

# FUTURE RESOURCE SCARCITY CHALLENGES

## THE ENERGY-WATER-FOOD NEXUS

*Sultan Ahmed Al-Jaber*

**T**HE imperative impact of the energy-water-food nexus is already taking a toll on global security, economic growth, and the well-being of countries around the world. In fact, today, many parts of the globe are suffering from resource scarcity that is further exacerbated by a changing climate. The stress levels on energy, water, and food are increasingly compounding, owing to rising populations, economic expansion, industrialization, and an increasing demand for resources. In addition to the scarce availability of, and access to, these resources, a complicating factor resides in the interconnectedness of the water, food, energy nexus, which poses significant prioritization challenges.

Many countries, including the United Arab Emirates (UAE), are often faced with having to produce food at the expense of exhausting water resources,

or producing water at the expense of heavy energy utilization rates. Sustainably securing these vital resources requires a unified political effort at the global level that promotes a multilateral, collaborative approach. Our efforts must be armed with the knowledge that cooperation, sound investment, and a commitment to advancing technologies will be the key to spurring the kind of breakthroughs necessary to tackle the resource challenge we face.

The focus must be on finding sustainable solutions that holistically tackle issues, such as boosting production, tempering demand, and allowing for greater access across the entire energy and resources spectrum. We must also commit to finding solutions that minimize our carbon footprint, and ensure resource security in a manner that is mindful of nations' sovereignty. Most readily, global policy measures are

*Dr. Sultan Ahmed Al-Jaber is the Minister of State of the United Arab Emirates and the UAE's Special Envoy for Energy and Climate Change. He also leads the UAE's large-scale aid program for Egypt, as well as concurrently serving as CEO of Energy for Mubadala, a UAE-owned corporation, and Chairman of its subsidiary Masdar.*

needed to take advantage of the opportunities to ensure the sustainable use of resources and the continued economic prosperity of nations.

In many parts of the world, the challenge remains at the governance level. A comprehensive, integrated approach to addressing resource scarcity is vitally needed. We must start by providing for proper policy and institutional frameworks that recognize and allow for a rapid response to the challenges we face. In doing so, we must not undermine the local geographical context of each nation, enabling us to tailor solutions that match each of their needs and unique socio-economic characteristics. We must also make sure that all key players have a stake in resolving these issues across government, industry and local enterprise.

**O**ur overall goal as a global community should be to develop a set of priorities around the energy-water-food nexus, and work collaboratively across government and industry to bring together the expertise and insights to help resolve these issues. Our stewardship and global responsibility needs to start with greater knowledge-sharing, effective and sound investment, and a commitment to advancing technological breakthroughs.

Indeed, a great deal of promise in solving the global resource scarcity challenges lies in further technological innovation. In recent years, we have seen how

technological advances helped revolutionize and allowed for the exploitation of unconventional hydrocarbon sources previously considered unrecoverable.

Theoretical possibilities can be made into reality within the sustainability and renewable energy realm, as well as through the greater use of innovative technologies. However, more action at the policy level is needed to make such solutions attractive to the private sector. Political will and leadership play a vital role in encouraging investment, as well as in driving broader commercial adoption. The effectiveness of this strategy will depend on a successful governmental and private sector collaboration in the research, development, demonstration, and deployment of sustainable ways of using our resources. Looking ahead, the need for a collaborative solution to resource scarcity is paramount in order to avoid the materialization of a major crisis before meaningful action is taken.

Certainly, multilateral collaboration at the government and institutional level can at times be complex and difficult to achieve at a pace that matches the increasingly apparent repercussions of resource scarcity. Hence, while we continue to foster greater global collaboration, we must also start at the state level. Nations—particularly those endowed with the necessary capital and technical know-how—must drive the global effort to develop solutions that address the energy-water-food nexus.

