U.S. CHAMBER OF COMMERCE FOUNDATION
Corporate Citizenship Center

THE ENERGY-WATER-FOOD NEXUS

INSIGHTS FOR THE BUSINESS COMMUNITY

THE ENERGY-WATER-FOOD NEXUS: INSIGHTS FOR THE BUSINESS COMMUNITY

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EXECUTIVE SUMMARY

In 2014, the U.S. Chamber of Commerce Foundation (USCCF) conducted research to better understand the interdependencies between three important natural resources: energy, water, and food (henceforth, E-W-F).

The goal of the research was to gather the current state of knowledge on a complex topic: the E-W-F "nexus." The nexus refers to the web of interactions that link E-W-F resources in a common system–growing food requires water, processing water requires electricity, electricity generation requires water, and so forth.

The research sought to find out what the private sector needed to know about the nexus to inform business strategies and to make operations resilient to energy, water and food shortages. The research found that systematically addressing resiliency to nexus challenges requires the following steps:

1. **UNDERSTANDING** the interconnected nature of the nexus.
2. **SURVEYING and DATA COLLECTING** to understand the resources a company depends upon.
3. **ASSESSING RISKS and OPPORTUNITIES** to see how a corporation's consumption of resources can impact business operations.
4. **IMPLEMENTING** technologies and programs to mitigate risks.
5. **COLLABORATING** with stakeholders to address shared risks.
6. **LEADING** the charge to address nexus challenges through engaging the business community.

The Energy-Water-Food Nexus: Insights for the Business Community summarizes the best guidance found in the literature for completing the steps listed above. The research also produced several overall findings:

- There are many ways that businesses can better understand their role in the nexus and become engaged in solving nexus challenges. This includes better understanding their connection to regional sources of E-W-F, better assessment of the resource risks to their business operations, and better engagement in nexus discussions and initiatives.
- Many nexus experts do not engage with the business community. Bridging the divide between corporate sustainability professionals and nexus experts allows businesses to provide new solutions to E-W-F challenges, and can help them mitigate risks to their operations.
- There are gaps in the nexus literature reviewed by this research. Some connections between E-W-F are well explored, while others receive little attention. Also, there many calls for better coordination of E-W-F resources, but less is offered for how organizations will convene to discuss better coordination.

Increasing globalization means that businesses face more constraints on resources, and that successful businesses will need to manage their resources more effectively. Based on the findings of this report, corporate engagement is critical because business operations are at stake. The private sector is in a unique position to innovate solutions to nexus challenges that only businesses can provide.

THE ENERGY-WATER-FOOD NEXUS: INSIGHTS FOR THE BUSINESS COMMUNITY

In 2013, the U.S. Chamber of Commerce Foundation (USCCF) held a meeting for leading companies interested in better managing their energy and water use. The companies said that their most pressing challenge was to create business operations that are resilient to energy, water, and food shortages. In particular, they were interested in understanding how energy, water, and food (E-W-F) interact in one system—the so-called E-W-F nexus. Through its Corporate Citizenship Center (CCC), USCCF produced *The Energy-Water-Food Nexus: Insights for the Business Community* to address some of their questions.

This report examines the current state of knowledge about the E-W-F nexus. Through a comprehensive search of the literature (vetted by industry, government,

and academic experts in the field), USCCF outlined the business challenges inherent in the E-W-F nexus, as well as the best ways for companies to assess their particular vulnerabilities to those challenges. The different sections of this report walk through the steps a business should take to

- understand the E-W-F nexus,
- discover connections to the nexus,
- assess the risks inherent in these connections,
- move forward with addressing these risks.

Each section provides insights gleaned from experts on the E-W-F nexus for how to best approach a particular step in the process.

Methods

Much discussion has taken place about the E-W-F nexus by different stakeholders; yet there is little documentation outlining how the business community should begin to address it. This research sets out to correct this gap.

To provide the business community with guidance required studying white papers and reports produced by domestic and international nonprofits, government agencies, businesses, and academic professionals. The literature search focused on recent documents (published within the past five years) to obtain up-to-date ideas. In addition, the search focused on documents where at least two of the three resource relationships were mentioned (e.g., energy and water, water and food, energy and food).

A group of experts in the field from academia, government, and business verified that the document list was comprehensive of nexus discussions.[1] The experts also suggested any documents they felt should be considered in a comprehensive literature review.

Besides the analyzed documents, the research also drew upon presentations and materials from *UNC Chapel Hill Energy-Water-Food-Climate Nexus Conference 2014*, which occurred March 5-8, 2014. These conference materials were used to help bolster information from the sources or offer greater context where appropriate.

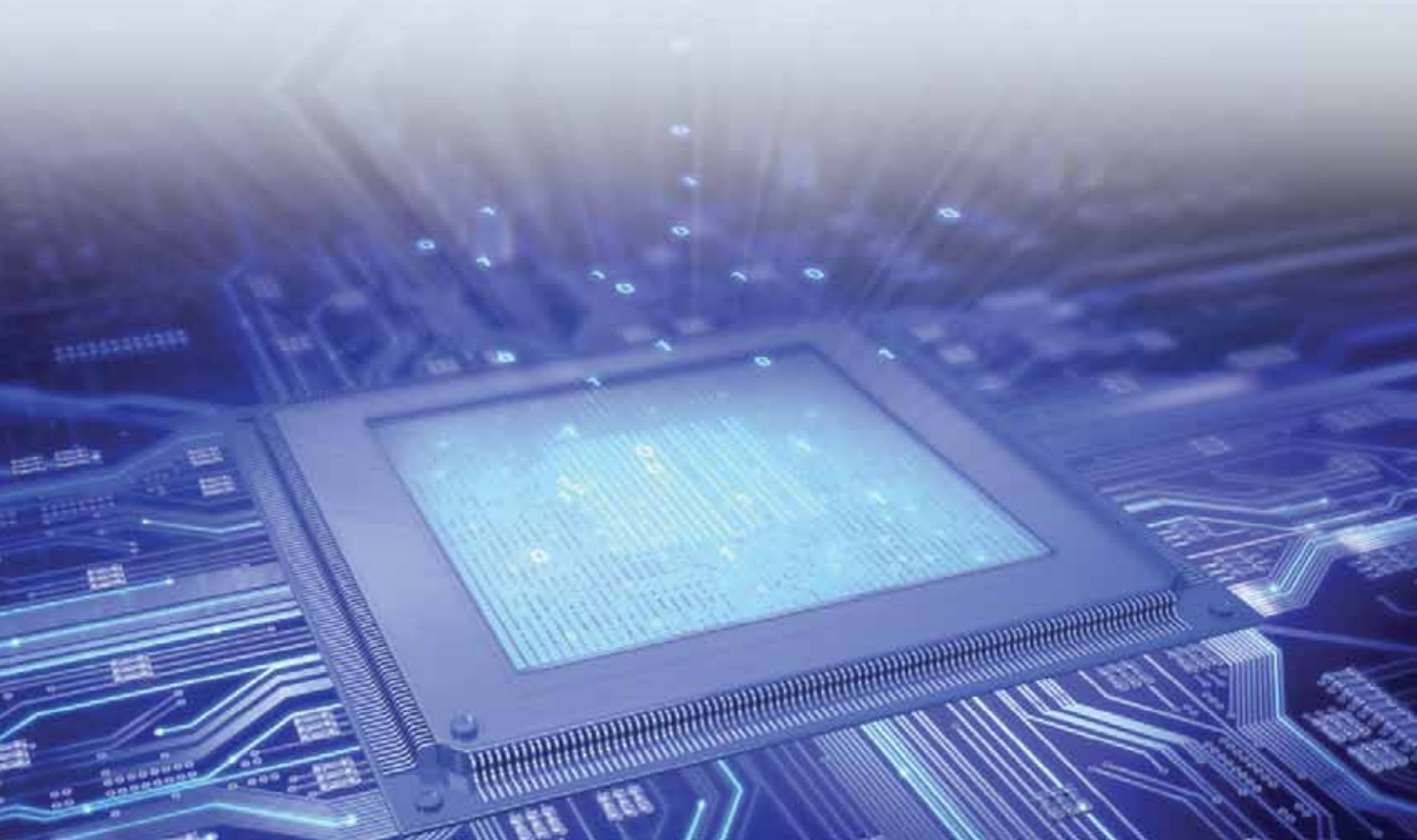
During the analysis, the documents were examined to summarize their arguments, recommendations, data sources, the parts of the E-W-F nexus they addressed, intended audience, and regional focus. That analysis lent itself to the six points that frame this research: Understanding, Surveying and Data Collecting, Assessing Risks and Opportunities, Implementing, Collaborating, and Leading.

