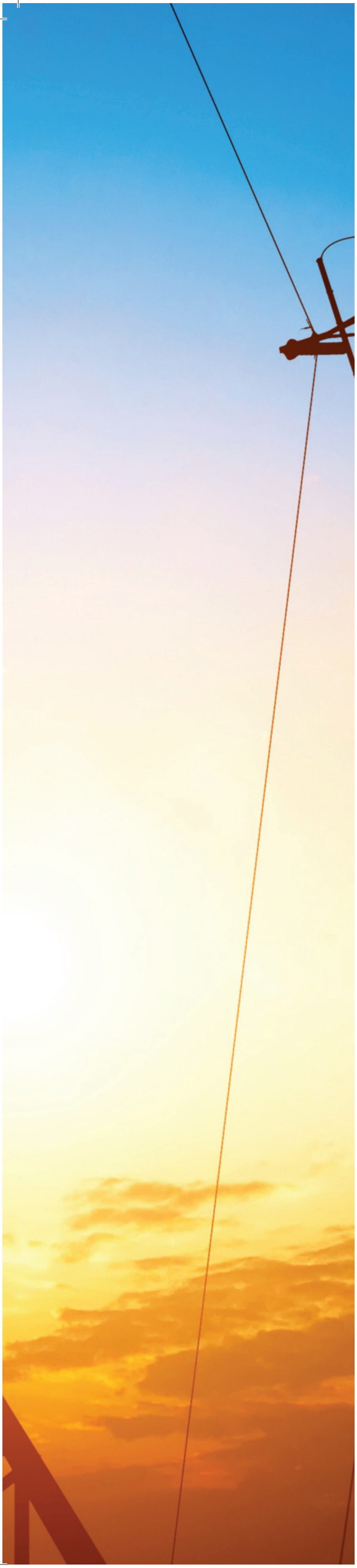
WATER AND ENERGY IN MENA

CHALLENGES, OPPORTUNITIES AND POTENTIAL

Clean Energy Business Council

مجلس صناعات الطاقة النظيفة



Introduction

There has been no shortage of debate in recent years about the water – energy nexus. Just as water is required to generate and distribute electricity, water supply and sewage disposal require energy. Predictions of dwindling water supply due to climate change and environmental degradation and an expected 56% increase in global energy consumption by 2040 (EIA) means that the co-dependency of this relationship will be tested. Nowhere is the tension on the water side of the equation felt more acutely than the Middle East and North Africa (MENA) region which although rich in fossil fuels, has less than 1% of the world's renewable water supply. As a result, almost 50% of the world's desalination capacity is located in the MENA region and the International Energy Agency's 2013 World Energy Outlook found that the six biggest users of desalination in MENA–Algeria, Kuwait, Libya, Qatar, Saudi Arabia, and United Arab Emirates–use approximately 10% of their primary energy for desalination. In fact, desalination accounted for more than 4% of the total electricity generated in the MENA region in 2010.[i] This paper will explore the following:

- The water demand and supply gap within MENA
- How to address this gap through technologies for desalination and water reuse but also more economically through demand management strategies. There are massive opportunities and potential highlighted in this section. For example, the MENA region is forecasted to account for more than 54% of the world's growth in desalination has a market estimated to be worth at least US$40 billion
- What all this change in the water sector might mean for private industries and how profit impacts loom for those industries that do not engage in effective water supply and management strategies.

Section 1 – MENA's Water Woes

The World Bank defines a region as water stressed if it has less than 1700 cubic meters **(cu m)** per capita. The MENA region on average has 1,274 cu m per capita. Sixteen of the 23 nations within the MENA region are already suffering from extreme water stress i.e. have less than 1000 cu m per capita (Fichtner 2011). There are political implications too:, dwindling water resources have already been linked to the resulting droughts and conflict in Syria, there are tensions between Ethiopia and Egypt over Ethiopia's plans to dam the Nile and the 2013 deal between Israel and Palestine over the Red Sea highlights the cooperation that will be required between countries that have previously found it difficult to cooperate. The impacts of this problem are imminent with Yemen's aquifers already on the brink of exhaustion and Oman is suffering from seawater intrusion and salinization of soils along the Gulf coast (World Bank 2012).

Total Renewable Water Resources (Billion Cubic Metres/Year)

Figure 1 demonstrates the water resource limitations of MENA and Gulf Cooperation Council (GCC) countries, compared to the United States, known for its abundance, and Spain, known for its water stress.

