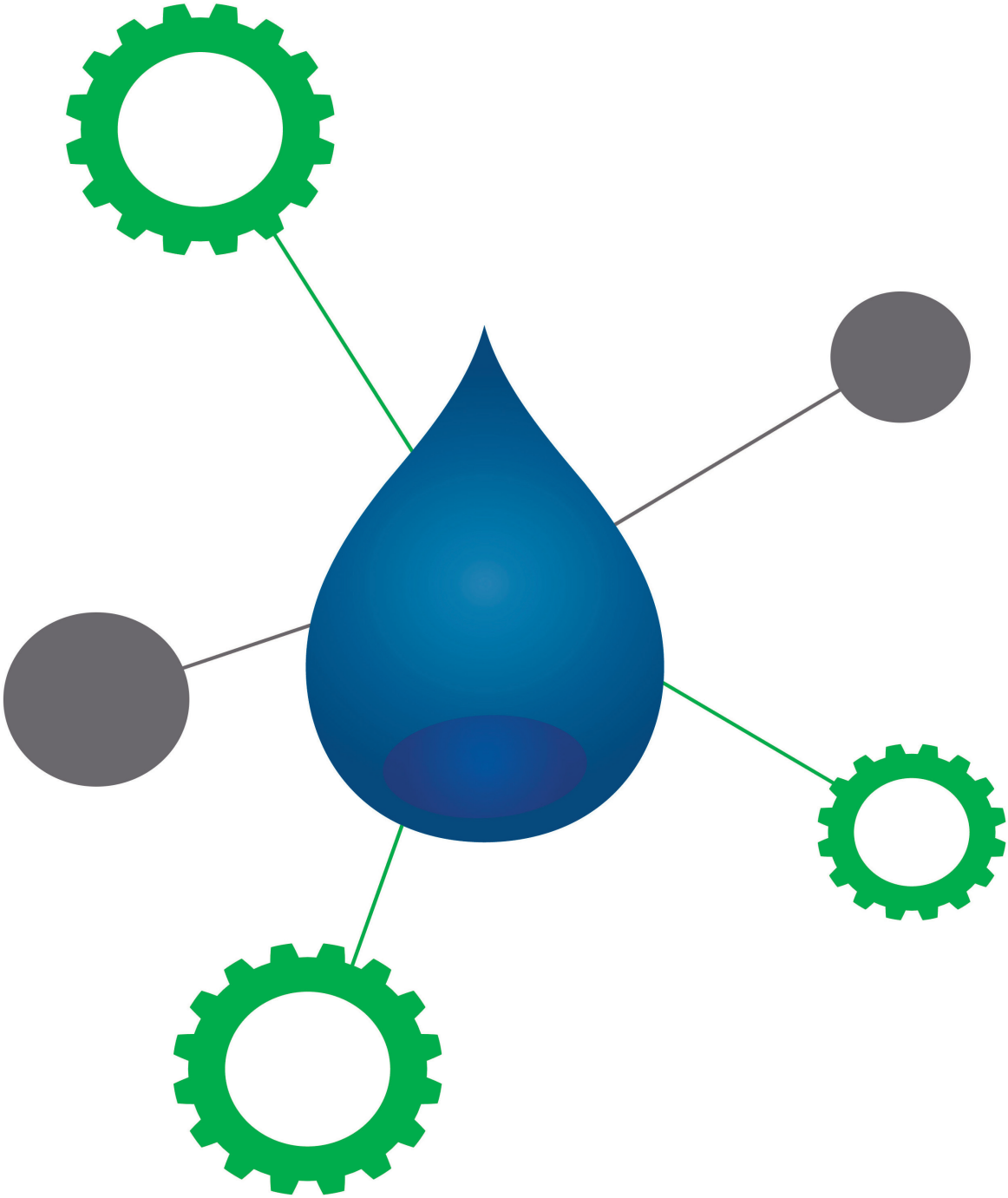
Energy-Water Nexus

The Business Case for a Systems Approach to Resource Management



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Following the launch of NAEM's formal benchmarking program this year, we are proud to introduce the first in a series of white papers on emerging issues in corporate environment, health and safety (EHS), and sustainability management.

Some of these topics are better known than others, but they are all systemic challenges that require new thinking, new processes and a new rubric for decision-making. As we know from our latest trends research, we are now entering a time when the effects of climate change and the environmental issues attendant with it will pose grave risks to business continuity. The environmental challenges of the future will require business leaders to take a holistic approach, make long-term investments in resiliency and form collaborative relationships with stakeholders at all levels.

