

Urban Flooding and Energy Efficiency: Leveraging Community Action

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ABSTRACT

Urban flooding is a widespread problem in the United States. Research in Cook County, Illinois, maps an unexpected trend: flooding is not correlated with federally designated floodplains, but instead is caused by rainfall that overwhelms the capacity of drainage systems. The consequences of urban flooding are significant. In addition to damaging buildings, flooding has community-wide impacts, including health risks, degraded water quality, and depressed property values.

This paper describes lessons learned from a pilot program co-delivered by the Center for Neighborhood Technology and its affiliate, Elevate Energy, which combines flood mitigation assessments with energy efficiency services. In addition to water conservation measures, recommendations to reduce flooding vulnerability are provided. Measures include standard plumbing and waterproofing repairs as well as source reduction strategies such as installing water permeable paving and disconnecting downspouts from sewer lines. Water conservation recommendations include building rain gardens and installing rain barrels to provide irrigation water.

One benefit of this co-delivery of energy efficiency and flooding mitigation services is a more comprehensive and systemic evaluation for building owners. By targeting flooded areas, the pilot engaged a new constituency and provided a mechanism for larger-scale solutions, for example, organizing a constituency to lobby for infrastructure improvements on a municipal level. The paper also includes a discussion on challenges, including cross-training energy auditors in unfamiliar trades and educating building owners on technically complex options.

As climate change precipitates extreme weather events, community flooding preparedness is an important aspect of resiliency. Bundling energy and water services can contribute to a future of reduced operating costs and safer, healthier buildings.

Introduction

Consideration of the relationship between water and energy efficiency has primarily been focused on water supply and conservation. But water removal and disposal systems are also important, and can have a significant impact when water acts in unexpected ways: specifically, when uncontrolled water invades a building. Flooding is an expected outcome in floodplains, which are designated geographic areas, usually near bodies of water. However, because of increased urbanization and paving of natural areas, a more recent type of flooding has emerged outside the designated floodplains, in places where flooding has previously not occurred. “Urban flooding” is defined as flooding that occurs in populated areas that have lost soil and vegetation surface area due to built infrastructure: pavement, roads and buildings.

The causes of urban flooding are multifaceted. One reason is the disappearance of open ground, especially in densely populated areas, where the built environment has interrupted natural drainage patterns. Another is that maintenance and upgrade investments of the existing

infrastructure have not kept up with development; municipal sewer systems were not designed to handle present day populations and modern water uses. In addition, many of these systems are still in place well past the end of their serviceable lives. A recent study estimated that 14 -18% of our nation's daily water use is lost due to aging pipes and outdated systems (CNT, 2013a). Finally, one of the consequences of climate change is that major storms are becoming more frequent, and are occurring in areas previously unaffected by severe weather events.

Thus, it makes sense to consider buildings' stormwater management systems as part of efforts to make buildings more energy efficient. A holistic approach can reduce the demand for water as well as the amount of water that must be removed after use. The synergy extends to the distribution and treatment of water, which also represents a significant expenditure of energy (EPA 2014).

The financial consequences of flooding are severe for both households and municipalities. An analysis of five years of Cook County Illinois data found claims totaled more than \$773 million during that timeframe (CNT, 2013b). Farmers Insurance recently filed a lawsuit against Chicago and its suburbs, citing flooding as a foreseeable risk for which local governments were liable (Weissman 2014). Because both the causes and consequences of flooding are not always confined to a single building site, it also makes sense to address flood mitigation on a community-wide basis.

This paper describes our efforts to design and implement a combined energy and water efficiency pilot program with an additional focus on flood prevention. While flood prevention is not an obvious complement to energy efficiency services, both share similar goals of making buildings operate efficiently and effectively. In cases where needs are acute, both services can make building residents safer and healthier. Reducing the costs and destruction of uncontrolled flooding can improve household and community resiliency

Background

Including evaluation of water use in an energy audit is not a new idea in the energy efficiency world; the water/energy nexus is well-documented (Young 2013). But the practice has been slower to take hold in some locations than others. Greater metropolitan Chicago is one of those areas. Water supply costs are relatively low and the proximity to the Great Lakes leads people to believe that water is plentiful. However, in recent years, this reality has changed due to both economic factors (municipal budgets are stressed) and the new climate reality. Chicago water rates have increased significantly, and additional increases are promised for the future. Therefore, including water efficiency recommendations in our energy efficiency work has gained a new urgency.

