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By William Sarni and Joseph Stanislaw

No water, no energy. No energy, no water.

Deloitte Center for Energy Solutions

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Introduction

Many companies have strategies for human resources, marketing, risk management, etc., but few have energy strategies and water strategies and even less have integrated energy–water strategies.

This is a glaring omission.

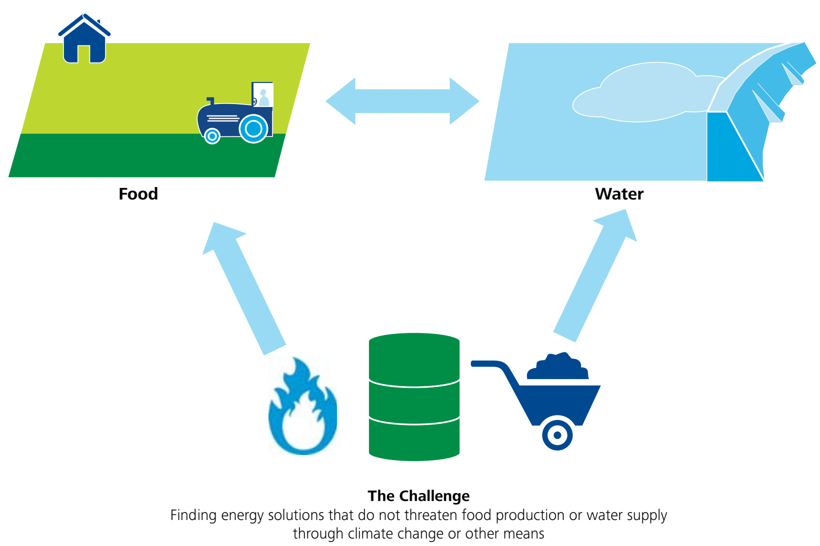
Energy can be considered an engine of economic growth. And the world needs more horsepower. The World Bank estimates that the economies of developing nations will grow six percent in the medium term, compared to 2.7 percent in higher income countries.[i] Meanwhile, the U.S. Energy Information Administration (EIA) estimates that world energy demand will increase by 53 percent between 2008 and 2035.[ii] U.S. EIA further predicts that a growing proportion of this demand will be met through low-carbon, renewable forms of energy, but the vast majority of it will still be satisfied by traditional fossil fuels.

While governments and businesses have grown accustomed to competing for energy, they are not so accustomed to vying for another essential resource: freshwater. Nonetheless, more occurrences of droughts and floods and increasing incidents of water scarcity are causing the public and private sectors to see freshwater for what it really is: a scarce and precious commodity that should be managed.

When examined separately, the competitions for energy and freshwater each raise serious concerns about economic development, national security, and public well-being. But taken together, and coupled with mounting food requirements, these concerns can be multiplied several-fold because the subjects of energy and water are inseparable. It takes vast amounts of water to extract, process, and produce many forms of energy, and it takes vast amounts of energy to extract, transport and treat water. Moreover, the availability of both energy and water impacts our ability to adequately supply food to an ever expanding global population. Unless we can manage energy and water, we will not likely be in a position to feed an increasingly hungry world.

The interrelationship between water and energy goes around and around. Increasing demands on water from the private and public sectors are impacting the world's ability to meet its energy needs. In parallel, the need for more and more water for agricultural, industrial and domestic uses requires more energy. A constraint in either resource limits the other, and this nexus of supply and demand poses substantial risks for virtually every government and every type of business.