The Energy-Water Nexus, in particular, will challenge businesses to re-think the business case for resource management. Although the return on investment for energy efficiency programs is well-understood, water conservation has been slower to gain momentum. As this white paper outlines, however, there's an intrinsic relationship between the production of energy and access to clean water that current schemes do not typically incorporate. As waning supply and increased demand start to put stress on these resources, companies will face new questions and tradeoffs.

This report is our contribution to helping our members understand this changing resource landscape, and providing them with the tools they need to think through the impacts of these resources on their operations. As this paper explains, ensuring a viable supply of energy and water will require long-term strategy and a systems approach to problem-solving. We believe that those who begin this adaptation process today will be best positioned for future competitiveness, resiliency and sustainability.

Carol Singer Neuvelt
Executive Director
NAEM

About NAEM

The National Association for Environmental Management (NAEM) empowers corporate leaders to advance environmental stewardship, create safe and healthy workplaces, and promote global sustainability. As the largest professional community for EHS and sustainability decision-makers, we provide peer-led educational conferences and an active network for sharing solutions to today's corporate EHS and sustainability management challenges. Visit NAEM online at www.naem.org.

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Introduction

"The biggest urgency is driven by climate...We're at a crossroads and it is getting tough." --Mike Hightower, Sandia National Laboratories

While many companies have successfully demonstrated the bottom line benefits of energy management programs, water conservation has typically been a harder business case to make. Because water is largely perceived as cheap and abundant, the long-term investments required to achieve water reductions may not deliver short-term returns.

What's missing from this analysis, however, is the inherent interdependency of affordable energy and clean, affordable water. Indeed, the supply of one literally depends on the other. It takes energy to pump water from the ground, to desalinate water for consumption and to treat wastewater. It takes fresh water to generate hydropower, to cool thermoelectric plants and to extract natural gas through hydraulic fracturing.

And supply of fresh water is already in jeopardy.

Of the 7 billion people on earth today, 2.8 billion live in an area that's water-stressed, according to the World Bank. By 2035, energy consumption will increase by 35 percent, which will, in turn, increase water consumption by the energy sector by 85 percent [1]. With much of this increased demand coming from the developing countries of the world, where water scarcity is already an issue, the global economy's manufacturing hubs are expected to be at the center of the tug-of-war for resources.

Although this issue is not entirely new, climate change-related droughts are intensifying the need for systemic solutions, according to Mike Hightower, Water for Energy Lead at Sandia National Laboratories. "The biggest urgency is driven by climate," he said. "We're at a crossroads and it is getting tough" [2].

Since the U.S. Department of Energy issued its report to Congress in 2006, other branches of government and international organizations have also visited the energy-water question and reached the same conclusion as Margaret Catley-Carlson, Vice Chair of the World Economic Forum's Global Agenda Council on Water Security: "If 'business-as-usual' water management practices continue for another two decades, large parts of the world will face a serious and structural threat to economic growth, human well-being, and national security" [3].

This white paper describes how changes in access to either energy or water could impact the business community. We begin by explaining how these issues are intertwined, how they will impact business continuity and what companies can begin doing today to address these coupled risks.

The Relationship Between Energy and Water

In 2005, 41 percent of all freshwater withdrawls in the United States were used for cooling towers in thermoelectric power generation plants.

Although energy and water have traditionally been thought of as separate resources, they are, in fact, interdependent. In this section, we outline the systemic relationship between them, and the intricate ways in which access to one affects access to the other.

Water for Energy Production

Water is a critical resource for the energy sector, from resource extraction and the processing of raw materials to the generation of electric power itself [2].

Water is essential during the extraction of natural resources through mining for coal, drilling for oil and hydraulic fracturing for natural gas. In drilling for fossil fuels, water is used to cool and lubricate the equipment and to suppress dust. In hydraulic fracturing, water is injected into the well to break open shale formations and release the gas. In addition, water is needed to transport energy through coal slurry pipelines and to carry coal down rivers on barges [3].

Thermoelectric power generation, which uses fossil fuels, biomass or nuclear materials, also consumes large amounts of water [4]. In 2005, 41 percent of all U.S. freshwater withdrawals were used to for cooling towers in thermoelectric power generation plants. During the production process, the plants withdraw and circulate fresh water to cool the towers. This process of evaporative cooling accounts for 3.3 percent of total water consumption in the United States [2].

Energy for Water Production

Although it varies by region, up to 13 percent of the energy use in the U.S. relates to the pumping, treatment or distribution of water. In California, for example, as much as 19 percent of electricity is used for water extraction, purification and disposal of wastewater [5]. At the beginning of the use cycle, energy is used to pump water from the ground, from lakes and from rivers. It is also needed to remove harmful pollutants and salt. And finally, energy is necessary to pump water through the pipelines to deliver it to the end users. Energy is also necessary to treat and dispose of wastewater [6]. Wastewater plants use lots of energy to aerate, pump and process solids out of the water. At these plants, energy is the second highest expense, next to labor, representing 30 to 40 percent of a municipality's energy consumption as a whole. In addition, energy demand is expected to grow at water utilities by about 20 percent with anticipated environmental and population challenges [5].