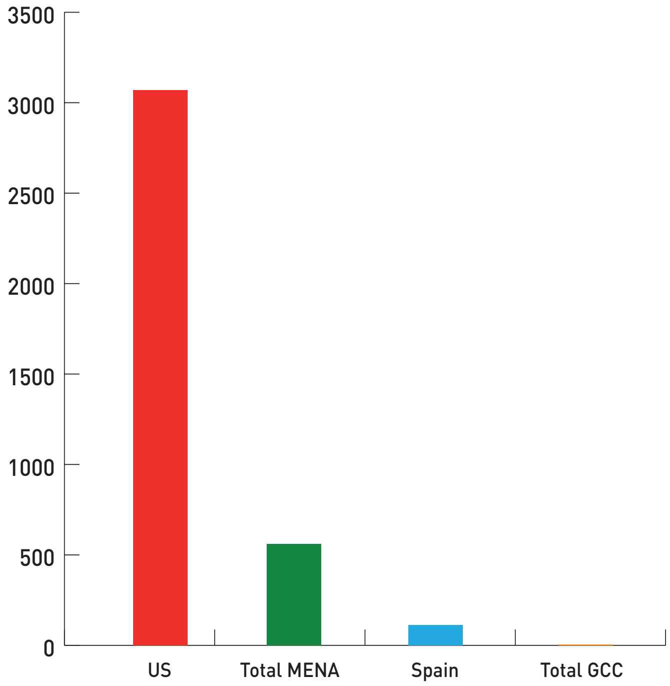
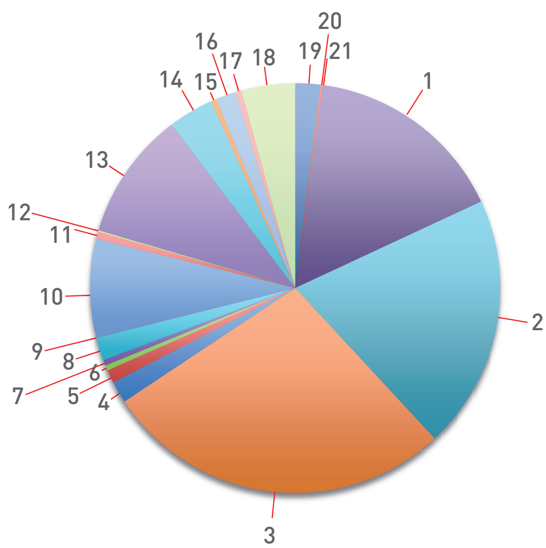


Figure 1 - Source: FAO Aquastat

The current supply and demand gap within MENA has been estimated at 43 cubic kilometres a year. The World Bank has also made predictions as to how this gap might develop in the future based on existing trends. Under an average climate change scenario, it was set to grow to 199 cu km/year. Although all countries with MENA experience an increase in their water gaps, between now and 2050, countries such as Iran, Iraq and Egypt experience a much greater growth (World Bank 2012).

MENA Country Shares of Water Gap: 2040-50

1) Egypt	15.89%
2) Iran	20.05%
3) Iraq	27.54%
4) Israel	1.72%
5) Jordan	1.05%
6) Kuwait	0.40%
7) Lebanon	0.45%
8) Libya	1.83%
9) Malta	0.02%
10) Morocco	7.74%



11) Oman	0.57%
12) Qatar	0.12%
13) Saudi Arabia	10.15%
14) Syria	3.57%
15) Tunisia	0.42%
16) UAE	1.60%
17) West Bank & Gaza	0.46%
18) Yemen	4.24%
19) Algeria	1.98%
20) Djibouti	0.00%
21) Bahrain	0.19%

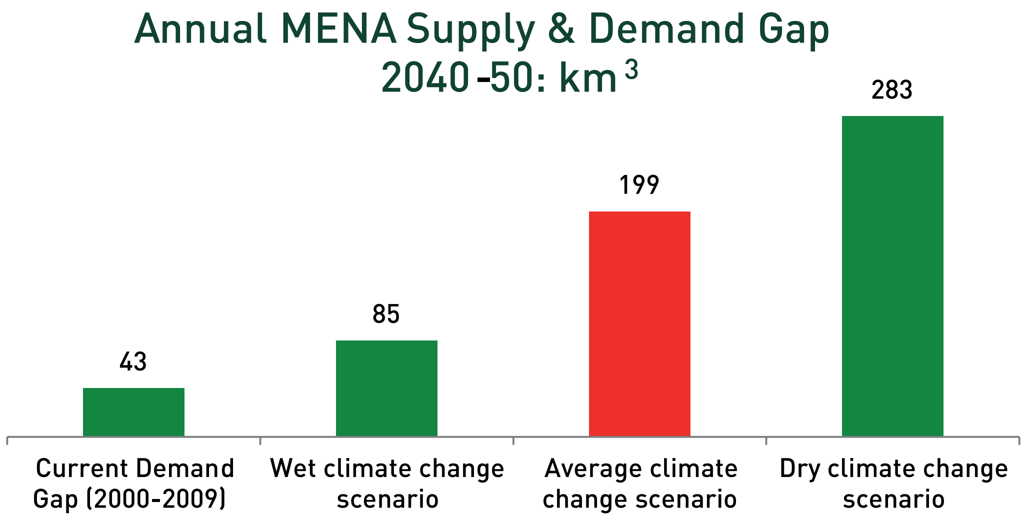


Figure 2 - Adapted from World Bank 2012

Increasingly the region, and in particular the GCC countries, are meeting water needs through desalination and waste water reuse. Figure 3 shows the growth of desalination capacity within the UAE since 2000. However, most of the remaining withdrawal is met by groundwater. This use of groundwater is unsustainable and groundwater levels have been dropping steadily all over MENA (FAO Aquastat). The dire consequences of continuing along this path cannot be over stated. Fossil groundwater is a common pool non-renewable resource and once used up it is gone. Even with enormous scale ups in desalination projects and wastewater reuse within the GCC countries, predictions for the future still show heavy reliance on groundwater to bridge the gap.