UNDERSTANDING

Energy, water, and food (E-W-F) are connected to the inputs and outputs of every business. In the manufacturing sector, energy and water are used to power, cool, and clean machines, mix materials, and in production processes. Many of the raw materials that manufacturers transform into products come from plants and animals. E-W-F resources are also critical for other sectors. Data centers need power and water to run. Accountants, consultants, and financiers require power, water, and food to do their jobs, and companies with an investment in global markets will face instability if there are shortages of natural resources around the world.

Starting in the 1970s, environmental experts identified the growing need for examining E-W-F in a concerted fashion.[2] For example, if water is not available where it is needed, companies must use energy to transport it. Hence, the cost of water is much higher than its nominal cost out of a faucet; it also includes the cost of power needed to move it from that outlet to where it is desired.

Since the 1970s, it became apparent that energy, water, and food are connected to whole systems of production.[3] The food system is not just the final agricultural products, but everything it takes to produce and sell them. It includes harvesting, raising livestock, processing agricultural products, and preparing food for sale. The energy system is composed of everything that goes into power generation, including creating electricity through turbines powered by water or steam, growing foodstuffs for biofuels, producing and refining fossil fuels, and distributing energy to consumers. The water system extracts freshwater, treats wastewater, supplies cooling in energy systems, and irrigates crops.



In a sense, there is energy embedded in each drop of water, there is water embedded in each joule of energy, and there is water embedded in each calorie of food.

The E-W-F systems are all connected, and the connections between the systems have come to be known as the E-W-F nexus. The idea behind the nexus is that each resource is connected to the others, because each requires some amount of the others to be produced. In a sense, there is energy embedded in each drop of water, there is water embedded in each joule of energy, and there is water embedded in each calorie of food. The nexus concept highlights how important it is to cohesively examine the production of E-W-F. In fact, as globalization and productive capacities grow, crises have shown the real need to examine the linkages between the systems.

The following sections will establish the basics of what is known about each resource and the relationship of that resource to the others in the nexus.

Food

In a sense, food is a type of energy—the calories required to fuel the bodies of animals. Its additional role as mechanical energy becomes clearer every day, as more and more food products are distilled into biofuels to operate machinery. The needs of 7 billion people, 22 billion livestock animals, and biofuel engines around the world require a significant amount of food.[6] While the world's farmers produce enough to feed every person in the world more than 2,700 calories daily, inequality between regions' ability to produce food means that temporary shortfalls will likely grow.

By most measures, food production will have to increase by about 70% by 2050 to keep up with demand.[7] The pressures on food production come through two growing trends. The first is the increase in caloric consumption by individuals around the world. More individuals mean more calories, and there are projected to be around 9 billion people by 2050. Furthermore, as people in developing countries gain the resources required to adopt a more western-style diet, their average caloric consumption rises. In 1961, the average person consumed 2,250 calories per day; by 2007 it was 2,750, and by 2050 it is projected to be 3,070.[8]

The second trend is the increase in the use of foodstuffs to produce biofuel. The world's production of biofuel in 2007 was 1.1 million barrels a day. In 2011, the world produced 1.9 million barrels a day.[9] While production processes gain efficiency through time, the growth of biofuels may put considerable pressure on the food and land supply. Any agricultural product converted to biofuel cannot be used for food, sparking debates over whether fuel or food should be prioritized.

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Energy

Energy refers to the generation and use of fuels used to power machines. The energy system includes electricity producers, oil and natural gas refineries, sellers of gasoline for vehicles, and any other business that extracts, refines, or distributes fuel or electricity.

A growing population is creating more energy demands around the globe. In 1949, the United States consumed about 32 quadrillion (a million billion) British thermal units (btu—this amount is equivalent to about 9.4 trillion kWh) of energy. By 2007, that number had tripled to 101 quadrillion btu.[10]

Starting around 2000, increased conservation efforts, better building design, and more efficient production methods meant that

NEXUS IN ACTION: THE 2011 TEXAS DROUGHT

In 2011, Texas experienced the hottest and driest summer on record, and precipitation was lower than previous records set in 1956. Temperatures were above 100°F for 40 consecutive days, causing drought and straining Texas' energy and water resources. With strain on several systems (water and energy), the interactions between E-W-F began to surface. The drought reduced crop yields and affected livestock, costing Texas farmers and ranchers more than $5 billion. Electricity demands reached all-time highs due to the excessive heat. At the same time, water shortages threatened more than 3,000 megawatts of generating capacity because electric plants could not cool their equipment or run their turbines. Electricity costs hit $3,000 a megawatt hour. For comparison, the highest cost that New England has ever experienced is $230 a megawatt hour.[4] In addition, more than 16% of electricity production depended on water sources with historically low levels.[5] The 2011 drought in Texas is emblematic of how E-W-F resources are connected and the risks that can occur when multiple systems are strained at the same time.

increases in energy consumption halted in the United States. A large part of this trend is due to the manufacturing sector. In the past 10 years, while production in the manufacturing sector decreased by 3%, energy use decreased nearly 17%.[11]

Around the world, though, a downward trend is generally not observed. Rapid increases in population, the movement of energy-intensive production processes to developing countries, and a growing demand for western-style living has resulted in rapid increases in energy consumption globally. In 2010, when the United States consumed 98 quadrillion btu, the entire world consumed 524 quadrillion btu. By 2040, that global number is expected to increase to 820 quadrillion btu, with little change expected in the United States or other Organisation for Economic Co-operation and Development (OECD) countries.[12]

While much of that increase in energy demand comes from residential and production needs, a significant portion of it will come from agricultural and water needs. Energy plays a key role in preparing water for consumption. According to the River Network, in 2009 more than 521 million MWh of electricity per year was used to move and treat water in the United States, with another 304 million MWh a year to heat it.[13]

The use of energy for food is one of the least fleshed out linkages in the literature reviewed for this report. This connection did not appear in any of the literature considered in this research. While there are measurements that show how much energy it takes to get food to the consumer, this energy comes in many different forms that are difficult to compare. For example, the human energy to secure food, the energy required to irrigate fields, and the transportation costs to get it to market. This gap demonstrates that many linkages in the E-W-F nexus still need to be explored.

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Water

Water is a natural substance that plays a critical role in many manmade and natural processes. The water system encompasses all organizations that distribute freshwater and treat wastewater. Although water covers 70% of the earth's surface, only about 2% of the world's water is freshwater, and about two-thirds of freshwater is in the form of glaciers and icebergs.[14] That leaves in lakes, rivers, and accessible aquifers an amount of freshwater in the world that would fit in a sphere roughly 35 miles in diameter.[15] While that amount has been sufficient throughout human history, industrial and population growth over the past 200 years has made freshwater reserves vulnerable.

