Net-Zero Water and More: Moving Beyond "Low Flow"

(http://www2.buildinggreen.com/print/article/net-zero-water-and-more-moving-beyond-low-flow) (http://www2.buildinggreen.com/printmail/article/net-zero-water-and-more-moving-beyond-low-flow)

These emerging water strategies are finding momentum and filling the need to address efficiency and resilience on multiple scales.

By Candace Pearson

As a result of the severe drought in California, St. Helena City Council announced mandatory water rationing for its homes effective January 2014. It imposed a limit of 65 gallons per person per day—one-third of the average water consumption in the state—with a $374 charge for every 748 gallons above the limit to take effect in a few months.

(/sites/buildinggreen.com/files/articles/images/A5526/1%20WaterShed%20constructed%20wetlands.jpg)
The WaterShed project was designed for a constructed wetland to filter greywater for reuse, but the system will not be utilized because Montgomery County has no permitting process for such a system.
Photo: Scott Tjaden

In turns out that emergency regulations like these can help a lot in the short term: in St. Helena City, water use fell by 33% just two weeks after the announcement, and the rules have since been lifted due to recent rainy weather. There's a clear need for more long-term solutions, though; drought conditions there have eased a little bit, but in California and many other places, water consumption continues at unsustainable rates, with "fossil water" aquifers being rapidly drawn down and consumption levels based on historical rainfall patterns that have literally dried up.

While this crisis has been long in the making, some architects and planners say they are finally seeing room to make progress. Buildings with net-zero-water performance, many of them driven by Living Building Challenge (http://www.buildinggreen.com/auth/article.cfm/2009/5/29/The-Living-Building-Challenge-Can-It-Really-Change-the-World/) requirements, demonstrate one kind of response, but these exemplary projects have faced serious regulatory obstacles. We'll explain why, and what's needed to make headway on that front, and also explore solutions that utilize the connections between energy and water to have an effect spanning an urban scale.

Net-Zero and Regulatory Limits

The aim of net-zero-water projects is to meet all water needs through what falls on the site or can be recycled from waste streams, as well as to manage all wastewater and stormwater onsite. In

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theory, a net-zero-water project could be a closed-loop system disconnected from services. However, inflexible codes and regulations mean these closed-loop systems have some leaks: of the few net-zero-water projects that exist, most contribute in some way to sewer loads or have to rely on the municipal system for their potable water supply because the project was not able to obtain the necessary permits.

Rainwater everywhere but not a drop to drink

Rainwater harvesting (http://www.buildinggreen.com/auth/article.cfm/1997/5/1/Rainwater-Harvesting/) is one of the most widely used alternative supply strategies across the country and practically a requirement for net-zero. Rainwater collection systems can cut potable water use to a fraction by using rainwater to flush toilets or irrigate (see "Rainwater Harvesting: Standout Products in a Rising Market (http://www.buildinggreen.com/auth/article.cfm/2012/5/31/Rainwater-Harvesting-Standout-Products-in-a-Rising-Market/) "). What if rainwater could supply all of a building's water needs, including drinking water for the occupants? In many cases, it can, but project teams who have tried have hit a regulatory wall.

U.S. Rainwater Harvesting Laws

(/sites/buildinggreen.com/files/articles/images/A5526/2%20RainwaterHarvestin_Maps.jpg)

Localities look to the state for health regulations on water quality, but only a few have instituted state-wide rainwater harvesting laws delineating where it can be utilized and for what uses.

Source: National Conference of State Legislatures

At the Sacred Heart Preparatory School in California, the library was built for net-zero energy and water and was the first ever to achieve Platinum under LEED for Schools. But the project still hit a few stumbling blocks, according to Pauline Souza, AIA, director of sustainability at WRNS Studio—most disappointingly when it came to rainwater harvesting.

The library was designed and originally permitted to use a rainwater collection and treatment system that would supply the building's potable water, but when the team went back to verify the plans just before construction, the City "looked surprised," Souza told *EBN*. "I don't think they were clear about what it meant when they signed off originally."