Water efficiency can be addressed by managing both the supply and end use/demand side. Measures to reduce the amount of water used, such as faucet aerators and low-flow showerheads, are low-hanging fruit. Using greywater (water that has been used by building residents for dishwashing or showers and can be reused for other non-potable purposes) is a subset of supply management. Greywater systems have great and untapped potential. However, they require significant investment in re-engineering plumbing systems and require policy changes in many municipalities. Thus, the incentives are less compelling in a context where water is cheap.

However, fees based on usage are not the only costs for water. The costs of waste water treatment also need to be considered. The system for removing waste water and stormwater runoff via the sewer system, and for delivering the effluent for treatment is “accomplished through a network of purification plants, tunnels, pumping stations, water mains, sewer mains, valves and structures that require constant upkeep and maintenance.”¹ When sewage and storm drain systems work as designed, water disappears quickly and is out of sight and out of mind. But water from a large storm event can overwhelm even a well-designed sewer system. The default response is to upgrade the sewer infrastructure. But for many municipalities, the cost for this upkeep is prohibitively expensive. Chicago began construction of the Tunnel and Reservoir Plan, a giant auxiliary sewer and reservoir system, in 1975. Many decades and millions of dollars in budget overruns later, the project is still incomplete.

When these systems don’t work as designed, the result can be basement flooding. An analysis of flood and drain-backup damage claims in Cook County, Illinois found that damage from these events is “chronic and systemic, resulting in damage that is widespread, repetitive and costly.” Moreover, there are “multiple social and economic impacts on property owners: our online survey found that 84% reported suffering from stress and 13% from ill health associated with basement flooding. Forty-one percent lost the use of part of their property, 63% lost valuables and 74% lost hours of work to clean up” (CNT 2013b).

Traditional fixes for basement flooding at the individual building level owing to infrastructure failures are to install a sump pump, backwater valve, or overhead sewer. However, these installations are costly. An alternative is a system that prevents water from entering and overwhelming the sewer in the first place. For example, the building’s downspout (which collects water runoff from roofs and sends it to the sewer) can be disconnected and diverted. In the context of the new reality of scarce water supply, stormwater can be repurposed for a needed use, such as into a rain barrel for irrigation.

This pilot project was designed to explore the issues in water management, as well as energy and water conservation, in buildings. Complementing energy efficiency with flood mitigation services would have multiple benefits. The reality of climate change means that water will often be in the wrong place, at the wrong time, and in the wrong quantity. For building residents, reducing flood damage would have direct financial and health benefits. Urban flooding has consequences beyond property damage—for example, it degrades water quality by contamination with runoff carrying pollutants like fertilizer and motor oil. This pilot was undertaken in part to test a direct mechanism to help mitigate the effects of climate change and make communities more resilient.

Pilot Project Description

Elevate Energy developed “whole site” assessments for buildings that combine a standard energy audit, including water energy efficiency measures, with recommendations for reducing stormwater impacts. These assessments provided building owners with independent expertise and helped them make informed decisions regarding building and site improvements.

¹ <http://www.cityofchicago.org/city/en/depts/water.html>

The pilot target audience was comprised of owners of single family and small multifamily (two to four unit) buildings. An early observation was that the model for incorporating water assessments into the energy audit proved to be different for these housing types than for larger multifamily properties. For the latter, the number of residents makes water bills large enough that building owners are motivated to try and reduce them. These properties currently have options such as performance-based contracting, where vendors can install a suite of products that can be financed by the water savings.

In contrast, small multifamily buildings have proportionately lower water bills and therefore, savings opportunities are smaller. In Chicago, single and two-family homes have minimal incentive to save water, because their water service is unmetered.² This oddity is a historical remnant of vintage buildings. At the time they were built, water was so inexpensive the cost of providing a meter was prohibitive.

Although extensive water efficiency measures might not be cost-effective options, we chose to focus on this building type because these properties are more likely to have basement units converted to livable space. Thus, the consequences of flooding were more adverse than in a basement used solely as a service area for mechanicals or for storage, as is more common in larger multifamily buildings. Wet basements reduce the amount of usable space in the building and decrease property values by 10-25% (CNT, 2013a).

