

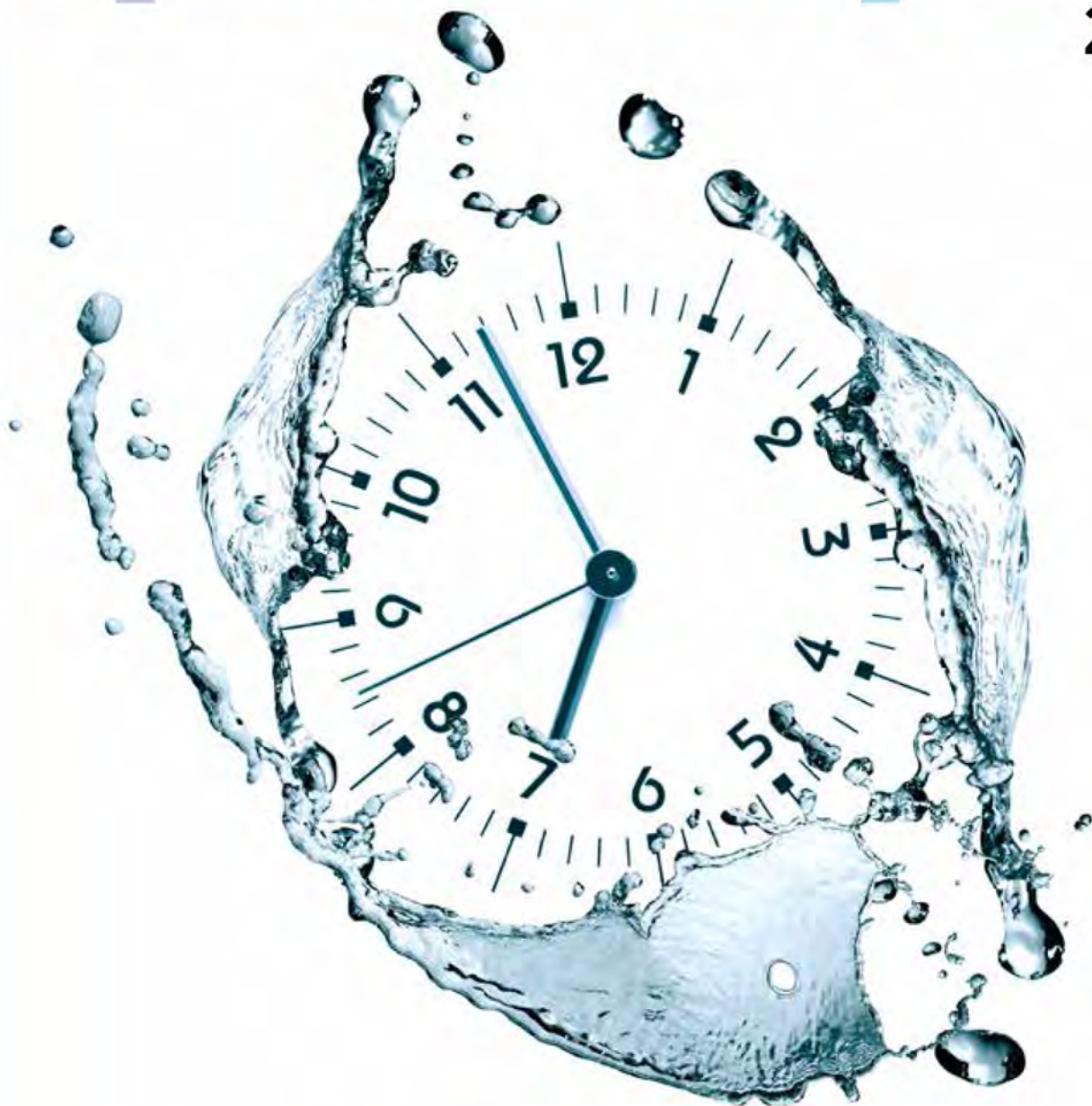


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# Special Report

2016



*The Future of*

## **QATAR'S WATER SECURITY**

**Aligning Academia & Industry up to 2030 and Beyond...**

# “We never know the worth of water till the well is dry.”

Thomas Fuller, 1732

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# The Clock is Ticking

BY SEAN EVERS

*Managing Partner, Gulf Intelligence*

The world is fast approaching a global water crisis. The UN expects a 40% global shortfall of water availability by 2030, with 650 million (m) people currently living without access to clean water. The global population is expected to boom from 7.4 billion (bn) today to 9.5bn by 2050 and the earth's climate patterns are undeniably shifting and putting more strain on fresh water access.

The links that match global water demand with clean and sustainable supply are broken and time is running out to mend them. Each country and region of the world faces different degrees of challenges and urgency. But, what is common to them all is a critical importance to have a proactive strategy to meet future demand growth, while also being prepared to respond to emergencies.

Aside from our daily personal domestic needs, a reliable water supply is at the crux of every industry, be it energy, construction, hospitality... a long list follows. Much oil and gas production and 98% of the power produced worldwide relies on a steady water supply.

Qatar's natural water resources are essentially depleted and the country only gets seven inches of rain per year. Qatar's inter-ministerial Permanent Population Committee estimates that residents consume 675 litres of water per capita per day – nearly twice the average consumption in the EU. Accordingly, Qatar's Mega Reservoir – one of the largest of its kind worldwide – is increasing the country's national

**“ On a global scale, is the finance being funnelled into research and development (R&D) leading to innovations fast enough to guarantee the booming population by 2050 can be provided for? Probably not.”**

water storage capacity to seven days with more reservoirs to follow and Kahramaa, the country's electricity and water utility, reduced the water subsidy in January. The subsidy cut marked an unprecedented move, with Qatar's leaders hoping it will trigger a shift in water consumption throughout the country's industry and communities.

On a global scale, is the finance being funnelled into research and development (R&D) leading to innovations fast enough to guarantee the booming population by 2050 can be provided for? Probably not. So, what are the solutions? How can water that is generated with oil and gas production be reused and recycled most economically, especially against a backdrop of low oil prices? How can the cost of desalination technologies be reduced to make them economically sustainable over the long-term? What can wider industry do to reduce their water wastage and what areas should R&D be focused on to have the greatest impact at the fastest rate? Time is ticking.

Though inevitably multifaceted, the solution must be underpinned by a holistic effort. Industry, academia and government must unite their efforts to fix today's water crisis – and quickly. ■



## 650

million people worldwide live without access to clean water.

# Qatar's Water Security: Our Journey Has Just Begun

BY H.E. ESSA BIN HILAL AL-KUWARI  
President, Kahramaa

**W**ater security is at the very heart of Qatar's survival. Aside from our basic human survival, our geopolitical security, economy, industries and communities all rely on a guaranteed and safe water supply. Accordingly, bettering Qatar's water security outlook is one of the country's three Key Challenges in the National Vision 2030, along with energy security and cyber security.

The pressure on Qatar's water resources has grown significantly over the last decade and we are at the beginning of our journey of innovation

and behavioural change to ensure that tomorrow's supply is safe. Our water resources today are becoming strained due to the fact that we only get seven inches of rain per year and the country's population is growing – today's 2.5 million (m) residents are forecast to multiply eightfold by 2050. Plus, more water is needed for our expanding agricultural and industrial sectors.

