



**EMPOWERING
WATER UTILITY
INNOVATION -
A PATHWAY TO
SUSTAINABILITY**

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FOREWORD

Innovation and sustainability are the two holy grails to attain in contemporary business. Innovation is about testing the present, pushing the envelope and challenging the norms to



create ideas and discoveries that realize greater value for customers and economies. Sustainability, also a process of change, is defined by practices that strike a balance between social, environmental and economic interests to benefit current and future generations.

As the Principal Investigator for the Water Research Foundation (WRF)/Water Environment & Reuse Foundation (WE&RF) Project *Fostering Innovation within Water Utilities*, Arcadis developed the Innovation Framework as a tool for accelerating innovation in the water sector. In this report *Empowering Water Utility Innovation*, we advocate that innovative investments and programs will likely yield sustainable outcomes.

A previous report, the Arcadis *Sustainable Cities Water Index* (SCWI) evaluated 50 cities to identify which ones are harnessing water assets for the greatest long-term advantage. The SCWI defined water sustainability according to three overarching criteria: resiliency, efficiency and quality and concluded that in order to achieve long-term viability, city leaders need to pay close attention to each area of water sustainability. Which brings us to this report, where we reveal innovation as a pathway to water sustainability. These innovations lead to the attainment of 'Sustainability Dividends' such as storage security, waste reduction and asset longevity, which ultimately benefit the utility, the city in which it operates and most importantly, the people which it serves.

An awakening is needed. Failure of our water utilities to innovate will inhibit not only our ability to achieve water sustainability, but also business sustainability, impacting brand, bottom line and customer satisfaction ratings. Utilities are the hands in which governments and cities put their trust in to provide water, our most precious resource, to citizens and businesses. In the face of climate change and the need to manage assets, innovation is the clear and needed answer for water utilities to evolve and thrive. While over 90% of utility professionals surveyed in the WRF/WE&RF research believe that innovation is critical to the future of their organizations, very few have effectively adopted all key disciplines of innovative utilities.

Arcadis' *Empowering Water Utility Innovation* report highlights the WRF/WE&RF research Innovation Framework to enable an environment of creativity, experimentation and incubation to achieve new approaches to serve customers, manage assets, finance investments and realize superior utility performance with the added dividend of enhancing sustainability. Many utilities are now in prime position to ante up to innovation strategies. I invite you to read this report and take the actions needed to become an innovative utility – collaborate with peers, consultants and partners in and outside of the industry. It is this shift that will allow utilities to address their challenges more effectively.

John J. Batten
Global Cities Director,
Arcadis



GUEST FOREWORD

Fostering Innovation within Water Utilities

Innovation, as a business practice, has been broadly practiced in the private sector for decades. More recently, studies have examined the methods for adopting these practices in the public sector, but few guidance resources are available to water utilities as they face emerging challenges unique to their business model and mission.

Utility structure and processes are built for reliability and repeatability, which can breed a culture averse to trying new and relatively untried ideas. Consequently, investment in new concepts can be slow.

Potential innovators or “ideators” have daily responsibilities that crowd out idea development and communication. Further, ideas are often undeveloped and difficult to translate into concrete actions and outcomes.

To spur innovation developments in our water utilities, Water Research Foundation (WRF) and Water Environment & Reuse Foundation (WE&RF) launched the research project, *Fostering Innovation within Utilities*, in partnership with Birmingham Water Works Board and other utilities from North America, Europe, Asia and Australia, to develop guidance for utility innovation based on successful programs in the utility and commercial sectors.

Like us, these utilities saw a need for an Innovation Framework geared specifically toward utilities to foster a culture that encourages creativity and facilitates implementation of new ideas. In total, project partners from 50 utilities, professional associations and commercial sectors worked together to develop a knowledge base from over 30 innovation programs including 14 detailed case studies.

The term “innovation,” as used in the guidance manual, is defined as the application of new ideas resulting in increased value to utility customers and/or increased utility productivity. Using published literature, global surveys and lessons learned from current programs, the research team facilitated a series of workshops with water utility professionals from around the world to develop a framework for fostering innovation within utilities. This manual is intended to help utilities that are building or improving utility innovation programs.

Our hope is that water utilities will use this guidance manual to assess their innovation environment, which can foster new ideas and allow implementation of new approaches that will transform their organizations and enhance their ability to meet future challenges.

Rob Renner
Chief Executive Officer,
Water Research Foundation

The full guidance manual and more about the project can be found at www.waterRF.org/FosteringInnovation



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EXECUTIVE SUMMARY

Water utilities are facing complex pressures.

Challenges include aging infrastructure, shifting workforce demographics, unreliable sources of supply, emerging regulations and rising customer expectations. Forward-thinking utilities of all sizes are creating programs to address these challenges. These programs and cultures produce new tools, practices and processes that reduce expenditures, improve organizational resiliency, create new revenue streams, strengthen community relations/brand and improve employee morale, staff engagement and product quality.

The industry recognizes the importance of innovation, but we are in the early stages of the journey.

While over 90% of utility professionals surveyed believe that innovation is critical to the future of their organizations, few have effectively adopted the key disciplines of innovative utilities. The good news is that innovative utilities are leading the charge for others to follow.

Culture is the biggest hurdle to innovation.

While risk aversion is often quoted as the primary culprit in stifling utility innovation, the challenge is more fundamental than it first appears. The nature of the business influences the behavior of utility employees, organizational norms and hiring practices. Over time, this dynamic produces procedure-centric siloed organizations, which are not ideal for fostering innovation. Further, unarticulated risk profiles make utility leaders wary of trying new concepts.

The role that utilities play as part of innovation is evolving.

For the past decade, the water industry has tried to drive innovation through the development of technologies, however we believe that utilities hold the key to enabling

an era of holistic water sector innovation in a move from being the consumer of innovations to the creator of them.

Building an innovation engine is achievable at any scale.

Research and results from a series of collaborative utility leader workshops identified eight key disciplines of innovative water utilities. These disciplines provide the foundation for a culture of innovation and can be actively implemented as part of an innovation program.

Digital is changing the industry.

The impact of the digital era is bringing new opportunities and challenges to our field. In a data-rich industry like water, technology disruptors such as the Internet of Things (IoT), Big Data, Predictive Analytics, Cloud Computing and Mobile Technology – to name a few – will fundamentally change the way the business is run. Utilities must adjust their processes, systems and people to adapt to the digital landscape. Innovative utilities will be the driving force and key beneficiaries of the digital transformation.

Innovation is a pathway to sustainability.

By building an environment of creativity, investment and experimentation, innovative utilities foster new approaches to serve customers, manage facilities and finance system infrastructure needs. Innovation enables utilities to effectively engage internal and external resources to continuously improve operations and increase value for their customers through improved system resiliency, efficiency and quality, the three elements of water sustainability. Not only is innovation a pathway to utility sustainability, but it transforms utilities into catalysts for regional sustainability.

3

INNOVATION AND SUSTAINABILITY

“WE ALL HAVE PROBLEMS - WHAT WE NEED ARE SOLUTIONS. AMERICAN WATER BELIEVES THAT INVESTMENT IN RESEARCH AND INNOVATION IS STRATEGIC AND NECESSARY TO ADDRESS THESE CHALLENGES.”