The pilot offering included a traditional energy audit by a Building Performance Institute (BPI) certified auditor to identify opportunities for energy efficiency upgrades and identify health, safety, and comfort issues. Water conservation opportunities were added as a direct-install offering. Auditors carried faucet aerators and low-flow showerheads that could be installed at the time of the audit. It was recommended that a water meter be installed if not already present and water savings estimates were calculated in dollars and gallons, and included in the building report.

Building owners were also offered a stormwater assessment service. Wetroof™, is the nation's first wet weather retrofit service. The goal of the project was to identify approaches, tools, and services to help reduce flooding in properties and neighborhoods. The target properties were those impacted by urban flooding and not located in a designated floodplain.

These assessments had a significant customer engagement component. The program used the assessment as an opportunity to engage and educate property owners. Unlike energy audits for larger buildings, where the auditor can work with a manager or maintenance staff, the building owner is required to accompany the auditor as they performed the assessment.

Wetroof assessments include a homeowner interview, followed by a visual inspection of the property and technical assessments of flood risks. The interview gathered additional information about ephemeral characteristics of flooding, such as height of water, condition of water entering home, and duration of inundation. A visual inspection is used to confirm owner reported experiences with flooding. Technical assessment includes “televising” the sewer (examining the private sewer drain with a camera) to determine if there are existing risks associated with the condition of the private sewer drain, monitoring levels of moisture in basement foundation materials, and testing infiltration capacity of soils. The combined

² City of Chicago MeterSave <https://www.metersave.org/>

assessment allowed the audit team to make an informed recommendation for measure to mitigate future flooding.

For both the energy audits and the Wetofits, Center for Neighborhood Technology (CNT) and Elevate Energy staff served as an intermediary between the building owner and contractor. This was a value-added service for both of these parties. Building owners often needed assistance in finding qualified contractors, and contractors benefited from reduced customer acquisition costs. Because building envelope improvements were almost universally needed in these buildings; energy audits included a consultation with an air sealing and insulation contractor at the time of the assessment, and the assessor could consult with the contractor on developing an appropriate scope of work.

The results of the assessments were summarized in a written report, which included a prioritized list of recommendations for upgrades and estimated costs. The energy audit reports included the actual proposal for the air sealing and insulation work, as developed during the site visit. The costs for flood prevention measures were an educated estimate of the prices for the work. Identifying the contractor pool and developing an inventory of measures and costs were part of the deliverables for this pilot.

The following measures were potential recommendations in a Wetofit assessment.

- Disconnect downspout
- Add extension to downspout
- Gutter cleaning and maintenance
- Install sump pump
- Upgrade sump pump - secondary or battery backup
- Clean sump pump line
- Install backwater valve
- Install overhead sewer
- Cut and cap standpipe
- Patch and caulk windows with proper slope
- Repair existing concrete/grout in foundation
- Remove impervious surface
- Install permeable paving
- Amend soil
- Grade landscape
- Install water harvesting system: rain barrel /cistern with proper overflow route
- Add drywell or infiltration trench for rainwater capture
- Install flow-through planter
- Install rain garden or bioswale
- Plant native or adapted vegetation
- Install green roof

The measures showed considerable range in complexity and cost. Additionally, it was not uncommon for the recommended measure installations to require the coordinating of multiple trades, such as plumbers, landscapers, and paving contractors.

For building owners who wanted to invest in the upgrades, we identified contractors, managed their site visits, and reviewed their bids. After or during construction, we provided oversight inspections.

One is Not Enough—Promoting Collective Action

The confluence of factors that cause urban flooding can be, in many cases, beyond the individual property owner's ability to solve. Paved surfaces are the predominant feature of

typical urban environments. In addition, many cities are served by aging and inadequate sewer systems. Chicago's network of water infrastructure has, in many cases, been in service for over 100 years. These systems are often in poor repair or overdue for replacement, and even in the best case scenario are inadequate for handling the demands of modern living and its plumbing needs.

Chicago also shares the challenge of many cities—scarce revenue dollars. The reality is that areas experiencing urban flooding will be competing for the allocation of limited funds. While expanding storm sewer storage capacity may be necessary, these projects are massive multi-year commitments, not a quick fix.

As short-term responses to urban flooding, the City of Chicago promotes several lower-tech options for mitigation. One is a technological fix—installing “rain blockers”, a plastic device that fits inside the grated sewer openings covering catch basins in the street. Rain blockers work by slowing the flow of water into combined sewers. Streets remain flooded for several hours after a storm event, but stormwater that is kept out of the sewer reduces the risk of sewer backups into homes.