After another review, the City determined that the system could be approved, but only if the school applied to be a water utility and hired a full-time operator to conduct daily testing for water quality—"a burden and perceived risk the school didn't want to carry," Souza explained. The water is instead currently used for an orchard.

Two other projects, the Bullitt Center (http://www2.buildinggreen.com/blogs/americas-greenest-office-building) and the science wing at the Bertschi school (http://www.buildinggreen.com/auth/article.cfm/2013/4/15/Seattle-School-Earns-World-s-Fourth-Living-Building-Certification/) —both based in Seattle—have installed full potable rainwater harvesting systems knowing they would not initially be used for their intended purpose. In Bertschi's case, the investment was made in the hope that regulations will change, and in the Bullitt Center's case, the project has continued to pursue a city permit with an offer to conduct independent testing.

Why so strict?

"When you think about it," commented Pauline Souza, "It is stunning that we can't use rainwater to drink, when that used to be the cleanest source."

The high bar that is set for potable rainwater systems in commercial buildings is, of course, meant to protect public health, though the technology has been proven and tested in many parts of the U.S. (see "Alternative Water Sources: Supply-Side Solutions for Green Buildings

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(http://www.buildinggreen.com/auth/article.cfm/2008/4/29/Alternative-Water-Sources-Supply-Side-Solutions-for-Green-Buildings/)). For example, several homes in Austin, Texas, use rainwater harvesting to supply all of their potable needs, and at Hawaii Volcanoes National Park, a rainwater catchment system provides 5.5 million gallons of drinkable water per year, with park employees picking up the responsibility of recording the water quality data.

Purification and filtration products range from using chlorination to UV light filters to membrane filtration and are certified through NSF/ANSI standards to ensure safety. "There's no doubt that these technologies work," says Allison Wilson of Ayers Saint Gross Architects and Planners. "The sticking point is in the regulation." One of the biggest is that State Health Departments ultimately have jurisdiction over water quality, but few have given clear direction on what standards rainwater must meet for potable use.

(/sites/buildinggreen.com/files/articles/images/A5526/3%20Hawaiisand-filter.jpg)
Large sand filters at Hawaii Volcanoes National Park filter rainwater for potable use.

Photo: Pacific Island Parks

Chris Hellstern of ZGF architects worked on the Bertschi School when he was with KMD architects. Hellstern told *EBN* that even though states and localities are responsible for setting regulations on rainwater harvesting, it became clear through discussions with the Washington Department of Health that the agency is hesitant to change policies until the U.S. Environmental Protection Agency (EPA) changes its guidelines; EPA suggests in its Municipal Handbook (http://water.epa.gov/infrastructure/greeninfrastructure/upload/gi_munichandbook_harvesting.pdf) that *non-potable* uses "are the best match for harvested rainwater." Other states, like Texas and California, have a similar approach, offering the same loophole for commercial buildings if it can meet the standards applied to a utility—not prohibiting rainwater for potable use in theory but making it nearly impossible to practically achieve.

In some parts of the U.S., particularly in the West, rainwater harvesting systems may not be allowed even for non-potable uses. Colorado, for example, grappled for years over whether rainwater harvesting violated downstream users' water rights and ultimately has made allowances only for residences on certain types of wells and several mixed-use developments that it considered pilot projects. Most states don't have any legislation addressing the issue at all. Some cities and municipalities may have their own code allowances, and a lack of regulation does not stop one from petitioning for an exemption, but guidance and clear water-quality standards at the state level—to clarify whether rainwater should be treated before it is used in toilets, for example—would help streamline adoption.

Good news from the residential side

We are, however, beginning to see movement, particularly on the residential side where rainwater collection for potable water use is much less constrained. Atlanta, for example passed an ordinance in 2011 allowing single-family residential customers to retain water for potable use, though they must maintain a city water account. Texas and Ohio both enacted legislation to allow rainwater for potable use at the state level, and the building code in Portland, Oregon permits rainwater reuse for potable uses at family dwellings through an appeals process.