Figure 1.
The Challenge of Unintended Consequences: The Devil's Triangle

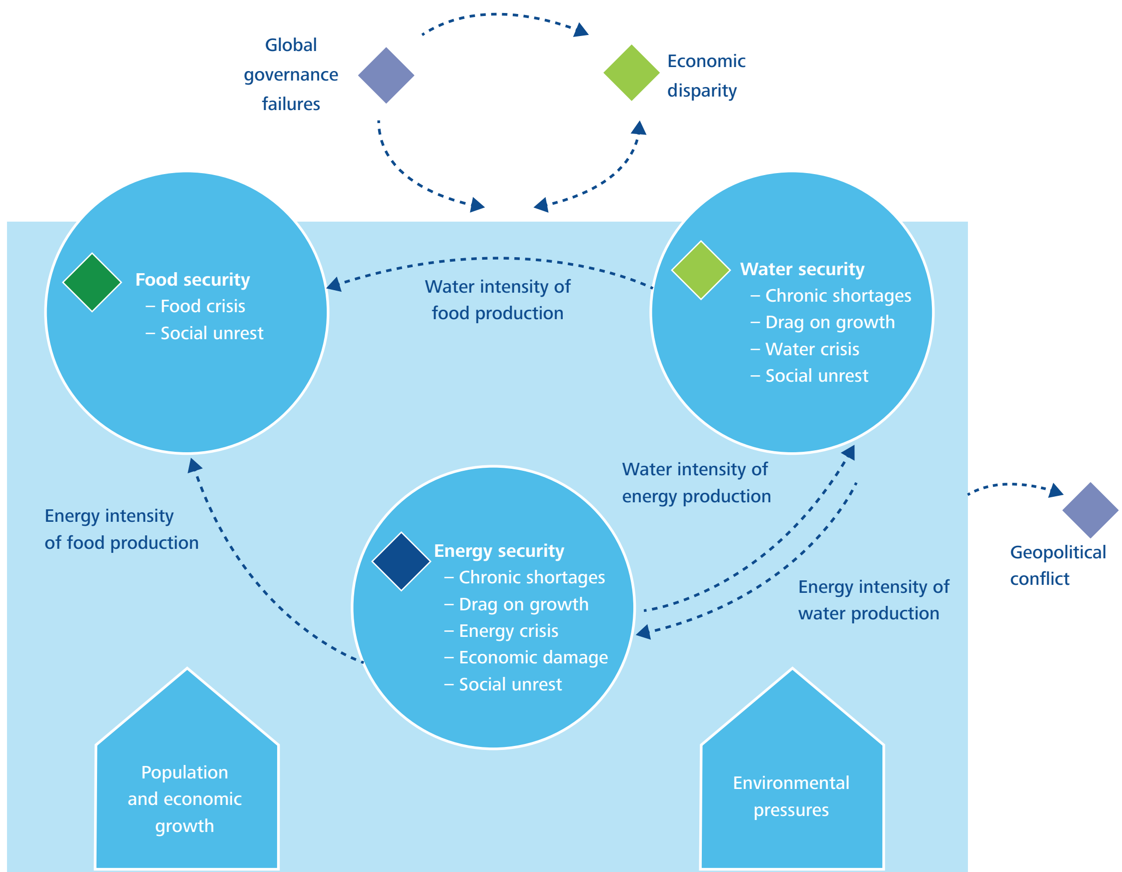


Source: The JAStainislaw Group LLC

The effects of climate change are also exerting pressure on the fulcrum of the water/energy relationship. Due to shifting weather patterns, scientists are less able to use historical hydrological data to predict future water availability.

The news, however, isn't as bad as it may seem. Like steam that powers a turbine, the increasing tension between water and energy can be harnessed to drive change and innovation—a 21st century paradigm of multifaceted problem-solving. Meeting the energy and water requirements of the current and projected population is expected to require a radical rethinking of how to use resources. This can spur innovation in the form of low water footprint energy technologies and low energy footprint water technologies. It is also likely to spawn a host of productive new services and partnerships.

Figure 2.
Energy water-food nexus



Source: World Economic Forum

Water works: Global trends in water access and usage

The popular consensus regarding freshwater is that when supplies dwindle, we can make or find more of it. The reality is that the amount of fresh and accessible water is static, and demands on this finite resource are increasing. Accordingly, so are the incidents of water scarcity.

Many countries today are extracting groundwater faster than it can be replenished. According to the World Economic Forum, Mexico is exceeding its groundwater supplies by 20 percent, China by 25 percent and India by 56 percent.[iii] And this trend is likely to continue, within these nations and elsewhere. The reasons? A number of forces are exerting intense pressure on the world's water resources:

- population growth
- economic development and urbanization
- the rise of the middle class

According to the United Nations' Population Division, the global population is estimated to grow by about one billion people between 2010 and 2025. With this growth naturally comes the need for more water, energy and, of course, food. This is expected to lead to more water-intensive agricultural practices, which will likely exacerbate the already enormous draw on freshwater resources required by the sector. Over the next 10-15 years, not only will agricultural output need to grow to feed more people, but also its makeup will need to change to accommodate evolving diets that are anticipated to increasingly include more water-intensive food products such as meat and dairy. Population growth will likely also exacerbate the energy-intensity of water due to dropping groundwater tables, greater reliance on desalination processes, and the need for progressively larger conveyance systems for surface water transport.

Most of this expansion is anticipated to happen in China, India and other emerging economies where urbanization and industrialization are simultaneously taking place. This poses yet another conundrum: Economic development in emerging markets is anticipated to catapult three billion people into the middle class.[iv] From cars to houses, electronics to entertainment, members of this upwardly mobile population may increasingly want "to have what they're having" in the more developed economies.

Add urbanization into the mix, with more than half of the world's population already residing in cities and even more poised to move there,[v] and the stage has been set for a substantial shortfall between water supply and demand, which could be as high as 40 percent by 2030.[vi] Translated another way, by 2030 two out of every three people will likely live in an area of high water stress.[vii]

The stage has been set for a substantial shortfall between water supply and demand, which could be as high as 40% by 2030.