Water demand in Qatar has grown by an annual average of 10.6% over the ten years, with last year's 535m cubic meters of water consumption expected to hit 900m cubic meters by 2025. If

today's business-as-usual approach continues, Qatar will face serious and structural threats to its economic growth and national security over the coming decades.

We are not the only ones readdressing our traditional views of managing our water. The World Economic Forum's Global Risks 2015 Report ranked water as the global risk with the greatest potential to impact economies and societies over the next decade, which will inevitably force all countries to better their water management strategies.

Kahramaa, whose water networks cover 99.8% of Qatar's water supply, ensures that everybody has access to clean water. Water conservation,

efficient water use and water recycling are the most important drivers that support Qatar's quest for water security. Kahramaa launched Tarsheed, the National programme for the Conservation and Efficient Use of Water and Electricity, in 2012 with plans to reduce the country's water consumption by 35% within five years.

**“ The World Economic Forum's Global Risks 2015 Report ranked water as the global risk with the greatest potential to impact economies and societies over the next decade.”**

Kahramaa has also reduced the number of leaks in its water network to below 5%, while the level of non-revenue water losses – water that has been 'lost' in the distribution network before reaching customers – have fallen to around 19%. We are targeting 10% by 2018.

Water recycling and reuse have also undeniably climbed higher on the agenda of Qatar's water-related stakeholders, including the Ministry of Municipality & Environment and the public works authority, Ashghal. Now, treated sewage and industrial water are used for garden irrigation, landscaping, construction works and district cooling services.

Desalination plants have evolved rapidly over the last two decades and approximately 150 countries now use such technologies to help meet their fresh water requirements. In Qatar, water from desalination feeds 99% of municipal demand.

The success of Qatar's desalination technology highlights the importance of investing human and financial capital into water-related research and development (R&D). Such efforts will be integral to developing efficient technologies and scalable infrastructure to meet water demand up to 2030, as well as ensuring we cope well with any natural disasters.

Our R&D team has built strong and cooperative relationships with similar teams in Qatar – a unified effort is the only way we can all succeed. We must collectively improve Qatar's water security by finding solutions that navigate the logistical and cultural barriers that stand in our way. ■



## Kahramaa's Top 5 Initiatives to Better Qatar's Water Security:

1. Continue to build Mega Water Reservoirs.
2. Recharge the underground aquifers in Qatar's northern and southern fields.
3. Establish bilateral and collective interconnections across the GCC and other countries.
4. Equip the existing underground water reservoirs and wells with solar power to run the pumps during emergencies.
5. Install sensors to monitor radiation at the sea-side entrances of desalination plants.

## Key Macro-Steps to Improving Qatar's Water Security:

1. Use R&D to align Kahramaa's objectives with those in industry, including utilities.
2. Encourage and adopt new technologies in water production, transmission, distribution and consumption.
3. Increase the level of man-made and natural water storage capacity.
4. Encourage and support the use of treated and recycled water in industries, landscape and construction works.
5. Support and incentivize water conservation and efficient water use throughout Qatar.

## In Numbers

**99.8%**

Kahramaa's water networks cover 99.8% of Qatar's water requirements.

**35%**

Qatar plans to reduce the country's water consumption by 35% within five years.

**150**

The number of countries where desalination is used to help meet water demand.

# Qatar's 2030 Goals: SHIFTING GEARS

BY DR. HASSAN AL-DERHAM  
*President, Qatar University*

**C**hange' is a simple word, but to achieve it takes considerable financial and human capital.

Over the last ten years, Qatar's brightest minds have been dedicated to successfully designing and building the country's research and development (R&D) ecosystem across multiple platforms.

Qatar's sweeping remit to boost its R&D has been sharply focused on meeting the country's three Key Challenges, as outlined by Qatar's National Vision 2030: energy security, cyber security and water security.

After a very successful decade and with 2030 rapidly approaching, Qatar must change gear. Qatar must focus on collecting precise results from all our R&D studies under the three Key Challenges to generate fresh intelligence that enables us to progress at a faster rate.

The small size of Qatar could be a weakness, as the country's population of 2.5 million (m) people could translate into a lack of human resources. Equally, being a small country has enabled Qatar to accelerate its progress and innovate faster than some others. Instead of achieving our targets over a 25 year period, we were able to achieve our goals in ten years, for example. Small is good, especially if we have a global vision and if we interact with others both regionally and globally to build a strong and multifaceted network.

But Qatar's three Key Challenges will not succeed without a clear alliance between its industry and academia. Gaps in this relationship could have significant and negative consequences as the years roll on and if not addressed, Qatar's progress will not accelerate as quickly as we need it to.

Industry should be ready to help academia propel their learning and research capabilities and ensure that it has the tools it needs to facilitate world class R&D. This includes investing in new laboratories, or particular research projects where companies can also contribute their practical on-site expertise and knowledge. Better communicating the type of talent pool that industry expects to need over the coming decades would also help academia prepare today's curriculum to create tomorrow's professionals.

Equally, Qatar's academia cannot do research purely for the sake of research. Efforts have to be focused in order to deliver results that are useful to the industry and to Qatar's economy as a whole.

It must be a holistic and organized effort. Platforms where industry and academia can communicate are essential to ensure that each side is moving in a similar direction. Clearer processes would also boost Qatar's ability to do applied research – research that answers a specific question – which can lead to innovative technologies in the energy, cyber and water sectors. Commercializing and exporting these innovations is another tick in Qatar's box to become a knowledge-based economy by 2030.

A knowledge-based economy means moving away from a dependence on oil and gas revenues and instead, focusing on elevating the intellect and expertise of nationals in Qatar.

The economic impact of lower oil prices on budgets should not be allowed to curb R&D associated with Qatar's three Key Challenges. A large majority (86%) of respondents to a Gulf Intelligence Industry Survey in April said that continuing such investments is an absolute must-have. Maintaining this momentum is especially important as 42% of respondents said that Qatar's management of its three Key Challenges is not urgent enough.

Qatar's push for a knowledge-based economy is at the heart of its energy, cyber and water security targets. It is something that is often spoken about, but to actually shift the mission statement of a country's economy and culture is a great undertaking.

Building laboratories, establishing research programmes and widening the country's PhD offering is not enough.

We also need to adjust the way we think. The brightest young minds in Qatar need to think critically and to see a problem with fresh eyes. Fuelling the spirit of innovation throughout the country's youth is imperative. This is how change begins and without a united effort between industry and academia, Qatar's goals will falter. ■



**“The brightest young minds in Qatar need to think critically and to see a problem with fresh eyes. Fuelling the spirit of innovation throughout the country's youth is imperative.”**



# Government Should SPEARHEAD Qatar's Water Security?

**Q**atar's government is critical to establishing clear mandates by encouraging the interaction of the country's entities in order to improve today's strained water security outlook. An isolated approach rarely works and while the support and cooperation of industry and academia are vital, it is the government that outlines the country's vision and objectives.

The government has the authority and capacity to encourage executives

By Dr. ADEL SHARIF

Research Director, Qatar Environment & Energy Research Institute (QEERI)

and institutions within industry and academia to work together. Today's communication between the two can be limited and that gap must be bridged for Qatar to hit its National Vision 2030 goals – the time to create a cohesive

network is running short. The demand for water in Qatar is expected to rise by 1.6x from the 535 million (m) cubic meters last year to 902m cubic meters by 2025, which is a staggering rate of growth in just a decade. The population

**“Government-led action is vital to allow novel ideas on paper to be actualized as innovations in the field.”**

of 2.5m is expected to rise by eightfold by 2050, which will put additional pressure on the country's strained water resources.