You have to crawl before you can walk, says Pete Muñoz, P.E., senior engineer at Biohabitats. "Once you have the small residential systems out there, it helps to educate the public. We are starting to see that there is less of a learning curve when we go for things outside the current regulatory framework."

In the meantime, non-potable rainwater collection has

SW Ecodistrict

(/sites/buildinggreen.com/files/articles/images/A5526/4%20SWEcodistrict.jpg)
Plans for the SW EcoDistrict include rainwater collection on top of roofs and stormwater collection in underground aquifers so that entire blocks may share this resource and reduce potable water consumption on a district scale.

Source: National Capital Planning Commission

plenty of room to expand and bring huge water savings. It's also a solution that has the potential to scale up. In plans for the SW Ecodistrict (http://www.ncpc.gov/swecodistrict/) , a 15-block federal precinct just south of the National Mall in Washington, D.C., a proposed district-scale aquifer will capture and reuse rainwater and stormwater throughout the year, reducing potable water use 63%.

Wastewater: More regulatory hurdles

Predictably, the same kind of regulatory hurdles arise with reusing graywater (http://www.buildinggreen.com/auth/article.cfm/2009/2/26/Graywater-Collection-and-Use/) . University of Maryland students who submitted the winning entry to the Solar Decathlon in 2011 have been working ever since to get the project situated in its permanent location in Montgomery County. One of the distinguishing features of the WaterShed project (http://www.buildinggreen.com/auth/article.cfm/2011/11/1/University-of-Maryland-Wins-Fifth-Solar-Decathlon/) was a constructed wetland, which was designed to filter graywater for use in irrigation. "There are no regulatory permits for graywater reuse within the state of Maryland," Scott Tjaden, one of the students who worked on WaterShed, told *EBN*. "The house is plumbed for graywater, but it will go to the sewer."

"There's a big opportunity for legislation for a lot of these systems." Tjaden continued. "Right now, it is about showcasing that this is feasible and helping people see the importance."

There are signs, though, that regulation is catching up (see "Clearing the Way for Water Savings in Plumbing Codes (http://www.buildinggreen.com/auth/article.cfm/2010/3/31/Clearing-the-Way-for-Water-Savings-in-Plumbing-Codes/) "). In California, reusing graywater for irrigation and flushing toilets was authorized statewide in 2009 with amendments to the plumbing code. In order to speed adoption, local jurisdictions even made their own efforts to streamline permitting. In Los Angeles, says Osama Younan, chief of the Green Building and Mechanical Engineering Section in the Los Angeles Department of Building and Safety, "Graywater and rainwater catchment regulations have caught up, but the codes were still too complicated for people to understand. So we figured out how to make all the requirements clear and simplify the permitting process."

The growing acceptance of recycled water and the realization that it could be a drought-resistant water supply recently led California Governor Jerry Brown to sign a bill in October 2013 that requires state health and water officials to evaluate by September 2016 the feasibility of recycling wastewater for direct potable use. There's even a good chance their findings might be supportive, experts say; Orange County already injects treated wastewater into underground aquifers and withdraws it again for potable use, effectively doing the same thing.

Even where progressive regulations aren't in place, however, taking the time to work with regulators can also pay off. With the Bertschi Science Wing, the team struggled with how to manage graywater onsite. Regulations allowed it to be discharged underground, but in the school's urban setting, that wasn't practical. Instead, the team figured they could use the supply to water a vegetated wall, but that worried city officials in the approval process. "I guess they were worried the kids would lick the plants," Chris Hellstern joked, but once the team explained that the water was sufficiently locked in by plant mass, and that the water would be kept below the surface of the soil, it "opened their eyes to the possibility."

It's important for architects to keep pushing for innovative projects, according to Ryan McEvoy, principal of Gaia Development, because a "constituency" is needed to pass policy. "The architects have the ability to effect change, but the only way they can do that is by getting owner buy-in. Once you have ownership buy-in, the market is in your favor."