And as freshwater becomes scarce, more energy is required to extract it from deep aquifers, process saline water into potable water and deliver freshwater over long distances.

The Relationship Between Energy and Water

Impact of Energy Production on Water

	Energy Source	Impact on Water Quantity	Impact on Water Quality
Energy Extraction and Production			
	Oil and gas exploration	Water for drilling, completion & fracturing	Impact on shallow groundwater quality
	Oil and gas production	Large volume of water produced, impaired	Produced water can impact surface and groundwater
	Coal and uranium mining	Mining operations can generate large quantities of water	Tailings and drainage can impact surface water and groundwater
Electric Power Generation			
	Thermoelectric (fossil, biomass, nuclear)	Surface water and groundwater for cooling and scrubbing	Thermal and air emissions impact surface waters and ecology
	Hydroelectric	Reservoirs lose large quantities due to evaporation	Can impact water temperatures, quality, ecology
	Solar PV and Wind	None during operation; minimal water use for panel and blade washing	None during operation; minimal water use for panel and blade washing
Refining and Processing			
	Traditional oil and gas refining	Water needed to refine oil and gas	End use can impact water quality
	Biofuels and Ethanol	Water for growing and refining	Refinery wastewater treatment
	Synfuels and Hydrogen	Water for synthesis or steam reforming	Wastewater treatment
Energy Transportation and Storage			
	Energy Pipelines	Water for hydrostatic testing	Wastewater requires treatment
	Coal Slurry Pipelines	Water for slurry transport; water not returned	Final water is poor quality; requires treatment
	Barge Transport of Energy	River flows and stages impact fuel delivery	Spills or accidents can impact water quality
	Oil and gas storage caverns	Slurry mining of caverns requires large quantities of water	Slurry disposal impacts water quality and ecology

(Source: U.S. Department of Energy, "Energy Demands on Water Resources: Report to Congress on the Interdependency of Energy and Water," 2006.")

Looming Challenges

"The world population is expected to reach 9 billion people by 2050; with this will come an increased demand for already-limited water resources."

Fresh, potable water is in high demand, while the supply is waning. With the growth of the middle class in developing nations and human population growth across the world, water supplies will be stressed to meet the increased demand. Climate change is expected to further exacerbate these challenges, by altering which regions have access to fresh water, and introducing distribution challenges to communities already struggling to meet their water and energy needs [7].

Water Supply

Across the world groundwater supplies are drying up, due to extended droughts and increased consumption. In the past, as surface water supplies were depleted, communities relied on groundwater. Now, the fresh water in those groundwater tables are diminished, making it more difficult to access. Indeed, as stated in the 2006 U.S. Department of Energy Report to Congress, "some regions have seen groundwater levels drop as much as 300 to 900 feet over the past 50 years because of the pumping of water from aquifers faster than the natural rate of recharge" [2].

Climate change has the potential to further reduce freshwater supply even more. As the earth warms and the ice and snow cover melt, that freshwater will turn saline as it melts into the ocean. Climate change also threatens to reduce the freshwater supply due to changing weather patterns. As some regions no longer receive rain and others now get rain instead of snow, this change impacts local water supplies. Many U.S. states are already aware of the need to ensure water supply during extended droughts, however, even if a region has high levels of precipitation, that freshwater may not reach the communities that need it, when they need it. For example, much of the western U.S. is dependent upon snowpack for their water supply. In the past, as the snow pack melted, it was stored in the Colorado and Columbia River reservoirs. As warmer weather causes the snow to melt earlier, or rain instead of snow, the Columbia River reservoir is forced to release early. This means the water is not available for communities who rely on that reservoir later [2].

Aging infrastructure also poses challenges for water supply, as water is lost through leakage and inefficient distribution networks. In the U.S., both the energy and water infrastructures are four decades old, and are struggling to support the demand of a growing population [8]. Past water infrastructure investments focused on dams and reservoirs, improving water availability to some arid regions, but there have been only a few surface water reservoirs built since 1980.

Growing Demand

The world population is expected to reach 9 billion people by 2050; with this will come an increased demand for already-limited water resources. Most of this population growth worldwide will be in urban areas of developing nations in Asia, Latin America and Africa. In these regions, water supply is limited and there are already problems with energy distribution [9]. Within the U.S., the already water-scarce Southwest is experiencing some of the fastest population growth across the country [2]. This increase in population will also require more freshwater than is available to meet the growing demands.