Government-led action is vital in not only opening the door for innovation, but also in setting up a supportive network that allows novel ideas on paper to be actualized as innovations in the field.

For instance, I was able to bring a business to the market at the Centre for Osmosis Research and Applications (CORA) at the University of Surrey in the UK, as the universities there have a system that emphasizes the positive impact of research. My idea was supported by the university because it was in line with the government's mandate. The support for water research and subsequent innovations could improve Qatar's water management and will also gain traction as the government deepens its push to build a knowledge-based economy

– placing more of an emphasis on the country's intellectual assets, rather than hydrocarbons.

If we want to replicate the success story that I had in the UK in Qatar, the country is required to take ideas that are generated in laboratories to industry. For this to become a reality, the government in Qatar must provide clear guidelines that empower people throughout the country to realize their potential.

All of us in Qatar – government, industry and academia – need to be concise when speaking about who is best to lead the push to improve the country's water security challenge. If the question is whether Qatar should put everything that relates to water under a government-led umbrella, then the answer is clearly no. If we are talking about putting everything that specifically relates to the national priority of improving water security up to 2030 and beyond, then the answer is yes.

Qatar does not have a significant local industry, with many companies acting as service providers.

Subsequently, the country does not have the local capability and facilities to independently lead a national effort to spur technological and legislative innovations. Equally, governmental support is integral in helping researchers conjure concepts in the laboratory before turning them into an innovation that actively supports Qatar's water security.

Much progress has already been made in Qatar, including the ongoing success of Kahramaa's Tarsheed programme, which is the National Campaign for the Conservation and Efficient Use of Water and Electricity. Tarsheed plans to reduce the country's water consumption by 35% within 5 years. If achieved, this tight target would help establish a global benchmark and support Qatar's push to become a knowledge-based economy by 2030.

Government, industry and academia are equally crucial pieces of the jigsaw that Qatar must finish to ensure the country's water security up to 2030 and beyond. While government should spearhead a new water culture, all three must fulfil their obligations – the clock is ticking. ■





## **Government-Industry-Academia STRATEGIES TO BOLSTER QATAR'S WATER SECURITY?**

Panel Session at The Gulf Intelligence Qatar Industry Water Security Forum in Doha

- **H.E. Essa Bin Hilal Al-Kuwari, President, Kahramaa**
- **Prof. Mariam A. Al-Maadeed, Vice President for Research & Graduate Studies, Qatar University**
- **Dr. Adel Sharif, Research Director, Qatar Environment & Energy Research Institute (QEERI)**
- **Dr. Simon Judd, Maersk Oil Professorial Chair, Gas Processing Centre, Qatar University**
- **Ms. Sara Al-Said, Reservoir Engineer, Occidental Petroleum**
- **Moderator: Sean Evers, Managing Partner, Gulf Intelligence**

*Sean Evers: Your Excellency, is it fair to say that Qatar's leadership have ramped up their efforts to improve water security?*

**H.E. Essa Bin Hilal Al-Kuwari:** Yes, there is a commitment from the government to reduce the consumption of water and electricity as part of Qatar's National Vision 2030. This is the only way to make water resources sustainable for the next generation. We are working with the government on many campaigns to change the habits of the people in Qatar. We are starting on how best to educate youngsters at school to use water efficiently. This effort continues through to young adults and the older generation. We will also force people to improve the way they use water by putting rules and regulations in place and then there is the price itself.

It is like a triangle; one corner is education and awareness, one corner is implementing rules and regulations and the third corner is the price of water. We have succeeded on all three points so far and we will continue to focus on increasing the country's awareness.

*Sean Evers: How quickly can Qatar move from having practically free water and power to selling it at full market value?*

**H.E. Essa Bin Hilal Al-Kuwari:** Everybody is paying bills, except Qataris in their own residences. The subsidies do not only apply to electricity and water. There is a full regime throughout the education

**“ It is like a triangle; one corner is education and awareness, one corner is implementing rules and regulations and the third corner is the price of water.”**

*H.E. Essa Bin Hilal Al-Kuwari, President, Kahramaa*

and health sector too, for example. It is a complete package. The government will decide one day how to change the subsidies and what percentage should be adjusted based on the situation in Qatar.

*Sean Evers: How much of Qatar's future demand do you expect to be affected by the need for conservation?*

**H.E. Essa Bin Hilal Al-Kuwari:** Our target under the Tarsheed programme is to reduce Qatar's electricity consumption by 20% and 35% for water consumption. We can exceed these targets by putting in more effort and implementing more rules and regulations.

*Sean Evers: How much work needs to be done to improve the alignment between industry, academia and government?*

**H.E. Essa Bin Hilal Al-Kuwari:** The alignment has started, but it has not reached the level that we are aiming for. Today, much of the burden rests on the government and I think we need to collaborate more with industry and academia to come up with solutions.

*Sean Evers: Dr. Mariam, 78% of respondents to a Gulf Intelligence (GI) Industry Survey said Qatar's government must take the lead in bettering the country's water scarcity problems. What is your view?*

**Prof. Mariam:** Government is very important, but academia can also think outside of the box. I would like to involve more students, researchers and people from the industry and government in this movement, but academia should lead this initiative.

*Sean Evers: Your Excellency, what is your view?*

**H.E. Essa Bin Hilal Al-Kuwari:** I think we should put all the efforts from the industry and academia under the umbrella of government, but we are also looking for industry and academia to take more responsibility.

**Dr. Simon Judd:** The balance is moving towards industry in Qatar, as they are the ones with the most vested interests if you are talking in terms of US dollar signs. Many of the innovations – putting ideas into practice, not just on paper – are provided through an industrial push at some stage. Most of the activity driving this change will come from industry, as they are the ones with the most to gain.

*Sean Evers: 78% is a very big majority. Is there a risk to depending too heavily on government leadership?*

**Dr. Simon Judd:** That is a difficult one. The government essentially sets the rules, but the onus is on industry in terms of developing solutions. Industry's efforts must be in collaboration with academia and the government.

*Sean Evers: Sara, do you expect that 78% to change during your career?*

**Sara Al-Said:** The government should be the umbrella leading the effort, but we should not neglect the efforts made by industry and academia. Academia has many ideas and collaboration with industry would arrive at solutions, but communication between the two is not handled well. In industry, the data confidentiality may be keeping academia at a distance. Also, I strongly recommend that academia offer courses in primary



## “The balance is moving towards industry in Qatar, as they are the ones with the most vested interests if you are talking in terms of US dollar signs.”

*Dr. Simon Judd, Maersk Oil Professorial Chair, Gas Processing Centre, Qatar University*

schools to make sure that the concept of water security is in youngsters' minds. When they get older, they will believe in the need to preserve water and can take action.

**Prof. Mariam:** Academia consists of two parts – research and the teaching – and both can contribute to Qatar's important initiative. Improving science, technology, engineering and mathematics (STEM) skills and improving the awareness of water security are very important. Qatar University is doing this very well. We have different research programmes that focus on nanotechnology, membranes and gas processing, for example. Many topics relate to water, especially in science and engineering.