As with rainwater systems, the barriers around potable use have not stopped people from thinking about scaling graywater systems up to whole districts. The Lloyd EcoDistrict under development in Portland, Oregon, includes plans to serve a four-block area with a Living Machine, recycling the graywater output for toilets and irrigation. "The city gave their support because it [the Living Machine] will not be contributing to the sewer system," explained Craig Briscoe, director of integrated design at Glumac. He's still wishing for more: "If you want to go wastewater-to-potable, you still have to send it back to nature; that's the only way anyone's comfortable with it, " Briscoe regrets, but using this technology at the district scale is still a big step.

(/sites/buildinggreen.com/files/articles/images/A5526/5%20SonomaCarbonFreeWater.jpg)

These photovoltaic panels were installed adjacent to a storage pond to help offset Sonoma County Water Agency's average annual energy demand of 4.8 MW. Such projects demonstrate the water-energy nexus is driving combined water-energy projects.

Photo: Sonoma County Water Agency

The Water-Energy Nexus

Though net-zero water is promising, it is extremely difficult to achieve and affects only one site at a time. In order to address the challenges of today's mostly centralized water infrastructure, some have turned their sights to water efficiency and what has been termed the *water-energy nexus* (http://www.buildinggreen.com/auth/article.cfm/2010/9/29/The-Water-Energy-Connection/) . These opportunities are found on both the supply side—where water is needed to produce energy and energy is needed to treat and transport water—and on the demand side, where consuming water uses energy.

Thinking at the site level

At the site level, the water-energy nexus rears its head through the embedded energy costs needed to transport water and through the direct energy needed to pump water throughout buildings (see "Saving Energy by Conserving Water (http://www2.buildinggreen.com/blogs/saving-energy-conserving-water) "). Simply reducing use with the help of water-efficient fixtures will save both water and energy (see "Water: Doing More with Less (http://www.buildinggreen.com/auth/article.cfm/2008/2/3/Water-Doing-More-With-Less)).

However, other ways to utilize the water-energy nexus to compound savings are just starting to be explored. In some cases, water collected at the site might be able to offset cooling needs with lower energy demands. Craig Briscoe told *EBN*, "We are in the beginning stages of connecting stormwater and energy." For an EcoDistrict in Japan, he is exploring the possibility of using stormwater as "a potential heat sink."

Adam Cohen, an architect with Structures Design/Build in Virginia, has already explored that same idea using an onsite detention pond as a heat sink for a dental office. Water is circulated in closed-loop piping through the pond and run along tubes attached to chairs in dental exam rooms to provide radiant cooling. In Central Texas at the Cascading Creek House, designed by Bercy Chen Studio, rainwater is collected in a basin on the roof, and heating and cooling are supplied to the house through water-source heat pumps and radiant cooling loops.

Utilities get in the game

But it's on the supply side that these ideas have really started to take off—in many cases because of necessity. Pete Muñoz says it's hard to comprehend the effect our design decisions have, but we will soon be faced with a new reality that will demand better water stewardship because of the massive amounts of water needed for cooling or generating steam at power plants. "Energy is highly dependent on water supply, and with dwindling snow pack, a warming climate, and changing rain patterns, water for that energy supply simply isn't going to be there. With the storage capacity that we have, we simply can't capture *and* make energy out of it."

Heather Cooley, director of the Pacific Institute's Water Program, says understanding that reality is all the more important now as some areas realize that they have no "traditional water supplies left" and will have to make decisions about the next marginal supply, some of which may be more energy-intensive than others. Utilities want to explore their options before investing in a supply that has hidden embedded energy costs.