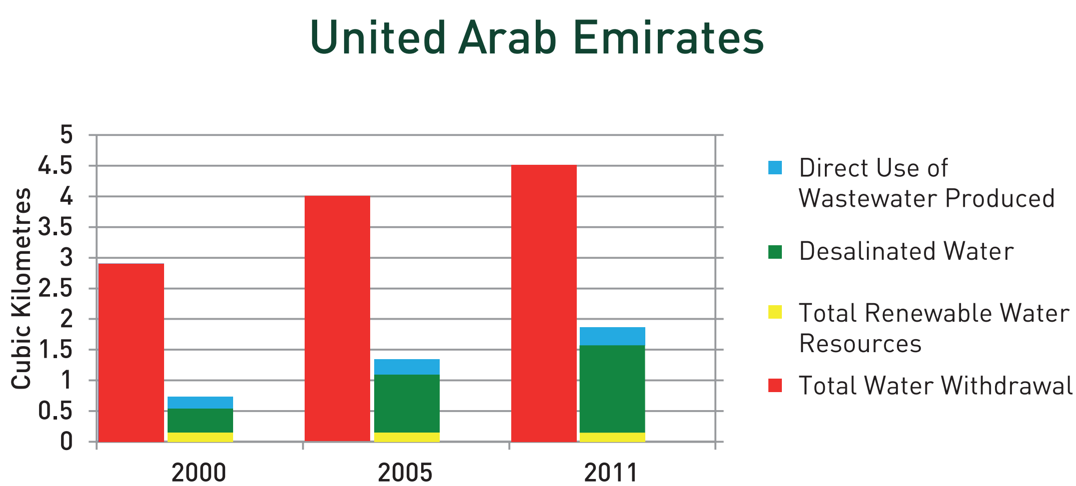


Figure 3 - Source: FAO Aquastat, BNEF

Basic economics tells us that a growing supply and demand gap can only lead to rising prices unless more innovative and cost-saving ways are found to plug this gap. The most economically-viable steps that can be taken are demand side measures (discussed below). The World Bank estimates that if no demand side measures are taken, the cost of bridging the Gap would be US$300 to US$400 billion but if all demand side measures are implemented, the cost could fall to US$100 billion (World Bank 2012). The Kingdom of Saudi Arabia (KSA) alone is estimated to require US$33.3bn worth of investments in this sector (NCB 2009).

Section 2 - What Options are Available to Address the Demand and Supply Gap?

Supply Side Options

1. Desalination

Desalination is a major component of any future water planning in the MENA region. There are several desalination options available to a country when considering how to address the supply and demand gap. The main options within the GCC context all involve water separation and fall under two headings:

What are the Desalination Options?

Thermal and Electrical Distillation

All of these processes work on the basis of evaporation of the saltwater solution and collection of pure water when condensation forms as the vapor cools.

Multi- Stage Flash Distillation **(MSF)** desalinates by evaporating and subsequently condensing seawater in various stages each time functioning on lower pressure than the last. The heat required for the thermal part of the process is usually sourced from the steam from the water stream cycle of a power plant. MSF is a robust, proven technology even with high levels of salinity and can be built to a very large scale – almost 800,000 cu m per day. It has a very high energy component due to the need to boil the seawater.

Multi- Effect Distillation **(MED)** which again involves evaporating seawater in a number of stages or 'effects'. The evaporation from each stage flows into the next stage where it is again heated and evaporated until clean distillate water is produced. As with MSF, the required thermal component is sourced from a co-located power plant. MED plants can't be economically built to the same size as MSF, the largest producing 38,000 cu m per day. The energy component is much lower than that necessary for MSF as less electrical energy is required in addition to the thermal energy (NCB 2009).

Membrane Technology (Purely Electrical)

Sea Water Reverse Osmosis **(SWRO)** accounts for over 50% of the world's desalination capacity. Reverse Osmosis **(RO)** is a process where pressure is used to push the water solution through a membrane, with the membrane preventing the larger solutes (the salt) to pass through. RO is becoming increasingly popular in many parts of the world as the most energy efficient of all the large-scale processes requiring only electrical and not thermal energy. It can also operate as a stand-alone plant as the heat recovery from the electricity generating process is not required. Freshwater recovery rates from the seawater are higher for SWRO than for either of the other technologies. Distilling seawater produces a concentrated brine waste that is 3–4 times the volume of the fresh water produced. In contrast, RO produces brine volumes only 1.0–1.5 times the fresh water production, and if the brine disposal problem can be managed, RO plants do not have to be located near the sea. SWRO plants have exhibited limited economies of scale at plant sizes larger than 80 000 cu m/day and in some cases its feed water requires pre-treatment especially in the high saline waters in the gulf, increasing costs.