*Sean Evers: 48% of respondents to a GI Industry Survey said that Qatar would benefit from consolidating all of its in-country water research under a single umbrella, with the resulting intellectual property (IP) shared by all. What are your thoughts, Your Excellency?*

**H.E. Essa Bin Hilal Al-Kuwari:** Each country and region have their own challenges and you cannot

have one entity serve all their needs. In Qatar, I think it would be better to have the country's efforts under one umbrella. Having a laboratory that represents the GCC countries with similar challenges may reduce the cost of R&D, but I do not think this would work on a global level.

**Dr. Simon Judd:** I cannot think of the advantage of having a disaggregated approach and it makes sense to pursue any kind of efficiency.

**Dr. Adel Sharif:** There are two areas here. One is the national priority, which is the water security as per the government's National Vision 2030. This needs to be under a single umbrella and requires a consolidated effort that includes government, industry and academia.

*Audience Member #1: Do you have any research in place to measure the impact of climate change on Qatar and what research we can do, or technologies we can introduce to prepare for any changes?*

**H.E. Essa Bin Hilal Al-Kuwari:** Climate change may be a good thing for Qatar, as it means we may have more rain. We do not know what will happen in the future, but our colleagues are managing the climate change agenda.

**Prof. Mariam:** We have very good research centers dealing with these areas. I would like to invite you to visit the Environmental Studies Center and the Sustainable Energy Center, which have good publications and reports.

*Audience Member #2: Consolidating all the country's efforts under one umbrella is dangerous – it goes against innovation and allowing different schools of thought to come together. It would take a lot of entities out of the equation and sharing IP will put the industry off, as that is how they become competitive. We should allow for market competition, while having good collaboration between all the entities.*

**H.E. Essa Bin Hilal Al-Kuwari:** I totally agree. I am not for centralization, but aligning efforts would be a good solution.

*Audience Member #3: The oil companies in Qatar, especially Qatar Petroleum, have huge data systems that can be used effectively for this purpose. The government should step in and facilitate the communication between academia and industry to share information and data.*

**Sara Al-Said:** Yes, there should be a data bank, or something to facilitate communication between academia and industry. This is very important.

**H.E. Essa Bin Hilal Al-Kuwari:** We are building a data bank to hold all of Qatar's information on water resources. It is being built and everybody will be able to access it soon.

*Audience Member #4: There needs to be more visibility on where the improvements in Qatar's water security can be made, so that industry and academia can focus their efforts to create the most impact. This visibility is owned by Kahramaa, which has all the various information on Qatar's consumption levels, for example. We cannot improve what is not measured.*

**H.E. Essa Bin Hilal Al-Kuwari:** Everybody providing their own data on their water and electricity consumption is a new initiative in our campaign to increase national awareness. Every month, we will send messages to everybody in Qatar to show them their level of consumption, as well as showing them whether their consumption is above the national average. This way, people can start to understand how much they are consuming.

*Sean Evers: Your Excellency, you have the floor for any final thoughts.*

**H.E. Essa Bin Hilal Al-Kuwari:** Qatar's water supply is secure and I want people to be relaxed and enjoy their lives. We have strategies to manage any scenario, including disasters. They are in safe hands. ■





# Produced Water

What are the best strategies that the oil and gas industry in Qatar can use to maximize the shared economic value of its produced water?

**O**il and gas operations usually generate significant quantities of water from reservoirs – globally, the average ratio is three barrels of produced water for one barrel of oil. Water-strained Qatar faces a tricky outlook, as it is the world’s largest liquefied natural gas (LNG) exporter and also produces 680,000 barrels a day (b/d) of oil. Qatar’s produced water is either treated and then re-injected into a reservoir to help sustain the pressure, or it is directed to a disposal well. The economic incentives for oil and gas companies have to improve so that produced water is nearly always reused, or recycled.

There is an urgent need to establish standard treatment procedures of produced water, but such efforts have not gained traction in Qatar. Industry and water experts argue that the government has not defined firm guidelines for quality standards and that there is little context in terms of international best practice.

Produced water is a potentially valuable source of water and could prove highly useful for Qatar’s bid to improve its long-term water security, as per the National Vision 2030. The economic argument for reusing, or recycling produced water can be justified if low cost treatment plants and technologies are applied to the process. But, treating

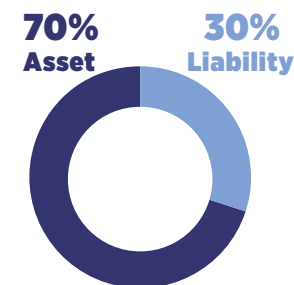
produced water using today’s measures is expensive, as produced water tends to be a poorer quality than sea water – which is used for desalination – and requires advanced treatment. The process is made more complicated by the fact that there are only tailor made solutions for treating produced water – the quality differs in every field – and there is a further distinction between the treatments of gas associated water and water produced during oil production. This means Qatar must explore multiple solutions, which has both cost and human capital implications.

Qatar aims to reduce around 30% of its total produced water over the medium-term, which is a considerable goal given the aforementioned ratio of 3:1. Qatar has a window of opportunity to place its research and development (R&D) teams and industry at the forefront of the global wave of water innovation by leveraging the country’s strong academic base and industrial infrastructure.

Exporting knowledge on how best to recycle and reuse produced water in a cost-efficient manner, especially against the backdrop of low oil prices, will elevate Doha’s intellectual profile and support its goal to both improve its water security and become a knowledge-based economy by 2030.

## In Numbers

Produced water is a by-product of oil and gas production. Globally, roughly three barrels of water are produced with every barrel of oil. Should regional energy producers consider this resource as an:



Source: Gulf Intelligence Industry Survey



**3:1**

The average ratio globally is three barrels of produced water for one barrel of oil.

## 1 Explore Innovative Re-injection Processes

R&D teams can focus more strongly on improving today's produced water re-injection processes at oil reservoirs to reduce any loss of injectivity. Re-injection can take place either in the producing reservoir, which is the preferred configuration, or in disposal wells in a non-producing reservoir. In both cases, it is important to have the technologies that are able to treat the water at required specifications to avoid loss of injectivity and ultimately, keep costs low. R&D teams can either develop solutions with innovative technologies, or optimize existing technologies.

Total, for example, has developed and validated Flex technology through an industrial pilot, which aims to reduce the cost of produced water re-injection for pressure maintenance. It is based on ceramic membranes and allows the treatment of both sea water and produced water. In this case, a unique plant replaces two specific plants and cuts costs and boosts efficiency. Re-injecting produced water into an oil reservoir can also be used for chemical-enhanced oil recovery (EOR) by mixing it with a modified ionic composition, or with even more sophisticated EOR processes. EOR is increasingly needed in Qatar and the wider Gulf – Oman, Kuwait and the UAE, for example – to enhance the performance of maturing oil fields.

## 2 Investigate Desalination Applications

A greater emphasis on R&D also sits at the heart of the re-processing of produced water through desalination, which can ensure the water is suitable for industrial and irrigation use, for example. Technological innovations, or the use of crossover technologies – tools used in other industries that can be adapted to enhance water management strategies – are key. Today's desalination technologies, which focus on a separation process used to reduce the dissolved salt content of saline water to a usable level, are largely inapplicable to produced water. For example, the



salinity in produced water is often too high for reverse osmosis, which is a technology that removes a large majority of contaminants from water by pushing the water under pressure through a semi-permeable membrane. A promising new technology that could be applied to desalinating produced water is forward osmosis – potentially a more energy efficient route.

