Singapore International Water Week

WATER UTILITIES LEADERS FORUM

18 - 19 SEPTEMBER 2013

Position Paper for Session 3 -
"Innovation: A Cliché or A Necessity in Face of Today's Water and Wastewater Challenges?"

Prepared by: CEO (PWN Technologies) Jonathan Clement

Senior Assistant Director (PUB) Chong Mien Ling

Industry Development Executive (PUB) Gu Yan

1. According to the United Nations[1], around 700 million people in 43 countries currently suffer from water scarcity. Ironically there is actually sufficient freshwater on the planet for seven billion people. However water is unevenly distributed and too much of it is wasted, polluted and unsustainably managed. Water use has been growing at more than twice the rate of population increase in the last century and an increasing number of regions are chronically short of water. In the face of water scarcity which can be aggravated by rapid urbanisation and climate change, many nations have come to the realisation that business-as-usual is no longer an option. New ways of water management and service delivery are required. In other words, many countries called upon innovations in policy and technology for water sustainability.

2. Innovation means doing things better and differently and can be in various aspects such as technology, policy or even capacity building. Innovation can simply be looked upon as turning ideas into value. This paper focuses its discussion on technology innovation[2] and looks specifically at 1) what are the innovative technologies that can be implemented in the face of today's issues and 2) the enabling environment for innovation.

Identifying appropriate innovative technologies

3. Looking across the globe, technology has undeniably played a key role in addressing many of our water challenges. Taking the example of Singapore's journey[3] on used water management, Singapore has moved from a night-soil bucket system in the 1890s to a sewerage system with trickling filters and humus tanks in the 1910s. Activated sludge process was only implemented after the Second World War. The intensive sewerage development programme started in the 1960s and finally paved the way to Singapore's used water management system today. Today Singapore is 100% sewered and applies state-of-the-art activated sludge treatment. Treated effluent is also reclaimed using advanced membrane technology to high-grade recycled water for direct industrial applications and indirect non-potable use. Singapore continues its research into efficient used water treatment technologies including membrane bioreactors and anaerobic treatment options. Singapore's journey has been driven by rapid urbanisation, land scarcity and the urgent need to augment its water resources. Technology innovations were made in consideration of the feasibility of the state-of-the-art technologies, the latest international best practices, and prevailing economic and social situation.

4. Technology innovation does not merely mean implementing the latest, most advanced technology. In this paper, technology innovation refers to the application of new technology relevant to the local context of a water utility for the purpose of making improvements to current performance as well as the level of socio-economic development

[1] International Decade for Action 'Water for Life' 2005 – 2015
http://www.un.org/waterforlifedecade/scarcity.shtml

[2] There are multiple stakeholders involved in innovation and their interconnections are complex. In this session, we will mainly discuss the inter-play between technology providers and the utilities.

[3] http://www.pub.gov.sg/about/historyfuture/Pages/UsedWater.aspx

in the country. Figure 1 illustrates the various possible pathways towards better drinking water quality as an example. The illustration assumes a present day situation that the water utility is able to meet the national drinking water standards. Over time if the water utility continues business-as-usual, the situation may deteriorate in the face of aging infrastructure and rapid urbanisation that increases the risk of pollution of source water. To maintain compliance with the national drinking water standards (innovation path 1), the water utility would have to innovate to mitigate the risks by for example, installing sensor and process control system with corresponding corrective actions to be taken during events of contamination. With increasing customers' expectations and performance benchmark, utilities may choose to further enhance their treatment capacity to meet stricter treatment targets (eg. installation of ultraviolet disinfection system to inactivate *Cryptosporidium*) (innovation path 2). In the longer term when a utility is competent in delivering safe drinking water to the communities based on prevailing international best practices, the utility may shift its technology innovation towards removal of contaminants of emerging concerns (eg. installation of reverse osmosis system to remove endocrine disrupting compounds (EDCs)) (innovation path 3).