According to World Bank estimates from a 2010 baseline, world energy consumption will increase 35 percent by 2035, which will increase water consumption of the energy sector alone by 85 percent. With already stressed and depleted water resources, accessing freshwater to meet demands will be extremely expensive and challenging not only for energy and water utilities, but agriculture as well [9].

Looming Challenges

"Ensuring our water and energy supply will require multidisciplinary scientific and technical expertise, and involve long-term, high-risk investment with little profit incentive in the short-term." – U.S. Department of Energy

An increase in both energy and water will be needed to produce, process and distribute food. Agriculture already accounts for 71 percent of water withdrawals globally [10]. Not only will the increased number of people require increased food production, but with the growth of the middle class, diets are changing as well. Demand for energy and water intensive foods, such as meat and grains are estimated to increase by as much as 50 percent by 2025, according to the World Economic Forum [10]. Having sufficient energy and freshwater supplies to produce enough food to meet the nutrition needs of a growing population and changing diets will be one of the most complex challenges of our future.

Competition for Shared Resources

In Georgia and Tennessee there is a water debate that dates back to 1802. The border between the two states was mis-marked by surveyors, placing it approximately a mile south of the 35th parallel. Due to this mistake, Georgia does not have access to the Tennessee River. This dispute has resulted in decades of debate over the true rights to the river and has not been settled [11].

In the West, there are disputes over the Colorado River, which used to flow from the Rocky Mountains to the Gulf of California. In the 1922 Colorado River Compact seven states divided up the River's water, leaving Mexico with 10 percent of its flow. Now that the river has been diverted to provide water to large cities such as Los Angeles, Phoenix and Las Vegas, the river no longer reaches the Gulf. The River dries up in Mexico, where it was once relied upon for farmland and fishing. To date, Mexican and American authorities are working to restore the Colorado River's flow through Mexico [12].

Lack of common national strategy

While individual states are often able to address local challenges, the lack of a national strategy makes it challenging to systemically address the energy-water nexus nationwide. In February 2006, the national laboratories submitted a report to Congress outlining the scope of the energy-water nexus, calling on the federal government to develop a long-term, integrated resource planning policy.

Within this report, the authors enumerated areas of opportunity for the federal government, beginning with research to understand the nation's surface and groundwater resources, which at the time of the report, had not been quantified. They also called on the federal government to make the types of investments necessary to secure a safe supply of drinking water over the long-term, an approach that falls outside the ability of any one company or utility to achieve. "Ensuring our water and energy supply will require multidisciplinary scientific and technical expertise, and involve long-term, high-risk investment with very little profit incentive in the short term," the report's authors wrote [13].

Potential Impacts on the Business Community

"A disruption in either energy or water supply could pose a serious risk to business continuity."

As outlined above, a disruption in either energy or water supply could pose a serious risk to business continuity. In this section, we look at the variety of ways this could play itself out in the context of resource scarcity.

Interruptions in Energy Supply

The climbing demand for water and energy creates challenges for households, government and business alike. Not only are water and energy resources shared at the state and local level, but also between states. Low water levels directly affect energy supplies. On the Missouri River, for example, when the river level is low, more energy is required to pump the water from the river, which reduces production efficiency, and even threatens to shut down power plants [2]. Similarly, although it is one of the largest electrical power plants in the Southwest, the Hoover Dam is in threat of being shut down, if Lake Mead drops below 1,050 feet. At that point, air bubbles would flow through the turbines, greatly reducing efficiency and the needed water to power the generators. If this were to happen, Southwest energy markets would be destabilized [14].

Outside of the U.S., lack of rainfall in Venezuela led to power interruption and drought in Brazil resulted in eight months of power rationing. Across Europe coal and nuclear power will decrease due to water need for cooling towers. In Africa drought has limited hydropower capacity, water scarcity has threatened uranium mining and South Africa has shifted all new power plants to dry cooling [9].

Factors that affect energy use of water resources

(Source: Congressional Research Service, 2014)

Potential Impacts on the Business Community

"Once water becomes scarce, any new supplies of water are expected to cost more."

Cost

While water is relatively inexpensive now, the Department of Energy's 2006 report to Congress predicted that even current shortfalls justify a new look at the cost: "Given current constraints, many areas of the country [United States] will have to meet their energy and water needs by properly valuing each resource, rather than following the current U.S. path of largely managing water and energy separately while making small improvements in freshwater supply and small changes in energy and water-use efficiency" [2].