While a growing population has increased the number of people who need water, the bigger problem is that more of them live in places where fresh water is difficult to find. Places like the American West, Australia, Mexico, the Middle East, Africa, and much of Asia have stressed water reserves. The OECD forecasts that by 2050, 40% of the world's population will live in a stressed water basin.[16] Combined with current groundwater depletion, that will result in hundreds of millions of people in cities and rural areas without consistent access to water around the globe.[17]

Manufacturing processes are also a major part of water usage. While demand for water around the world is expected to increase 55% between 2000 and 2050, the increase in manufacturing demand for water during the same period is expected to be 400%.[18] That number ignores the fact that a lot of manufacturing growth during that period

The OECD forecasts that by 2050, 40% of the world's population will live in a stressed water basin.

will come from those same locations where finding freshwater is already difficult. Many companies realize this. Ninety percent of the S&P Global 100 Index companies across all industry sectors identify extreme weather and water scarcity as current or future risks to their business.[19] However, only 42% of the executive boards of the Global 500 companies surveyed in a CDP survey were engaged on water issues externally.[20]

According to the United Nations, 90% of global electricity generation requires water, either to turn turbines or cool systems, which makes water indispensable to the energy production process. In 2005 alone, the United States withdrew 143 billion gallons of water per day for thermoelectric power production. Four billion of these gallons were consumed (i.e., they do not return to a natural watershed).[21] The situation in Europe is similar. The U.N. forecasts that a lack of available water in Europe will decrease its coal and nuclear power generating capacity by 6% to 19% by 2060.[22]

Water is also essential for the cultivation of food. Around the world, about 60% of total crop production is rainfed, but the rest is significantly irrigated to maximize production. The largest consumer of water in most societies is the agricultural sector.[23] While irrigation systems can be improved and made more efficient, such as switching to drip irrigation, these improvements require more energy. Food systems are also vulnerable to extreme water conditions, both droughts and flooding.

Conclusion

Most global population forecasts suggest that the global population will reach 8 billion people in the next 15 years, with many of them securing or demanding a higher standard of living.[24] The Stockholm Environment Institute argues that agricultural production will have to increase by about 70% by 2050, and about 50% more primary energy will need to be available by 2035.[25] These realities will require substantial changes in how people interact with the E-W-F systems.

After years of writing on the relationships between E-W-F, including a recent burst of activity in the last 10 years, experts have firmly established the basic details of the nexus. It is generally agreed that E-W-F issues are all connected and that stresses in any one resource will connect to stresses in the others. It is acknowledged that there are particular variations on E-W-F challenges by region, industry, and technology implemented. The most recent documents generally call for greater integration of E-W-F governance and data collection so that those stresses can be readily identified.

Yet beyond these fundamentals, more information needs to exist. There are many calls for stakeholders to address their E-W-F risks, but little is being done to create the frameworks for doing so. Many advocacy groups complain about the lack of coordination among government agencies, utility companies, the private sector, and consumers. But little has been done to construct the collaborations needed to identify and solve E-W-F challenges. As one commenter aptly put it: "It is time for nexus thinking to make way for nexus action."[26]

The following sections discuss the steps companies can take to better understand their connection to the nexus, the risks they face, and how they can move forward discussions around nexus collaboration and implementing scalable solutions.

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SURVEYING & DATA COLLECTING

How exposed is any company to E-W-F (abbreviation for energy, water, and food) risks? Thought leaders on the E-W-F nexus highlight the difficulties of answering this question. First, each resource is stressed and faces constraints. Second, there are interconnections tying each resource together. Therefore, actions taken to alleviate stress on one resource may have negative consequences on another. Third, exposure to risk comes not just from a corporation's immediate needs but also from the needs of its supply chain. If a company requires material inputs that are at risk, then these risks are lurking just one step away from their direct operations.

Only one solution can help a company understand its E-W-F needs and evaluate its risks—surveying and collecting data on its operations and the operations of its suppliers. This section highlights what is known about gathering data on your operations and assessing your risk to E-W-F challenges.

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Gathering Data Effectively

To a certain extent, the ideal solution for understanding a company's E-W-F risks is simple—begin assessing every place where energy, water, and food are inputs to the business, and then assess every way that

these resources might be constrained or interact with each other. Once these inputs, constraints, and interactions are known, it is straightforward to understand and mitigate these risks.

Obviously, this simplified version of the problem does not do justice to the difficulty of conducting such an assessment. This section provides information from the literature on how to better see a corporation's connections to the E-W-F nexus.

First Steps in Viewing the Nexus

Corporations are not new to measuring E-W-F consumption. More companies are collecting information through tools like the Global Reporting Initiative, the Carbon Disclosure Project, and the Dow Jones Sustainability Index. The use of these methods is rising. According to research from the Governance & Accountability Institute, 20% of Fortune 500 companies created a sustainability report in 2011, whereas 57% of the companies reported in 2012.[27] These methods enable corporations to see their direct (and to a limited extent, indirect) consumption of E-W-F. However, they focus on measurement in isolation, and they do not consider the interlinkages and interdependencies of these resources.

The documents reviewed in this research offer several methods to reveal a corporation's connection to the nexus. For instance, many documents noted life-cycle assessment (LCA). LCA is a method for understanding the environmental footprint of a product from its beginning to its end. Sometimes called "cradle to cradle" analysis, the vision is to understand the total consumption of resources that a product will require and to assess how the product's end stages can be turned into the most useful beginning stages of another product. In an EY/GreenBiz study, 43% of companies employ LCA as a strategy for future financial advantage.[28]

By thinking about the end use of a product, a company can envision how that product will be recycled or otherwise converted into another useful product. This reduces the company's environmental footprint and can sometimes convert waste streams from a cost center to a profit center. More important for assessing risks, LCA reveals how a corporation is dependent on the E-W-F a product needs before it enters a corporation's boundaries, and how much it will likely consume after leaving those boundaries. Knowing this consumption shows a corporation which resources might put their products at risk.

Another practice mentioned often in the documentation was to measure "ecosystem services." Measuring ecosystem services is a method for evaluating the value that various natural ecosystems provide to individual businesses or to the economy as a whole. The concept behind the practice is that natural processes filter and store water, prevent erosion, provide raw materials, and otherwise contribute services that have economic value. Unlike manmade systems, natural systems often create value with little intervention. Significantly, ecosystems can often balance competing E-W-F demands without direct management.

The value of measuring ecosystem services lies in its ability to better see the picture of economic value creation. To prevent excessive rainwater runoff, does it make more sense for a city to build water retention facilities or to plant more trees? Properly evaluating the correct course of action requires knowing the advantages and costs of each system. This also holds for businesses hoping to expand their operations. In 2014, Dow is "validating tools and models that can assign a value to [ecosystem] services in order to support Dow's decision-making when it comes to designing, constructing, and operating its manufacturing sites."[29]

Finally, a third method mentioned in the literature is to conduct scenario analysis. This is basically a recommendation for

companies to map out the consequences of potential situations in which their key inputs are affected by E-W-F shortages. The essence of this approach is summarized by the following quote from an EY/GreenBiz Report:

> The questions for a company are fairly straightforward: Do we have sufficient access to water to achieve the level of output as needed throughout our production system? … Or, more simply: When are we going to run out of water and where?"[30]

The point of scenario planning is not to definitively predict the future, but rather to consider where tipping points might exist that would materially affect business operations. Shell has conducted scenario planning for more than 40 years. In its reports:

> [The scenarios] aim to be thought-provoking yet plausible, highlighting matters already in the foreground and also, crucially, background developments that should be brought to the fore. Used effectively, these alternative outlooks can help organisations address difficult issues that need to be explored collaboratively even though there may be deeply divided opinions about them.[31]

Sharing Data

After collecting data, it can be advantageous for a company to share the results of that data. For instance, after conducting numerous studies, The Coca-Cola Company produced a series of maps that showed where it could encounter vulnerabilities to its water system. After using the maps for its own planning, the company shared the maps with other companies looking to address the same risks.[32] Similarly, the American Council for an Energy-Efficient Economy found that energy and water utilities receive significant benefits when they share data. Not only can they be better informed about the connections between water use and energy production, but they can reach their customers more efficiently by working together.[33]