MARK LECHEVALLIER, PHD, DIRECTOR OF WATER TECHNOLOGIES, AMERICAN WATER

The Arcadis Sustainable Cities Water Index (SCWI), developed with the Centre for Economics and Business Research (CEBR), defines water sustainability as resiliency, efficiency and quality - critical elements of a city’s success (Figure 1). Water is fundamental to a city’s quality of life and sustainability; when a city’s water resources are properly leveraged, the city has the ability to attract people and investment to stimulate growth. At the same time, when cities do not adequately manage their water resources, their vitality and competitiveness may be threatened by flooding, water scarcity, service interruptions and water quality issues.

Such challenges are reflected in the United Nation’s (UN) Sustainable Development Goals. In Sustainable Development Goal 6, the UN focuses on ensuring safe access to water and sanitation for all and in Sustainable Development Goal 11, the focus is on making cities inclusive, safe, resilient and sustainable. However, water utilities are faced with numerous roadblocks that hinder their progress to achieving sustainability such as aging infrastructure, an aging workforce, unreliable sources of supply, emerging regulations and rising customer expectations, which result in escalating costs of service. These costs have traditionally been passed on to customers through

increased water rates - for example, nearly 70 percent of North American utilities report flat or dropping water sales¹ - sagging demand, concerns over affordability and dropping revenues are leading utilities to question longstanding practices.

As managers of water, wastewater and stormwater systems, utilities should play the leading role in water sustainability. Some cities are implementing strategies to become more sustainable. This may be in the form of bold challenges to address issues across the social, economic and environmental spectrums of sustainability; or a decision to do more with less, or address the threat of climate change. In response, so too then must the utilities adapt to become more sustainable and better stewards of our water resources.

An awakening is needed.

Utilities are increasingly realizing that they need to think differently and adopt new and strategically innovative approaches and ambitions. Some pioneering utilities have already begun to transform by embracing innovation and adopting dynamic and sustainable practices. This trend has opened the door to tools, practices, technologies and processes - innovations - resulting in reduced expenditures, improved organizational resiliency, new revenue streams, strengthened community relations and brand, improved employee morale, better product quality and more. These advances have fueled follow-on improvements, resulting in an infusion of new ideas to fortify their utility organizations, an increase in value to the consumer and a realization of sustainability dividends (see Figure 10 - Innovative Water Responses and Sustainability Dividends). Utilities are discovering that fostering a culture of innovation is a pathway to sustainability.

¹ American Water Works Association, *State of the Water Industry Report*, 2015

FIGURE 1: THREE ELEMENTS TO A SUSTAINABLE WATER FUTURE



“ UTILITIES ARE INCREASINGLY REALIZING THAT THEY NEED TO **THINK DIFFERENTLY** AND ADOPT NEW AND STRATEGICALLY INNOVATIVE APPROACHES AND AMBITIONS. ”



Want to see examples of sustainability dividends?

SEE PAGE 24

4 CLOSING THE UTILITY INNOVATION GAP

91%
OF WATER UTILITIES BELIEVE THAT INNOVATION IS CRITICAL TO THEIR FUTURE

40%
OF WATER UTILITIES HAVE SEEN MEASURABLE CHANGE THROUGH INNOVATION

The WRF/WE&RF global research team, led by Arcadis as the Principal Investigator, conducted a water and wastewater utility survey and four face-to-face workshops with utility leaders, which resulted in the utility innovation framework.

It found that of the 423 utility professionals surveyed, over 90% of respondents believe that innovation is critical to the future of their organization. However, only 40% believe that they have seen measurable change through innovation. For decades, the water industry has tried to drive innovation almost solely through the consumption of new products and services. Adoption of these products and services, led from the outside, has been slow and relatively isolated. Utilities at the forefront of innovation have moved from being a consumer of innovative products to becoming the prime driver for innovation (Figure 2 – Moving the Center of Gravity). They are active in identifying the key challenges faced by their organization, as well as leveraging both internal and external resources to help develop solutions. **We advocate that utility-led innovation holds the key to enabling an era of water sector sustainability.**

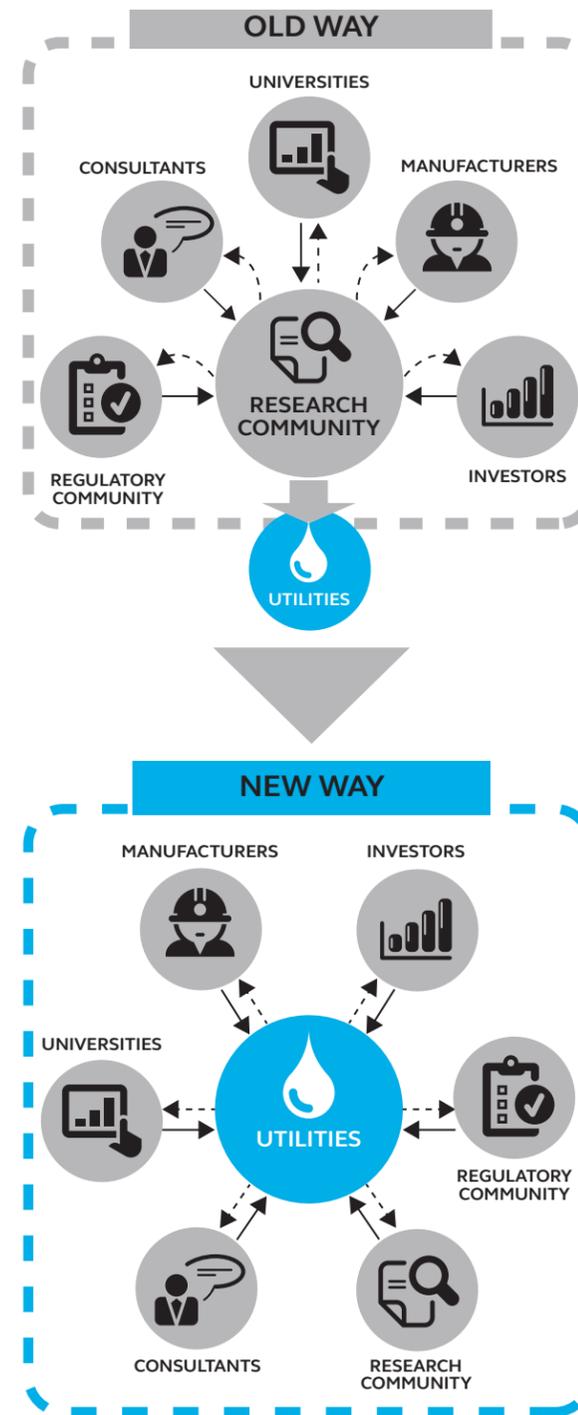
Utilities are seeking a wider and more tech-savvy stakeholder group, such as digital and business advisory consultants, to facilitate innovation. A number of utilities have embraced partnerships that can assist them in this journey. Increasingly, utilities are redefining supply chain relationships into collaborative partnerships to enable idea development.

The survey reveals that utility innovation programs are now beginning to branch out to consider expanded services, processes, finance and business models. It is this shift that will allow utilities to more effectively address their challenges.

Innovative utilities are charting a course for others to follow.