Energy essentials: Global trends in energy demand and production

The same factors that are exerting pressure on water supplies are also heightening energy demand. According to the U.S. Energy Information Administration, world energy demand is anticipated to increase by 53 percent, from 505 quadrillion Btu in 2008 to 770 quadrillion Btu in 2035.[viii] Most of this growth is expected to come from emerging nations. For instance, energy demand in the U.S. is forecast to rise approximately 14 percent between 2008 and 2035.[ix] In comparison, combined energy use in China and India is expected to more than double during this time period, accounting for almost one-third of world energy consumption by 2035.[x]

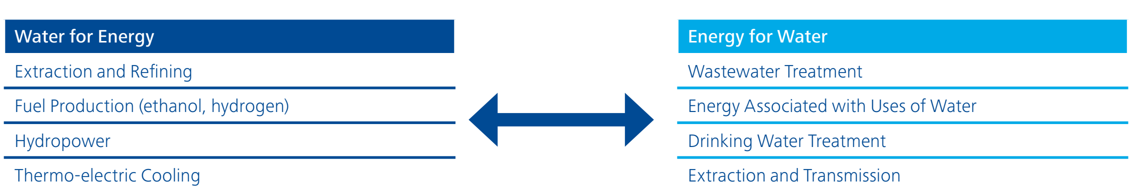
Despite this formidable supply challenge, the call for alarm, which was once trumpeted by peak oil theorists and concerned analysts, has dissipated in recent years as the energy industry has demonstrated significant production capacity tied to new-found methods for accessing oil and gas reserves located in deepwater and salt basins, as well as for tapping unconventional deposits locked in shale formations and tar sands. Present forecasts suggest that the world's proven oil reserves will last about 46 years; coal reserves about 118 years; and conventional natural gas deposits about 59 years at current production levels.[xi]

Meanwhile, the big story of the past decade has been the shale gas boom, which began in the U.S. The oil and gas industry has known for decades that an immense amount of natural gas was locked within a number of well-known shale formations throughout the world. The trick was to figure out how to unlock these resources in an economically and technically viable way. Recently, the key was found in the form of horizontal drilling with multi-stage fracturing and stimulation techniques. While shale gas production is still largely a North American phenomenon, the potential for global expansion is substantial, with about 6,600 Tcf of technically recoverable shale gas estimated to exist around the world.[xii] Unconventional resources such as shale gas—and now tight oil—could extend the longevity of the world's fossil fuel supplies much farther than originally fathomed.

The world doesn't appear to be running out of energy resources any time soon, just the most easily accessible ones. This fact is moving the energy industry into a category of production that requires advanced technology, sophisticated human resources and significant capital investment—and accordingly, higher market prices to support increasingly expensive exploration and production efforts. New levels of difficulty and expense in accessing resources are also adding to price volatility as the industry battles demand fluctuations, infrastructure challenges, and supply bottlenecks in transporting resources from remote and often inhospitable locations. There is also the ubiquitous potential for unforeseen market shocks, ranging from geopolitical events to natural disasters, economic crises in developing nations, and many other "black swans" in between.

One of these potential shocks isn't a "black swan" *per se*, in the sense that those with foresight are aware of its growing likelihood. By and large, energy production is a thirsty business, and water scarcity is becoming a significant risk. Demand for water in energy and industrial use is projected to rise sharply between 2000 and 2030, increasing by 56 percent in Latin America, 63 percent in West Asia, 65 percent in Africa and 78 percent in Asia.[xiii] This escalating demand for water, which is occurring in concert with an upwardly spiraling demand for energy, raises questions about the energy industry's susceptibility to supply disruptions caused by water shortages or difficulties in treating and managing existing water resources.

Figure 3.
Water for Energy / Energy for Water



Source: Deloitte Consulting LLP

Tapped out? An overview of water use in the energy sector

Are we in danger of supply chains halting and delivery fleets stalling because of increasing draws from the metaphorical tap? The answer is, "It depends." When it comes to water use, different energy sectors have vastly different water footprints. And while the terms "clean", "green" and "renewable" may connote low carbon emissions, they may not necessarily imply low water consumption (concentrated solar is the exception with higher water requirements).

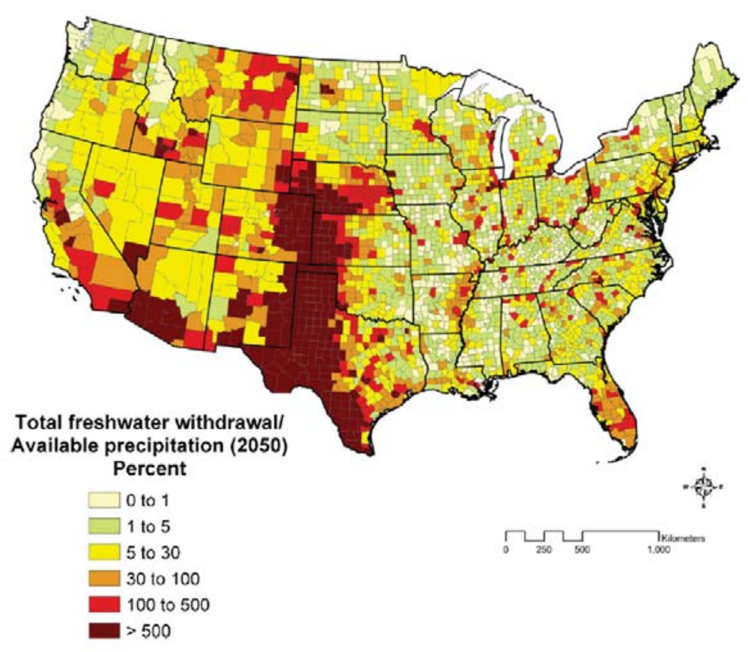
The utility sector, for instance, is heavily water dependent, with most thermal power generation facilities needing vast amounts of water for cooling processes regardless of whether uranium, coal or natural gas are used as the base fuels. Recent droughts in Europe illustrate this dependency, as several nuclear facilities in France were forced to shut down to prevent over-heating when they could no longer withdraw sufficient amounts of river water.