Sharing results can also win reputational value by demonstrating success stories. Publicly declared sustainability goals enabled Darden Restaurants to promote that it achieved (and exceeded) its commitment to reduce water and energy consumption by 15% by 2015.[34] A 2013 EY/GreenBiz survey found that 62% of the surveyed companies make their environmental and social goals public and report progress against their goals.[35]

Better Integrating the Nexus into E-W-F Measurement

"Meaningful analyses of the [nexus] will require a new class of models, measurements, and observations that are consistent with global climate and socioeconomic constraints, and capable of resolving regional … decision-making and natural processes … [while capturing] the full range of … interactions and feedbacks."[36]
– Department of Energy Report

A corporation's measurement of its E-W-F consumption can only go so far to show where it is at risk. A corporation still needs to survey the consumption of these resources in the regions in which its facilities sit. Without a regional framework, corporations cannot see how their combined consumption is interacting with the resource endowments of a particular region.[37]

To truly embrace the nexus concept, a framework must be created that can evaluate the joint consumption of E-W-F in a region. A notable attempt to do this is outlined by the Department of Energy (DOE) in a comprehensive report on the nexus. Figure 1 on the next page shows the framework envisioned by the DOE. It shows the three-part linkages that exist between E-W-F systems.[38]

Figure 2 shows the linkages between the systems typical for the state of California.[39]

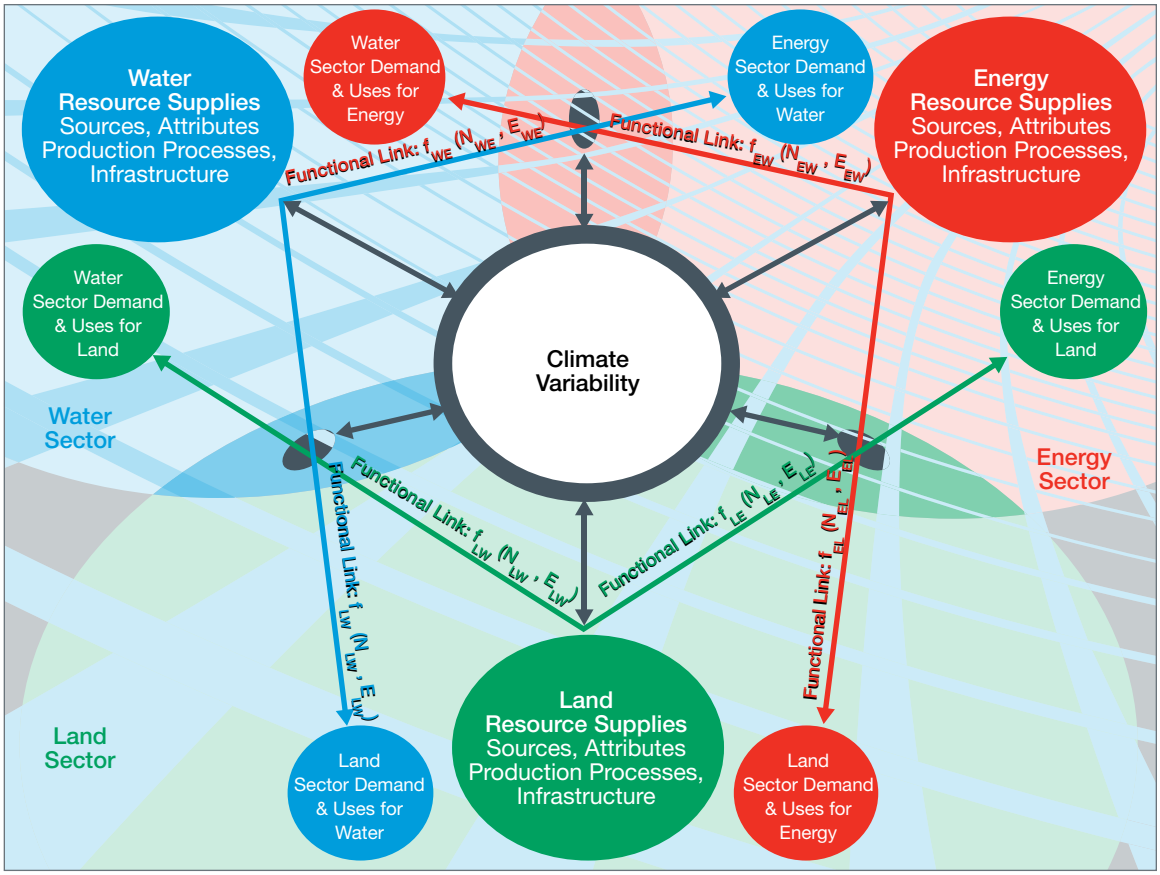
In its report, the DOE also includes diagrams for issues typical to the Gulf States and for the interconnections present during the drought that hit Texas in 2011. What is useful about the DOE framework is its ability to outline the supplies and demands for E-W-F in one complete picture. Another useful element of the framework is its "Demand-Endowment-Technology" scheme. This scheme models three things: demand for resources across each possible resource dyad (e.g., food-water, water-energy, etc.), the endowments that exist in a region for each resource, and the technologies and processes that are drawing down on these resource endowments. In an appendix to the DOE report, the department outlines likely linkages between each dyad. This appendix shows possible impacts businesses could face due to E-W-F shortages.

Conclusion

This section presents some of the best methods available for measuring a company's connection to the E-W-F nexus. It also highlights that measurement frameworks need to evolve to better measure E-W-F interdependencies at the regional level.

The nexus literature reviewed in this research offers a profusion of facts about the amount of water that goes into producing various forms of energy, the amount of energy that goes into producing and cleaning various kinds of water, and the amount of water that goes into producing various kinds of food. These facts stress the importance of connecting measurements of E-W-F together, but they do little to address how one would actually do so. How do we get better data

Figure 1 – Department of Energy framework for a general relationship between resources



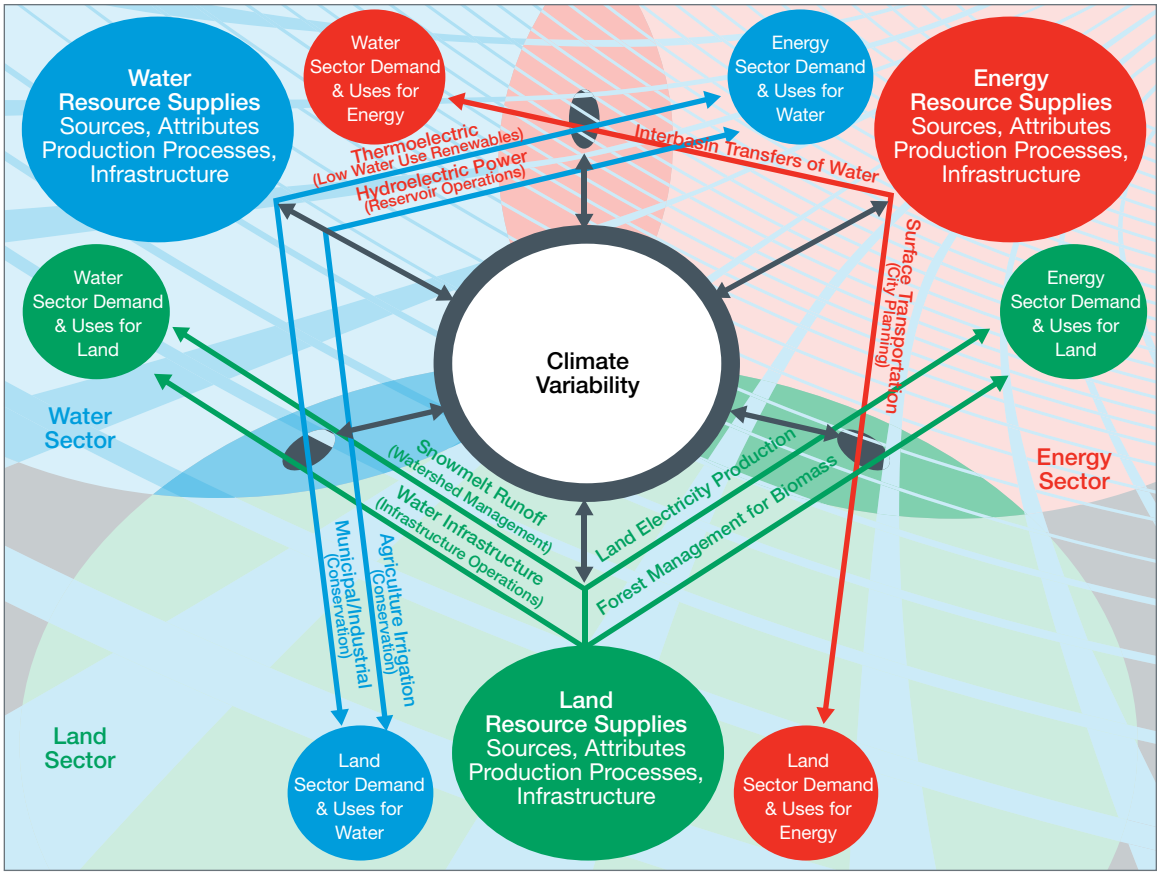
on the E-W-F nexus? It is clear that two developments must happen to understand the flows of E-W-F in the United States.