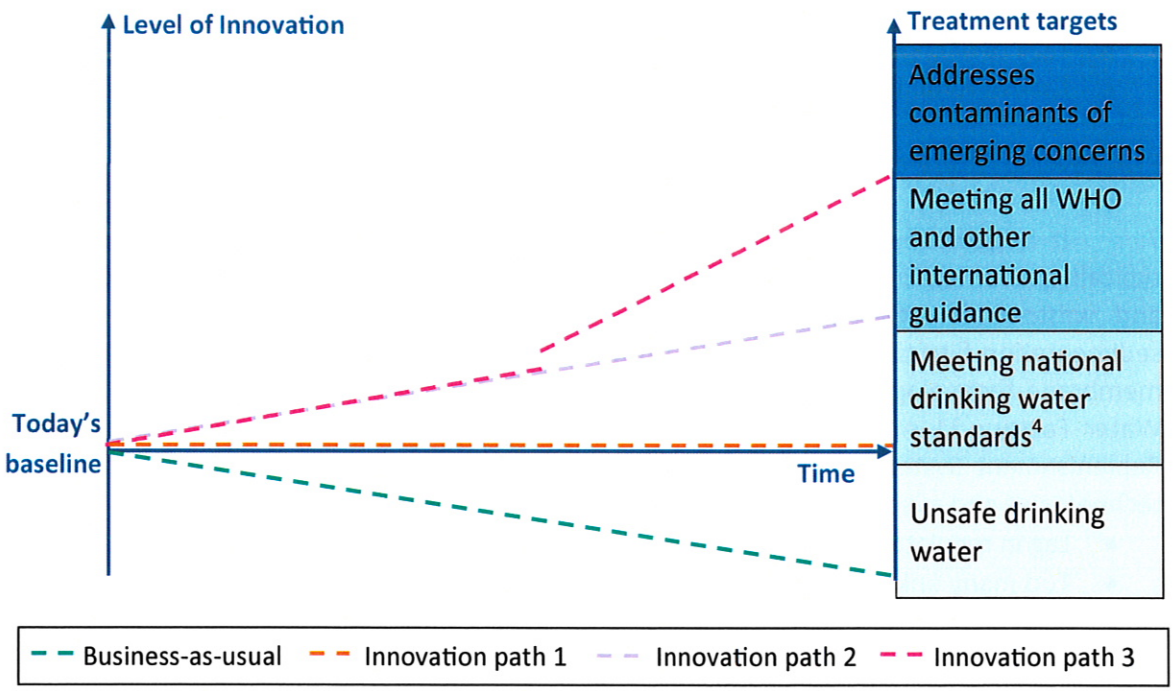

Figure 1. Possible innovation pathways to improve water quality of drinking water

5. Innovation is hence possible despite the current baseline of any utility and it is noted that the innovation pathway will be unique for each utility. The good news is that over the past decades of research and development, many technologies have become much more cost effective. Over time it is hoped that the learning curve and innovation path for developing utilities can be short-circuited. With so many challenges that are commonly faced by utilities including water scarcity, rapid urbanisation, increased pollution and

[4] This illustration assumes that the national drinking water standards are less stringent than the prevailing international guidelines and standards for drinking water quality.

extreme weather conditions, **what are some implementable technology innovations to augment water resources through unconventional sources and effective management of non-revenue water, treat water and wastewater sustainably and reduce reliance on conventional energy sources?**

Are technologies like low energy desalination, advanced oxidation, nanotechnology new and improved membrane material and resin technologies, leak detection and management ready for widespread implementation among the water utilities?

Creating an enabling environment for innovation

6. Thomas Friedman[5] once asked, "Do you know what my favourite renewable fuel is?" His answer was "An *ecosystem* for innovation." Although this quote was not made specifically in the context of innovation in the water industry, it brought out two key ideas - innovation is necessary for sustainability and innovation does not exist in isolation but requires an ecosystem or an enabling environment. The possible barriers faced by water utilities to innovate will hence have to be discussed. Some of the challenges include:

a. Risk-adverse nature of the water sector
b. Lack of alignment between research communities and utilities
c. Lack of funding

Risk-adverse nature of the water industry

7. It is generally recognised that the water utilities are risk-adverse in nature and typically prefer implementing tried-and-tested technologies. The most widely applied water and wastewater treatment processes remained conventional flocculation-coagulation-sedimentation-filtration and activated sludge processes respectively. The pioneer in using membrane technology for water reuse – Orange County Water District ran its pilot plant, Water Factory 21 since 1976 before the full-scale implementation of the Groundwater Replenishment System in 2007. The reasons behind the long ingestion period of water technologies and a lack of adoption by water utilities can be attributed to:

- Lag in regulatory framework
- Too many unknowns and lack of capacity in new technologies
- New technologies are deemed more expensive
- Water has a direct impact on the health and safety of the consumers and impact from technology failure will be dire