Furthermore, the requirement for water in the utility sector doesn't stop there. Water is also required to clean and process coal. The mining industry, too, needs water for operational purposes in order to produce many of the base fuels that are used in power generation. For instance, the U.S. Geological Survey (USGS) estimates that to produce and burn the one billion tons of coal Americans use each year, the mining and utilities industries withdraw between 208 and 284 trillion liters of water annually.[xiv]

Water use in the oil and gas sector is also an increasing challenge. This concern has become especially apparent in shale gas production, which employs hydraulic fracturing and stimulation techniques. As its name implies, this type of production uses highly pressurized water, which is typically mixed with chemical additives and suspended particles (e.g., sand grains or artificial ceramic material), to fracture the source rocks and open a pathway for releasing the gas deposits. This process, which often requires between two and four million gallons of water per well[xv], is creating tensions between oil and gas companies and other water users in certain regions, as they all compete for scarce water resources. In response, industry organizations as well as individual exploration and production companies have launched various water management initiatives aimed at engaging local stakeholders and applying cutting-edge techniques to manage water sourcing, increase re-use, enhance treatment processes, and safely store and transport process water.

A comparison of the extent of shale gas in the U.S. and projected water scarcity highlights the tension between energy resources and water availability.

Figure 4.
Projected total water withdrawal as percent of available precipitation in 2050



Source: Natural Resources Defense Council

Where water and energy collide: A global perspective

The competition for water is impacting the energy sector and, in turn, economic growth right now. The extent to which these constraints are being felt varies by region according to factors such as energy demand growth, hydrological conditions, environmental regulations, and the maturity of water-resource management practices. An examination of three regional case studies—China, South Africa, and the United States—exemplify how these factors intertwine. These regions were selected because their water/energy demands are representative of many of the challenges occurring throughout the world.

China: Is there enough water?

At a recent press conference, Hu Siyi, vice minister of China's Ministry of Water Resources, issued a 'stark warning' stating that water usage in China had "already surpassed what our natural resources can bear." And he is just the latest in a long string of public officials to have sounded an alarm. China's economy, more than most, runs on water. Approximately 96 percent of China's electricity takes water to generate,[xvi] and about 70 percent of the country's power is produced through coal-fired generation. [xvii] To keep pace with the country's rapid economic growth, coal production in China has tripled since 2000 to 3.15 billion metric tons a year.[xviii] Government analysts project that China's coal producers will need to dig even deeper to fuel continued economic expansion, increasing their output by 30 percent, or one billion metric tons annually by 2020.[xix]

In addition to concerns about carbon emissions, some economists believe that China's continued reliance on coal could interrupt its extraordinary economic progress. The freshwater needed for mining, processing, and consuming coal accounts for the largest share of industrial water use in China, representing about one-fifth of all the water consumed nationally.[xx] This puts China's demand for energy, and particularly for coal, at crosscurrents with its plans for developing modern cities and manufacturing centers, which will also require vast amounts of freshwater to construct and operate. The economic impacts of this tug-of-war are already being felt. According to the EIRIS Water Risk Report (June 2011), the external costs of water scarcity and pollution already amount to 2.3 percent of China's GDP, of which 1.3 percent is attributable to water scarcity and 1 percent to the direct impacts of water pollution. And the probability is increasing that these impacts will become even more severe. CEC, an association representing power firms, is warning that China could soon face increased power supply outages due to a shortage of coal.[xxi] The problem, according to industry executives and Chinese government officials, is that there is not enough water to mine, process, and consume the enormous coal reserves that reside in the country's dry northern regions.

Africa: Water and energy increasing the cost of doing business

Africa is hot, and is getting more so due to changing weather patterns. According to the World Wildlife Fund (WWF), 14 countries in Africa are already experiencing water stress, and another 11 nations are expected to join them by 2025. Put another way, nearly 50 percent of Africa's predicted population of 1.45 billion people will likely face water stress or scarcity by then. In addition to the obvious humanitarian implications, this shift is also threatening economic development.