Conversely, as water supplies diminish, energy supplies from sources that rely heavily on water will become less secure. Already, solar thermal plants in California, which use a surprisingly huge amount of water for cooling, have had to decrease electricity production due to the extended drought. More commonly understood is the large water footprint from thermoelectric plants burning coal, natural gas, or using nuclear fission to generate steam to turn turbines (see "Saving Water by Saving Energy (http://www2.buildinggreen.com/blogs/saving-water-conserving-energy) "). The U.S. Geological Survey in 2009 estimated that 49% of the nation's total water use and 53% of fresh surface-water withdrawals went to the production of thermoelectric power. (The "consumptive use" for power generation is far lower—because most of the cooling water used is returned to the river or reservoir from which it was drawn. However, when river and reservoir levels drop during drought or overuse, that water isn't always there for power plants to use.)

In contrast, wind and solar photovoltaic panels look good for drought-prone areas. According to its "Outlook for Renewable Energy 2014 (http://www.acore.org/outlook2014) " report, the American Council on Renewable Energy (ACORE) finds wind power alone saved 36.5 billion gallons of water in 2013. These figures are bringing energy stakeholders, including electric utilities, to the table with a new sense of urgency to talk about water strategies.

Opportunities for coordination

On the supply side, experts are calling for coordination between energy and water utilities. Cooley told *EBN,* "Some of the barriers are that water and energy are managed by different entities. They are siloed and don't have a history of working together."

A report conducted by The Alliance for Water Efficiency (AWE) and American Council for an Energy-Efficient Economy (ACEEE) called "Addressing the Energy-Water Nexus; A Blueprint for Action and Policy Agenda (http://www.aceee.org/white-paper/addressing-the-energy-water-nexus) " suggests the benefits of such collaboration would include:

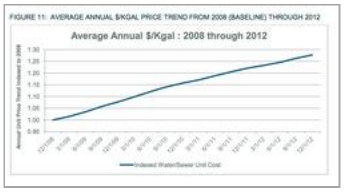
• More stakeholders: Water and energy utilities have relationships with different manufacturers and retailers, so running joint programs can bring wider participation and uptake of new technology.

• New savings: Collaborating and combining technologies and expertise means opportunities for savings will not be overlooked.

• Increased knowledge: Tracking, metering, and evaluating the results of different programs from two perspectives could provide deeper understanding of the water-energy nexus.

According to Cooley, we are already in the midst of a "transformation of coordination." Cooley cites a master utility agreement between the Los Angeles Department of Water and Power as a model because it "allows them to coordinate on a host of programs, rather than go on a program-by-program basis." Four joint programs have been developed as a result of this partnership, including one that offers a "tri-resource" customer incentive program, encouraging the reduction of water, electricity, and natural gas use.

Average U.S. Water Prices



[(/sites/buildinggreen.com/files/articles/images/A5526/6%20waterprices.jpg)](/sites/buildinggreen.com/files/articles/images/A5526/6%20waterprices.jpg)
Water and sewer prices in the U.S. have climbed almost 30% since 2008 and are expected to continue to rise.
Source: Ecova, Inc.

The Sonoma County Water Agency (SCWA) is also drawing attention for its integrated water and energy approach. As a part of its "Carbon Free Water" program, the agency has installed photovoltaic systems mounted on the roof of the administrative building and lining the edge of the wastewater storage ponds in order to offset its energy needs. But to achieve its goals, SCWA had to start by targeting the demand side—promoting low-water-use landscapes and offering rebates for low-use fixtures. The result has been a reduction in water delivery of 25% since 2005. The agency then focused on improving water efficiency by replacing old electric motors and pumps and optimizing aeration systems. Those efforts reduced the agency's energy use by 18%. Through a multifaceted approach of reducing water demand, using less energy, and meeting remaining needs through technology with a low water footprint, the agency claims its energy use will be carbon-free by the summer of 2014.

Grant Davis, general manger at SWCA, attributes the success of the program to a board that gave them permission to innovate, but he believes similar programs are replicable once the financial structures are figured out. He hopes that through a partnership with Applied Solutions, lessons learned from this pilot can be used to scale up. "We are kind-of a microcosm of what California is going through—shifting from being less dependent [on fossil fuels] to more renewable."