In the past, the high-energy requirements of MSF and MED technologies was not an issue for the GCC regions where energy costs were low relative to other countries. However, in recent years the use of SWRO and MED technologies in the region has increased with SWRO increasing 5 fold in the present decade and MED increasing 6 –fold. (Fichtner Task 1 2011). Desalinated water is estimated to cost between $1.50 and $2.00 per cu m depending on location and technology used (World Bank 2012).

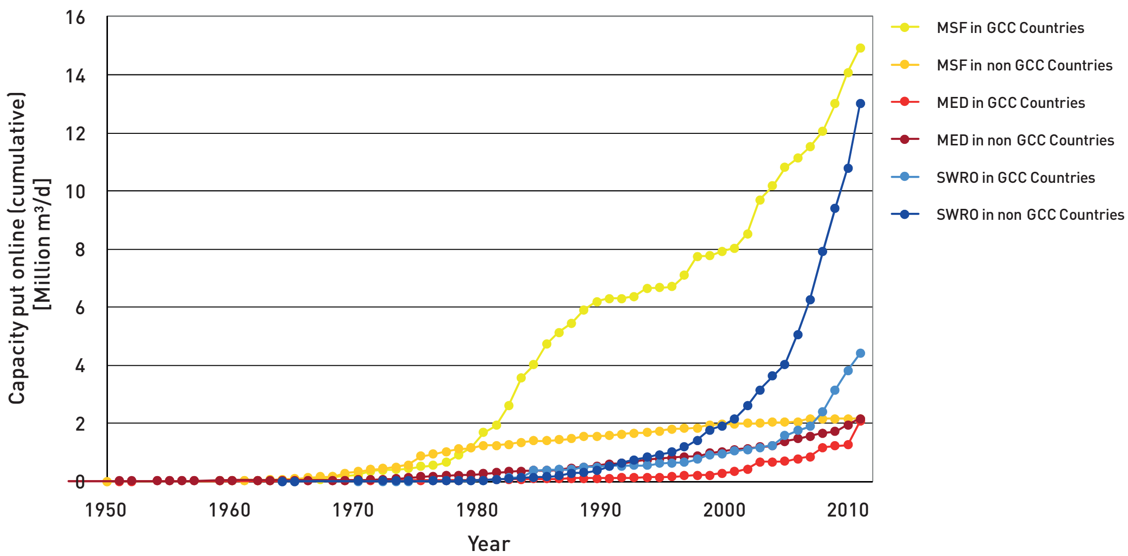


Figure 4 - Source (Fichtner Task 1 2011)

Separating Power and Water

The most expensive element in all three technologies is the energy component, accounting for one third to 55% of the operating costs for the plant (IRENA 2013). The cost of thermal desalination depends entirely on the cost of fuel and total MENA electricity demand for desalination purposes is expected to triple by 2030 to 122 TWh by 2030 (IRENA 2012).

Producing heat and electricity alongside water offsets the high initial capital investment of MSF. However, what if you are producing water without power? The justification and the average cost figures will no longer apply. In the GCC countries, power demand is seasonal. In the summer months, demand peaks as air conditioning is cranked up to deal with the desert heat. Water demand on the other hand remains relatively consistent all year round. This leads to a situation where you are switching on MSF plants for peaking power in the summer but in winter letting them run purely for desalination purposes. The Taweelah B1 plant in Abu Dhabi is an example of this. Based on a fuel analysis of this plant (see Figure 5) not only are the cost savings of co-generation not realized for most of the year, but also it appears to be highly fuel inefficient to use that plant for just those peaking months. In addition, MSF plants need to operate at 70% to 80% of their design capacity, which means whether you use the electricity or not you need to operate these desalination plants at this level and that potentially involves a large waste of fuel resources (Fichtner Task 1 2011). On this analysis, it makes sense to separate power and water generation in order to increase flexibility and maximize fuel efficiency. This partly accounts for the increase in SWRO technologies popularity in recent years.