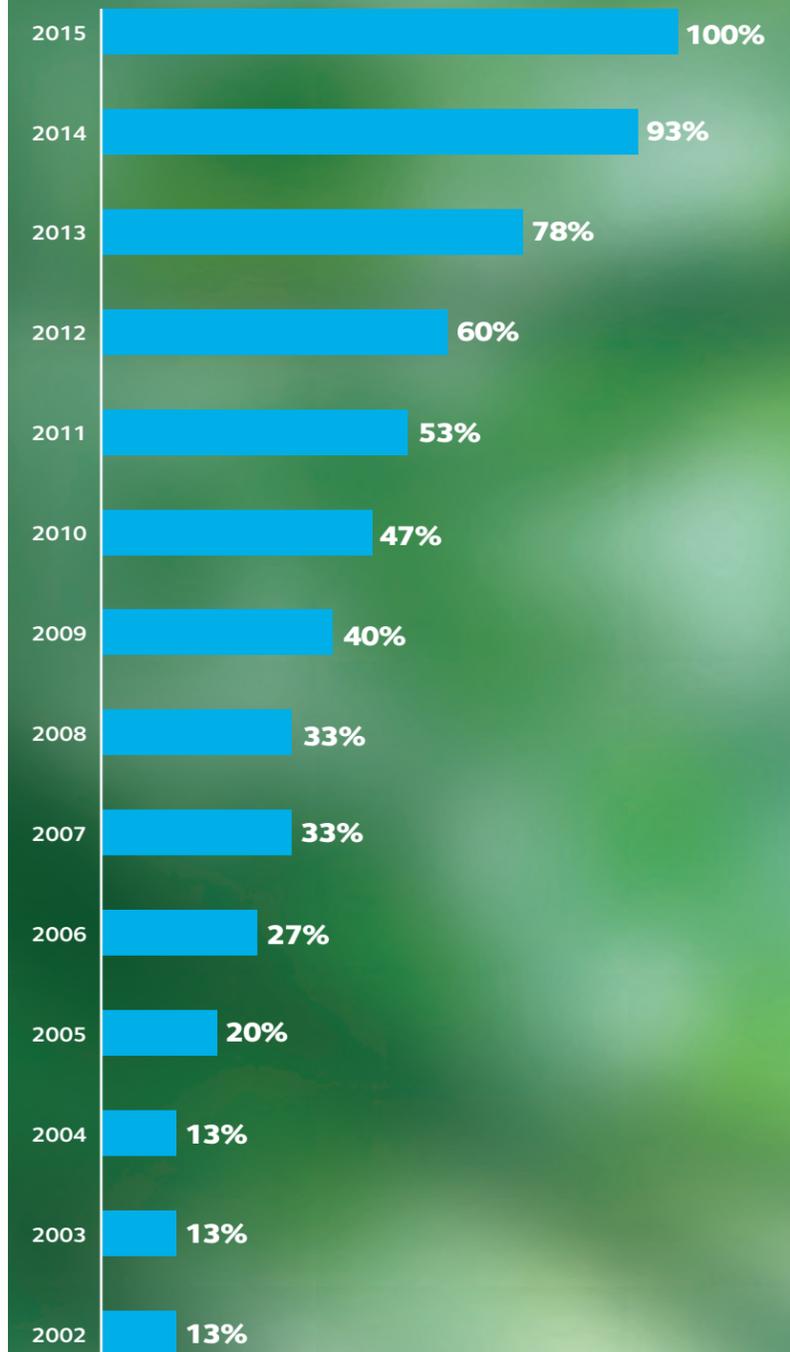
Of the 82 utilities surveyed, over 30 had utility-led innovation programs. Most programs are relatively new with over 80% launching within the last 10 years (Figure 3 - Growth of Utility-led Innovation Programs). Leadership is dominated by large utilities collectively providing service to nearly 80 million customers in North America, Europe, Asia and Australia, representing over \$14 billion in total annual expenditures as well as \$53 million in designated innovation investments. Lessons learned from organizations engaging in innovation as a business imperative will become increasingly available to utilities of any size thereby reducing implementation costs and narrowing the innovation gap. **To foster a culture of innovation, utilities are articulating new values, investing in new processes and seeking broad stakeholder engagement to create new norms for utility management and operation.**

FIGURE 2: MOVING THE CENTER OF GRAVITY



Source: Published by WRF, Project #4642

FIGURE 3: GROWTH OF UTILITY-LED INNOVATION PROGRAMS



Source: Data Published by WRF, Project #4642

5

BARRIERS TO INNOVATION

“
TO BREAK DOWN
THIS BARRIER,
UTILITIES MUST
**FOSTER
A SAFE
ENVIRONMENT**
FOR INVESTMENT,
DEVELOPMENT AND
ADOPTION OF
NEW IDEAS.
”

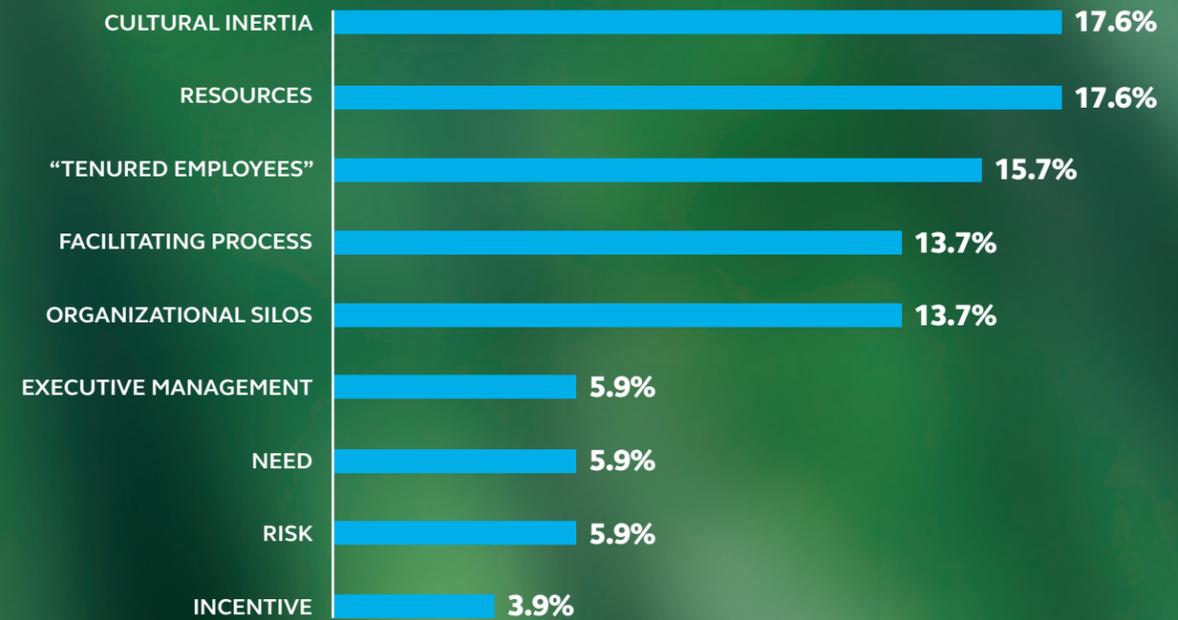
Compared to the private sector and select public services, water utilities have been slow to embrace the practice of innovation. Risk aversion is often accepted as the primary culprit in stifling utility innovation; however, the research suggests that the challenge may lie deeper than it first appears (Figure 4). The top five internal challenges to innovation revolve around the themes of culture, structure and resources. While seemingly separate, these challenges are interrelated.