## 3 Support the Emerging Biofuels Market

The treatment of produced water can be costly and greater R&D efforts should be focused on how the raw material of produced water can be used for economic benefit. Reducing the associated costs with treated produced water will also help incentivize the oil and gas industry to proactively find disposal solutions. One such example is the production of biofuel using grasses and plants that are able to tolerate the irrigation of producing water directly, or at least after a relatively few low-cost treatment steps.

R&D into identifying and then screening the grasses and plants that are most able to survive the irrigation

of produced water would be highly valuable and save costs over the long-term. This process would have multiple benefits, including pioneering a low-cost treatment of what is effectively a waste product. It would also elevate oil and gas companies' environmental ethos – important as the legalities surrounding their environmental impact gain traction – and help decrease global warming by increasing the world's grass and plant populations.

## 4 Tighten Treatment Standards

The government needs to provide guidance on the quality standards that must be applied to the treatment and management of Qatar's produced water, especially in terms of local legislation and international best practice. The standards of produced water treatments should meet the quality standards of the final objective. For example, treated produced water used for industrial purposes will encounter different quality standards than produced water allocated for environmental discharge, or irrigation. Clarifying the correlation between the untreated produced water and its final use will help R&D teams

and energy companies pin down the treatment technologies they require. Streamlining this correlation has the potential to reduce the level of water and economic waste.

There is a surplus of produced water in Qatar and huge volumes are earmarked for environmental discharge. Using low cost and more extensive produced water treatments, such as phytoremediation and wetland engineering, will encourage the natural biodegradation of hydrocarbon contaminants in the produced water. Plus, the treated produced water from such wetlands tends to be a high quality and has useful downstream applications for industry and agriculture.

Treatment systems that include creating artificial wetlands also have the benefit of enhancing ecological biodiversity in Qatar, where such habitats have been radically impoverished in recent years. Qatar's academia, such as the Environmental Science Center at Qatar University, is well-placed to explore this innovative and environmentally friendly route alongside the oil and gas industry.

## Produced water from wetlands tends to be high quality and has useful downstream applications for industry and agriculture.”

## 5 Establish a National Management Framework

There is little argument that produced water is a problem for the oil and gas industry, a significant environmental threat and a regulatory challenge. Cost-effective and environmentally-sound strategies and technologies can transform Qatar's produced water into a valuable asset. But, there is one vital ingredient – a nationwide framework to manage produced water.

The objective of this framework would be to identify, quantify, evaluate and assess both the challenges and opportunities posed by the management of produced water in arid Qatar. The integrated approach would also consider the large volume of produced water generated by the gas-to-liquids (GTL) industry.

The framework could include the

characterization and classification of produced water in different categories of treatability and it would identify the quantity of produced water from oil, gas and GTL industries. The evaluation and assessment of the potential environmental impact of produced water would be incorporated into new regulations. There would also be a comprehensive assessment of existing and emerging treatment technologies and integrated and hybrid configurations to treat produced water. The framework would bring produced water collection and treatment facilities under water sharing agreements and the establishment of a beneficial reuse matrix, which considers both the natural and engineered conveyance systems, water qualities and agricultural application. ■



“There is little value in improving the supply-demand water balance if industries that are vital to the country’s GDP suffer financially.”

# Industry Consumption

What are the best strategies that Qatar’s industry can use to reduce its wastewater?

The way Qatar’s industries view water consumption is undergoing a paradigm shift and the spotlight is increasingly focused on seeking out cost-effective strategies to reduce wastewater and ramp up the percentage of recycled and reused water. Energy, agriculture, hospitality and construction are just a few of the sectors that must embrace change and adjustments are needed across the spectrum, from rethinking endlessly flowing fountains at hotels to better conserving water in the country’s major material industries.

Qatar’s groundwater aquifer receives less than 40 million (m) m<sup>3</sup> per year as natural recharge, but around 220m m<sup>3</sup> per year is taken out – the imbalance makes the need for change obvious. Small changes like switching from a 2.5 gallons per minute (GPM) shower head to a 1.5GPM could save up to 10 gallons of water in ten minutes.

The rise of industrial water demand appears to be unstoppable as Qatar’s population of 2.5m grows alongside the country’s expanding industry. The prime concern amongst industry and water experts is that there appears to be a lack of direction, or even intervention from the government on how to tackle the country’s water scarcity.

Qatar is in urgent need of an integrated and holistic industrial water policy, which collectively considers the country’s water cycle and industries’ mandates to ensure that improvements are adopted in an environmentally and economically

friendly way. There is little value in improving the supply-demand water balance if industries that are vital to the country’s GDP suffer financially.

The establishment of a clearer regulatory framework by the government – a new rule book, essentially – would give industry much-needed guidance. Such a structure would be a healthy mix of a top-down and bottom-up approach and ensure that all players are accountable for their water consumption. Industry and water experts in Qatar make an important distinction between the government providing direction and controlling water consumption – the latter is not as popular.

Industries also need to ramp up the amount of grey water – used water without fecal contamination – and black water – water used in toilets, for example – by encouraging collection points at their offices, or building sites. Some companies are already doing this, but many more must join the table to ensure that Qatar’s industries are collectively moving down a sustainable pathway.

Preserving the country’s environmental integrity also remains a priority amongst industry, with many experts supporting the need to conduct environmental impact assessments on available water supplies and contamination before commencing construction.

By *Nicholas Carter*  
Director – Middle East, Baringa Partners

## In Numbers



10

Switching from a 2.5 gallons per minute (GPM) shower head in offices and hotels, for example, to a 1.5GPM could save 10G in ten minutes.



220

Qatar’s groundwater aquifer receives less than 40m m<sup>3</sup>/yr, yet around 220m m<sup>3</sup>/yr is taken out – a worrying imbalance.

## 1 Enhance Government-led Guidelines

The government is at the heart of introducing both economic and non-economic policies to create a more sustainable approach to industrial water management in Qatar. Possible economic policies include charging for the treatment of wastewater based on its quality and quantity. A fee would encourage industry to think more carefully about their consumption, as would the introduction of quotas and wastewater generation quotas. A higher tariff could be applied when exceeded. A third economic policy could be the complete, or partial privatization of the water sector, which would encompass the supply, distribution, collection, treatment and disposal of water.

Non-economic policies include the deployment of more efficient technologies and processes, such as cooling towers. The government could also stipulate the percentage of water that must be recycled by companies on a case-by-case basis. Agriculture accounts for around 60% of Qatar's total water consumption, even though the sector's contribution to the country's GDP is in single digits. Banning the cultivation of water guzzling crops entirely and shifting the planting season to the winter months only – Qatar's summer temperatures average 35 degree Celsius – are necessary steps. The agriculture sector could also improve the use of drip irrigation to minimise water wastage. Quotas and the use of treated grey water should be applied to all sectors, from hospitality to construction. If introduced, all the suggested economic and non-economic policies would be overseen and regulated by the government, or an independent authority.