- Basic data on the production and consumption by region are needed. This includes the amounts of each resource that are being produced, and the average production and consumption of different types of facilities in the region. These basic data are needed to form a baseline picture of how E-W-F resources are being extracted from the environment.
- Better tools are needed for understanding the interrelation of resources. Ideally, one system should be able to estimate how changing consumption of one resource would affect the consumption of the other resources, as well as identify short- and long-term stresses that are likely to occur from different development scenarios.

One possibility for improving data is to measure resources by groupings that make better sense for each resource. This means "accounting for natural boundaries, such as watershed, energy utility or geo-political zones … in existing gridded calculations and observations."[40] This accounting would allow data gatherers to be those with the most connection to, and responsibility for, the resources being observed.

A way for the private sector to contribute to the data collection effort is to engage in conversations about the kinds of information that should be gathered and to streamline data gathering to most effectively meet their

Figure 2 – Department of Energy framework for the specific relationship between resources in California



needs. Another improvement that would benefit corporations is to bridge the divide between the corporate sustainability world and the world of policy experts who deal with the nexus.

The tools used by corporate sustainability professionals generally measure E-W-F usage in silos. They concentrate less on measuring the interdependencies of E-W-F.

For instance, the Global Reporting Initiative (GRI) provides a method for reporting a company's E-W-F consumption. But its method does not direct companies to measure consumption with the nexus in mind. In the energy portion of the GRI, the tool asks for estimates of the indirect energy that is consumed to supply an organization's direct energy needs.[41] However, it does not consider things like the water indirectly consumed to generate the organization's energy needs. More important, it does not encourage a company to identify the sources of its energy and water. Without surveying its sources, a corporation cannot see how its operations are interacting with its local environment.

To a limited extent, sustainability tools are making inroads on indirect consumption. For instance, life-cycle analyses take surveying beyond the immediate consumption of the organization to find the E-W-F embodied in the entire lifetime of a product. A similar approach has been to explore the footprint of suppliers. This is another way that corporations consider the indirect consumption that is beyond their own walls. Still, there is more room to grow. It is not enough to just know the amounts of E-W-F consumed by a company. The E-W-F nexus shows that assessing risk requires thinking about the places from which resources are being sourced, and other organizations that might be drawing from those same sources. It would help if corporations had better frameworks to fully consider the sources of their consumption and the risks they run from shortages at these sources.

ASSESSING RISKS & OPPORTUNITIES

Once a corporation is measuring its energy, water, and food (E-W-F) consumption, the next step is to assess the risks and opportunities connected to this consumption. Inconsistencies in the quantity or quality of E-W-F inputs represent a risk to operations. Reducing these risks can translate into opportunities for gain.

The documents in this study offer information for how to begin assessing risks. Primarily, the information focuses on the need to be pragmatic.

One example highlights the value of starting with qualitative risk assessment. In 2003, Coca-Cola conducted a qualitative assessment of its water risks by regions. The company regarded this assessment as a "key turning point" for recognizing that water quality and quantity were material challenges for their business.[42] It should not be thought that all risk assessments must be quantitative to be of value. Another piece of advice highlights that "it is important to think about which operations or areas of the facility have the most outdated equipment, where the energy use is highest, and how expensive it would be to upgrade."[43] The idea is that companies should identify the "fenceline"—a bounded area where improvement goals are focused and implemented, before they move to goals like surveying external suppliers.

The following risks were commonly listed in the nexus literature reviewed by this study.

- Risk to Inputs of Operation
- Regulatory Risk
- Risk of Unforeseen Trade-Offs
- Reputational Risk
- Risks in the Value Chain
- Disaster Risks

Companies should consider these business risks after they have completed the first step of surveying their E-W-F consumption.

Risk to Inputs of Operation—One of the clearest ways that a company can face risk from the E-W-F nexus is when energy, water, or food is a direct input to their operations and one or more of these resources becomes scarce. Fifty-one percent of CEOs expect their company's core business to be affected by natural resource shortages by 2018.[44] Global 500 companies surveyed by the CDP say that two-thirds of their vulnerabilities to the water supply were already occurring or going to occur in the next five years. If a company relies on energy, water, or food then inconsistencies in quality and quantity constitute a risk to continued operations.

"Increases in the frequency of drought conditions can further depress water viability for production in water-stressed areas. GM has production facilities in Mexico, an area that was hit hard by drought in 2012, and there is a risk that increases could disrupt production due to lack of water availability. Mexico accounts for about 6% of the global production. A one month disruption of GM's production, for example, could result in loss of US$27 Million in net income."[45]

Regulatory Risk—If a segment of the government believes that E-W-F resources are inappropriately consumed by the private sector, a typical response is to generate new regulations to change consumption patterns. The burdens of government regulation are a likely risk for companies in the future.

"New Environmental Protection Agency (EPA) Regulations, which will govern the potential effects of water intake structures on fish populations, could affect as many as 31 power plants owned and operated by American Electric Power (AEP). The EPA is also expected to propose changes to regulations that govern the treatment and discharge of power plant waste waters. The impact of these new regulations could cost as much as US$1 billion for the entire AEP fleet of coal-fired power plants."[46]

Risk of Unforeseen Trade-Offs—The essence of the nexus concept is that E-W-F systems are all interrelated. These interconnections mean that risks lurk in unexpected

places. Actions that will positively reduce consumption of one resource may have overall negative effects on the consumption of other resources. It is important when conducting risk assessments to consider the second-order consequences of any sustainability initiative.

"Suncor Energy recognizes that as you strive toward 100% water recycle or zero liquid discharge, you can potentially increase your carbon footprint (energy requirements) and land footprint (landfilled solid waste). Suncor Energy has developed a tool through the Oil Sands Leadership Initiative to evaluate the net environmental effects of a project or decision to find the balance between land, air and water."[47]

Reputational Risk—To a certain extent, companies are risking their brand value if their consumption stresses the E-W-F nexus. Thus, it benefits companies to consider how their role in the E-W-F nexus might garner negative and positive public sentiment.