8. The drinking-water sector is relatively well-regulated with most countries having established national drinking water standards. Water utilities are primarily driven by their obligations under these regulations and would adopt technologies as needed under such obligations. For example a utility in USA or New Zealand would be required to achieve adequate treatment efficiencies for *Cryptosporidium* and *Giardia*. Treatment options for consideration will include filtration systems (including membrane technology) and UV

[5] Thomas Friedman is an American journalist, columnist and Pulitzer Prize author. He writes a twice-weekly column for The New York Times.

disinfection. In contrast water utilities in other countries that have no such obligations will have little impetus to adopt advanced filtration or disinfection technologies. As another example, utilities will also have few incentives to develop new water analytical methods since these new methods will not be recognised as standard methods by regulators. While the development of standard methods is necessary for quality control and assurance, we need to better engage the different stakeholders, including the regulators, to shorten the ingestion period of water technologies.

9. To mitigate the risks in introducing new water technologies, that is to minimise the unknowns, a step-wise approach in the form of bench-scale testing to pilot testing to demonstration of any new technology can be adopted. Bench-scale testing is a proof-of-concept that the science behind the technology works. A pilot plant tests the technology and validates that the technology works as a system. At demonstration scale, the technology is tested under actual field conditions and further optimised. This approach of testing new technologies ensures that every new technology is developed systematically and optimised in accordance to local context. At the same time, through this process of testing and optimisation, the capacity of the water utility can also be built up. **How can utilities build in such technology evaluation process in their operations? How else can utilities ensure that new technologies are being considered in their project design?**

10. New technologies are often looked upon as advanced and expensive. Conventional outdated treatment technology is often used in some parts of the world because it has a long track record and is perceived to have a lower risk. Consultants in particular choose these designs or systems because they are familiar with them. However, new technologies are developed to be more efficient, compact and environmentally friendly; and are developed to improve efficiency and sustainability. Yet, because new technologies are often perceived to be too risky or too complex for developing countries, they are overlooked. This means that many utilities that are improving their systems will miss out on what will bring them value, and be stuck with inheriting outdated technology. **How should the cost-benefit analysis of new technologies be appropriately done, taking into account the full life-cycle cost of the technologies and the quantification of other externalities - better service level, higher willingness to pay by customers and safeguarding of public health?**

<u>Lack of alignment between research communities and water utilities</u>

11. The primary objective of water utilities is to provide water services to customers. Water research may or may not be part of its organisational setup. Continuous research and development however is critical to ensure that water utilities continue to deliver their services effectively and sustainably, taking the latest scientific knowledge and technological know-how in consideration. The challenge is to ensure that the research communities are aware of the knowledge gaps in water utilities and for the water utilities to be kept abreast of the latest technological developments.

12. Several research organisations have been set up as a bridge between the research communities and water utilities. The Water Research Foundation is a subscription-based research organisation with over 950 water utilities from North America, Europe, Australia

and Asia as subscribers. Subscribers have access to the latest research findings conducted by the Foundation and at the same time, are able to shape research agenda through the Facilitated Research Services programme in which the Foundation undertakes research on topics identified by subscribers. Another research organisation, Technologiezentrum Wasser (TZW), the German Water Centre, conducts applied research and provides scientific advice to, and in close collaboration with, water utilities, companies, public authorities and universities. Such water utility-centric research entities are helpful to advance technology innovation in water utilities. **Would this model be applicable to other utilities in creating an environment where their needs are effectively communicated to the research community so that researchers respond with technology innovations? How else can the utilities reach out to the research community, both local and global to solicit for innovative ideas?**

13. Globally there are a number of water events being held regularly, including Stockholm Water Week, IWA World Water Congress, WEFTEC and the Singapore International Water Week, to name a few. These are also opportune events where different stakeholders (policy makers, water utilities, technology providers, academia) of the water industry get together.

Lack of Funding

14. Innovation does not come free. Even return on investment for some innovations is less than three years making it economically viable, the issue on who pays for the initial investment for innovation remains. The revenue source for water utilities typically comes from the following three sources:

a. Water tariff
b. Government
c. International development organisation

How can utility leaders secure funding from the above or other sources to develop research programmes to meet their needs? What are the other avenues for fund mobilisation? How can utilities assure the government that funds for research programmes bring back value to the country, and how could this value be quantified?

15. There have also been a number of collaborative models in which water utilities and research organisations have come together to engage in research of mutual interest to various parties. In addition to the Water Research Foundation mentioned above, the Global Water Research Coalition is another of such model. By coming together and pooling research dollars together more research can be done with every dollar spent.