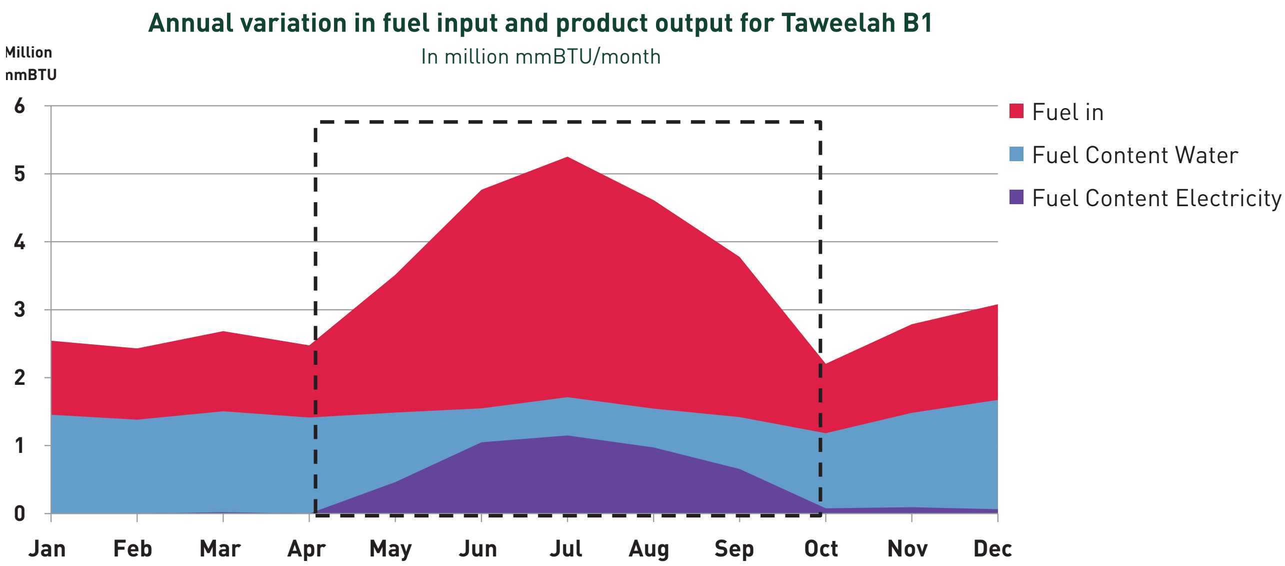


Figure 5 - Source: Ambata Capital and ADWEA

Fossil Fuel Uncertainty

Thermal technologies made sense while fuel was cheap but fuel subsidies are becoming a major problem in the region and governments are under pressure to phase them out with a resultant increase in fossil fuel prices. The price for natural gas, the energy feedstock for many of these desalination plants, has been kept at or below US1.00/MMBtu in most of the GCC countries. This is compared to an average of US$4.00 to US$6.00/MMBtu in the USA (even in the midst of a shale revolution) and between US$12.00 to US$16.00/MMbtu in Europe and Japan. Gas shortages are becoming a problem within the region especially in Egypt, Oman and even KSA. Natural gas is the dominant source of power generation in the Middle East (Booz) and demand for natural gas in the GCC is likely to rise more than 50 per cent, from 256 billion cu m in 2011 to 400 billion cu m in 2030.

Subsidies for natural gas are costing countries in the MENA region up to 13% of their GDP and there is growing recognition among policy makers in the region that the price of gas will need to impact cost of supply, at least in the short term while import and shale gas options are explored (Hakim 2012). The price of MSF with an unsubsidized fossil fuel cost is almost double that of the subsidized fuel estimate (US$1.60 versus US$0.85). (IRENA 2012). Increasing energy prices will necessarily impact desalination costs directly. Estimates for 2050 desalination costs are as high as US$2.50 per cu m, an increase of over 100% (World Bank 2012), but this is very dependent on the availability and price of natural gas and could in fact be much higher.

Renewable Technologies

The fuel uncertainty discussed above makes the initial case for renewable sources to generate energy. Although there are some small projects completed in the MENA region (such as the solar desalination plant in Al-Khafji Saudi, an PV RO plant), less than 1% of the desalination capacity worldwide uses renewable energy sources. Most of this is solar thermal followed by solar PV and wind. (IRENA 2012 and World Bank 2012).

Even without the level of investment in research and development that the industry is calling for, Figure 6 shows that the costs of renewable desalination are very close to competing with fossil fuels even today. Solar stills are already cost competitive but Wind RO, Solar CSP and Geothermal are not far off the current fossil fuel desalination costs (Figure 6). However, cost is not the only consideration in relation to choice of renewable technology. On a consideration of scale, solar stills only work at the individual level, solar PV at the household level and wind/geothermal at the village level. Only solar CSP at this point is capable of producing greater than 5000 cu m per day. Due to storage potential CSP is also capable of being a baseload desalination option and it is for this reason that Fichtner and the World Bank argue that greater levels of investment are required in this particular technology as an option for the MENA region. Although, it is worth noting that geothermal too has baseload potential. Renewable SWRO is more expensive than MED in the Gulf, although increasingly governments concerned about the environmental implications of desalination will consider the reduced brine emitted by SWRO.