"In a highly globalized information economy, public perceptions can emerge rapidly around business decisions that are seen to impact on aquatic ecosystems or local communities' access to clean water."[48]

"Reputational risks could lead to higher costs of capital or decreased share price and loss of social license to operate, leading to business disruption. It could also make it more difficult to get access to land or lengthened permitting processes for new mines or expansions."[49]

Risks in the Value Chain—CDP shows that 23% of Global 500 businesses surveyed were unable to identify whether they are exposed to risks across their supply

chains.[50] If a key supplier experiences a shortage, this can mean a critical shortage in a company's inputs.

"In 2011, Intel requested baseline data and reduction goals from top suppliers for water, energy, and waste and collected responses from 98% of its top Tier 1 suppliers. Intel also requested water and waste metrics and looked for the presence of established goals, placing an emphasis on suppliers located in water-stressed countries. In 2012, 80% of Intel's top Tier 1 suppliers tracked water metrics."[51]

Disaster Risks—E-W-F risks are heightened when a natural or manmade disaster affects a region. The systems for regulating E-W-F in the United States were generally designed to handle spikes and shortages in each resource individually. In normal times, these systems can typically balance competing demands for resources. However, when disasters overrun or compromise these systems, the interplay of ripple effects can grow unabated into vicious cycles. Scenario planning of disasters can reveal vulnerabilities to key E-W-F inputs.

"The likelihood of catastrophic events is not trivial and [because disasters create feedback loops] the exposure to damage (and risk) is virtually unlimited.[52]

Conclusion

"Most critically important resources are not, in a global sense, geo-physically scarce. In other words, there are few signs that humans will 'use up' all minerals, fossil fuels, or water. Rather … scarcities are most often revealed in the [economic, political, environmental, and equity] dimensions, and associated in some way with aspects of governance."[53] – *The Global Resource Nexus*

The full extent of E-W-F risks is unknown. Some treat consumption of E-W-F resources as a disaster beyond repair.[54] Based on statistics about the production and consumption of E-W-F, claiming that resources will be totally gone in the imminent future is an exaggeration. On the contrary, crises like the Texas drought of 2011 and Hurricane Katrina point out that E-W-F systems are linked, and that real and damaging results can occur if the connections between E-W-F are ignored. Between hyperbolic arguments about total resource scarcity, and the total dismissal of any risks lies the truth about a company's risk to E-W-F challenges. Assessing the tangible risks a company faces can take E-W-F concerns out of the realm of rhetoric and into the realm of manageable calculation.

IMPLEMENTING

Once the energy, water, and food (E-W-F) risks a company faces are known, the next goal is to set a plan for mitigating these risks. This section describes advice gleaned for effective implementation of an E-W-F nexus action plan.

According to IBM projections, $1 in energy savings can often drive an additional $6 to $8 in operational savings.[56] In addition to savings in operations, reducing E-W-F consumption is an opportunity for brand differentiation, making your supply chain more resilient to shortages, and staving off legal and regulatory risks. Yet, as with every aspect of the nexus, there are many missing pieces to the puzzle of how corporations should tackle environmental policies and programs. The following topics outline steps for implementing a E-W-F nexus plan after data have been gathered and risks have been determined.

Setting Your Strategy

"Developing a smart energy and environmental policy is a complicated process. That's why many companies have yet to develop any type of comprehensive policy."[55] – Report by IBM

The steps outlined by most experts for building a E-W-F strategy are best summed up by the following scheme outlined by the EPA: PLAN, DO, CHECK, ACT.[57] The essence is to "plan" through gathering data, establishing baselines, and setting

priorities. Then, one should execute the plan ("do"), "check" on its progress, and "act" by ensuring that the plan is continually realigned with business strategy. During the execution of the plan, one should list out the tasks that need to be performed, assign responsibilities for the tasks, and set realistic deadlines for completion.

PLAN, DO, CHECK, ACT is the basic outline for mitigating E-W-F risks. Beyond the basics, the literature contains additional information. For instance, according to PepsiCo's Senior Director of Sustainability Dan Bena, setting goals is the best way to achieve in-house change.[58] Having clear intent to collect data about E-W-F consumption permits benchmarking to occur and is valuable for short and long-term planning.

A whitepaper from IBM also highlights three Ss—Strategy, Synergy, and Significance. The paper argues that leading companies set clear strategies for managing environmental consumption, they hunt out synergistic innovations that maximize several goals simultaneously, and they focus on the monetary significance of initiatives for the bottom line.[59]

A final piece of guidance from the literature highlights the importance of getting a sustainability plan in place early. The sooner a plan is enacted, the less existing operations need to be reworked. This is especially true of long-term ventures. Once a factory is built, its design is fairly set. It is important to have a sustainability vision early in the creation of a factory because there will be little room for structural change once the factory is built.[60]

CEO Leadership

According to an EY/GreenBiz report, the C-suite is a crucial group for establishing sustainability as a "strategic risk management issue as opposed to being seen simply as a means of 'doing the right thing.'"[61] The same sentiment was echoed in an IBM report: "We believe it is paramount that leadership establish and communicate a sustainability vision supported by a well-defined strategy … Regardless of how it fits into the overall business strategy, a successful sustainability program must have the right level of leadership attention and commitment."[62] Clearly, one of the most important factors for ensuring that the nexus is taken seriously is whether top leadership (the board, CEO, C-suite) has a strong sustainability vision, and whether they communicate this vision to their employees.

Recent company surveys provide glimpses into the state of corporate sustainability leadership. CDP measured board-level oversight of water management and reported that 58% of respondents have oversight of water in their business strategy or plan. However, many sectors said that they have a higher level of concern about their risk of exposure than they have board-level oversight.[63] An IBM survey found that 43% of corporate respondents indicated that their sustainability programs report to the CEO office—a sign that sustainability is taken seriously. Only 12% of the companies did not have any documented sustainability strategy. An additional 8% reported that sustainability initiatives were decoupled from the overall business strategic direction. More than a third of their participants reported a "loosely" integrated sustainability strategy, 23% reported that sustainability and business strategy were in alignment, and the remainder said that sustainability was core to their overall business strategy.

Generally, these numbers indicate a transitional period for sustainability initiatives. A large and growing percentage of companies are showing commitment to sustainability. Every year more of the world's largest companies are integrating sustainability into the core of their business plan. Still, much work needs to be done before companies are fully strategic with their resource management.

First, sustainability has made headway; yet the majority of companies report that sustainability is not reported to the CEO office. As the evidence shows, only when leadership articulates a sustainability vision can a company fully embrace it. Second, the issue of the E-W-F nexus lags behind the adoption of other sustainability concepts. In the EY/GreenBiz survey, 79% of respondents said that sustainability risks are incorporated into their enterprise risk management framework. Yet, when respondents were asked if their company ever ran scenario analyses for key E-W-F inputs, only 30% responded yes.[64] Thirty-six percent responded that their company had no plans to conduct these analyses. Concrete assessment of risk is the only way to really understand how the nexus might impact business operations and to take steps for being resilient to nexus challenges.

Sending the Message down the Supply Chain

In 2013, CDP identified that only 37% of its survey respondents required key suppliers to report on water risks and management, despite more than half (52%) reporting that they sourced key inputs from regions subject to risk. Twenty-three percent of those same businesses were unable to identify whether they are exposed to water risks across their supply chains.[65]

The nexus highlights that regional shortages in energy, water, or food will have ripple effects throughout a region. These shortages will affect multiple companies relying on resources that may have nothing to do with the primary shortage. Just as the ecology of E-W-F is interrelated in a region, so is the economy of buyers and suppliers. To become resilient to E-W-F shortages, one's suppliers must also gather data and assess their risks.

