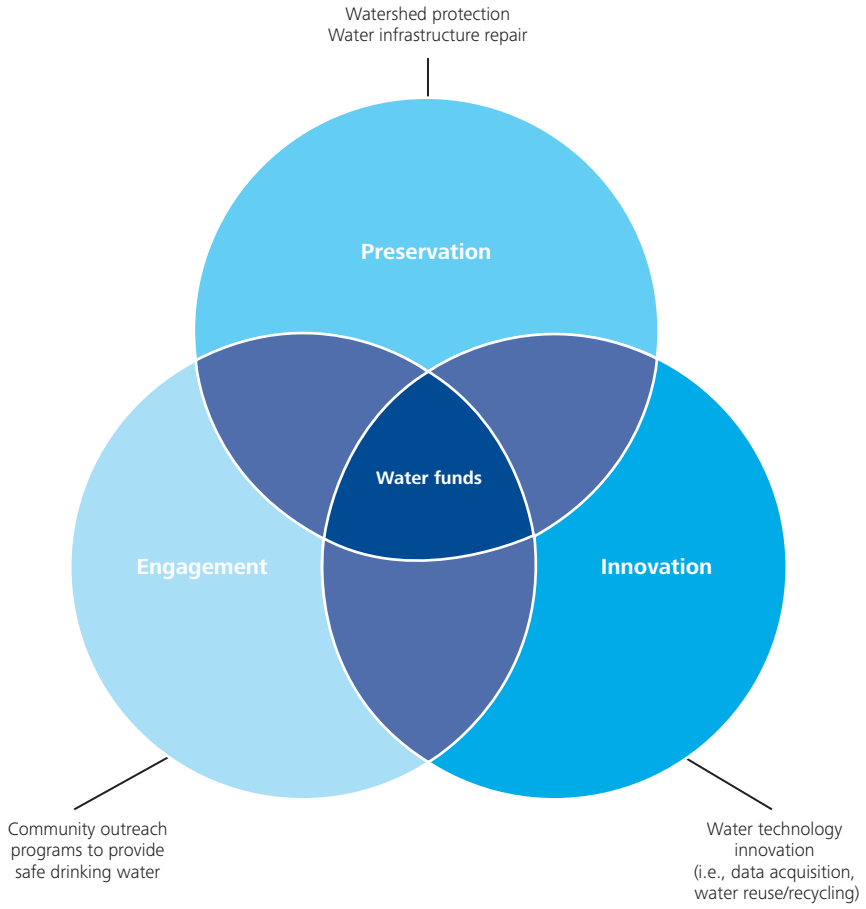
Water risk ultimately transiates to financial risk for companies; falling to assess and manage this risk in comprehensive manner may jeopardize financial results and business continuity

Source: Modified from "Watching Water" JP Morgan Chase Global Equity Research, April 2008.

While more and more executives are becoming convinced of the imperative for water stewardship programs, many do not know how to launch such an effort. Assessing how much water the company is using in its operations and across its value chain is a good starting point. Next, companies may wish to consider water-related risks and opportunities and how they could financially impact the business, along with identifying stakeholders at each reservoir. While the hydrologic cycle is global, water concerns are local. That is why it is essential to invite local input when developing corporate water-related strategies.

Furthermore, in our experience the water stewardship programs that contribute the greatest value to a company typically include three basic components: preservation, engagement, and innovation.[23] Preservation relates to initiatives that seek to reduce overall water consumption as well as to preserve water quality; engagement refers to working with external stakeholders whose interest in water issues could affect business outcomes; and innovation involves the adoption of new technologies, processes or partnerships that enhance a company's water-related goals. These components, and the inter-relationships among them, are illustrated in Figure 4.

Figure 4. Effective water stewardship strategies employ a strategic mix of three basic principles



Source: Willam Sarni, "Getting Ahead of the 'Ripple Effect'", Deloitte Review, http://dupress.com/articles/getting-ahead-of-the-ripple-effect/

Fueling growth — Leveraging water stewardship to support business growth

Where water scarcity is concerned, our observations suggest that companies generally follow the trajectory described by the maturity model presented in Figure 5. They change their business models to move from addressing the issue at their own company level, to addressing it at a stakeholder level with a focus on risk, to addressing it at a stakeholder level with a focus on growth.