Water-energy-nutrient nexus

Not only are connections with energy opening opportunities to pursue water savings, but its connection with the waste stream also holds potential (see "[Waste Water, Want Water (http://www.buildinggreen.com/auth/article.cfm/2013/1/28/Waste-Water-Want-Water/)](http://www.buildinggreen.com/auth/article.cfm/2013/1/28/Waste-Water-Want-Water/)"). "We are starting to see an energy-water-nutrient nexus," according to Muñoz, "and that's were things get interesting."

He points to the example of the Clean Water Services Durham Wastewater Treatment Facility west of Portland that has been filtering phosphorous from the waste stream and turning it into fertilizer. After seeing the reduced operating costs and increased capacity at which the plant can run when less phosphorous is clogging pipes and equipment, the utility is now approaching corporate clients and offering to help them do urine capture before it even enters the waste stream to relieve processing loads in other treatment facilities. A urine diversion approach would save water through use of waterless urinals, save energy since waste would not need to be transported or treated as heavily, and produce a usable, income-producing product.

Between fecal matter and urine, 88% of the nitrogen and 66% of the phosphorous is contained in the urine, which is also simpler to handle, so urine diversion can be simple and low-budget. This was recently demonstrated by a group of students at the University of New Hampshire who operate a "pee bus" with simple urinals mounted on a trailer. The experiment was launched when the town of Durham noticed spikes in nitrogen loads at the water

[(/sites/buildinggreen.com/files/articles/images/A5526](/sites/buildinggreen.com/files/articles/images/A5526) treatment plant between 11 p.m. and 2 a.m. on party nights—the end result of “thirsty” college students. Reducing those spikes means less nitrogen is released into the environment through the effluent.

/7%20DurhamNutrientRecovery.jpg)
The Durham Clean Water Services wastewater treatment plant was the first in the U.S. to install a struvite recovery system to turn phosphorous into slow-release fertilizer. It has since installed another larger system at its Rock Creek facility and is approaching commercial clients to drum up interest for onsite urine capture.

Photo: Clean Water Services

Even one of the largest utilities is exploring how the water-energy-nutrient nexus might be leveraged to its advantage. The James C. Kirie wastewater treatment plant in Chicago is currently using a heat pump to extract heat and cooling from effluent (the sanitized water leaving the plant). Termed “sewerthermal,” this system is currently serving the facility’s two small administrative buildings, but only 2% of the energy contained in the effluent is being harvested. Frank Avila, commissioner of the Metropolitan Water Reclamation District of Greater Chicago, is in the midst of proposing a new bill that would allow the District to “sell or otherwise dispose of recovered resources or renewable energy resources,” according to the bill’s synopsis. Avila explained to *EBN,* “We are hoping to be able to sell sewerthermal to the surrounding neighborhood,” and the bill would also open doors for the utility to install a system for nutrient capture and sell the resulting fertilizer product.

Avila notes, “We are living in God’s country—we have water. But if we can recover resources from it, then big picture, we are going to be taking less out of Lake Michigan.” The sewerthermal systems replace boilers and natural gas consumption while providing heating and cooling more efficiently. This winter, Kirie operated at roughly 70% cost savings on heat, and 50% savings on cooling is expected.

“Everyone is talking about water now,” Avila said, “and wastewater has never been used in the ways we are now finding we can use it. The first step is public awareness to show that we can actually use this stuff, but it could become a part of our green infrastructure.”

Mounting Incentives

Is the market ready to capitalize on those opportunities? The typically low cost of water does not incentivize conservation, and for better for or worse, that’s been slow to change. Upfront costs for rainwater harvesting systems, dual plumbing for water reuse, and onsite treatment systems are obstacles because of long payback periods.

“Water is still cheap as a utility,” Allison Wilson told *EBN*. “It’s hard to convince clients on a technology which has a simple payback of 250 years.” Pauline Souza adds, “The cost of water doesn’t compare to the value.”