The City also strongly encourages the disconnection of downspouts from the municipal sewer system. Rain water that is directed into a home's private sewer drain increases the risk that water may backup into the home's basement during larger storm events, or if the private drain is blocked, in cases of grease build-up or partially collapsed drains. Instead, this harvested water could either be diverted to a rain barrel for use as irrigation or into land-based filtration sites like a rain garden. To promote these solutions, the City established the Sustainable Backyards program, which provides 50% rebates on the costs of rain barrels, native plants, and compost bins.

Due to the localized nature of urban flooding, the City is attempting to organize residents in a concentrated geographic area, such as a city block, to work cooperatively on reducing the likelihood of flooding. This strategy increases the likelihood that when the effective but small-scale interventions of disconnecting downspouts are done in aggregate, they will have a significant, measurable effect on reducing stormwater overflow or reducing water backup in basements. This campaign, the Basement Flooding Partnership (BFP) asks property owners to work with City officials on urban flooding. The partnership emphasizes the collective responsibility of flood prevention: “Tired of Basement Flooding? Want to Be a Good Neighbor? Please join the Basement Flooding Partnership. It's Not Hard Or Expensive. But, You Have to Care.”³

Through this partnership, the City offers the expertise of its water and sewer department staff to evaluate the existing water disposal system and make sure mechanisms like rain blockers are in place and functioning. Engineers assess the sewer infrastructure to determine whether the existing pipe network is a sufficient size to handle the present and projected rain conditions. They also make site visits to evaluate the condition of the sewer lines via “televising the sewer” in the target area and, as necessary, perform repairs like removing blockages or cleaning mineral deposits lining the pipes. After the assessment, the City has a “report back” session where the City and residents meet to discuss the findings. To date, the City has completed six of these in-depth analyses.

³ BFP: http://www.cityofchicago.org/city/en/depts/water/supp_info/basement_floodingpartnership.html

The BFP is careful to make it clear that the City's responsibility is limited to what happens outside of people's homes, i.e., basement flooding is the building owner's problem. Wetrofit services are cited as a resource; however, no funding is provided for these assessments. This limits our ability to provide these services.

The City's stated requirement for deploying the resources of BFP is that 75% of the property owners in the target area must commit to "supporting" the effort before the City's resources are deployed. However, for the six partnerships that have occurred to date, community support has been limited. Part of this is due to the nature of those involved: the City staff are engineers, not community organizers. Building a constituency that understands the nature of urban flooding requires concerted, longer-term efforts that are sustained past the receding of the flood waters.

Simultaneously, CNT has been working to build an informed and involved public by holding outreach events organized to solicit input from people affected by flooding. These forums, dubbed Gross Gatherings, were convened in neighborhoods affected by urban flooding. Attendees shared flooding stories about the emotional devastation and economic loss brought about by urban flooding. The flooding constituency is also supported by a Facebook Group: "The Gross Gathering: Fighting Urban Flooding Together"⁴. These gatherings also generated the referrals for the Wetrofit pilot.

Results of the Pilot

Elevate Energy launched the Wetrofit pilot project in July 2013. The pilot was marketed with Elevate's Small Multifamily Buildings program over a six month period. During this pilot period, 160 applications were received. Applicants were asked via a survey with a ranked list why they were considering improvements for their building. Of those applicants, 60 (38%) ranked "Stop flooding" as the first or second priority. Most customers ranked "Save money on utility bills" as their first priority.

Another group of 44 applicants was referred from CNT's urban flooding outreach activities. Of these, 18 assessments were completed, and five projects had the recommended flood prevention measures installed.

A primary learning from the Wetrofit pilot was that finding contractors to provide flood prevention retrofits is a challenging task. The scopes of work recommended were for comparatively small jobs that construction contractors did not find attractive due to the small profit margin and, thus, they were reluctant to perform the work or priced their bids prohibitively. A skilled handyman could successfully undertake many of the proposed measure installations; however, these tradespeople typically did not have the insurance and licenses required of our partners.