Cost Range for Renewable Desalination Options versus Fossil Fuel Desalination Cost

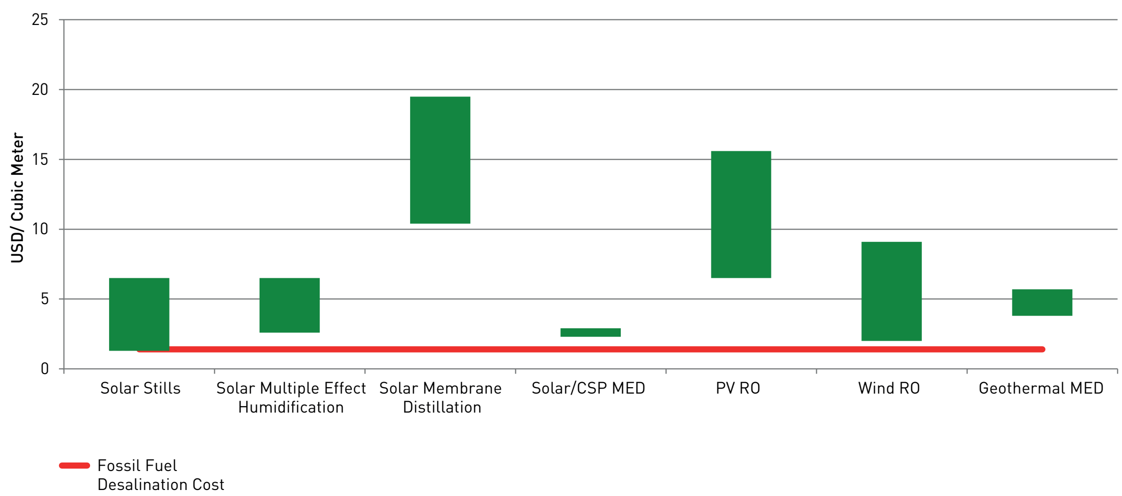


Figure 6 - Source: Adapted from information in IRENA 2012

Even viewing CSP as the highest cost option in a scenario analysis by Immerzal et al, it is expected to become part of the desalination mix in 2020 (World Bank 2012).

Beyond the economics there is also an environmental argument to bolster the argument to displace fossil fuels with renewable energy and reduce the carbon footprint of the industry.

This cannot happen overnight and any new technology requires investment and policy in order for innovation to occur. In this regard, the remarkable drop in the costs of solar PV can be attributed in part to the German government's commitment to this technology. The Gulf countries, in the case of renewable desalination technologies, have the option to follow suit and reap the rewards from such investments in research and development.

With the right incentives and potential fuel price increases, it will not be long before the contribution of renewables to the desalination mix in the Gulf increases. This is especially when the opportunity costs of oil is considered for exporting nations. For example, if current trends continue in Saudi Arabia domestic fossil fuel demand is estimated to reach over 8 million barrels a day leaving very little for export (World Bank 2012). This makes the case for renewables and energy efficient technologies such as RO much stronger than fossil fuels based MSF and MED.

The MENA region is forecast to account for more than 54% of the world's growth in desalination capacity to 2016 and with a market estimated to be worth at least US$40 billion, it is a good time to be involved in the desalination business in the Gulf.[ii]

2. Wastewater Reuse

Wastewater reuse is the second option on the supply side and the more economical option as compared with desalination especially when energy consumption is compared. Project costs can be up to 80% cheaper than desalination mainly associated with the reduced energy requirement, which is 0.1-1.3kWh per cu m versus SWRO at 2.3 – 4.0 KWh per cu m (BNEF 2013). Cost estimates for desalination range from US$1.00 per cu m to US$2.00 per cu m but water production costs of US$0.50 per cu m have been given for waste-water treatment plants within the UAE.[iii]

There is huge potential within the region. According to the Arab Water Council, 40% of water in the MENA region is reused after treatment, 8% is treated and discharged and over 50% is discharged without any treatment. Saudi is the only country that has set itself a specific reuse target and by 2020, they intend to bring this sector from 0.4 billion cu m annually to 1.6 billion cu m annually. This will involve investment in not just the plants themselves, but also in the collection and distribution network. Saudi's National Water Company has engaged in massive privatization in the sector to achieve this and the government has earmarked US$17.9bn and US$12.8bn (in opex and capex respectively) for its water treatment and distribution sectors up to 2020 (BNEF 2012).

There is a perception problem with reuse of water outside of the irrigation sectors. Saudi has tried to overcome this by offering different tariff structures for those consumers that utilize reused water. This is specifically targeted at the industrial sector.

The rest of the region does not have specific targets but the benefits of water reuse in this water stressed region are recognized. The UAE has steadily been increasing its capacity but even there, up until the Jebel Ali sewage treatment system was installed there was huge pressure on their collection systems which sometimes led to the illegal dumping of sewage causing environmental problems as well as the associated opportunity cost of loss of recycled water (ACUWA 2010). Water reuse counts for just under 10% of the water supply in Abu Dhabi (ACWA 2010) but in March of 2013 they announced that they were targeting zero water wastage within one year.[iv]

New technologies will drive adoption and industrial participation in public private partnerships should be encouraged especially where income streams from by products such as fertilizers, energy and plastics might be available. An example of this is Canadian company BioteQ which extracts saleable metal materials from waste water. The Jebel Ali plant in Dubai also is extracting fertilizer for resale at its plant.