The United Arab Emirates is no stranger to resource scarcity, and as such has the proven experience to support a global action plan. At home, while we have been blessed with one of the largest hydrocarbon reserves in the world, the delicate balancing act we play centers around maintaining our leadership as a global energy exporter, while also meeting our increasing domestic energy demands. As one of the leading economies in the Gulf, the UAE has enjoyed average gross domestic product growth of more than six percent since 2006. As a result, we have seen domestic energy demand rise by more than nine percent. This robust and welcomed growth, juxtaposed against the backdrop of scarce water and food resources in the UAE, is our call to action as we transition to sustainably secure our resources.

The UAE's leadership recognizes the complexities of the energy-water-food nexus and its potential impact on national (and international) security. In response, proactive policy measures have been taken and astute investments have been made. In addressing our resource challenge, our strategy has been to do so in a manner that increases our country's economic resilience, while simultaneously creating new economic opportunities. The UAE is achieving this by investing in technology, raising awareness about the need for sustainability, and developing needed infrastructure.

## ENERGY DIVERSIFICATION AND INNOVATION

One might wonder why a country blessed with abundant hydrocarbon reserves is so committed to investing and pioneering a future beyond oil and gas. That is the UAE. Our vision for sustainability dictates our mission. The UAE has gained a central role as a leading voice in the energy arena—certainly as a key hydrocarbon supplier—but increasingly as a pioneering nation working towards a more sustainable world. For many years now, we have put words into action.

To meet this rising demand, both domestically and globally, and to secure continued and ample access to affordable energy, we have created innovative solutions to ensure our country's long-term energy security, whilst positioning the UAE as a global energy supplier. Key underlying factors that constitute the foundation of our domestic energy policy include energy efficiency and energy diversification. Emphasis on efficiency and diversification allows us to grow and maintain our role *vis-à-vis* our energy customers, by helping them satisfy their energy needs and driving greater economic prosperity around the world. Domestically, this allows us to both preserve and boost the UAE's role as a responsible, global energy player.

At a time when countries are realizing the impact of their carbon footprint and are struggling to reduce their emissions,

the UAE has been an early leader on the issue. It should come as no surprise that UN Secretary-General Ban Ki-moon bestowed the UAE with the honor—but also the responsibility—of hosting a critical meeting leading up to the UN Climate Summit in New York in September 2014. This recognition (the meeting is entitled “The Abu Dhabi Ascent”) comes as a result of many years of leadership by the UAE on the issue of climate change. Similarly, the fact that Abu Dhabi was selected as the permanent headquarters of the International Renewable Energy Agency (IRENA) in 2009 is a testament to the UAE's commitment to sustainability and clean energy. Dubai has also committed to generate five percent of its power from renewable energy sources by 2030, and is building the Mohammed bin Rashid Solar Park, anticipated to generate 1000 megawatts, towards meeting that goal.

The UAE's success has come largely thanks to its early commitment to achieving a diversified energy mix domestically, as well as through sound investment in the realization and commercialization of renewable energy globally. The creation of Masdar is a big step in that direction. Based in Abu Dhabi, Masdar is a renewable energy company whose mission is to invest in renewable energy and clean technology domestically and around the world. Masdar remains competitive by adopting an integrated and holistic business model

that relies on investments with both financial and social returns, and hones in on the development of human capital, large-scale renewable energy projects and sustainable communities.

Masdar is a key factor in cementing the UAE's strategic role as a leading energy player. For the past eight years, Masdar has been a leader in advancing the dialogue on this issue, as well as in fostering innovation around renewable energy through research, education and investment. For instance, the Masdar Institute of Science and Technology, which is part of the broader Masdar Initiative, has set a new regional standard for research and development and education. Masdar has also excelled at effectively demonstrating that large-scale commercialization of renewable energy is possible, through large-scale investment in concentrated solar power and wind projects domestically and globally.

At the heart of our energy strategy is a steadfast commitment toward sustainability, including fostering sustainable energy sources that play to Abu Dhabi's competitive advantage. Domestically, the UAE has adopted a widespread strategy of energy diversification to strengthen its energy security.