And since the vulnerability of the water supply is linked to energy production, once water becomes scarce, any new supplies of water are expected to cost more, too, according to Kelly Sanders, Assistant Professor at the University of Southern California. "We're getting to the point with population growth and water stress from the changing climate that we've tapped our convenient sources of water, so we are switching to marginal water resources that are more energy intensive," she said [15].

This is likely to hold true in developing nations as well, where the cost of doing business may change the bottom line benefits for companies with a global supply chain.

Permitting

Natural resources are shared among businesses, communities, the agricultural sector and other stakeholders, whose needs are considered in the permitting process. In regions where water is managed by permits -- such as in the water-scarce West -- rights are assigned based on seniority and need, with agriculture and local community users being the first to receive water rights, according to Sanders. In areas like California and Texas, where water reservoirs are over-allocated, any new business users must purchase water rights from existing owners at a steep price. Since energy generation requires access to water, any limitation on water naturally creates a limitation on energy. "You're seeing in places like Arizona and Nevada that a lot of development is being stalled because residential developers and power generators can't pin down the water rights to move forward," Sanders said. "That's going to be constraining for a lot of large operations moving forward" [15].

Potential Impacts on the Business Community

"When deciding to locate facilities and employees, companies will consider if those areas can support growth." – Jolecia Marigny, AstraZeneca

Siting

Constraints on water and energy will likewise influence the sites of future development, said Jolecia Marigny, the Global Safety, Health and Environment Business Partner for AstraZeneca. "When deciding to locate facilities and employees, companies will consider if those areas can support growth. This is especially true if the business is water-intensive," she said. "It's certainly more desirable to site a facility geographically where water is easily available to everyone - commercial, agricultural and residential users – versus in a region where greater competition exists for an adequate low-cost supply" [16].

Some businesses, for example, have chosen to avoid Texas because of water availability problems, according to Sanders. The question of water availability is also affecting cost-of-doing-business calculations for those operating in states such as Arizona and Florida, she said. "Even though a lot of these states are very business friendly, if water becomes more expensive or it's not available at all, that's going to be a lot more concerning than the other regulations that might be imposed," she said [15].

Policy

At both the state and federal levels, policymakers are increasingly recognizing the importance of the energy-water nexus, with legislation aimed at promoting a holistic view of energy and water, Sanders said. "The Department of Energy has really taken an interest in the issues from both sides," she said. "You can look at this as a very constraining relationship but you can also look at it as: if you make good decisions you can achieve synergies" [15]. In its report to Congress, the Department of Energy recommended that the U.S. Congress take a systems-based approach to natural resource policies and regulations:

> "Often, policies or regulations developed to support or enhance one area, such as increasing domestic energy supplies through enhanced oil recovery, could have unintended negative impacts on regional or national freshwater availability or water quality. System-level evaluations by stakeholders and government agencies can be used to assess the impact of current or proposed natural resource policies and regulations and improve future energy development and water availability" [2].

In addition to federal agencies, states such as California and Florida are studying the issue as well. Sea level rise is a concern in coastal areas for many reasons, including contamination of freshwater resources [15].

In the future, drought that affects key transportation waterways, like the Mississippi River, could also become important to policymakers, according to Sanders. "Because of the drought we haven't been able to get the barges as far down the river as we used to, or we've had to expend a lot of energy to dredge," she said. "That's a big issue in terms of supply chains. If our goods can't move, it stalls the economy" [15].

Some corporate strategies for reducing water purchases, such as rainwater capture, may be limited by local regulations [17]. Some states allow rain barrels, cisterns, green roofs and other techniques to capture rainwater; others require such equipment for new developments and some, such as Colorado, limit harvesting to a specific group of users [18]. Companies operating around the world face a complex web of regulations and policy to understand and integrate into their business strategies [8]. As energy and water both grow more constrained, Sanders said new regulations will likely emerge to address the rights and management questions.

Potential Impacts on the Business Community

"Many of the key nations in the developing world are among the most resource-stressed areas on earth."

Supply chain disruptions

Because water is such a local issue, each scarcity issue will be framed by the source, policies and competition of that specific area. Those with a global footprint, however, can expect water scarcity scenarios to create disruptions in the supply chain.
One of the first supply chain challenges will be supplying the needed resources to meet the demand for energy and water. According to Mike Hightower of Sandia National Laboratories, 40 percent of the water withdrawals among the developed countries of the world are used for energy and manufacturing. In the developing world it is 8 percent. "If the developing countries want to become more developed," he said, "[they] will have to increase water supplies by a factor of four" [19].

The increased competition for these resources will likely place pressures on supply chains as well. Many of the key nations in the developing world are already among the most resource-stressed areas on earth, according to the World Resources Institute's (WRI) water risk assessment tool. Per the WRI analysis, most parts of China face between medium to extreme high risks of water shortages, while most of Mexico and India are in either the high or extremely high risk categories [20].