Utilities are built to reliably produce a product. Reliability is built on repeatable processes, which are supported by standard workflows

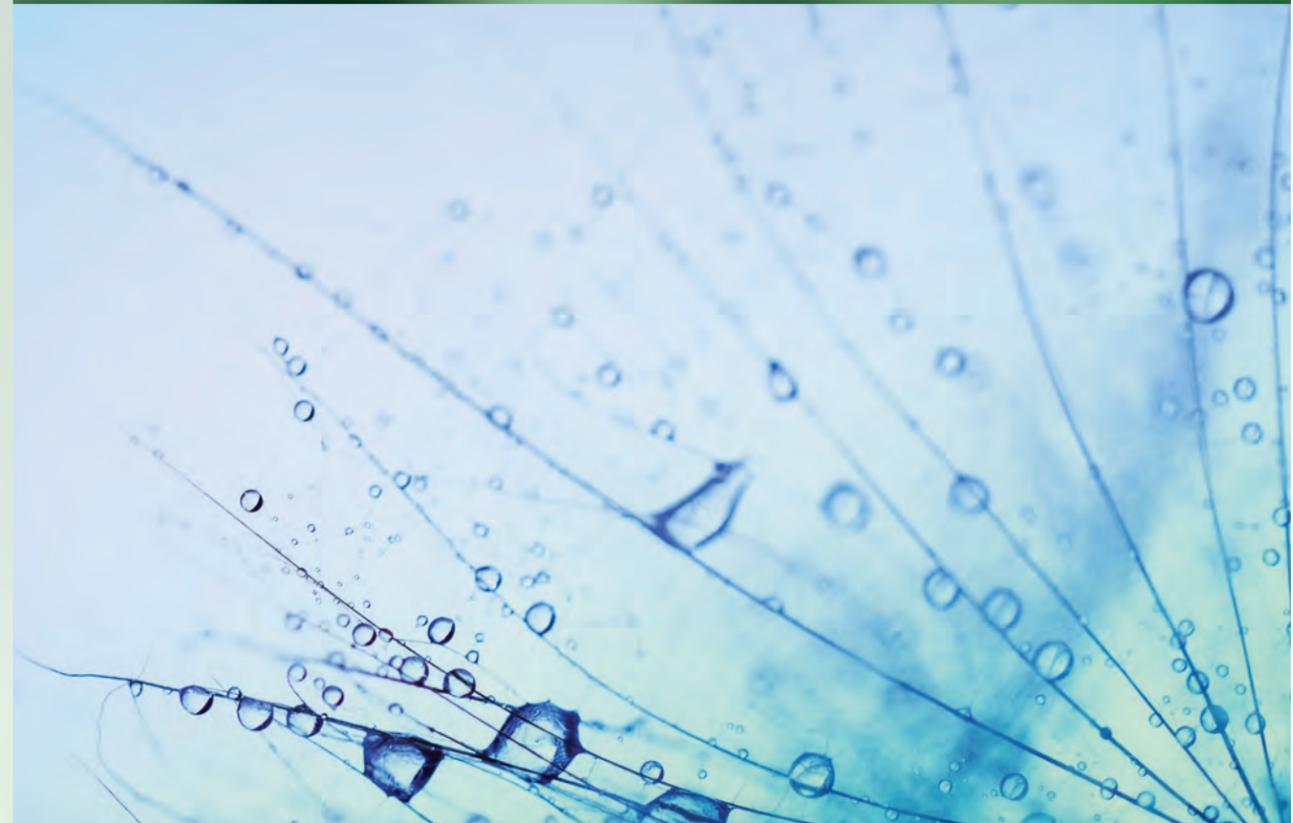
and budgeted investments, which are tracked by standard metrics. These metrics and workflows influence the behavior of utility employees and organizational norms. They also influence personnel decisions. Over time, this dynamic can produce procedure-centric siloed organizational cultures, which perform the basic functions, but hinder the drive required to become innovative. To break down this barrier, utilities must foster a safe environment for investment, development and adoption of new ideas.

Working together with the WRF, the WE&RF, leading utilities, professional organizations and private sector companies, we have collaboratively developed a framework accessible to all utilities for enabling innovation across organizational boundaries and over cultural challenges.

FIGURE 4: BARRIERS TO INNOVATION



Source: Data Published by WRF, Project #4642



6

BUILDING AN INNOVATION ENGINE

6A THE EIGHT KEY DISCIPLINES OF INNOVATIVE UTILITIES

Overcoming barriers and instilling organizational alignment with innovation goals begins with eight key disciplines - which came from the series of collaborative utility leader workshops of innovative water utilities. By implementing the following disciplines, utilities will build an engine of innovation that ultimately yields sustainability dividends. These dividends, such as greater revenue capture, waste reduction, and optimal network continuity, help the bottom line, utility engagement and culture and can secure the precious resource of water for the utility and, thus, the end-user. A list of example innovative responses and the sustainability dividends they yield can be found in Figure 10 of the appendix of this report.

These disciplines provide the foundation for a culture of innovation.

1. Visualize - maintain a long view that empowers and inspires innovation. Utility leaders must articulate the connection between innovation activities and the future of the organization.

2. Focus - define challenges that guide investment. Focus areas help define the character of the organization and nature of innovation.

3. Develop - invest resources in new ideas. Utilities must be able to provide space within the daily activities of utility staff for funding, idea development process and engagement of subject matter experts.

4. Evaluate - test concepts in scaled and relevant applications. Effective programs provide safe environments for testing progressively mature concepts in relevant settings with end-users.

5. Engage - motivate, enable and reward stakeholders. Transformative innovation programs invite broad participation of employees and stakeholders to provide thoughts and ideas.

6. Reach - utilize resources outside of organization. Stakeholders outside of the organization including peer utilities, consultants, universities, research centers, manufacturers and customers provide a vast array of new ideas that help utilities move beyond their organizational anchoring.

7. Communicate - capture and convey defining success stories. Powerful programs continually convey commitment to the program and opportunities for engagement, resulting impact of new ideas and access to new concepts, fueling continued engagement.

8. Evolve - implement concepts and measure impact. Ultimately, innovative utilities must promote organizational readiness for new ideas and concepts. This begins with the commitment of leaders, but ends with the adoption of innovation into the normal course of business.

Innovation programs missing some of these elements can be successful; however truly transformative programs actively engage all eight disciplines. The research team applied the key disciplines to the 82 utilities that responded to the survey.

The self-scores reveal consistently missing disciplines of 'Focus' and 'Engage' (Figure 6). The results reveal that most utility innovation is undirected, performed by a relatively few number of employees and is not effectively adopted into practice. This result was consistent across most global regions².

Leading utilities demonstrate the sustainability dividends of a healthy innovation engine that engages a broad range of stakeholders, aligns activities with utility imperatives and rewards adoption. However, the data demonstrates that the broader water utility industry has yet to model these behaviors.

² End values for Asia are only comprised of two utilities due to data availability.