A key piece of this strategy has been taking advantage of our potential in the solar power sector. One of Masdar's many achievements is Shams 1, a 100-megawatt concentrated solar plant

that powers 20,000 homes with clean energy. Shams 1 is not only the first large-scale renewable energy project in the region, but also a major step toward diversifying the country's energy sources. Indeed, the solar plant displaces approximately 175,000 tons of carbon dioxide annually. This is equivalent to planting 1.5 million trees, or removing 15,000 cars from the roads, and helps the UAE meet peak power demand during the summer months when electricity demand for cooling is very high. Through Shams 1, the UAE has deployed approximately 60 percent of the Concentrated Solar Power (CSP) currently operating in the entire Middle East and North Africa (MENA) region. Likewise, the UAE has deployed approximately 24 percent of the MENA solar photovoltaic (PV) capacity. The mega-engineering project is a harbinger and a forerunner to greater CSP projects in our country.

While the Shams 1 project is not only the first large-scale renewable energy project in the MENA region, it is the first in the Gulf and, as such, is an important step towards diversifying the country's energy sources and also sets an impor-

tant precedent for large-scale renewable energy deployment in countries with similar socio-economic context.

Clean energy investments such as these are also building knowledge capital domestically. The experience derived from building the plant has effectively helped boost Masdar's expertise and ability to

deliver other CSP plant projects both in the UAE and abroad. Furthermore, 66 local companies participated in the construction of Shams 1 and were able to take advantage of more than \$ 239 million in design and construction contracts. Besides the benefits to the local economy, Shams 1 has also put the UAE on the global renewable energy map as one of the leaders in total installed CSP capacity around the world.

In terms of capacity, the UAE is now second only to Spain (with 2,300 megawatts of CSP as of the end of 2013)—with much of it being built by Masdar—and the United States (with 882 megawatts). With global CSP capacity rising by 36 percent in 2013 alone, and the dominant solar technology currently targeted for deployment in the MENA region, the UAE's decision to invest in the technology at such a scale is a timely decision. It

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is one which looks to help Abu Dhabi and the region secure economic, social, and environmental benefits for years to come. Notably, our nuclear energy program is expected to meet 20 percent of our country's energy needs by 2020.

We are also doing cutting-edge work in the field of carbon capture, use, and storage (CCUS), and have developed the Middle East's first CCUS facility. The facility is projected to annually sequester 800,000 tons of carbon dioxide (CO<sub>2</sub>) emitted from the manufacturing of steel, which will then be utilized for enhanced oil recovery (EOR). The project positions the UAE amongst the pioneers in this cutting-edge technology, helping to reduce our carbon footprint whilst allowing for continued energy production to meet our export targets. The carbon capture facility will sequester CO<sub>2</sub> with the resulting gas then compressed and dehydrated for transportation to an onshore oil field. The CO<sub>2</sub> will then be used as a substitute for natural gas to boost yields in oil production.

Through EOR, and swapping the injection of natural gas for CO<sub>2</sub>, we will have the twin benefits of avoiding significant amounts of CO<sub>2</sub> from entering of the atmosphere, as well as freeing up greater amounts of natural gas for utilization in the power, water and industrialization sectors. In pursuing CCUS, the UAE is looking to

provide a means of helping address climate change, whilst enhancing the recovery of its hydrocarbon resources. Experience has shown that this project delivers positive economic and environmental returns.

The project is only one of 15 hydrocarbon recovery CCUS schemes currently underway globally, which underscores the UAE's leadership and innovative spirit in the energy realm. While carbon capture and storage technologies have existed for many years, large-scale deployment has proved challenging due to the associated capture and storage costs. The CCUS scheme, which utilizes captured carbon for enhanced oil recovery (EOR), has reinforced the UAE as an emerging hub for CCUS expertise. Furthermore, the country's embrace of CCUS underscores its commitment to reducing its own carbon footprint while improving the efficiency of oil and gas operations.