## 2 Improve the Distribution of Treated Water

Qatar has a widening network of collection and treatment systems for domestic wastewater, but the same does not yet apply to industrial wastewater. With Qatar's industries clustered in Ras Laffan and Mesaieed, it should be relatively straightforward to create an overarching framework that manages



**“ Qatar must adopt a preventative approach to its water scarcity, rather than today's reactionary mind set.”**

and treats industries' wastewater. The lack of an efficient distribution network to transport treated wastewater to the next user means considerable volumes of treated water – a resource that is suitable for agriculture and district cooling, for example – are lost.

Aligning the source of the treated wastewater with an end user not only helps Qatar monitor the country's supply-demand water balance, but it also makes industry accountable for their consumption and subsequent wastage. Pinpointing and regulating the destinations and volume of treated water could be supported by building a dedicated distribution network.

Kahramaa, whose water networks cover 99.8% of the country's water supply, has done commendable work in recent years to reduce leaks in its distribution network. Still, industries' journey has only just begun.

## 3 Explore Industrial Symbiosis

Industrial water consumption and wastage can be split into two camps; either within a business, or between businesses. The improvements that companies can make in-house are well-documented and more attention must be allocated to reducing and reallocating wastewater between different companies. For example, the steel industry produces fly ash, which can be used in the cement industry – a waste product in one company is a cheap resource for another. The same theory applies to Qatar's water management. There is no reason why more grey water from a company's offices cannot be treated and remarketed as irrigation for a landscaping company, for example. Such cooperation adds a revenue-generating asset to the seller's books, while reducing the cost of resources for the buyer – a win-win scenario. Similar trade-offs will especially



**60%**

Agriculture accounts for around 60% of Qatar's total water consumption, even though the sector's contribution to the country's GDP is in single digits.

**“ Qatar's small size could prove beneficial, as industries with a wastewater sharing agreement would have relatively low transport costs and travel times.”**

gain traction if strict wastewater quotas are introduced. Qatar's small size could also prove beneficial, as industries with a wastewater sharing agreement would have relatively low transport costs and travel times.

## 4 Create a Water Management Ecosystem

Three key pillars support the establishment of a water management ecosystem in Qatar, which could form the foundation of an executive master plan for the country's water security outlook.

The first pillar details the creation of

environmentally friendly policies and technologies – renewable energy, for example – that encourage a sustainable water supply. It also includes implementing best practices, plugging knowledge gaps through R&D and introducing evaluations of industries' demand for water. The second step involves determining governance mechanisms, which industry can use as a springboard to implement their in-house water management policies and strategies. And the third is the need to create an institutional framework that actions the recommended policies and supports the decision-making process.

## 5 Adopt a Holistic View

Much attention has been given to the benefit of research and development (R&D) in Qatar, but the conversation needs to progress. Qatar needs to focus on a more holistic approach that encompasses technology while also examining how all industries function. Elevating the level of integration between the different entities can reduce water wastage across the board. R&D into water management and technologies should be synonymous with development – research should be underpinned by clear and common goals. At the heart of a holistic approach is the need for the full collaboration of industry, academia and government. Academia plays a large role by developing highly-valued knowledge and expertise. A collaborative approach would ensure that Qatar adopts a preventative approach to its water scarcity, rather than today's reactionary mind set. ■



# Desalination

What are the most effective and sustainable strategies that Qatar can use to enhance today's desalination processes?

**D**esalination has proven to be a critical and innovative crutch for Qatar's water supply. Desalinated water feeds 99% of the country's municipal demand and the annual growth in demand is climbing by 10%. But, desalination remains a very expensive process. Qatar's current desalination infrastructure and technologies will struggle to keep pace with the country's booming population and subsequent water demand. The rate of technological innovation needs to accelerate.

The energy efficient desalination technologies being adopted in Qatar today have been in place in other countries – desalination is practiced in around 150 countries – since the 1980s. Using technology that is arguably dated also fails to support Qatar's goal to become a knowledge-based economy as

per the country's National Vision 2030.

The best route to introducing innovative technologies that reduce the soaring costs of desalination is to simultaneously invest in the country's water research and development (R&D) and seek global solutions. Perhaps Singapore's work into biomimicry – where mangrove plants and fish extract seawater using minimal energy – could be applied to Qatar?

The importance of environmental sustainability must also climb higher on the country's agenda. Desalination is rapidly increasing the already high salinity content in Qatar's waters. Aside from jeopardising the marine ecosystem, this means that desalination plants have to work double time to desalinate even saltier water that is produced from the initial desalination process.

## 1 Use Renewables to Power Desalination Plants

The world's first automated and remotely controlled desalination plant is located on a farm in Qatar and owned by Ali Hussain Ali Al-Sada. A secure supply of electricity generated by photovoltaic technology – the conversion of solar energy into direct current electricity – and wind technology powers the plant. The scale of such a plant would need revising to meet Qatar's rising water needs, but the project still highlights the effectiveness of using renewable power. Is this Qatar's future? Qatar could focus its R&D on how to use wind, solar and perhaps even wave technologies to power desalination plants on an industrial scale. While such exploration may be costly to start with – particularly considering the required human capital and testing equipment – the long-term economic gains would pay off.

## 2 Rethink the Management of Brine

The quality of the waters around the Gulf, including Qatar, are being jeopardised by industrial activity and in part, by the large amount of salt dumped back into the sea by desalination plants. Qatar's temperatures – an average of 35 degrees Celsius in the summer – naturally raise the salinity content of the surrounding waters. Consequently, the facilities that manage salinity for wastewater treatment should be replaced, or upgraded. Qatar's overall goal for the future of desalination should be to have zero liquid discharge, including brine.

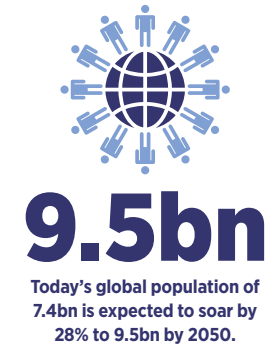
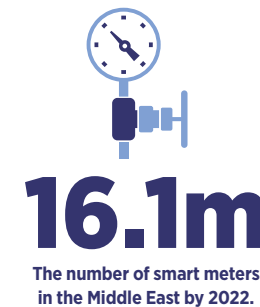
The doubling of the Gulf's water exchange between sea water and desalinated water – in line with rising power and water production – is expected to lead to an exponential increase in the salinity of Qatar's water. The surrounding waters could soon be overwhelmed to the point that desalination is no longer viable. To avoid such a dire outlook, the environmental impact of today's desalination processes must immediately be revamped by industry, academia and government to ensure that the method remains a reliable water source for decades to come.

## 3 Ownership of the Entire Supply Chain

Qatar needs to take control of the entire water supply chain, with R&D into home-grown desalination technologies playing a key role. Taking ownership of the entire supply chain will streamline the approval process for the much-needed technological innovations. Qatar would own the intellectual property (IP) and relevant licenses, thus alleviating bureaucratic bottlenecks. Water is a fundamental factor in ensuring a country's economic and national security and all relevant activities should fall under the umbrella of a single state-owned company.