Water scarcity in South Africa offers a poignant example. This semi-arid nation uses about 97 percent of its available water supply per year, with some experts suggesting that demand could exceed supply by 2020 if no drastic actions are taken.[xxii] Part of this strain is due to population growth in urban areas. Another part is related to industrial use. South Africa requires large amounts of water for mining and the production of electricity, whose limited supply may put additional constraints on economic development.

United States: Not immune to the water threat

From 25,000 feet in the air, Lake Mead is a sight to behold, a blue oasis in the midst of an otherwise parched landscape. Although the massive reservoir stands as a testament to the prowess of human engineering, some researchers are warning that it could evaporate as soon as 2021—and along with it, the ability to provide freshwater to 22 million people in the American Southwest and the capacity to produce essential hydropower from Hoover Damn.[xxiii] Researchers further point to the protracted drought in the Southwest, largely thought to be caused by climate change, and increased human demand as the culprits. Water scarcity, it appears, is not just a threat to developing nations.

Some U.S. states are already experiencing the economic effects of the increasing strain on the water/energy nexus. For instance, California dedicates about 19 percent of its electricity to water use, and prolonged drought conditions are poised to intensify the state's dependency on energy intensive, long-distance conveyance systems.[xxiv] This situation is anticipated to continue to exert pressure on water prices, which have already experienced large jumps. In 2009, water prices rose by 14 percent in Southern California alone, putting an unwelcome pinch on the state's water-intensive semiconductor and agricultural sectors.[xxv]

Figure 5.
Approximate Extent of U.S. Shale Gas

U.S. Energy Information Administration

The extent of energy-water constraints are being felt according to factors such as energy demand growth, hydrological conditions, environmental regulations, and the maturity of water resource management practices.

Hitting home: Water matters and increasingly so

These case studies suggest that the ramifications of the water/energy nexus are hitting many businesses close to home. The findings of the second annual Carbon Disclosure Project (CDP) Water Disclosure Global Report, which was conducted on behalf of 354 investors with assets of U.S. $43 trillion, support this assertion. Once seen as merely a far-off threat, the increasing competition for water is increasingly being viewed as something that should be acknowledged and dealt with now. According to the 2011 Report, many of the responding companies (59 percent) have identified water as a substantial risk to their businesses. Even more, over one-third of respondents have already suffered recent water-related business impacts with associated financial costs as high as U.S. $200 million. Nearly all respondents, 93 percent, report having some sort of "water plan." And these "plans" are not just related to risk. Almost two-thirds of companies surveyed have identified water-related opportunities, including cost reductions associated with increased water efficiency, revenue from new water-related products or services, and improved brand value.

But what about the interplay between water and energy? Do companies grasp how constraints or excesses in one quantity can lead to imbalances in the other? Notably, 72 percent of respondents say that they understand the trade-offs between water and energy. Yet, the energy sector itself did not reinforce the importance of this concept: The energy sector had the lowest response rate (47 percent) of all sectors participating, and it also had the lowest proportion of respondents (36 percent) who reported board-level oversight of water-related policies, strategies or plans. This is somewhat incongruous since 72 percent of energy respondents report exposure to water-related risk compared to an average of 59 percent across all respondents.

A reason for this incongruity may be found in the prevailing industry consensus on the type of risks and opportunities involved. Some industries, such as food and beverage, are relatively mature in the development and implementation of their water management practices since high-quality water is a direct input into their final products. Others, such as the mining and energy industries, are not so far along, even though water is a critical operational input. This is because water has historically been viewed as a compliance issue in these sectors as opposed to a strategic resource. As the competition for water intensifies, this view may change.

The path forward: Reducing energy's water footprint

The path forward in bridging the impending gap between energy supply and demand, and the corresponding strains on water resources, requires addressing the water/energy nexus from both sides of the equation. From an energy perspective, the solution involves reducing water consumption in traditional energy production as well as moving towards energy sources that are inherently less water-intensive. Technological advances are increasingly making both of these objectives possible. New methods of "dry cooling," which uses air-cooled condensers instead of conventional cooling towers, and water re-use and recycle schemes are giving traditional power producers new opportunities to reduce the quantity of water they need to withdraw, as well as to improve its quality prior to discharge or evaporation. Meanwhile, while some forms of renewable energy, such as biofuels and solar thermal, face similar water access challenges to their fossil fuel counterparts, others have negligible water footprints. Wind power and solar photovoltaics, in particular, fit this bill, which gives them an advantage that could trump cost per megawatt in certain high-stress regions.

Both of these tactics, reducing water consumed in traditional energy production as well as moving toward low-water alternatives, offer energy companies and forward-thinking businesses an obvious opportunity to save on the actual cost of water, but this is only the tip of the iceberg. Water is becoming a key strategic issue impacting business continuity (having the appropriate quantity and quality of water), license to operate, and brand value. Therefore, establishing a water stewardship strategy is becoming essential to mitigating risks and identifying opportunities beyond the apparent cost reductions.