The International Energy Agency stated that in the power and industrial sectors alone, up to one-fifth of all carbon mitigation by 2050 will need to come from CCUS, in order to limit the global warming effects of highly concentrated atmospheric carbon dioxide. The UAE is already on its way to ensuring a more sustainable energy future for its domestic market and reinforcing its role as a steward for greater environmental awareness globally.



**FOOD SECURITY**

Food security is a significant challenge faced by many nations around the world. The CGIAR Research Program on Climate Change, Agriculture, and Food Security estimates that 60 percent more food will be needed globally by 2050. This comes atop rising commodity prices and a more frequently volatile market for food staples amidst increasing global demand. These trends are positioned to have serious political and security ramifications. If not addressed, food insecurity could become a major source of tension between nations in the future.

In the UAE, ensuring adequate access and supply of food staples is a key priority in both our domestic and foreign policies. Our approach has been to address the food security challenge by focusing on sustainability as a matter of necessity.

At present, the UAE imports 90 percent of its food. As such, it is increasingly vulnerable to price fluctuations as well as to greater and more diversified accessibility to importing markets. According to the UN Food and Agriculture Organization, agricultural production globally needs to increase by 70 percent by 2050, and by 100 percent in the same timeframe in developing countries. Rising population and urbanization trends, compounded by the impacts of climate change, are exacerbating the challenges we face in providing adequate and affordable food access and supply.

In the UAE, a lack of arable land, extreme heat, and scarce water supplies are key obstacles to agriculture and the source of the country's heavy reliance on food imports. Agriculture accounts for less than one percent of the UAE's GDP, but is responsible for 80 percent of the country's ground water usage. This relationship—water for food—poses serious considerations and complicates the challenge with regard to water scarcity in the country.

To address these challenges, the UAE has embraced an approach that maximizes its potential domestically and its reach internationally. At home, we have committed to greater adoption of clean and sustainable farming as part of our green economy push. For us, this starts from the bottom up. For instance, we have committed to greater education and training in sustainable methods of farming that address the adverse consequences of improper use of fertilizers and irrigation. We are also stressing the need for greater recycling, better and more widespread use of composting, and more sophisticated waste management. We are also embracing and optimizing agriculture methods and crops that fare better in dryland environments. Importantly, we have kept a focus on the long term by ramping-up research and development to bolster our food production, while using less energy and water in the process. These initiatives have been particularly valuable as they help us boost the sustainability of our food supply domestically.

Internationally, we have also taken important steps to safeguard our access to food imports. This is most evident through our investment in farmlands around the world, as well as through multilateral cooperation and partnerships with key exporters, which provide us with access to existing markets and ensure new market opportunities to sustain our growing population.

**WATER SCARCITY**

The scarcity of water and land resources is increasingly preeminent as a looming challenge facing the world. Hence, the necessity for a wide-ranging examination and a constructive dialogue on how countries utilize, manage and value water has never been greater. Global water supplies are facing unprecedented and, in some regions, unsustainable levels of demand owing to rising population trends, increasingly apparent impacts of changing climate, changing land use patterns, and rapidly urbanizing and modernizing social patterns. An estimated 1.8 billion people will live in parts of the world with absolute water scarcity by 2050. Presently, there are 884 million people who don't have access to a safe source of potable water, which exacerbates the availability of adequate sanitation facilities for more than 2.6 billion people.

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Perhaps more acutely looming than energy is the water scarcity challenge that the UAE faces. According to the UN, water scarcity is defined as less than 1,000 cubic meters per person per year. The UAE's natural water supply per person is approximately half this amount. Certainly, our resource challenges require an apt balancing act. Water is a strategic commodity on par with, if not more important than, energy and food. Considering that only one percent of the world's water is fresh and drinkable, the Crown Prince of Abu Dhabi and Deputy Supreme Commander of the UAE Armed Forces, Sheikh Mohamed bin

Zayed Al Nahyan, summed it up best, stating that, "water is more important than oil."