3. Infrastructure

While not looked at in detail in this paper, it is important to note that on the supply side, large amounts of water are lost getting to the customer mainly due to old and inefficient infrastructure. The amount of non-revenue water i.e. water that is produced and lost in the region is 30 – 40% compared to international best practice of 10%. Infrastructure development is necessary in the region. Saudi alone plans to spend US$12.8 billion in this sector between now and 2020 (BNEF July 2012).

Demand Side Options

Now that we have explored the supply side options, going forward, how can demand be reduced or constrained, especially in light of increased population? Agriculture is a huge strain all over MENA on water resources both now and in future predictions. 80% of water used is for agriculture and it only contributes 2% to GDP (NCB 2009). The World Bank has estimated that the value of national wealth consumed by over-extraction of groundwater resources at 2% of GDP. So ironically, all of the wealth generated by agricultural production goes to replenishing the groundwater resources that were used to create it. (World Bank 2012). It is also worth noting that as shown in Figure 7 urban categories share of the gap doubles out to 2050 mainly due to population growth. Water use from individuals in this category will need to be curtailed and the most obvious way to do this is through price. However, as we will see below, most utilities in the region are under-employing water tariffs. Demand side management measures have the potential to reduce the bill for bridging the gap by up to US$300 billion dollars.

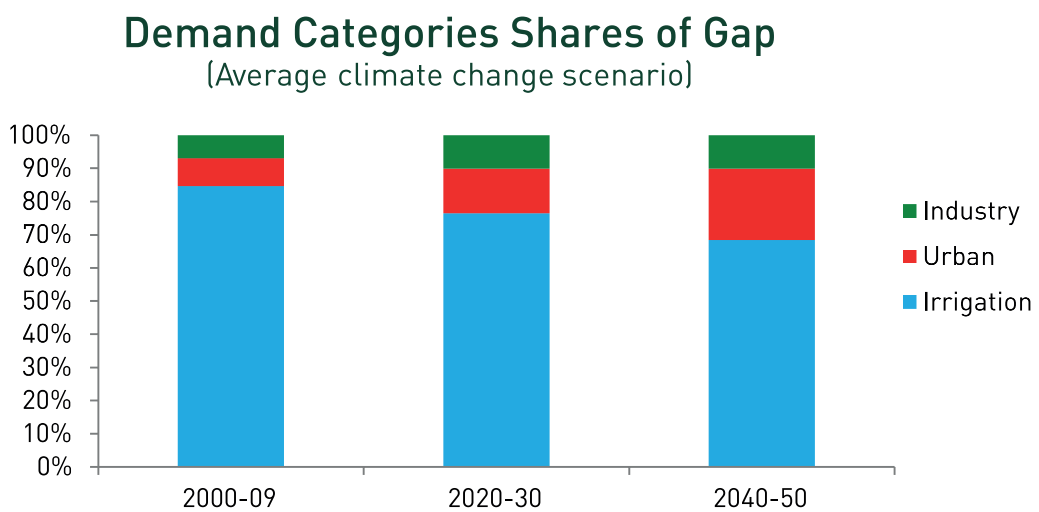


Figure 7 - Source: Adapted from World Bank 2012

1. Tariffs

Tariffs have been kept low in the region since the 1990s. The average tariff cost per capita (assuming that everyone is charged) bears little relation to the consumption rates. This encourages over-use borne out by some of the highest consumption rates in the world. KSA is third only to the US and Canada on a per capita consumption basis (Business Monitor 2010) and as Figure 8 shows other countries in the region, particularly the UAE, are not far behind. Figure 8 sets out the consumption rates per capita and what the tariff for an individual would be in each country based on that level of consumption.[v]