According to the World Economic Forum, the scramble for resources could trigger a retreat from globalization, as the risks of off-shored manufacturing begin to multiply. "The roles of international organizations may be thrown into question," the report's authors write. "Global companies, too, may face a baffling new landscape where the rules have significantly changed---or where there are no rules at all." The reorganization of the supply chains, therefore, could likewise disrupt business continuity in a variety of ways [10].

But perhaps the most disruptive aspect to resource competition is the threat of outright conflict, as the U.S. Department of Defense recently described in its 2014 Quadrennial Defense Review. In this report, the authors described a future in which climate change "may exacerbate water scarcity and lead to sharp increases in food costs. The pressures caused by climate change will influence resource competition while placing additional burdens on economies, societies, and governance institutions around the world. These effects are threat multipliers that will aggravate stressors abroad such as poverty, environmental degradation, political instability, and social tensions – conditions that can enable terrorist activity and other forms of violence" [21].

Potential Impacts on the Business Community

"The investment community has started to recognize the risks that resource scarcity will introduce."

Investor Interest

The investment community has started to recognize the risks that resource scarcity will introduce. Since 2010, the Dow Jones Sustainability has included water in its assessment criteria "to assess whether companies are able to measure their exposure to water-related risks and whether they have appropriate risk management systems in place to mitigate risks around quantity/quality of water, regulatory changes or stakeholder conflicts" [22]. And CDP (formerly the Carbon Disclosure Project), recently launched the CDP Water Disclosure to help institutional investors better understand the business risks and opportunities associated with water scarcity. In its press release to announce the new initiative, the organization quoted Marc Fox, Vice President of GS SUSTAIN Research at Goldman, Sachs & Co, as saying that "water issues are increasingly impacting companies' ability to uphold competitive advantage in many global industries. GS SUSTAIN Research currently incorporates water efficiency within its methodology and views increased disclosure of performance to be a critical step in assessing the effectiveness of companies' responses to the water challenges they face" [23]. Water is also among the core issues for Ceres, a leading stakeholder in reputational rakings.

What Companies Can do to Prepare

"If your water service is interrupted for one hour, or eight hours or a day, what is your risk exposure and what can you do to mitigate it?" – Todd Swingle, Cummins Inc.

In such a complex area as the energy-water nexus, solutions vary dramatically depending on the industry sector, geographic location and other circumstances of a company and business unit. Companies such as AstraZeneca, Cummins Inc. and Lockheed Martin are among those NAEM members who are taking a holistic approach to addressing this question. In this section, we share some of the solutions these companies have employed and describe additional strategies for adaptation.

Understand the Risk Profile

When assessing potential risk related to water and energy, NAEM members said they often begin by defining the scope of the problem.

At engine manufacturer Cummins, Todd Swingle, Director of Environmental Strategy said he likes to describe the risk in terms of its potential interruptions to the operations. "If I have a process that uses 50,000 gallons a day and reduce consumption by 10 percent, does that change my risk profile?" he said. "Not much. If I have unreliable supply and I'm not going to get water for a day, whether I use 50,000 or 40,000 or five gallons, I still don't have water, and I have to figure out how to maintain reliable production. That's the challenge is to get people to think about what is your risk exposure? If your water service is interrupted for one hour or eight hours or a day, what is your risk exposure and what can you do to mitigate it?" [24]

New tools are now available to help companies understand energy and water risks. The World Resource Institute's Aqueduct™ tool, for example, maps water risks and stress by country and river basin. The World Business Council for Sustainable Development's Global Water Tool© lets organizations see data on water availability, pollution, sanitation, precipitation, population and biodiversity for the areas where their facilities and suppliers are located [20] [25]. Sustainable Organizations' Corporate Water Gauge™ analyzes water use within the context of local watersheds and supplies [26]. It's important to find the current hot spots and establish programs that can survive over the long-term, according to Nick Martin, Sustainability Practice Lead with Antea Group.

What Companies Can do to Prepare

"Improving the efficiency of heating and cooling systems, installing higher resolution water meters or smart energy meters can also yield huge reductions (and cost savings) over the long-term."

Conserve Resources

Perhaps the most obvious solutions to the threat of water scarcity is to begin to conserve resources today. Improving the efficiency of heating and cooling systems, installing higher resolution water meters or smart energy meters can also yield huge reductions (and cost savings) over the long-term. While it might cost a few dollars per thousand gallons to buy water from the municipal utility, the cost of chemicals to treat the water, move it around a facility, heat or cool it, and dispose of it after use multiplies that cost by four or five times the purchase price. For energy-intense activities, that cost may be eight or ten times the purchase price. A conservation project that reduces water use by 100,000 gallons a year, therefore, will lead to a cascade of cost savings across the facility with a much greater cumulative impact [27].