FIGURE 5: EIGHT KEY DISCIPLINES OF INNOVATIVE UTILITIES



Source: Published by WRF, Project #4642

FIGURE 6: PERCENT OF SURVEYED UTILITIES ENGAGING KEY DISCIPLINES OF INNOVATION

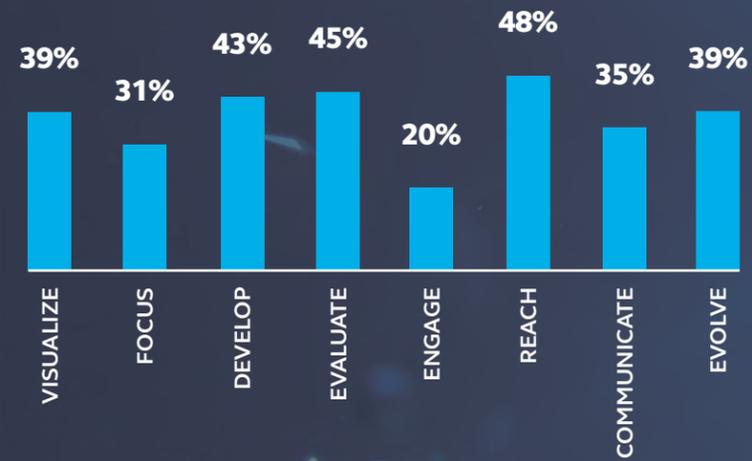
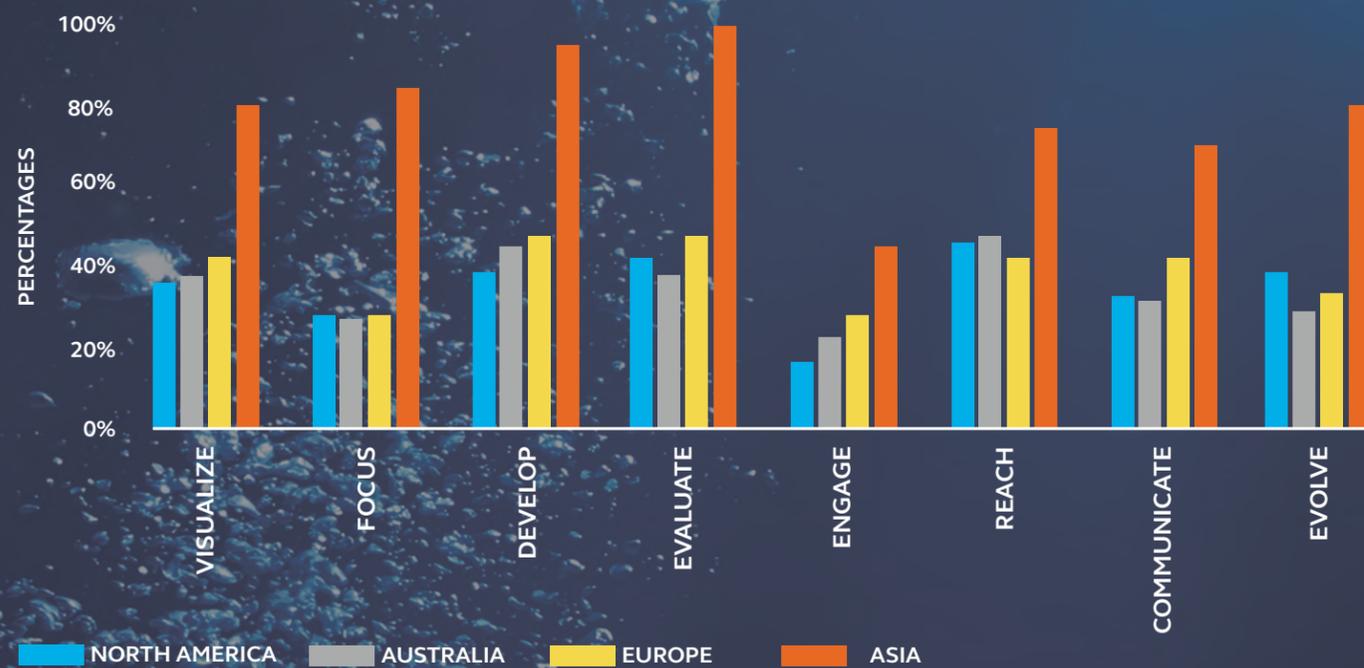


FIGURE 7: PERCENT OF SURVEYED UTILITIES ENGAGING KEY DISCIPLINES OF INNOVATION BY REGION



6B DEFINING A UTILITY INNOVATION FRAMEWORK

While eight key disciplines are useful for initial assessment and goal setting, our team simplified the disciplines into three primary elements for innovative utilities: Impact, Capability and Engagement (ICE Utility Innovation Framework). This framework provides an easy-to-understand and manageable tool that can be applied to a wide range of water utilities.

FIGURE 8: THE INNOVATION ENGINE

RESULTS - ORIENTED
Tangible and intangible improvement aligned with leadership and organizational philosophy



PEOPLE - ORIENTED
Ideators, mentors, adopters leading initiation and application of innovation

ECOSYSTEM - ORIENTED
Environment growth and maturation of ideas

IMPACT

An effective innovation program is results-oriented. Impact is focused on tangible and intangible improvement aligned with leadership and organizational philosophy. Measured by traditional organizational performance metrics, Impact is aligned with 'Visualize', 'Focus' and 'Evolve' disciplines.

CASE STUDY

The Metropolitan Water District of Southern California was born out of innovative thinking. Nearly 90 years ago, facing a burgeoning population in Southern California and a lack of water to support that growth, cities across the region united in a level of cooperation unprecedented at the time to create the Metropolitan Water District of Southern California.

Together, they built the Colorado River Aqueduct, an unparalleled engineering feat that relies largely on gravity to carry water 242 miles from the Colorado River, across the desert, through mountains to taps across the Southland.

In the decades since, Metropolitan has stood out as a leader in the water industry, not just for the size and scale of its endeavors, but for the innovative solutions and creative thinking that drive its ability to deliver water from sources high in the mountains to taps in our homes, schools and businesses.

One out of every 17 Americans live in Southern California. Metropolitan is working hard to identify emerging technologies and practices that provide water supply reliability to the region.

Those innovations may come from within Metropolitan's own workforce of talented men and women, or from the other side of the globe.

Through various programs, including the H2OTech Connect, which links the innovation community to industry professionals, or the Water Savings Investment Program that has already helped fund and jump-start 125 projects, the agency's leadership supports and guides worthy entrepreneurs to facilitate the movement of the best ideas to market.

By helping, supporting and encouraging these bold thinkers to understand the needs and business practices of the water sector, innovation happens at Metropolitan.

CAPABILITY

An effective innovation program is ecosystem-oriented. Capability describes the environment for encouraging, developing and managing ideas. The capability of an innovation program includes resource allocation and idea development. Key measures of this component include resource utilization metrics (e.g. facility engagement, innovation hours, spend) and utilization of an idea development process. Capability is aligned with 'Develop' and 'Evaluate' disciplines.

CASE STUDY

American Water, a private North American water company, launched their Innovation Development Process (IDP) in 2009 in search of ideas that benefit overall business operations, as well as create value for customers and investors.

Serving approximately 15 million people across the United States and Canada, American Water's large geographical footprint, diversity of water operations (e.g. large and small, surface and groundwater) and its dedicated research department makes it an ideal partner to validate and implement new technologies.

Technologies are selected and evaluated by two dedicated staff at bench and pilot facilities. Ultimately, they are moved to full scale evaluation at one or more of their facilities. One example was a technology for ultrasonic control of algae from a company called LG Sonic from the Netherlands. Four units were installed in a reservoir in New Jersey, USA allowing a nearby reservoir to serve as a control. The six-month evaluation

showed effective control of the algal growth and no evidence of taste or odor problems or algal toxins. An economic assessment showed the units saved approximately \$87,800 in operational costs, with a projected simple payback time of 1.8 years for the system (Schneider et al, 2015). To date, American Water's program has evaluated hundreds of technologies in this manner, implementing multiple promising concepts. The impacts have been multifaceted – saving tens of millions of dollars, increased strategic thinking of employees, encouraged in-house innovation, improved branding and customer/investor relations, increased operational performance and helped hold down future rates.

ENGAGEMENT

An effective innovation program is people-oriented. Engagement revolves around ideas and people including the source, nature and application of innovation. Key measures for engagement include the number of stakeholders involved in the program, number of ideas submitted and developed, adoption success rate and diffusion through the organization and number of partnerships with external agencies. This component is aligned with 'Engage', 'Reach' and 'Communicate' disciplines.