Contractors who did partner on the Wetrofit model also found the approach required by Wetrofit different from their standard jobs. Contractors often tended to endorse the repairs or

⁴ "Fed up with sewage, slime, mold and flies in your basement? The Gross Gathering is a forum for people fed up with wet basements and flooded yards as a result of urban flooding."
<https://www.facebook.com/groups/223230424495367/>

installations of their particular trade, without considering other options or a more holistic approach. For example, to a plumber, a flooded basement requires the installation of a sump pump. Green infrastructure recommendations, like changing the grade of the landscape and disconnecting downspouts, will not usually be considered.

As an unbiased third party who could evaluate various options and develop a scope of work that addressed the problems efficiently and cost-effectively, the assessor was a unique resource. On a post-audit survey, 100% of respondents were either “Very Satisfied” or “Satisfied” with the service. However, there was no consensus from building owners on the value of this service. When asked to assign a value, the responses ranged from “Less than \$100 (30%),” to “Greater than \$400” (20%), with intervening values evenly distributed.

Driving Demand and Barriers to Participation

The whole site assessment, like other energy efficiency programs, requires careful attention to the motivations that incent participation. For building owners, projected savings on utility bills are usually not sufficient to motivate investment in energy conservation measures; identifying other motivators is necessary. Removing barriers to participation is also key. We addressed one barrier, the cost of the audit, by securing funding from a charitable foundation for the energy audits. These funds were designated for low-to-moderate income housing, and were specifically targeted for small multifamily apartment buildings, with two, three or four units. The “free” audit was especially important as property owners were still struggling with the recent recession. The conversion ratio of energy audits to retrofits was 38%.

This economic reality also meant that many buildings were affected by deferred maintenance. In some cases, lack of investment resulted in deficiencies that posed health and safety hazards, such as furnaces emitting carbon monoxide, or other pre-weatherization barriers. Thirty buildings had conditions such as mold, friable asbestos, or unsafe combustion conditions identified at the time of the audit. While these conditions needed to be corrected before energy efficiency upgrades could be installed (another potential barrier), the identification of these deficiencies was a value-added benefit for these property owners. Their buildings were not only their most significant financial asset but also their place of residence. Emphasizing improvements that resulted in a safer, healthier home became one of the benefits cited as part of the more comprehensive whole site audit.

Building owners who sought the Wetrotfit assessment due to the severe disruption and high costs associated with flooding might be considered to be strongly motivated to proceed with measure installation. To date, the conversion rate of assessments to installations has been relatively low (28%). The pipeline for building owners considering recommended retrofits is 14 projects (82%) in “bid solicitation and negotiation” status. Building owners also reported via the survey that they were looking for financial assistance to implement the recommended improvements. This reinforced our observation that flooding was yet another burden for building owners, especially those in the low to moderate income population.

The pilot also identified failures in attempts to remove barriers. For example, rain barrels were recommended by the City and either subsidized with a 50% rebate or provided free. Rooftop rainwater capture is simple, cost-effective, and reduces demands on existing water supply sources as well as reducing the risk of sewer back-up (Garrison 2008). However, building

owners were required to purchase, transport and install the water barrels themselves, activities that many owners were reluctant or physically unable to perform.

How Good a Fit? Integrating Two Very Different Areas of Expertise

The change of focus from building-centric to a “whole site”-focused assessment accommodated both what building owners needed to maintain their real estate assets; and how meeting those needs could contribute to mitigating the effects of climate change. Energy efficiency provides both economic and environmental benefits. Adding a flood assessment to the program offering made sense as an efficiency in service delivery. Bundling the services would require only one meeting with the building owner. We also anticipated that offering these services together would provide cross-promotional opportunities, which would manifest themselves in savings in customer acquisition.

In reality, the bundling of these services proved to be challenging. Because most building owners had limited building-related knowledge, even well-crafted, simplified explanations of energy conservation and water-related measures were time consuming. When the pre-assessment consultations were attempted, building owners reported experiencing “information overload”. And while the goal was to convince building owners to consider a holistic perspective about their buildings’ operations, they were understandably fixated on the most disruptive problem. During the pilot period, only three properties had the combined Wetrotfit and energy assessment, and none of those completed the Wetrotfit measure installation. However, recruitment via cross-promotion of services was successful because the target population was familiar with our organization and its services—we solidified our status of a “trusted messenger”.