The path forward: Adopting a water stewardship strategy

Virtually every public and private sector organization today should develop a water stewardship strategy—although developing one is a long journey that many are just beginning. Such a strategy goes beyond simply managing water as a resource, to safeguarding it for all impacted stakeholders over the long term. Water stewardship, in other words, provides a framework for addressing the water side of the energy/water equation.

At a high level, water stewardship assesses how water usage and potential scarcity can impact internal operations, supply chain business partners, and other stakeholders in the watershed. It differs from traditional approaches to water management in that it emphasizes effective resource sharing. It also goes beyond the unit cost of water to take into account how competition for water can potentially affect business continuity (operational risk), brand value (reputational risk), and license to operate (regulatory risk). In assessing these risks, a comprehensive approach to water stewardship extends outside the organization's four walls to include upstream and downstream considerations in addition to direct operations.

Figure 6.
Water risk to business value at risk

	Supply chain	Manufacturing	Product use
Physical risk	• Temporary non-availability of water disrupts supply chain • Water scarcity drives up input prices (~2%-20%)	• Temporary non-availability of water disrupts operations • Increased capital expenditure on water treatment, water extraction, or alternative technologies to circumvent water problems raises costs	• Non-availability or scarcity of water required for using product or service limits growth
Regulatory risk	• Intensifying competition for scarce water constrains growth • Suspension or withdrawal of supplier's water license or discharge permits disrupts supply chain	• Intensifying competition for scarce water constrains growth • Reallocation to more urgent needs during drought disrupts operations • Suspension or withdrawal of supplier's water license or discharge permit disrupts operations and/or constrains growth	• Non-issuance of water license or restrictions on use of particular products or services due to water intensity raises costs or checks growth
Reputation risk	• Competition with household water demand constrains suppliers' growth • Responsibility "by association" for suppliers' water pollution damages brand or reputation, hinders growth	• Increased capital expenditure on wastewater treatment to meet or exceed standards • Competition with household demands, or pollution incidents, damages brand or reputation, hinders growth	• Public outcry regarding water intensity of product damages brand, reputation, hinders growth

Impact on financial performance

- Lost revenue from disruption of water supply
- Higher costs from:
- Supply chain disruption
- Changes in production processes
- Capital expenditure to secure, save, recycle, or treat water
- Regulatory compliance
- Increasing price of consuming or discharging water
- Delayed or suppressed growth, potentially impacting share price
- Potential higher cost of capital for businesses that rely heavily on fresh water resources

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

There are multiple benefits to adopting a water stewardship strategy—or at the very least, to beginning the journey. While risk mitigation may be the most apparent, several leading companies are discovering that a comprehensive approach to water stewardship can also reveal opportunities to improve supply chain efficiencies, enhance consumer perceptions, and increase profitability. Many of these opportunities are linked to technological innovations that lessen water intensity and promote water recycling and re-use.

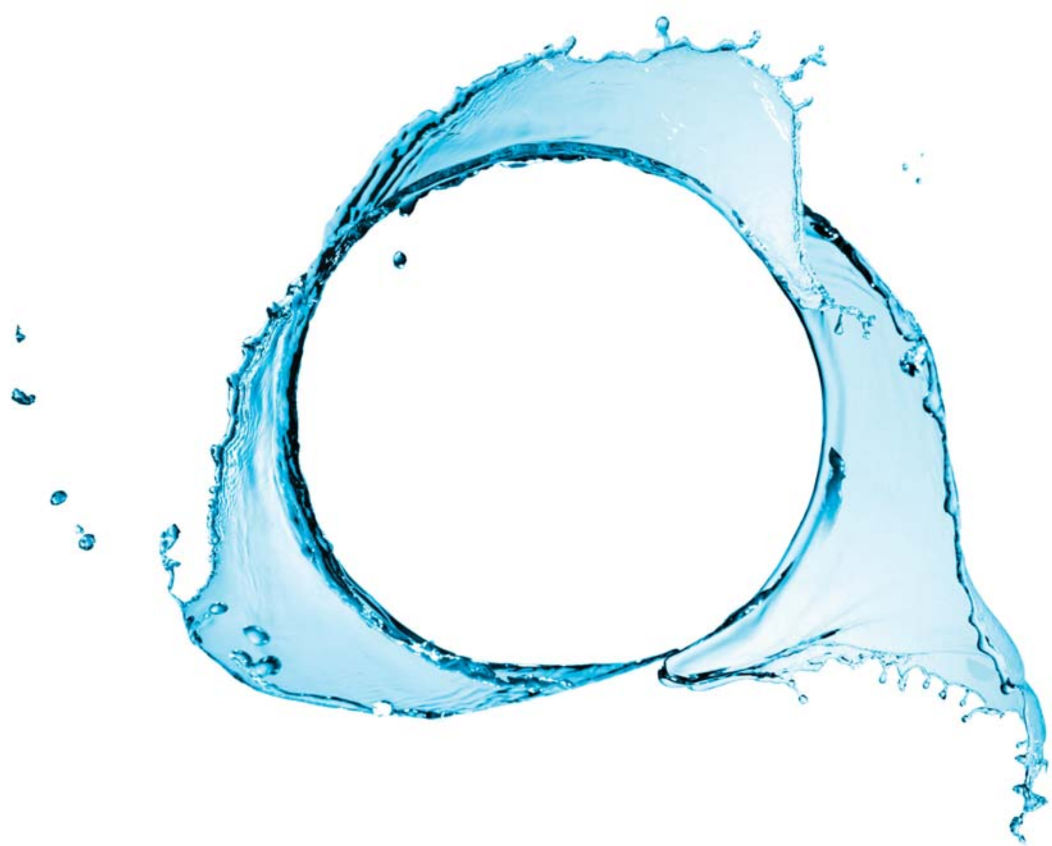
For instance, one international food and beverage company uncovered an opportunity to collect evaporated water from the production of evaporated milk and to reuse it for industrial purposes, thus saving 42 million gallons of municipal supply annually. A global hotel chain recently partnered with an ecologically oriented laboratory to develop a new laundry formulation and management system. Pilots of this system in 312 hotels saved 18 million gallons of water and reduced energy use by 15-25 percent. Scaling this system across its many brands now represents an even greater opportunity to generate value.