Some corporations are already making headway in determining the risks in their supply chains. As mentioned, Coca-Cola is a leader in assessing water risks. Similarly, in 2011 Intel collected information from 98% of its top tier-one suppliers. Specifically, the company asked its tier-one suppliers about their baseline data and reduction goals for water, energy, and waste. Intel specifically placed emphasis on surveying suppliers in water-stressed countries, and found that 80% of its top tier-one suppliers tracked water metrics.[66]

Companies like Intel and Coca-Cola are at the vanguard of surveying suppliers for E-W-F resiliency. As the CDP report indicates, most major corporations are not conducting these surveys. That is likely to change as consumers, shareholders, and the government hold companies responsible for the actions of their suppliers more and more.[67]

The trend toward more supplier surveys is a double-edged sword. On the one hand, more information can enable greater resilience to E-W-F challenges, and gives visibility to the system of E-W-F production and consumption. On the other hand, the tide of supplier surveys is already burdensome—major companies report receiving hundreds of surveys per year, tracking thousands of discrete pieces of information.[68] CDP found that requests for corporate water policies from investors quadrupled in just a three-year span.[69]

The corporate community will need to address this profusion of surveys. It is a waste for hundreds of surveys to ask the same questions in slightly different forms. It makes sense for leading members of the business community to create their own standards for information gathering and reporting, in coordination with key stakeholder groups. Trade associations, especially manufacturing trade associations, could be key conveners for standardizing methods that align with business needs.

COLLABORATING

The statement repeated most often in the energy, water, and food (E-W-F) nexus literature was that better collaboration was needed when planning the production and consumption of resources. Documents argued that the greatest obstacle to reducing nexus stress was poor collaboration among those who regulate and consume resources. Documents argued that federal and state governments lacked plans to gather information about E-W-F sources, and that utilities lacked a common framework for measuring and sharing their inputs and outputs.[70]

To solve nexus challenges the government, the public, and the private sector need to work together. How does a business connect with the stakeholders it needs to reach and the partners it needs to collaborate with? This section considers how the public and private sector can work together to better solve issues that no one organization can solve by itself.

Coordination of Utilities

"The water-energy linkage means that efficiency programs that save water will also save energy and vice versa. If utilities recognize this intersection and work together on joint programs they could learn from one another, document savings, share costs, and potentially achieve greater savings."[71] – Report by American Council for Energy Efficient Economy and Alliance for Water Efficiency

Utility companies manage the infrastructure that distributes, sells, and recaptures both water and energy. Because of this systemic role, they have tremendous potential for large-scale influence on water and energy measurement and improvement.

Many documents called for water and energy utilities to manage their resources jointly in the same regions. They highlighted the need to "establish ongoing water and energy workgroups to increase cooperation among energy and water agencies, utilities and communities, to share best practices and recognize the nexus as the first step toward working together."[72]

Considerable challenges exist for working together. Ninety percent of water customers are served by publicly owned servers, while about 70% of electric customers are served by investor-owned utilities.[73] Water utilities are generally smaller and cover smaller geographic areas than energy service areas. Sometimes water sources span several states with different policies and regulations.

Despite these challenges, there are ways forward. For instance, in 2007 IBM founded the Global Intelligent Utility Network Coalition, a group of utility companies working to accelerate adoption of smart grid technologies.[74] Trade associations for utility companies are another place where discussion of joint water and energy (and possibly even food) management could be improved. Convening the trade associations representing the variety of energy and water companies may be a fruitful manner of uncovering new ways to manage energy and water together.

Private Sector Partnerships

"Water issues are by nature cross-community and cross-boundary, and therefore cannot be managed simply within the fence lines of our own brewing operations. Rather they must be tackled as part of a broader approach, working in partnership with local stakeholders."[75] – CEO of SAB Miller Graham Mackay

Increasing business sector engagement is one of the most promising avenues for dealing with nexus collaboration issues. Up to this point, much of the discussion about the nexus has neglected to fully engage the corporate sustainability community. When the business community is referenced, it is often to discuss altering the prices of water and energy to create modified behaviors.[76] This indirect mechanism fails to directly engage business leaders to come up with a proactive solution for nexus coordination.

A 2012 KPMG white paper on sustainability points out that the time is ripe for the public and private sector to work together: "To achieve their strategies, governments need corporations to provide … green technology, the skills to deploy and operate it, and the funds of financiers to invest in delivering it. Given that many national budgets remain stretched as a result of the global financial crisis, the conditions seem ripe for the wider introduction of PPP structures using private finance."[77]

There are hints as to how the business community can be better engaged. For instance, in recent years, Shell did the following:

- Collaborated with the City of Dawson Creek in Canada to build a reclaimed water facility that virtually eliminated its need to draw on local freshwater sources for the operation of a natural-gas

venture. The project treats a volume of municipal wastewater that had previously been released, to a standard suitable for industrial, agricultural, and municipal uses.

- Worked with the University of Utrecht in the Netherlands to develop a new method for estimating the amount of water needed to generate energy from different sources more accurately, so that the most efficient technologies can be employed in different locations.
- Worked with local governments on water and land-use issues in Brazil, where the company has a major sugarcane biofuels business.[78]

Beyond public-private partnerships, the business sector can collaborate with other companies in private-private partnerships. As pointed out by Melissa McCullough, Senior Sustainability Advisor at EPA, waste is an inherent sign of inefficiency.[79] Where companies are generating large amounts of waste, it is likely that others in the same industry, or other stakeholders with similar steps in their supply chain, are also generating waste. This suggests that there may be room to work with competitors to find solutions that meet mutual needs.

When E-W-F risk is shared by an entire industry it makes sense, where legally possible, for industries to cooperate to avoid risks. If companies within the energy industry (e.g., natural gas, coal, hydroelectric) adopt a common framework for sharing data on energy usage, it can mitigate direct risks to their operations, the risk of unforeseen trade-offs, and may even mitigate reputational risks (e.g., outages) and regulatory risks (e.g., legislation mandating certain kinds of data sharing).

Conclusion

"Addressing global stresses requires coordination among increasing constituencies of decision-makers. But the more diverse the groups that are involved, the more that vested interests tend to block progress. … Fresh forms of collaboration are required that cut across familiar national, public-private, and industry-sector boundaries, but there are no strong models for such collaborations, and they are immensely difficult to get off the ground because different parties remain focused on their individual foreground issues and responsibilities."[80] – Shell New Lens Scenarios

Much of the challenge for coordinating the nexus lies in conflicting visions about who should be in charge of governance. More collaboration is definitely needed to ensure proper coordination of E-W-F resources. However, current conversations do not fully embrace the role of business in solving nexus challenges.

Globally, businesses have the unique capability to accelerate access to more efficient technologies, integrate the poorest in using this technology, make implementation devices viable and marketable, and stimulate development through economic incentives.[81] For example, the demand for technology to transport water cheaply and efficiently is in great demand in emerging economies.[82] Businesses solving this challenge would be able to corner a large market with relatively low returns, but high volume. Another place where businesses can be involved is through Water Benefit Certificates (WBC). The WBC model incentivizes the financing of water projects globally by certifying and selling units of water savings from conservation projects.[83] Engaging business in proactive discussions about nexus coordination is the only way to bring these kinds of mechanisms to scale.

LEADING

As globalization progresses, the world's resources and its economies are affected by actions from which they were formerly isolated. Understanding the energy, water, and food (E-W-F) nexus is critical to any business that wants to understand the challenges it may face in the future. This report identifies and explores several key steps for how corporations can address the E-W-F nexus.

The first step for any company wanting to understand its connection to the nexus is surveying and collecting data. This report offers the best available methods that exist for corporations to assess their ties to E-W-F inputs, stresses the importance of sharing results, and argues that more needs to be done to integrate nexus concepts into the most popular sustainability tools.

The next step is for corporations to assess risks inherent in their connections to the nexus. This report listed commonly referenced risks to businesses, and offered advice on how to start assessing risks.

The third step for a corporation is to implement sustainability plans that are aimed at addressing E-W-F risks and opportunities. This report discusses the importance of setting goals, getting leadership buy-in, and sending a sustainability message to suppliers.