**“Qatar could focus its R&D on how to use wind, solar and perhaps even wave technologies to power desalination plants on an industrial scale.”**

## In Numbers



Transforming novel ideas in the laboratory into innovations that cut costs and meet environmental standards at desalination plants is a challenging task. A state-owned company would have the financial and human capacity to implement a fast-track programme for the ideas that have the greatest chance of boosting sustainability at desalination plants. Technological innovations could also be explored alongside a partner research institution, which would help mend the wobbly bridge of communication between industry and academia.

## 4 Embrace New Technologies

One of the greatest challenges facing efforts to improve Qatar's desalination sector is a reluctance to adopt new technologies. This impediment stems from the government's tendency to make major investments on an exceptionally long-term basis, with some timetables stretching over five decades. This has led governments and companies to become adverse to change, as they have already spent considerable sums on today's desalination processes and want to avoid backtracking.

Another key challenge is the posture taken by suppliers, whose main objective is to ensure a reliable and constant delivery of desalinated water. A remit to explore and adopt innovative

technologies disrupts suppliers' status quo and many start to question their financial stability, which is especially the case for small and medium-size enterprises (SMEs) – a portion of the workforce that Qatar is trying to nurture. Consequently, suppliers must be incentivized and supported through the process – perhaps with technical expertise and financial capital – to ensure that Qatar is not left behind in the global race for innovation.

## 5 Introduce Tougher Rules

Creating stricter regulations and policies will help curb Qatar's sometimes wasteful water use and put less stress on the country's desalination infrastructure, thus bolstering their sustainability. Kahramma, made an unprecedented move in the country's push for water security in January 2016 by reducing water subsidies. The company also expects to complete the first phase of a smart meter deployment programme in Doha this year, which will enable residents to monitor their individual water consumption and see how they compare to the national average. This bottom-up approach is gaining traction; the Middle East's smart meter market is expected to reach 16.1m units by 2022 and nearly all (86%) of homes and businesses in the region could have smart meters installed within the same period. While slashing water subsidies and rolling out smart meters is commendable, Qatar's regulatory bodies need to continuously tighten up their rule book to stay ahead of the country's rising demand for desalinated water. ■



# Technology

How can innovations in water management be incorporated into Qatar's existing infrastructure at minimal cost and maximum speed?

**R**esearch and development (R&D), underpinned by a strong bedrock of financial and human capital, is critical to create technologies that will enable Qatar to better its water security in a cost-effective and quick manner, as per the National Vision 2030.

The three main entities in Qatar – government, academia and industry – bring their own perspectives, priorities and agendas to the brainstorming table. The country needs academic research goals, government-led priorities and an awareness of water consumption throughout industries and communities to ensure long-term water security. The success – and importantly, the speed of progress – of such plans requires the ability of all three entities to spur the country's technological advancements.

There is little value in starting the country's water technology portfolio from scratch. It makes more sense to elevate the efficiency and capacity of existing infrastructure, especially when low oil prices have put considerable strain on energy producers' budgets. This is best done by simultaneously using innovative technologies and crossover technologies, which are tools used in other industries that can be adapted to enhance water management strategies.

Novel developments could be applied to desalination such as permeable membrane materials and 'smart' resource metering. To fuel the spirit of innovation within Qatar, the country's primary entities must unite their efforts to enhance science, technology, engineering and mathematics (STEM)

education. Qatar's technological and water security goals could flounder without bolstering today's talent pool of scientific and technical expertise. Plus, rejuvenating Qatar's skilled workforce is in line with the country's mandate to become a knowledge-based economy – one that relies on intellectual value, rather than hydrocarbons.

There is significant appetite amongst experts for positive change, but the clock is ticking and R&D projects and associated funding should be chosen carefully to ensure the greatest impact up to 2030 and beyond. Ensuring Qatar has the technological capability to strengthen its water security rests largely on the government's shoulders, but all must support the leadership with their financial and creative efforts.

**1 Rethink the Entire Water Cycle**  
Using R&D to take a holistic view of Qatar's entire water cycle could reveal hidden economic and environmental opportunities, especially between industries. A quick review of the main themes in the full life cycle of water includes consumption, awareness, produced water, desalination and associated emissions. For example, brine (salt) build up in the sea is a major negative consequence of the desalination process, which currently meets 99% of Qatar's municipal needs. Perhaps Qatar could explore the benefits of establishing a small and local salt industry? Such a move, or similar pathways, would support the country's economic diversification goals, as well as its environmental commitments.

Qatar's industry, academia and government could also holistically explore ways to cheaply treat wastewater so that it can be used for irrigation. The country's arid landscape means there are few trees and greater green cover would help improve air quality, especially against a backdrop of industrial expansion and urban construction.

**“The country's arid landscape means there are few trees and greater green cover would help improve air quality, especially against a backdrop of industrial expansion and urban construction.”**

**2 Innovation, Innovation, Innovation**  
Time is short and earmarking a steady flow of finance for targeted R&D projects will increase Qatar's chances of introducing technological innovations to improve its strained water outlook. While innovations are rarely cheap, the evolution of desalination as a fundamental water management tool in Qatar and 150 other countries is one illustration of how integral investing in financial and human R&D capital can become.

Some experts argue that Qatar's R&D teams must create and commercialize all their water technologies locally, including the local registration of patents. They argue that this would elevate Qatar's intellectual status and support its position as a knowledge-

based economy. It would also enable Doha to export home-grown innovations to other countries facing water strife. Others counter that such an isolationist approach threatens to add multiple layers of bureaucracy and slow the speed of innovation at a time when Qatar is already working against the clock.

Foreign expertise and capital have been instrumental throughout Qatar's history of resource management and the country still has the option to buy the rights to technologies, or a license that allows modifications.

There must also be a stronger emphasis throughout Qatar's school curriculum on enhancing students' ability to think critically – the birth of all innovations – and a shift away from rote learning.

### 3 Use Membrane Technologies

Industrial manufacturing facilities typically require fresh water at various stages of operations. This includes process water – water that cannot be clarified as drinking water – and cooling water, as well as water for landscaping. For such applications, using high quality potable (drinkable) water that is produced by thermal desalination at municipal power and water plants is wasteful considering such resources are already stretched.

More industries could join the movement to improve Qatar's water security by installing commercially-available membrane technologies. Such technologies include reverse osmosis, which removes a large majority of contaminants from water by pushing the water under pressure through a semi-permeable membrane. Installing similar technologies could be an economic and environmental win-win for both Qatar's corporate and governmental entities. The reduced need for new desalination capacity would save the government money and provide companies with tangible evidence to prove their support of Qatar's 2030 goals. Plus, employees' enhanced awareness of water management would likely be passed on at home and help curb domestic water wastage.

### 4 Establish a Smart Water Network

The era of almost free water is nearly over, as indicated by Kahramaa, when it reduced water subsidies in January 2016. The sprawl of urban areas amid rapid population growth means the country's domestic water consumption is soaring. A Smart Water Network provides an intelligent and nationwide solution to Qatar's water security challenge by monitoring and balancing today's poorly correlated supply-demand levels.

A Smart Water Network refers to a number of data-driven components, which enable the optimization of water management and distribution. This includes reducing leakages, fine tuning pricing and improving communities' water awareness. A Smart Meter Network consists of high resolution water



# 80%

On Fridays, 80% of the consumption of grey water in Qatar comes from mosques and simple treatment processes would make this water suitable for agriculture and landscaping.

sensors that use a wireless network to transmit their measurements of real-time information to a central data management system. This management system combines metering data with climatological and hydrological information, which then translates the information into an easily digestible measurement of current supply-demand levels. Such real-time transparency can be collated to create historical data points that help identify trends and pinpoint areas of improvement, especially low hanging fruits – changes that can be made quickly and easily.