Organizations are at different levels of maturity with respect to addressing the challenges and opportunities related to water access and associated energy demand. Although the aforementioned companies are considered leaders, they still face challenges in adopting a holistic water stewardship strategy. The critical starting point for many companies today will be figuring out how much water they are using within direct operations, throughout their supply chains, and even indirectly in product use (i.e., How much water do consumers need to use our products?). Next comes assessing water-related risks and opportunities, which typically includes understanding and quantifying the business value at risk, followed by identifying potential stakeholders at each location and incorporating their perspectives as input into developing corporate, water-related strategies and goals. Of note, this latter step is where water stewardship differs from other resource management strategies.

The crux of effective water stewardship: Stakeholder collaboration—water is not a free good

While companies have grown accustomed to managing energy on their own, collaboration is important to an effective water stewardship. Both companies and governments are increasingly acknowledging that water must be managed differently than other resources because of its far-reaching implications: Nearly everything that we consume, depend on, or enjoy is tied to water. As a result, a trend is underway where the public and private sectors, along with not-for-profits and non-governmental organizations (NGOs), are coming together to understand how to share this scarce and precious resource. This trend is providing a chance for companies to take a seat at the table during public policy discussions. Energy companies, in particular, should increasingly embrace engagement with a range of stakeholders as a means of communicating their water-related needs to develop common solutions.

Other "hot topics" in water-related public policy discussions include incentives for conservation and smart pricing for water. Some of the strains on water usage have come about because water has largely been taken for granted as a commodity that is almost free. The price of water will need to increase to promote conservation while ensuring the price is affordable for vulnerable populations.



The future of water and energy: Free flow or collision course?

As the implications of water pricing illustrate, water is not a simple issue. Neither is energy. Water is largely seen as an essential right and a pre-requisite for human well-being. Energy, too, is tied in some way to everything that governments and businesses hold sacred: economic development, national security and environmental sustainability. If there is one lesson to be learned from the increasing demands on these resources, it is that neither energy nor water can be thought of in a silo. No longer can decisions about how to use or produce one quantity or the other be based solely on cost. Instead, impacts on all stakeholders within the watershed and on the electric grid—ranging from customers to supply chain partners, and communities to other businesses—should be considered. Moving ahead, this shift in mindset from competition to collaboration is anticipated to be essential to avoiding collisions and maintaining a free flow of opportunities at the intersection of water and energy.

Embracing new economic and business models means that meeting the needs of the water-energy nexus is not a zero sum game, but part of the new world of wins.

Managing the Nexus

Water Stewardship – Top Three Actions

- Track water use against energy use—how much water is associated with direct energy use (onsite), purchased energy and in your supply chain.
- Develop an understanding of your water footprint and water risk within the watershed.
- Engage stakeholders within the watershed to develop a collective water and energy conservation and management plan.

Energy and Power – Top Three Actions

- View energy development (oil and gas, biofuels, etc.) and power generation within the context of the local watershed, i.e., "watershed-scale thinking."
- Consider renewables (low water footprint) for watersheds experiencing water stress or scarcity.
- Engage stakeholders within the watershed to develop a collective water and energy conservation and management plan.

Notes

[i] World Economic Forum Water Initiative, *Water Security: The Water-Food-Energy-Climate Nexus*, 2011. (Pg. 7)

[ii] International Energy Outlook 2011, U.S. Energy Information Administration, http://www.eia.gov/forecasts/ieo/world.cfm

[iii] World Economic Forum Water Initiative, *Water Security: The Water-Food-Energy-Climate Nexus*, 2011. (Pg. 9)

[iv] Homi Kharas, *The emerging middle class in developing countries*, OECD Development Center Working Paper No 285, January 2010.