Finally, a corporation should consider the ways that nexus stakeholders can collaborate to find E-W-F risks and to remove waste through greater efficiency. This report emphasizes the value of collaboration between water and energy utilities, and offers examples for how corporations can work with public and private partners to become more involved in nexus initiatives.

Follow-Up Questions

Although this report provides answers to several key questions about the nexus, it also demonstrates how many questions still need to be answered. The nexus is far less appreciated than other concepts in the field of sustainability. The following questions and ideas should be addressed to advance our understanding of the nexus and to mitigate risks.

The Lack of a Full Model for E-W-F

Having an integrated model of E-W-F production and consumption would be ideal for corporations to track their resource needs and plan future developments. Just as the equation $e=mc^2$ famously allowed scientists to understand the conversion of energy to matter, and vice versa, it would be helpful if there was a system showing how many resources are embedded in the production and consumption of any one unit of energy, water, or food. The framework should also model the connections between resources geographically. E-W-F resources exist in real places with real limitations, so it is important to understand how E-W-F flows within and between regions.

We are far from having the $e=mc^2$ of the E-W-F nexus. The model outlined by the DOE in this report (see page 12) comes closest to the needed framework. Yet it primarily shows the components of the model that need to exist; it does not actually specify the amounts of each resource embedded in the others. Once a full framework is in place, it also needs to be translated into a tool that organizations can use to plan developments and expansions.

Another way that we lack a full model of E-W-F is revealed by considering the six dyads between the resources:

- food for water
- food for energy

GLOBALIZATION AND THE NEXUS: CORN ETHANOL

The debate around corn ethanol highlights the complexities of an increasingly interconnected and globalized world. Since the 19th century, the opportunity to use plants for energy has seemed attractive for diversifying energy sources. By 2011, the world produced 1.9 million barrels of biofuel a day.[84] Yet because of the connections between E-W-F, corn ethanol became embroiled in debates about whether it best maximized E-W-F demands during the food crises of 2008 and 2011. Those debates circled on the potential negative consequences to the food supply when farmland is diverted to biofuel production. Currently, the possibilities of cellulosic corn ethanol (i.e., using corn waste to generate energy) might change the debate again. Former detractors could become allies now that plant waste has become the source of energy instead of corn. This is a dynamic time where businesses are experiencing the ever-changing connections between E-W-F production.

- water for food
- water for energy
- energy for food
- energy for water

In examining the literature, it is clear that some of these relationships receive much more coverage than the others. Using food for energy (e.g., biofuels) is covered extensively; yet there is little consideration of other pairings, like using food for water. It is hard to know precisely what that relationship looks like. One way that food is used for water is in the calories consumed by individuals in the developing world when they gather water for their households. Another example is the use of source materials, such as nut shells, coconut husks, and peat, for use in water filters. To understand risks, each linkage in the E-W-F nexus must be fully explored.

The Role of Ecosystem Services

"When we try to pick out anything by itself, we find it hitched to everything else in the Universe."[85] – John Muir

Natural systems can provide benefits with economic value. For instance, forest cover can help minimize runoff and evaporation in watersheds, and natural marshlands can lower the cost of water treatment and lessen the impact of storm surges.[86]

The nexus challenges outlined in this report are often related to the complexities that ensue when natural systems are replaced with manmade designs. The second-order (and even third-order) ripple effects of human interventions are becoming increasingly complex to manage. The complexity of trying to re-create nature raises an important question: are there places where ecosystems should be bolstered to provide value without human management (or with minimal management)?

To understand the costs and benefits of any development plan requires knowing if natural or manmade options best maximize goals. At the moment, corporations would benefit from knowing more about the costs and benefits of ecosystem services, and integrating this knowledge into plans for expanded operations.

The Integration of the Nexus and Corporate Sustainability

This report reveals that the tools relied on by the corporate sustainability community tend to measure E-W-F consumption in silos. As the nexus concept makes clear, E-W-F inputs are connected to regional systems of production and consumption. Corporations would benefit if a standardized framework existed to comprehensively survey the geographic sources of their consumption and the risks faced by drawing from these sources.

One reason why corporate sustainability professionals have not embraced the nexus concept fully is that leading organizations studying the nexus often do not engage the business community. Some argue that only the government has a role in monitoring nexus stresses.[87] Others are skeptical of business commitments to sustainability.[88] As mentioned, many of the leading voices in discussions around the nexus are nonprofits whose main idea for engaging markets is to legislate the prices of E-W-F.[89] Of course, some sustainability professionals do understand the nexus, and some nexus experts understand the role of business. Still, it appears a gap exists between the communities that discuss corporate sustainability and the E-W-F nexus. Bridging the divide between nexus experts and corporate sustainability professionals could go a long way to address the issues of better measurement, coordination, and risk mitigation. To do this, corporate sustainability professionals and nexus experts need to discuss how to proactively work together.

Another rift between many nexus experts and the business community lies in the

issue of coordination. The nexus concept highlights the need to see the pieces of the E-W-F puzzle together. One of the comments repeated in the literature was that no single actor has a coherent vision over the governance of energy, water, or food, as well as an understanding of how these resource systems interact. No organization has a holistic view of the 2,110 watersheds, the more than 3,200 providers of electricity, and the more than 2.2 million farms in the United States.[90] There were calls in the literature for the federal government to collect better data on E-W-F resources. For instance, a white paper from the Atlantic Council states

> Comprehensive, up-to-date energy and water nexus data is lacking. Congressional and federal agency policymakers claim they lack the comprehensive nationwide data necessary to make appropriate decisions and plans. Unfortunately there is no nationwide data collection by an appropriate government authority.[91]

Furthermore, the Federal government affirms this lack of appropriate data. A Government Accountability Office report in 2012 called for the end of "stove-piping" energy and water coordination.[92] In a report to Congress, the Department of Energy stated that "collaboration on energy and water resource planning is needed among federal, regional, and state agencies as well as with industry and other stakeholders" in 2006.[93]

What many nexus experts do not question is the extent that the government should centrally manage E-W-F data and resources. Efforts to integrate federal governance of E-W-F appear to have stalled. In 2005, Congress authorized $500,000 to examine the "threat to national energy production resulting from limited water supplies."[94] The DOE began conducting this research through Sandia National Laboratories, and published the first report in 2006. A second report, intended to layout real-world solutions to energy and water stresses, has inexplicably not been released. In fact, the DOE has rejected 22 drafts of this so-called *Roadmap Report* presented for publication.[95] Market mechanisms can be a solution to address nexus challenges. Conversations between corporate professionals and other nexus experts can find alternate paths to avoid chronic and acute E-W-F shortages, beyond calling for greater government intervention.

Conclusion

Each business has two roles to play when dealing with the issues surrounding the E-W-F nexus. First is within its own organization. The more efficient a business can be when it uses E-W-F resources and the more resilient it is to changes in those resources costs and availability, the more profitable it will be in the long run. The second role that a business can play is as a steward in the communities in which it operates. By following the six steps outlined in this report, businesses can take a leading role in improving the health of the E-W-F nexus indefinitely.

ABOUT THE AUTHORS

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Jeff Lundy joined the U.S. Chamber of Commerce Foundation's Corporate Citizenship Center in February 2012 to oversee and advance its research agenda. Lundy works with CCC's network of companies to create their Business for Good Map presence. He also manages CCC's thematic maps (e.g., disaster aid, environmental innovation). In addition, Lundy also manages analysis and reporting on a broad range of issues on corporate citizenship.

Previously, Lundy served as a consultant for Empower Partners LLC, a social enterprise developing marketing models to help underserved inner-city businesses tailor their product lines to local consumers. Before that, he was an intern at the U.S. Bureau of Labor Statistics (BLS), where he selected new technologies to improve BLS's capture of respondent data.

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APPENDIX – LITERATURE LIST

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