The Wetrotfit pilot was staffed by a landscape architect, whose expertise was supplemented by the building science knowledge provided by energy assessors, who were all experienced, BPI-certified auditors. The pilot was envisioned as an opportunity to cross-train energy assessors in flood risk assessment, and some progress was made on this effort. However, the pilot also demonstrated that the learning curve was steep, and required expertise outside of a BPI-certified auditor’s skillset. For example, one of the auditors was a trained plumber, whose expertise proved to be highly relevant, and not quickly transferable.

The direct installation of faucet aerators and shower head fixtures was a definite efficiency for implementers and participants. Energy assessors replaced 59% of kitchen faucet aerators, 62% of bathroom sink aerators, and 60% of the showerheads in the housing units they visited. When water conservation measures were not installed, participants either had plumbing fixtures that did not fit the available equipment or refused installation. The latter is a common response of residents in older buildings where adequate water pressure is a problem.

The Wetrotfit pilot did not include recommendations on the related service of flood restoration of damaged interior spaces. This is an important component of flood mitigation. For – for example, the added costs of 10-15% would be offset by savings from the higher quality, more resistant installations (Algan 2006). However, providing this expertise is outside the scope of this pilot.

On both the energy and water assessments, staff inquired as to whether buildings had a metered water supply or were non-metered and paying the default water charge. The City’s

Department of Water Management’s “MeterSave” program⁵ is an effort to update the meter infrastructure. As an incentive for meter installation, the City provides a seven year guarantee that their bills would not exceed the non-metered cost. In most cases, they anticipated the metered water bill would be lower than it was before the meter was installed. While this represents a shorter-term loss of revenue for the City, it positions them for future increases in water usage charges that are based on data. Participants who took advantage of this offer found that the City’s assertion that their actual usage charges would be lower than the non-metered charge proved to be true. One participant reported significant reductions; with a water bill that is \$250 lower annually, other published reports cite savings that range from \$151-\$300 annually⁶.

Discussion

Including an assessment of water management in an evaluation of a building’s efficiency, on both the supply and end use or demand side, has value for both the building owner and the environment. While water conservation may not have the urgency in some geographic areas as it does in other locales, shortages and higher future costs are guaranteed and preparation for this eventuality are well-advised. However, the best mechanism for providing these value-added opportunities is not yet clear, nor is the business case. While customers who had received the Wetrofit service rated it highly, 59% of homeowners responding to a market potential survey indicated that they expected such a service to be free. A possible explanation could be an opinion that the service was akin to a “free estimate” from a contractor. This particular sample was also fielded to a group of homeowners who have been able to take advantage of “free” energy audits (which are made possible by grant funding).

There is beginning to be recognition that the economies of prevention and mitigation have a compelling cost-to-benefit ratio. There has been some progress in the industry globally in developing products and services to help global consumers and businesses reduce their exposure to climate change, which also reduce the emissions causing global warming (Mills 2009). This industry is reassessing risk management and recognizing that money invested on prevention and mitigation may have a better return than paying for post-flood relief (Zurich 2014).

In the U.S., the Center for Insurance Policy and Research has also been discussing climate change since 2008. The federal Biggert-Waters Flood Insurance Reform and Modernization Act of 2012 recognizes that the old flood hazard areas are changing and provides mechanisms for phasing in the risk premiums over a period of years (NAIC 2013). However, while the increased incidence of flooding has prompted a re-examination of flood insurance coverage; at present, changes in actual coverage rates (e.g. lower insurance rates for buildings with flood reduction installations) are not standard.

Changing the status quo from repeated, reactive responses requires changes in policy and practices. In the Great Lakes region, the Wetrofit model is part of a larger strategy on smarter water management. The initiative “Smart Water for Smart Regions” addresses multiple aspects

⁵ Participants are also eligible to receive a rain barrel, an outdoor water conservation kit or an indoor water conservation kit. <https://www.metersave.org/>

⁶ Chicago Tribune: http://blogs.chicagotribune.com/news_columnists_ezorn/2011/11/soak.html , http://blogs.chicagotribune.com/news_columnists_ezorn/2012/04/update-.html

of water use, conservation and management. Resources devoted to education and organizing as well as implementation are still a missing piece.

We believe this pilot start-up identifies an important emerging market. There is no shortage of opportunities for both energy efficiency upgrades and flood reduction retrofits. Strategies for more effective water use, collection and treatment methods will become increasingly important as incidences of urban flooding increase. Business-as-usual will only guarantee greater use of energy and higher costs.

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