[v] World Economic Forum Water Initiative, *Water Security: The Water-Food-Energy-Climate Nexus*, 2011. (Pg. 8)

[vi] World Economic Forum Water Initiative, *Water Security: The Water-Food-Energy-Climate Nexus*, 2011. (Pg. 9)

[vii] Ibid.

[viii] U.S. Energy Information Administration, *International Energy Outlook 2011*, http://www.eia.gov/forecasts/ieo/world.cfm

[ix] Ibid

[x] Ibid

[xi] The World Coal Association, http://www.worldcoal.org/, and BP Statistical Review of World Energy, June 2010

[xii] *World Shale Gas Resources: An initial assessment of 14 regions outside the United States*, U.S. Energy Information Administration, April 5, 2011

[xiii] World Economic Forum Water Initiative, *The Bubble is Close to Bursting*, 2009

[xiv] World Economic Forum Water Initiative, *Water Security: The Water-Food-Energy-Climate Nexus*, 2011. (Pg. 10)

[xv] Energyfromshale.org, http://www.energyfromshale.org/fracking-fracturing-water-supply

[xvi] http://chinawaterrisk.org/big-picture/

[xvii] http://www.upi.com/Business_News/Energy-Resources/2012/02/07/China-to-face-electricity-shortages/UPI-70581328638028/

[xviii] http://www.circleofblue.org/waternews/featured-water-stories/choke-point-china/, Feb. 15, 2011

[xix] Ibid.

[xx] Ibid.

[xxi] http://www.upi.com/Business_News/Energy-Resources/2012/02/07/China-to-face-electricity-shortages/UPI-70581328638028/

[xxii] Water Crisis by 2020, http://www.timeslive.co.za/local/article913892.eceWater-crisis-by-2020, Feb, 14, 2011

[xxiii] http://thewaterproject.org/water_scarcity_in_us.asp

[xxiv] http://energy.ca.gov

[xxv] EIRIS, *Water Risk Report*, June 2011, pg. 7

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Sarni has been providing sustainability and environmental consulting services to private- and public-sector enterprises for more than three decades, with a focus on developing and implementing corporate-wide sustainability strategies, as well as water stewardship programs. His diverse client list includes some of the world's most recognizable companies and he has managed complex projects throughout the United States, Europe and Asia. Sarni is the Deloitte Project Lead for the 2011 CDP Water Disclosure sponsorship and the Deloitte Technical Lead for the IBLF and CEO Water Mandate "Water Action Hub" project. He is also 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.

An internationally recognized thought leader on sustainability and corporate water strategies, Sarni is a frequent speaker for corporations, conferences and universities. He is the author of *Greening Brownfields: Remediation Through Sustainable Development* (McGraw Hill; **Greening Brownfields**), the recently published, *Corporate Water Strategies* (Earthscan, **Corporate Water Strategies**) and the forthcoming book, *Water Tech, A Guide to Investment, Innovation and Business Opportunities in the Water Sector (Earthscan 2013)*. Sarni is also on the International Editorial Board for the Utilities Policy Journal.

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Dr. Joseph A. Stanislaw is founder of the advisory firm The JAStanislaw Group, LLC, specializing in strategic thinking, sustainability, and environmentally sound investment in energy and technology. He is an independent senior advisor to Deloitte's energy and sustainability practices. As an energy industry leader, advisor, strategist and commentator, Dr. Stanislaw advises on future trends in the global energy market. Dr. Stanislaw serves on several boards in the energy and clean technology space. He is a member of the Council on Foreign Relations.

Dr. Stanislaw was one of three founders of Cambridge Energy Research Associates in 1983 and served as managing director for all non-U.S. activity until 1997, when he was named president and chief executive officer. He is an adjunct professor in the Nicholas School of the Environment and Earth Sciences at Duke University, where he is a Member of the Board of Advisors for the Nicholas Institute for Environmental Policy Solutions. Dr. Stanislaw was a Research Fellow of Clare Hall and lecturer in Economics at Cambridge University, where he was also a member of the Energy Research Group in the University's Cavendish Laboratory. He was a senior economist at the Organization of Economic Cooperation and Development's International Energy Agency in Paris.

Dr. Stanislaw is co-author of *The Commanding Heights: The Battle for the World Economy*. Now in the second edition, the book has been translated into 13 languages and made into a six-hour documentary on PBS. He is also the author or co-author of numerous reports and published papers on the geopolitics and economics of future energy supply and demand, including *Energy in Flux: The 21st Century's Greatest Challenge,* and *Clean Over Green: Striking a New Energy Balance as We Build a Bridge to a Low-Carbon Future,* and he is featured in the public television documentary, *Oil ShockWave*.

Dr. Stanislaw received a B.A., cum laude, from Harvard College, a Ph.D. in Economics from the University of Edinburgh, and was awarded an M.A. from the University of Cambridge. He is one of only several people to have been awarded an Honorary Doctorate and Professorship from Gubkin Russian State University of Oil and Gas in Moscow.

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May 2012