However, according to a 2013 Ecova report (http://www.ecova.com/media/357490/big_data_look_at_energy_trends_2008-2012.pdf), the cheap water trend is beginning to change. It finds water and sewer prices in the U.S. have climbed almost 30% since 2008 and will continue to rise as water supplies decline and deferred infrastructure upgrades become necessary.

In addition, a rate survey (http://www.cvwd.org/service/rates/RateSurvey.pdf) conducted by Raftelis Financial Consultants and the California-Nevada Section of the American Water Works Association suggests that utilities are moving away from uniform rates in favor of tiered pricing (http://www.buildinggreen.com/auth/article.cfm/2008/8/28/Water-Policies-Encouraging-Conservation/). Of utilities surveyed, only 23% applied uniform rates.

“The unique thing about water is that you pay for it going in and you pay for it going out,” notes Craig Briscoe. If water and sewer do become more expensive, then savings on the input side could compound on the output side.

Nutrients in Human Waste

Nutrients in Human Waste

Parameter	Units	Urine	Feces	Blackwater
Wet mass	kg/person/yr	550	51	610
Dry mass	kg/person/yr	21	11	40.5
Nitrogen	g/person/yr	4,000 (88%)	550 (12%)	4,550
Phosphorus	g/person/yr	365 (67%)	183 (33%)	548

Source: Rich Earth Institute

(/sites/buildinggreen.com/files/articles/images/A5526/human-waste_800.jpg)
Urine diversion presents a significant opportunity to capture most of the nutrients in human waste. As this chart shows, almost 90% of the nitrogen in human waste is in the urine, along with two-thirds of the phosphorus.

Source: Rich Earth Institute

Where utilities have been slow to act, decentralized district-level solutions can offer the economy of scale needed to make innovative projects feasible, according to Muñoz. “As you scale up, things become more economical,” he explains, “because you can use the same system for a larger flow.” That’s why ecodistricts represent such great opportunities for innovation. Briscoe adds that they also allow multiple stakeholders to “pool resources to make it a more affordable option for everyone.”

Missing rewards

Another challenge is that the potential to leverage the water-energy nexus to better account for embedded cost savings is constrained by the absence of good metrics. “For example, we might know that an efficiency program saves water and energy, but we don’t have a methodology for how much energy is saved by water projects,” explains Cooley. “We can easily estimate the amount of energy needed to heat water, but it is harder to account for embedded energy. And if we don’t know how much is saved, no one gets credit for what may be a good program.”

In addition, because water is imported over long distances, water savings in one region may only have an effect on energy in another region, making it unclear who is responsible for funding. If water and energy utilities do unite forces, it is still difficult to allocate costs and benefits among project partners. “What’s missing is the ability to quantify benefits that come from multiple sectors,” comments Grant Davis, regarding his experience with the Carbon Free Water project.

However, if the cost effectiveness of upgrades is not immediately clear from direct water- and energy-use reduction standpoints, other benefits from increased collaboration could sway utilities—including the fact that creating dual water and energy audits and rebate programs reduce the costs of education and outreach efforts, according to the AWE and ACEEE report previously mentioned.

Another trend that might be changing is the amount that water utilities are investing in efficiency. “Energy utilities are investing 2% to 2.5% of their revenues in efficiency, and on the water side it is 1%” explains Cooley. “You see that [water utilities] are more dependent on grant money to fund efficiency programs.” This may change since efficiency upgrades are such “low-hanging fruit,” but on the other hand, it’s another argument for water utilities to seek greater collaboration with energy utilities because of the added funding and momentum.