CASE STUDY

Queensland Urban Utilities (QUU) is the largest water and sewerage distributor-retailer in South East Queensland and fourth largest in Australia.

QUU delivers drinking water, recycled water and sewerage services to more than 1.4 million customers and has approximately 1,000 employees. In its purpose to "enrich quality of life", and commitment to drive operational excellence a formal innovation program was launched in 2013.

QUU acknowledges that an innovative mindset and culture is vital to delivering a successful innovation program. As such, it provides a supportive environment for its employees to generate ideas, follow them through, share innovative stories and their cultural journeys and inspire others to be creative and inventive. The organization actively seeks to challenge itself and industry thinking to design solutions that overcome economic, environmental and social issues.

Since establishing the innovation program, over 100 new innovations have been generated by QUU employees, leading to

operational efficiencies of approximately \$6 million (AUD). As a result of the program successes, QUU was awarded the 10th Most Innovative Company in Australia in 2015 as part of the Business Review Weekly Awards – a first for a water and sewerage service provider. This accolade is recognition of its efforts to embed an innovation program that empowers its people to transform new ideas into efficient and effective business solutions.

The Innovation Precinct, at QUU's Luggage Point Sewage Treatment Plant, is the first of its kind in Australia and is integral in supporting and developing an innovative and collaborative culture. The Precinct enables its employees, partnering organizations and universities to look for smarter, more efficient ways to operate. The dedicated facility brings together a diverse range of stakeholders with the aim of developing an alternative set of ideas and problem-solving approaches to be

generated in an innovative and collaborative environment. The facility is an established cultural symbol for the generation of innovative solutions and brings the organization's award-winning innovation program to life.

This innovative partnering approach has enabled the hosting of more than \$4.2 million (AUD) in scientific research projects with universities and over 30 industry partners. Through collaborative partnerships, the organization is focusing on new innovations targeting the optimization of current processes, enhancement of operational capacity and capability and enabling informed capital investment decisions which will transform its sewage treatment plants into the sustainable dividend of future's zero energy, manufacturing facilities that support communities – whether that's in a rural or urban setting.

7

LAUNCHING UTILITY INNOVATION

We recommend three phases for an innovation program implementation plan, whether it be an entirely new program or enhancing an existing program. Phase 1 provides an understanding of the resources, perceptions and existing gaps in the organization. Through Phase 2, utilities can develop “fit for purpose” program elements. Phase 3 provides early phase launch activities proven to enhance the success. Below are the phases and tangible steps, while common pitfalls strategies for mitigation are outlined in Figure 12 in the appendix of this report.

Phase 1 - Assessing Innovation Environment

Using a customized and scalable cross-departmental survey, the current innovation environment can be assessed and gaps can be identified. Crucial observations may include differences in self-assessment scores between departments, roles and stakeholder groups. Surveys should be accompanied by a fact checking exercise to validate and take inventory of available resources. Effective self-assessment surveys and analysis help utilities build on strengths and address organizational and cultural gaps. Open forum discussions provide a great opportunity to capture pain points that may become focus areas for innovation as well as early ideas for consideration.

Phase 2 - Program Creation

Sustainable utility innovation programs are tailored to the expectations, environment and resources of the specific utility. The ICE Framework provides utilities the flexibility to use industry metrics and user defined discipline maturity levels to develop “fit for purpose” program elements; building impact, capability, engagement and organizational readiness. Establishing an innovation leader early in the program creation phase is a key catalyst for effective planning and program launch.

Building the Innovation Engine: Building Impact.

Establish program purpose and vision. Before investing resources into an innovation program, a utility must establish their purpose and vision of the program based on organizational values and ambitions.

Define selection criteria and focus areas. Organizational values can be transformed into idea value profiles or dimensions. The value profile can be used to evaluate individual ideas for development. Clearly articulated focus areas for innovation investment including key impact metrics will target program activities that will result in the greatest impact for the utility.

Building Capability.

The resource allocation and idea development process. Resources can include funding, time, access to testing facilities or other staff, advisors, supply chain partners, training, information and customer engagement. Utility innovation programs must prioritize resources in order to strengthen their capacity to deliver efficient and effective innovation programs.

Define the idea testing process. Installing a process for testing and refining innovative ideas is key to prioritize, which innovative actions will reveal the greatest return on investment. This is often a process where an idea is first defined, assumptions identified, tested, verified and adopted.

Building Engagement.

Identify “on ramps” for program participation. Innovation programs must nurture broad connectivity with staff and the organization. These programs offer an array of engagement opportunities for staff at any level. Appropriate role descriptions and recognition awards are powerful tools for engagement.

Identify partnerships and external enablers. Resources outside of the utility are powerful enablers and sources for best practice and innovative ideas. They also provide an effective risk mitigation tool for evaluating complex concepts and providing program assurance. Utilities should evaluate their current supply chain and partnerships to create networks that identify and validate implementable innovations.

Develop a communication plan. An effective communication plan is critical to transforming culture. Existing storylines of successful utility innovation, especially quick wins, should be identified, captured and actively communicated. These stories can immediately strengthen the culture and improve morale, which strengthens the probability of program success.

Developing Organizational Readiness

Building Company Lore. Success will provide momentum for change and help encourage increased participation in innovation activities. New storylines built upon the legacy examples of innovation will help sustain the program and contribute to creating a culture of innovation.

Phase 3 - Program Launch

Establish Urgency. All change requires breaking the gravitational pull of current practices and clearly articulating the benefits of utility innovation. Failure to effectively do this will inevitably result in program failure.

Start Small. It is tempting to move quickly to full-scale application of an idea. Taking on a complex idea too early can lead to process confusion. Building early innovation teams with proven innovators and advisors will help refine the program and better define needed resources. Starting small allows innovation leaders to strengthen communication. Innovation teams lose traction when communication is slow or expectations are ill-defined.

Slow Grow the Metrics. Early metrics should focus on the impact of specific innovative ideas, with the organization avoiding aggressive goal setting. Innovation programs often grow slowly with quality of idea submissions improving over time as the program gains acceptance. Use the first year to benchmark program activities and impact across the ICE Framework.

Revisit Resources. Although it is possible to start a program without idea development funding, it is recommended that programs earmark reasonable funding available for innovation. After six to 12 months, innovation leaders can revisit the impact and investment as well as assess feedback from innovation teams.

FIGURE 9: LAUNCHING UTILITY INNOVATION



Source: Published by WRF, Project #4642

“GIVEN THE INFRASTRUCTURE FUNDING GAP, DECLINE IN FEDERAL RESOURCES, AND RISING UTILITY RATES, MANY UTILITIES ARE REALIZING THAT THE BEST HOPE TO CLOSE THE GAP AND MANAGE RATES IS INNOVATION.”

JEFF MOELLER, PE, DIRECTOR OF WATER TECHNOLOGIES, WATER ENVIRONMENT & REUSE FOUNDATION

8

INNOVATION AS A PATHWAY TO SUSTAINABILITY

“SHIFTING TO AN INNOVATIVE CULTURE, ONE THAT IS OPEN TO NEW IDEAS, PURSUES STATE-OF-THE-ART PRACTICES, AND TAKES A COLLABORATIVE APPROACH, WILL HELP ENSURE LEVELS OF SERVICES ARE MAINTAINED DESPITE THE INEVITABLE UNCERTAINTY OF THE ENVIRONMENT IN WHICH WE OPERATE.”