Water consumption in the UAE—and Abu Dhabi particularly—is among the highest in the world. Our groundwater supplies are depleting at an increasingly rapid pace and are replenished at a rate of less than four percent annually. Indeed, for every liter of water that goes back into the groundwater reserves, 25 liters are used in the UAE. In response to the challenges we face, we have adopted a broad-based strategy that focuses on three key pillars: greater water conservation, inno-

vation in research and development, and sound investment in desalination plants.

Perhaps the simplest and most efficient approach the UAE is undertaking is through conservation and eliminating inefficiencies. Decreasing water demand and maximizing utilization to imperative needs are low-cost, high-return alternatives that we have embraced. Underscoring the nexus of food and water, Abu Dhabi’s agriculture and food safety policy aims to reduce water use in agriculture through reduced subsidies for certain livestock feed crops, the deployment of high efficiency irrigation systems in the farming sector, as well as in public landscaped spaces, and piloting of greenhouse agriculture that can provide up to a 15-fold improvement in the amount of crops produced per cubic meter of water.

Desalination has been a major contributor to the UAE’s autonomy in its water provision domestically. Abu Dhabi sources 40 percent of its water and virtually all of its drinking water through desalination. This sourcing comes from treating waste-water, drawing from aquifers, and from desalination—the latter is by far the largest source. There are 25 existing desalination plants in the UAE, and an additional plant has recently

been commissioned at Mirfa. While highly capital intensive to build, on the upside, the actual cost of desalination has been dropping over recent years, thanks to greater technological advances and efficiencies.

Significant vulnerabilities associated with desalination plants remain, however. Not all UAE plants are using the latest technology, for instance. Greater reliance on desalination to meet our potable water needs has caused the Arabian Gulf to become one and a half times as saline

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as average seawater in the 60 years since the region’s first desalination plant was built in Kuwait. In the open ocean, seawater is normally 35 parts per thousand (ppt) of salt. In the Arabian Gulf, however,

that statistic hovers at 50 ppt near desalination plants. The natural desert environment also poses significant challenges. In wetter regions around the world, groundwater is a resource that is replenished naturally. Given the aridity of most of the Arabian Peninsula, this natural process is not replicated in the region. For every liter of fresh water that flows into the Arabian Gulf, seven are lost to evaporation. While the increase in salinity as a result of evaporation is still several orders of magnitude higher than what is attributed to desalination, the latter certainly aggravates the natural process

further. We are also consistently improving our desalination capacity to preempt any deleterious impacts from natural and accidental disruption such as red tide algal bloom, which negatively affected our water production in 2007 and 2008.

A unique characteristic to the UAE is our reliance on thermal cogeneration of power and water—which reinforces the correlation between energy and water. In the UAE, both are co-produced. Although efficient, this dynamic creates significant issues when nuclear and renewables bring greater amounts of electricity to the grid. The Masdar Renewable Desalination program has been a visionary approach to enabling a more robust power and water system. The pilot program is aimed at testing and developing advanced energy-efficient seawater desalination technologies suitable to be powered by renewable energy sources.

**STRATEGY OF RESILIENCE**

In addressing our challenges within a unique socio-economic context, the UAE has chosen an approach that focuses on addressing its immediate national concerns, without compromis-

ing its leadership on the global scene as a key energy exporter, and as a steward for greater environmental awareness.

The global impact that we are continuing to make has been manifold. One way has been through sound investments in renewable projects worldwide; another, through creating platforms for dialogue that raise awareness and incentivize greater action around issues of resource scarcity. Also regionally, our impact has been through setting an example of how a committed leadership in the sustainability realm, focused on efficiency and diversification, can effectively spur the innovation and action necessary to tackle the challenges ahead.

In short, we are pursuing a strategy of resilience that commits to research and development, investment in technology, fostering greater international cooperation, and, above all, resource conservation. It is through this vision of sustainability that we believe we can find the solutions to the resource conundrum we face. ●