Some utilities are reducing their water use by using less water-intensive cooling towers. This reduces their reliance their on a water source, therefore mitigating water scarcity risks. Some of these practices include dry cooling systems and re-use of wastewater from natural gas extraction [19].

Increase awareness of the problem

In far-flung global organizations, it's may be impossible for a single person or even a team of environmental managers to identify all the possible projects that would improve water or energy efficiency. That's why companies are building awareness of the water-energy nexus across the company so that the facilities managers who make project decisions every day can spot opportunities themselves and know when and how to tap environmental expertise. At Cummins, Swingle treats the water audits he conducts each year as consultation visits. He spends a day teaching employees how to do water balances, understand their risks and mine for efficiency opportunities. A proprietary Excel-based model further helps him quickly assess a plant's relative risk ranking when it comes to a variety of water risk factors [24].

"Unless you're a company that can pass every project through a limited set of experts, you're going to miss a significant number of opportunities," Swingle said. "[Employees] want to do a good job and they want to save resources. There's no lack of desire or will; it's how do you make it easy for people to identify opportunities and execute on them?" [24]

What Companies Can do to Prepare

"Lockheed Martin uses an energy procurement strategy that includes some advanced purchase."

Store and Reuse Water

While rainwater capture and storage is a popular concept among small organic gardeners, it's also something that can be applied in a manufacturing context as well, experts say. At pharmaceutical and biologics company AstraZeneca, the company uses an 80,000 gallon water collection tank to supplement its cooling tower. The grey water tank collects water from roof drains and water treatment reject, with the main source being the company's Water for Injection system. On average, the system produces 7,500 gallons per day and is able to supply all the cooling tower demand in the winter months [16]. Even in the summer, when more cooling is needed, the grey water tank reduces AstraZeneca's municipal water purchases. "We always want to be able to use grey water when its feasible," says Marigny. "It's one of the most beneficial ways I've seen companies pursue sustainable practices" [16].

Plan Ahead

Even when water and energy are available and businesses can gain rights to those natural resources, price swings may present another potential risk. To hedge against the occasional, dramatic price volatility, Lockheed Martin uses an energy procurement strategy that includes some advanced purchase of energy, falling short of 100 percent of the need, said Hal Ehrhardt, Senior Manager of Lockheed Martin's Energy and Environmental programs. "Then you can manage your demand when you get one of those unusual events that drives the index high," Ehrhardt said. And because of the costs to transport, heat and treat water, energy costs directly connect to water costs [17].

What Companies Can do to Prepare

"The lack of integrated energy and water planning and management has already impacted energy production in many basins and regions across the country." – U.S. Department of Energy

Collaborate

As the World Economic Forum Water Initiative called for in the 2011 "Water Security: The Water-Food Energy-Climate Nexus" report, it is imperative for government, businesses, institutions and society to collaborate to address crisis issues, such as future water supply [10]. The DOE's recommendations to Congress also included collaboration among federal, regional and state agencies, as well as with industry and other stakeholders:

> "In most regions, energy planning and water planning are done separately. The lack of integrated energy and water planning and management has already impacted energy product in many basins and regions across the country…Mechanisms such as regional natural resources planning groups, are needed to foster collaboration between stakeholders and regional and state water and energy planning, management and regulatory groups and agencies. These collaborative efforts are needed to ensure proper evaluation and evaluation of water resources for all needs, including energy development and generation" [2].

Through a collaborative effort, the largest U.S. nuclear energy facility, the Palo Verde Nuclear Generating Station in California reclaims wastewater from nearby municipal systems for its condenser cooling needs. Palo Verde uses well water for reactor coolant and steam. As a result, 4 million people receive power in a desert environment, with no risk of waterway contamination [28].

Sanders also sees an opportunity for business to partner with the agriculture sector, given the access farmers typically have to water. One option she envisions is for companies to give farmers access to water-saving technology in exchange for some of their water rights. Some food companies, such as Nestle and General Mills, are already leading the way in this area, working with farmers to irrigate more efficiently and even looking at projects to recharge the groundwater [29]. This mutually beneficial effort helps farmers use less water, while also reducing water risk for the companies.

It's also important to win allies within a company for an integrated energy-water management strategy, NAEM members say. AstraZeneca's Marigny gains an understanding of each site's circumstances and perspectives, listens to their suggestions and reports back on how she's using their input [16]. Lockheed Martin allows different facilities compete for funding environmentally oriented infrastructure projects, so they're not jockeying for capital with new manufacturing or development programs. That "gated capital" process has led to a biomass boiler system, HVAC upgrades and other innovations [17].