Resilient design to fill in the gaps

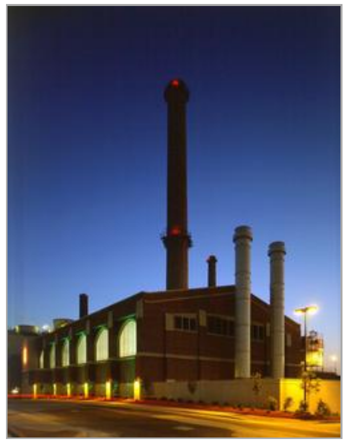
Where financial models do leave gaps, project teams are finding that the resilience argument works to provide some justification. With West Virginia’s 2014 Elk River chemical spill fresh in people’s minds, and wells continuing to run dry as the California drought drags on, public awareness about the threats to the security of our water is running high.

“More and more people are understanding the importance of water. When we see its limits, the idea of a water supply becomes more real to the public, says Muñoz. “This year has become a big eye opener.”

Such a lens can make decentralized water look like a good idea from a resource security perspective. “If you look at West Virginia, having gone five days in a row without access to water, you realize that if they had had a decentralized system or net-zero-water building it would have almost been like a storm shelter—you might not rely on it for everyday [needs], but 300,000 people without access to water is a big concern," says Ryan McEvoy. Craig Briscoe agrees that a benefit is the multiplicity of systems. Referring to the Lloyd Ecodistrict project, he says, "It occurred to me that should there be a disaster of some kind and the public infrastructure is damaged, you still have a big source of water there."

Some universities and colleges have already invested in a decentralized system to supply their own water needs. Cornell University, for example, maintains its own potable water system, supplying 35,000 people. The system is capable of providing 1.7 million gallons of water a day but can tie into Ithaca's water supply if needed.

Schools in particular recognize the need for a reliable source of water, according to Pauline Souza. In conversations with the Sacred Heart School, an administrator brought up how important it is to have operable bathrooms; in a disaster, a school can operate without electricity, but it has to close down without working bathrooms. "That's when you realize how important water is. Without it, everything stops," says Souza.



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The combined-heat-and-power facility at University of Missouri-Columbia has so-called black start capability, and the campus operates its own full capacity water system so that, in an emergency, the campus can operate independently.

Photo: Assassi Productions of Santa Barbara, California

Schools are also more apt to think long-term, says Brian Feagans of Ratcliff Architecture. "If you can tie resilience thinking into the long-term survival of the organization, you can really have success," says Feagans. Not only might they consider it part of their educational mission, but also "they are more likely to look beyond upfront capital because they have to consider a long lifespan."

These resilience discussions naturally tend lead to water's connection to energy, where schools are also taking the lead with district-scale systems. At the University of Missouri–Columbia (MU) the campus can operate in islanding mode and provide water and power even if the city's centralized systems go down. Deep well pumping stations currently supply drinking water to the campus, which can be connected to the municipal supply for backup. The campus also has "black start capability," meaning it can start generating after an outage without needing to draw power from the grid, according to Paul Hoemann, the director of campus facilities at the MU, because a two megawatt diesel generator at its combined heat and power facility can be used for auxiliary power to start up other steam and electric generating equipment.

In the context of the Carbon Free Water program, Grant Davis argues that a transition to renewable energy sources is best: "It is clear that making a water system less dependent on fossil fuels and more tied to renewables makes for a more resilient system," he says. But until that's possible everywhere, schools, at least, are taking measures to ensure that if their energy supply is threatened, water delivery won't also come to a halt, which could be a model for other district-scale projects.

A Range of Solutions

As practitioners break down barriers to net-zero water, address the water-energy nexus, and piggyback on resilience discussions, experts are finding a second wind to approach water in a new way. "It's not hard to say that we need to be ambitious," says Souza. "It comes down to maintaining our existence."

Whatever the motivation, solutions that get more from water on multiple scales are most exciting. Water use restrictions and efficiency programs are being utilized when water is scarce to control needs from the demand side, which translates to more favorable financial drivers and support for the resilience argument that appeals to a diverse group of stakeholders. Net-zero strategies offer more management over the site, and eco-district and utility-scale solutions bring an economy of scale to efficiency solutions. All of these strategies show promise, and if employed together, could offer a multi-dimensional approach to managing our water needs.

May 5, 2014

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