Figure 5: Water strategy maturity model

Water cost considered
Pursues internal initiatives

Water value considered
Pursues collective action

No strategy

- Actual or perceived water scarcity is not acknowledged as a salient issue
- All resources are treated equally Cash flows are heavily weighted
- Current market price of water governs decisions

Efficiency strategy

- Recognizes water scarcity as a driver of costs
- Costs of acquisitions and use of water are combined
- Profitability risks are heavily weighted
- Focuses on water conservation – efficiency
- Targets and goals set for internal water efficiency

Risk strategy

- Risks of water scarcity are managed at the facility or business-unit level, but not consistently at the level
- Stakeholder engagement is pursued to improve access to water, income cases on an ad hoc basis
- May calculate the full costs of water or use a "shadow price"
- May participate in public policy formulation
- Ad hoc investment in technology innovation at the facility level
- "Social license-to-operate" risks are heavily weighted

License-to-grow strategy

- Internalizes externalities (e.g., water and ecosystems) – considers these external issues
- Recognizes the need to manage water scarcity as a platform for growth
- Where relevant develops products business models that take into account scarcity, and product/service offerings address water scarcity
- Consistently quantifies value of water, not just its costs or full costs
- Proactively engages with stakeholder and leads water-focuses initiatives and collective action programs – more than just participating
- Participates in water-realated policy development
- Invests in and accelerates technology innovation at the corporate level
- Social license-to-grow' mindset regarding water issues

Source: William Sarni, "Fueling growth: You can't always buy what you need", Deloitte University Press, July 28, 2014. http://dupress.com/articles/water-stewardship-growth-strategies/

Companies whose operations and growth depend on water, such as E&P companies, should be aware of where they fall along these stages of maturity.[24] This understanding can help management frame the steps needed to address water risk and to align its water strategy with its business growth strategy. For instance, a company that recognizes it is operating at the "efficiency" level, but whose future growth prospects depend heavily on access to water, can plan to move to the "risk" level through relatively modest investments in stakeholder engagement, perhaps piloted in one or several business units. Or it could seek to leapfrog to the "license-to-grow" level through more dramatic changes, such as spearheading collective action programs in critical watersheds and quantifying the value of water, not just its cost.

Oil and gas companies looking to leverage their water strategies to drive business growth should ask the following questions as they relate to the value chain:

- What or who do water prices depend upon?
- How likely are prices to fluctuate and why?
- What are the water scarcity risks common to all users?
- What scarcity-related risks are particular to our company?
- How severe are these risks to the way our company does business today?
- How severe are these risks to prospects for future growth?
- What is the value of water to our company's business and growth strategy?
- Where will engagement with stakeholders enhance the overall value of this resource to the enterprise, including increases in value driven by risk and cost reductions?

Think water, water everywhere

When it comes to water, a company cannot always buy what it needs. Oil and gas companies, which must continuously earn the "social license to operate," must increasingly understand the business value of water and have an enterprise-wide strategy for engaging with stakeholders. Perception is reality for local communities that believe they are competing with industry to obtain water in the volumes they need and at the quality they require. Here, the oil and gas industry has a tremendous opportunity: It knows how to manage reservoirs related to oil and gas formations, and these hydrological techniques can also be applied to the water reservoirs shared with the local community. If done properly, the oil and gas industry can enhance water availability for all, and in so doing, dispel the old adage that oil and water do not mix.

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Will has been providing environmental and sustainability consulting services to private- and public-sector enterprises for his entire career, with a focus on developing and implementing corporate-wide sustainability and water strategies. Mr. Sarni's diverse client list includes Fortune 500 companies, multinational corporations, and non-governmental organizations (NGOs). He has managed complex projects throughout the North America, Europe and Asia, working with some of the world's most recognizable companies and NGOs. He is also leads the Deloitte team on the annual Interbrand Best Global Green Brands sustainability performance ranking highlighting the value of sustainability in creating brand value and the Deloitte team with the Consumer Goods Forum on Health and Wellness Measurement and Reporting.

He has worked with a range of companies, university technology transfer offices, and startups in evaluating the technical viability and market potential of innovative water technologies and in supporting M&A programs. His experience in "water tech" includes data collection, analytics and visualization tools, water efficiency, filtration and treatment technologies.

An internationally recognized thought leader on sustainability and corporate water strategies, Mr. Sarni is a columnist on sustainability and water strategies for GreenBiz. He is the author of Corporate Water Strategies (Earthscan 2011, and in Chinese by Shanghai Jiao Tong University Press 2013) and *Water Tech – A Guide to Innovation Investment, and Business Opportunities in the Water Sector* (Routledge 2013). He is currently working on, *21st Century Growth: Beyond the Energy – Water – Food Nexus* (Dō Sustainability 2015).

Sarni is a board member of the Rainforest Alliance, and he is on the Water Leadership Working Group for the World Business Council for Sustainable Development, the Water Working Group for the Business and Industry Advisory Committee to the Organisation for Economic Co-operation and Development, the Scientific Program Committee for Stockholm World Water Week and is an advisor to the University of Cambridge Natural Capital Leaders Platform "The right value for externalities" collaboration, with a focus on the value of water. He was the Deloitte Project Lead for the CEO Water Mandate "Water Action Hub" project and was the Deloitte Project Lead for the Carbon Disclosure Project Water Program from 2011 through 2013.

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