What Companies Can do to Prepare

"Often times, programs that save energy also wind up saving water, too."

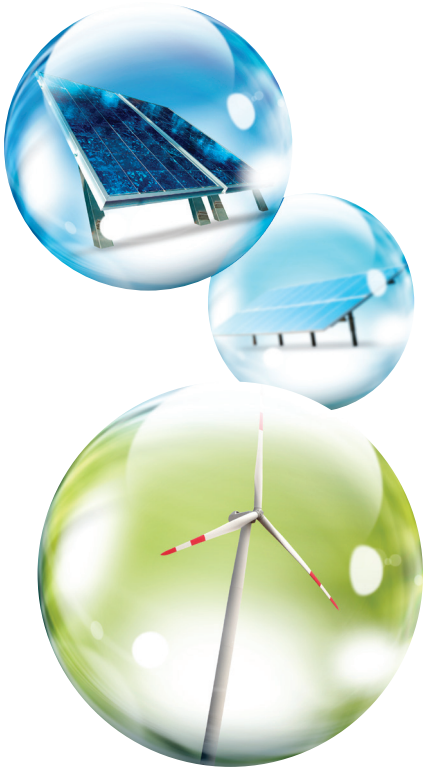
Take a systems approach

Often times, programs that save energy also wind up saving water, too. "An awful lot of our energy projects have great water savings, and a lot of our water projects have great energy savings," Swingle said. "It's been a nice linkage. In most of the cases we're dealing with we're seeing that correlation occur where improvements in one help the other" [24].

The U.S. Army, for example, set a long-term goal to reduce waste, net energy used and net water used to zero across U.S. installations. The Army aims to use a combination of waste energy from building and boiler stack exhausts, and renewable energy, water harvesting, grey water, repurposing waste and other strategies to achieve complete self-sufficiency [30].

Switch to Renewable Sources

According to the Department of Energy, certain renewable energy technologies consume no freshwater during operation, making them an option for those companies that have on-site power generation. These sources include: wind solar photovoltaics, solar dish-engine, geothermal, hydroelectric and ocean energy systems [2].



Lockheed Martin, for example, aims to harness the power of the oceans to generate energy. In development: a 62.5 megawatt peak power wave energy generation project off the coast of Victoria, Australia; a 10 megawatt ocean thermal energy conversion pilot project off the coast of southern China; and a partnership with Atlantis Resources Ltd. to optimize the design of a 1.5 megawatt tidal turbine that will be used in the MeyGen tidal stream project in Scotland's Pentland Firth and Canada's Bay of Fundy [31] [32] [33]. Not only do these projects break ground in developing renewable technology, they helped develop a new line of business from Lockheed Martin, at a time when traditional aerospace projects are stable to shrinking [17].

Innovate

And finally, new technologies and process innovations also present opportunities for business to achieve resource reductions. Cummins, for example, must routinely load engines and test their functionality, a process that creates waste heat or energy. Instead of loading engines with a resistance device that must then be cooled, (often with water) the company uses regenerative dynamometer that makes it possible to generate energy as an output. "Not only are we reducing our energy demand, we are reducing our water to cool the system," Swingle said [24].

Additional Resources

For more information about this issue, please visit:

- National Conference of State Legislatures: http://www.ncsl.org/research/environment-andnatural-resources/overviewofthewaterenergynexusintheus.aspx
- Sandia National Laboratories: The Energy-Water Nexus: Completing the Energy Sustainability Puzzle, http://www.sandia.gov/energy-water/docs/NEXUS_v4.pdf
- United States Department of Energy: Energy Demands on Water Resources: Report to Congress on the Interdependency of Energy and Water (2006), http://www.sandia.gov/energy-water/docs/121-RptToCongress-EWwEIAcomments-FINAL.pdf
- United Nations: Water for Life, http://www.un.org/waterforlifedecade/scarcity.shtml
- Webber Energy Group at the University of Texas at Austin: http://www.webberenergygroup.com/
- World Economic Forum. (2011). Water Security: The Water-Food-Energy-Climate Nexus, http://www.gwp.org/Global/ToolBox/References/Water%20Security_The%20Water-Food-Energy-Climate%20Nexus%20(WEF,%202011).pdf
- World Business Council for Sustainable Development: Global Water Tool, http://www.wbcsd.org/work-program/sector-projects/water/global-water-tool.aspx.
- World Resources Institute: Aqueduct Initiative, http://www.wri.org/our-work/project/aqueduct

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