MATT RIES, PHD, PE, CHIEF TECHNICAL OFFICER, WATER ENVIRONMENT FEDERATION

Utilities need to adopt innovation in their services, processes, technologies and finance and business models to maximize sustainability. Much of innovation adoption will be led by digital initiatives.

The surveyed utilities were asked to rank over 100 innovative concepts by urgency and impact, and elements of digitalization topped the list as it relates to asset management. In a data-rich industry like water, technology disruptors like the Internet of Things (IoT), big data, predictive analytics, cloud computing and mobile technology are fundamentally changing the way we run our businesses. Utilities must adjust their processes, systems and people to adapt to the digital landscape. Innovative utilities will be the driving force and key beneficiaries of the digital transformation with commensurate benefits to their customers and their cities. There are many examples of digital innovation impacting the industry. Distributed computing, cloud services and predictive analytics have opened the door to real time decision making, which is being applied to forecast the behavior of the power market and adjust operations accordingly, thus lowering operational expenditures and ensuring financial longevity. The application of the IoT in Intelligent Water Networks is allowing the implementation of sensors in assets to diagnose issues before they take place or severely disrupt operations (e.g. connected sensors that detect moisture in a pipe and can detect minor leaks). This approach allows the implementation of proactive and focused preventative programs.

Considering that on average, fixing an asset is three times more expensive than maintaining it, and that replacing the asset is up to six times more expensive, it is very easy to connect how the use of these emerging technologies contribute to more sustainable practices.

By creating an environment of creativity, investment and experimentation - in short, innovation - utilities foster new approaches to managing water resources and facilities, serving customers and cities and financing system infrastructure needs. Cumulatively, these ideas can give rise to new business models that commercialize partnerships or new products from what was once considered waste. Innovation also enables utilities to effectively engage internal and external resources to continuously improve operations and increase delivered value to their customers. These not only place utilities on the path towards sustainability, but transform them into catalysts for regional growth and sustainability. The goal is to make intentional changes to the processes, organizational structures and to the products and services generated by a utility to jumpstart a virtuous cycle that results in resilient, efficient and qualitative environmental benefits for the utility and the city it serves.

As an example, some utilities are looking at other industries to identify importable and adoptable technologies for the water sector. Such innovations, which accomplish the same core tasks, but more efficiently, can spur additional transformations resulting in a more cost-effective and/or sustainable way of doing business.

CASE STUDY

Waternet is a public water cycle company, providing drinking water, sewerage collection, wastewater treatment, stormwater and flood control services for the City of Amsterdam and the Regional Water Authority for Amstel, Gooi and Vecht.

The company serves over 1.3 million customers across 20 municipalities. Recognizing that the world and utility industry is changing, Waternet launched an innovation program as a catalyst for driving change. Waternet established core values of efficiency, sustainability and customer-orientation. They defined strategic ambitions of building a circular economy for their organization with an emphasis of recovering energy and resources from the complete water cycle ultimately reaching energy neutrality by 2020.

Waternet's unique structure allows them to evaluate opportunities across the spectrum of water management practices.

To focus efforts that established four key innovation areas:

1. Climate neutral
2. Climate adaptation
3. SMART Business operations
4. Connecting with community

In addition to their energy neutrality goal, Waternet has established performance goals of reducing end products for disposal (e.g. sludge), improved water quality in major water ways,

reduced operational cost and reducing annual CO2 production. With an annual innovation budget of €1.6 million and a funnel-based stage gate process for concept development, Waternet is exploring partnerships for example with the local waste incineration plant that can use sludge and biogas in return for electricity and heat. They are exploring the use of groundwater and sewer heat recovery for heating and cooling of buildings, improving urban resiliency and a three-level approach for flood management. They are leveraging research and development to explore the benefit of waste segregation and treatment, struvite and calcite reuse strategies and development of power to protein technologies.

Waternet cannot achieve its ambitious goals without good partnerships. For that reason, Waternet is working together with many students, businesses and residents on a daily basis to achieve better water. Finally, success along these lines of research will result in improved environmental and operational sustainability.

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CONCLUSION

It is our hope that the water sector sees the results of this WRF/WE&RF project as a call to action and steps up its ambition to become innovation leaders. As you can see in the case studies in this report, there are a number of global water utilities who have already come to this conclusion, and as this sector is a collaborative one, those who haven't yet prioritized innovation can look to their peers and networks for inspiration and support.

Connecting innovation with sustainability, Arcadis finds clear evidence that innovation is a pathway to becoming a sustainable utility, thereby realizing dividends from their investment. These dividends result in financial, consumer and environmental benefits, all of which strengthen a utility's brand, business, bottom line and satisfaction ratings and ultimately improve quality of life for the people it serves.

As the Principal Investigator on the WRF/WE&RF project and a leading global design and consultancy for built and natural assets, Arcadis is passionate about partnering and building out innovation programs with the water sector to become a leading, innovative and sustainable industry.

NOTES

All graphs, figures and references to the Water Research Project #4642 were used with consent of the Water Research Foundation. To learn more about the Water Research Foundation and Project #4642, Fostering Innovation Within Water Utilities, please visit www.waterRF.org/FosteringInnovation

About the Water Research Foundation

The Water Research Foundation is the leading not-for-profit research cooperative that advances the science of water to protect public health and the environment. Governed by utilities, WRF plans, manages, and delivers scientifically sound research solutions on the most critical challenges facing the water community in the areas of drinking water, wastewater, stormwater, and reuse. Over the last 50 years, WRF has sponsored nearly 1,500 research projects valued at \$500 million, and serves more than 1,000 subscribing organizations.

For more information, go to www.WaterRF.org.

INTELLIGENT WATER NETWORKS AND THE PUSH FOR INNOVATION

For decades, the approach to water networks for many cities could be said to be passive - many treated water to a high standard only to be distributed by an aging network, with limited or no information on its performance in real time. Similar can be said for the conveyance of sewage.

Intelligent Water Networks will enable utilities to take more active control and more efficiently manage precious water resources.

So, what is an Intelligent Water Network? The IWN starts with robust sensors deployed into the networks to measure relevant parameters. The data from these sensors is being generated quicker and with greater levels of granularity, e.g. from 15 minute to 15 second intervals. The connectivity to report that data back to a central control center is allowed through the Internet of Things. Then analysis of the data, whether through manual, automated or more advanced fuzzy logic routines, allows for interpretation. A final key element of the 'system' is building processes into the utility's informed reaction to allow action to be taken by people, with a commensurate improvement in network performance.

Many utilities around the world are already embracing the IWN concept. Thames Water in England operates a European Union - funded network in reading using smart meters and a self-learning algorithm for determining leak rate and repair effectiveness. In Florida, Jacksonville Energy Authority water division is using acoustic sensing technology to digitally assess pipe condition (wall

integrity). A utility in the Middle East is installing real time monitoring devices in the sewer network to improve knowledge of network performance, with long term aim of reducing sewer flooding. South West Water, in England, now includes SewerBatt digital acoustic sensing technology as part of the sewer inspection and cleaning contracts. Designs for the second deep sewer tunnel for Public Utilities Board in Singapore include fiber optic cables embedded into the sewer wall to monitor structural integrity over the life of the tunnel. Similarly, Public Utilities Board employs a wireless sensing network monitors hydraulic and quality for remote detection of bursts.

In the future, super-connected intelligent water networks will have system wide sensors and high speed connectivity to enable monitoring of performance in real time and as a self-adapting operation. This next evolution in water networks will generate greater resilience in the system and see the elimination of the problems we deal with today, such as service outages and sewer flooding events.