### 5 Enhance Water Collection Systems

Improving the collection of Qatar's grey water – used water without fecal contamination – could significantly reduce the level of potable water being used in agriculture and landscaping. Agriculture makes up around 60% of the water consumption in Qatar, even

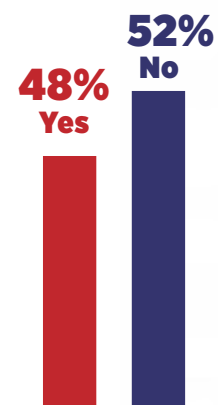
though the sector's contribution to GDP is in single digits – an unsustainable trade-off. Grey water could be collected from mosques, shopping centres, air conditioning units and corporate buildings, for example. Successfully reusing the ablution water at mosques could help establish a nationwide benchmark for projects in other areas. On Fridays, 80% of the consumption of grey water in Qatar comes from mosques and simple treatment processes would make this water suitable for agriculture and landscaping. All the water from mosques – including black water, which is used in toilets – is currently funnelled into a common sewage system, which renders the grey water unusable. Collecting data at mosques in busy industrial and commercial districts to map out a preliminary cost-reward blueprint would ascertain how effective reworking Qatar's water collection systems could be if applied across the board. ■

# THE GULF INTELLIGENCE QATAR INDUSTRY WATER SECURITY FORUM

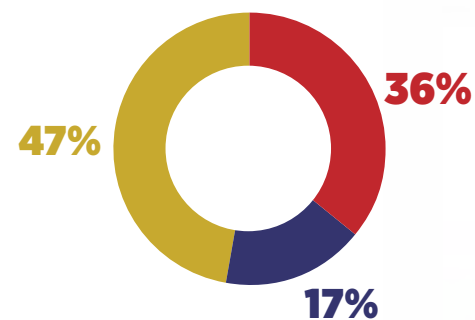
Hosted at Qatar University's Research Complex, April 2016

## INDUSTRY SURVEY: RESULTS

Would Qatar benefit from consolidating all of its in-country water research laboratories into a Master Plan, with the intellectual property shared by all?



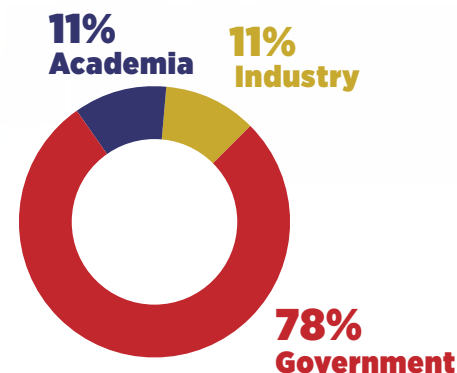
Which technology strategy should Industry-Academia prioritize to better Qatar's water security as quickly as possible?



- A** Focus R&D investment on improving efficiencies of existing technologies
- B** Today's technologies are not advanced enough – invest in new solutions
- C** Crossover technologies – adopt and adapt technologies across industries



Which entity should take the lead in coordinating Qatar's water security strategy to ensure the delivery of 'fit for purpose' local solutions for local challenges?



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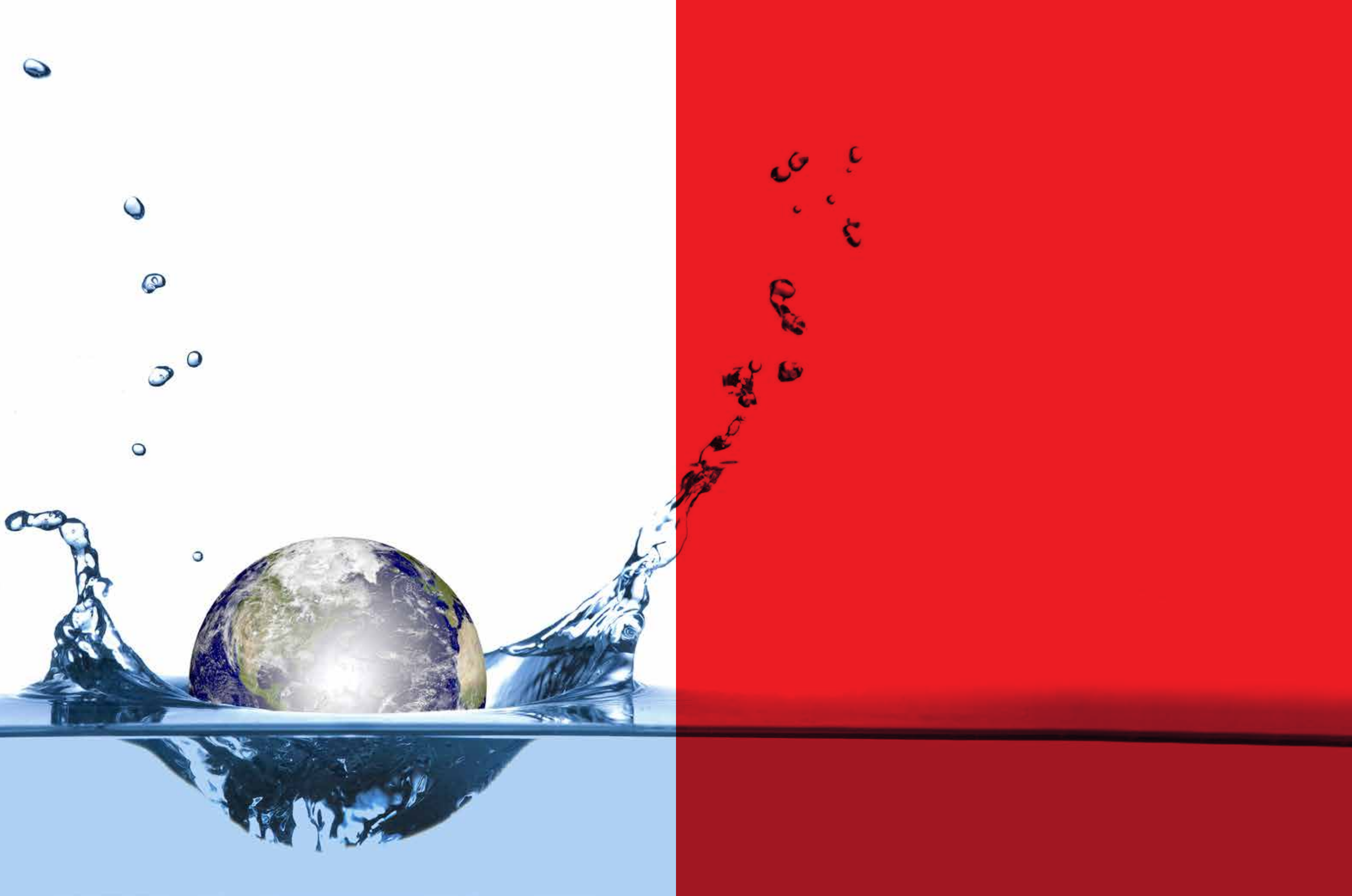
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