ABOUT THE WATER ENVIRONMENT & REUSE FOUNDATION AND LIFT

The Water Environment & Reuse Foundation (WE&RF) is a charitable corporation which conducts research to treat and recover beneficial materials from wastewater, stormwater, and seawater including water, nutrients, energy, and biosolids while facilitating interaction among practitioners, educators, researchers, decision makers, and the public. Our research represents a portfolio of more than \$200 million in water quality research.

WEF/WE&RF Leaders' Innovation Forum for Technology (LIFT) brings together experts, practitioners, and industry specialists to accelerate adoption of innovative technologies across the water sector. Several examples of key LIFT programs and activities include:

- **LIFT Working Group:** A peer to peer utility innovation network that includes over 400 municipal and industrial facility owners.
- **Technology Scans:** Identify, screen, and evaluate innovative water technologies.
- **LIFT Link:** Online innovation and collaboration platform that includes over 100 new water technologies.
- **National Test Bed Network:** A network of over 70 test facilities for piloting and demonstrating technologies.
- **SEE IT Scholarships:** Provides travel scholarships for utility personnel to visit other utilities with innovations of interest and to share experiences.

Visit www.werf.org for more information.

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APPENDIX

FIGURE 10: INNOVATIVE WATER RESPONSES AND SUSTAINABLE DIVIDENDS

Water Sustainability Pillar	CHALLENGES*	INNOVATIVE RESPONSE	SUSTAINABILITY DIVIDENDS
Resiliency	Water Stress	<ul style="list-style-type: none"> • Direct Potable Reuse • Stormwater harvesting • Desalination • Diversification 	<ul style="list-style-type: none"> • Optimized long term supply
	Green Space	<ul style="list-style-type: none"> • Encourage policy for Green Infrastructure (GI) investment • Credit banking • Retrofit existing infrastructure 	<ul style="list-style-type: none"> • Maximized economic benefits from GI • Water quality improvements to receiving waters • Reduced flood potential
	Flood Risk	<ul style="list-style-type: none"> • Multi-level barriers • Building with Nature 	<ul style="list-style-type: none"> • Enhanced public amenities • Minimized loss and damage during storm events
	Reserve Water	<ul style="list-style-type: none"> • Smart planning 	<ul style="list-style-type: none"> • Securing long term storage
Efficiency	Water Loss	<ul style="list-style-type: none"> • Intelligent networks 	<ul style="list-style-type: none"> • Greater revenue capture • Less waste • Big Data capture
	Water Charges	<ul style="list-style-type: none"> • Creating new revenue streams • Redefining current practices • Expanded Public - Private Partnerships • Big data & analytics 	<ul style="list-style-type: none"> • Less waste • Affordability • Resilient business model
	Metered Water	<ul style="list-style-type: none"> • Community education • Intelligent networks 	<ul style="list-style-type: none"> • Greater revenue capture • Less waste • Big Data capture
	Reused Water	<ul style="list-style-type: none"> • Direct Potable Reuse • Reimagine customer relationships 	<ul style="list-style-type: none"> • Waste reduction • Demand management
	Service Continuity	<ul style="list-style-type: none"> • Investment in monitoring technology • Integrated asset management • Information communication portals 	<ul style="list-style-type: none"> • Real-time information • Minimal network disruptions • Asset longevity
Quality	Sanitation	<ul style="list-style-type: none"> • Addressing consolidation of failing systems • Ensuring capacity in sanitation systems • Satellite sanitation systems • Digital condition assessment 	<ul style="list-style-type: none"> • Reduced raw water pollution • Improved property values • Enhanced economic development
	Treated Wastewater	<ul style="list-style-type: none"> • Creating alternative storm surge management capacity • Local partnerships to manage unpermitted discharges 	<ul style="list-style-type: none"> • Decreased overflows of untreated wastewater • Higher quality and quantity of water capture
	Water-related Disease	<ul style="list-style-type: none"> • Advanced real-time monitoring and analysis technologies (e.g. mobile platforms, IoT and Big Data) 	<ul style="list-style-type: none"> • Proactive mitigation of water quality events
	Threatened Freshwater Species	<ul style="list-style-type: none"> • Expanding impact analysis to include ecosystem indicator species • Advanced species monitoring tools 	<ul style="list-style-type: none"> • Early warnings and anticipation of threats
	Raw Water Pollution	<ul style="list-style-type: none"> • Waste stream segregation 	<ul style="list-style-type: none"> • Improved nutrient/resource recovery
	Drinking Water	<ul style="list-style-type: none"> • Advanced real-time monitoring operations and analytics • Agile and resilient treatment and mitigation capabilities 	<ul style="list-style-type: none"> • Improved access to safe and reliable water, especially during emergencies

* (Water Sustainability Indices from *Sustainable Cities Water Index*)

FIGURE 11: UTILITY INNOVATION AND WATER SUSTAINABILITY



FIGURE 12: PITFALLS AND CHALLENGES

NAVIGATING THE PITFALLS OF IMPLEMENTATION	PITFALLS AND CHALLENGES	STRATEGIES FOR MITIGATION
<p>PHASE 1 Assessing Innovation Environment</p>	<ul style="list-style-type: none"> • Poor development of survey. • Selective polling. • Single channel survey. • Perception-only surveys. 	<ul style="list-style-type: none"> • Hit the eight key disciplines in survey. • Include diversity in participants. • Supplement surveys with focus groups, town halls, and write ins. • Validate findings with fact checking.
<p>PHASE 2 Program Creation</p>	<ul style="list-style-type: none"> • Weak senior direction and advocacy. • Middle management quagmire. • Undefined processes. • Too unwieldy a process. • Slow communications. • Limited engagement opportunities. • Poorly considered adoption strategies. • Missed synergy opportunities. • Missed commercialization opportunities. 	<ul style="list-style-type: none"> • Begin with executive management setting expectations and appointing a Innovation Lead. • Executives must stay engaged to ensure direction, focus and resourcing. • Middle managers should be included in planning, resourcing and responsible for success. • Engage all stakeholders in program creation through focus and test groups. • Idea assessment and management processes must be clearly defined and available to all staff. • Establish a program that works for your organization and culture. • Leverage levels of maturity in goal setting which allows programs to grow with their organizations. • Programs should allow for focused and “blue sky” concepts as well as a range of innovation types. • Avoid permanent innovation teams that will lead to an “us and them” dynamic. • Create multiple points for engagement with role descriptions and responsibilities. • Include end-users in idea development and testing to increase adoption rates. • Regular and prompt communication with ‘ideators’. • Know how to discuss intellectual property. • Include end use concept and expected impact in idea submission requirements. • Idea management platforms that support archiving and coding assist in finding like opportunities to merge teams and ideas.
<p>PHASE 3 Program Launch</p>	<ul style="list-style-type: none"> • Lack of urgency. • Program growth too quickly. • Unaligned idea submissions. • Ambiguous impact. • Poor capture of successes. • Under-resourced innovation leadership. • Funding structure that doesn’t incentivize idea development and implementation. 	<ul style="list-style-type: none"> • Establish urgency, connect innovation to organizational success and follow with communication of quick wins. • Hand picked or a limited number of innovation teams should move through the program in the early stages to allow for refinement of processes, tracking, communication and resourcing. • Idea submission forms and selection process must clearly articulate program priorities and values. • Establishing a communications plan that includes engagement with the team as well as broader organization will help transform the organization culture as the stories become company lore. • Agree on simple metrics that can be tracked and reported. These metrics should map directly to the value profile established during program creation. • Recognize time required to engage organization and innovation teams. • Development stage-related funding.

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