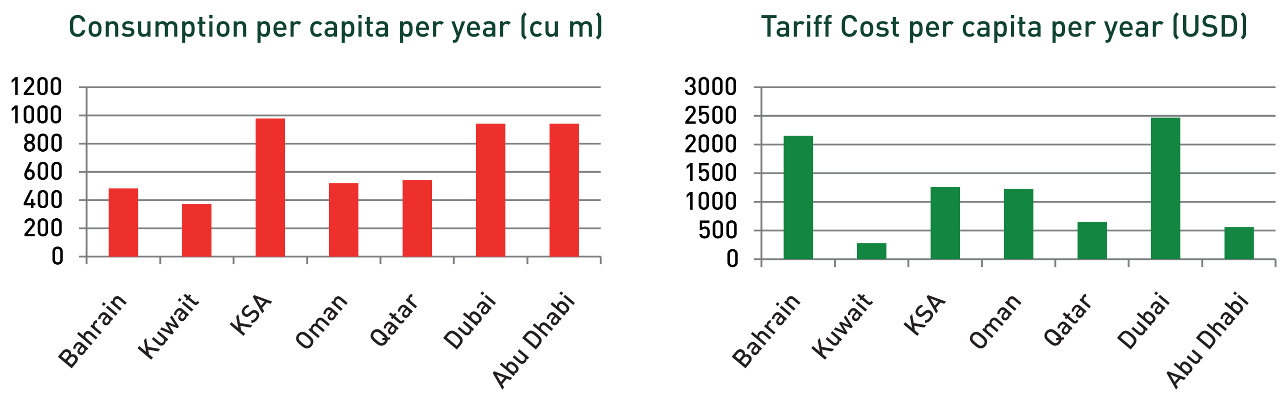


Figure 8 - Source: NCB 2009, CEBC Research

Tariffs should be employed to decrease demand. The argument being that a higher tariff should encourage demand management among customers. In this regard it is interesting to look at a comparison between Dubai and Abu Dhabi: Abu Dhabi, through Abu Dhabi Water and Electricity Authority, subsidizes its water while Dubai Electricity and Water Authority (DEWA) engages in full cost recovery resulting in water tariffs that are four times higher than in Abu Dhabi. However, consumption rates in the two Emirates are practically the same, which suggests that either (a) tariffs set by DEWA are not high enough to discourage demand or have not had time to produce a demand side response, or (b) that water consumption is inelastic to price. The answer is probably more complicated and requires closer examination of the individuals that are charged. For instance, DEWA does not charge UAE nationals, which may mean that high water users, particularly those locals engaged in agriculture in the region are not actually subject to any tariff. Moreover, since agriculture accounts for 80% of water consumption in the region, unless tariffs are applied to everyone a full cost recovery system as applied by DEWA may not necessarily reduce water demand the way it would be expected to.

A look elsewhere in the region reveals that Kuwait, which has the eighth highest GDP in the world, charges the least for its water, which in Qatar nationals are provided with free water, although expatriates are charged at a subsidized rate of US$1.21 per cu m. The cost of producing and distributing water in those countries however is estimated to be US$1.64 per cu m and US$1.10 per cu m, respectively (NCB 2009). It is costing countries far more than they are charging for deliver of water to their customers e.g. the estimated cost of processing and delivering water and removing waste in KSA is US$1.30 per cu m and tariffs there start as low as US$0.03 per cu m (BM KSA 2010). Given the amount of investment required in this sector – an estimated US$27 billion to US$212 billion annually - local authorities will need to start recovering some of this investment through effective tariffs (World Bank 2011).

2. Agriculture

Countries within MENA are beginning to recognize the increasing strain on their water resources caused by the outsized claim of the agricultural sector, which is up to 80% of water demand. Irrigation efficiency is also very low at 30% compared to a world average of 45% (World Bank 2011). Within the GCC, Saudi Arabia, the UAE and Oman show the highest agricultural consumption rates. But changes are afoot: Saudi abandoned its self-sufficiency food drive in January 2008 due to the strain on its resources and now has a goal of full reliance on wheat imports by 2016 (NCB 2009), and Abu Dhabi has also aimed to reduce water consumption on farms by 40% by end of 2013. (ABFCA 2010). Reducing water consumption in the agricultural sector could provide as much water as desalination by 2050 and it is by far, the most cost effective option with costs for improvement in agricultural practice estimated at $0.02 per cu m. (World Bank 2012).

Section 3: Something's Gotta Give – Why the Private Sector should take note.

So as a private sector company, why should you care? In 2011 Trucost bench marked 186 FTSE 500 companies on profit risk from increasing commodity prices. They found that for many sectors, water would become an increasingly important issue over the coming years. The analysis showed that if all water used by suppliers were priced at US$1.13 per cu m, water costs would account for a larger share of EBITDA than oil, coal, wheat and cotton combined in 21 sectors. Among the groups of people most exposed to an increase in water costs were the general industrial sectors. According to Trucost, a 10% increase in commodity prices impacts EBITDA by 13%. Industries that rely heavily on GCC water as an input, such as food, chemicals, petroleum, electricity generators, will need to look at private initiatives to avoid reductions in their bottom line. For example, if Qatar decided to implement a cost recovery system for their water, it would double the cost of that particular input for their industries and based on Trucost's analysis, this could impact EBITDA by up to 130%.

In the UAE it is possible to make a direct comparison as to how subsidized versus unsubsidized water may impact companies, by looking at what water would cost companies if they were hypothetically based in Dubai (unsubsidized water) versus Abu Dhabi (subsidized water) and charged for all their water use. Estimating the water footprint for the production of industrial products is fraught with uncertainty but some of the academic findings for both cement and fertilizer two of the UAE's key industries are VERY high and have been estimated at 80 liters per kilo and 150 liters per tonne, respectively.[vi] At CEBC, we looked at production estimates based on real plants within the UAE. Also analyzed was Emirates Group. It produces a sustainability report and its exact results for water consumption were used although obviously this is an international group and purely hypothetical to assume all its operations within one area.

Water Tariff Costs (based on water usage not actual charges) In Dubai Versus Abu Dhabi

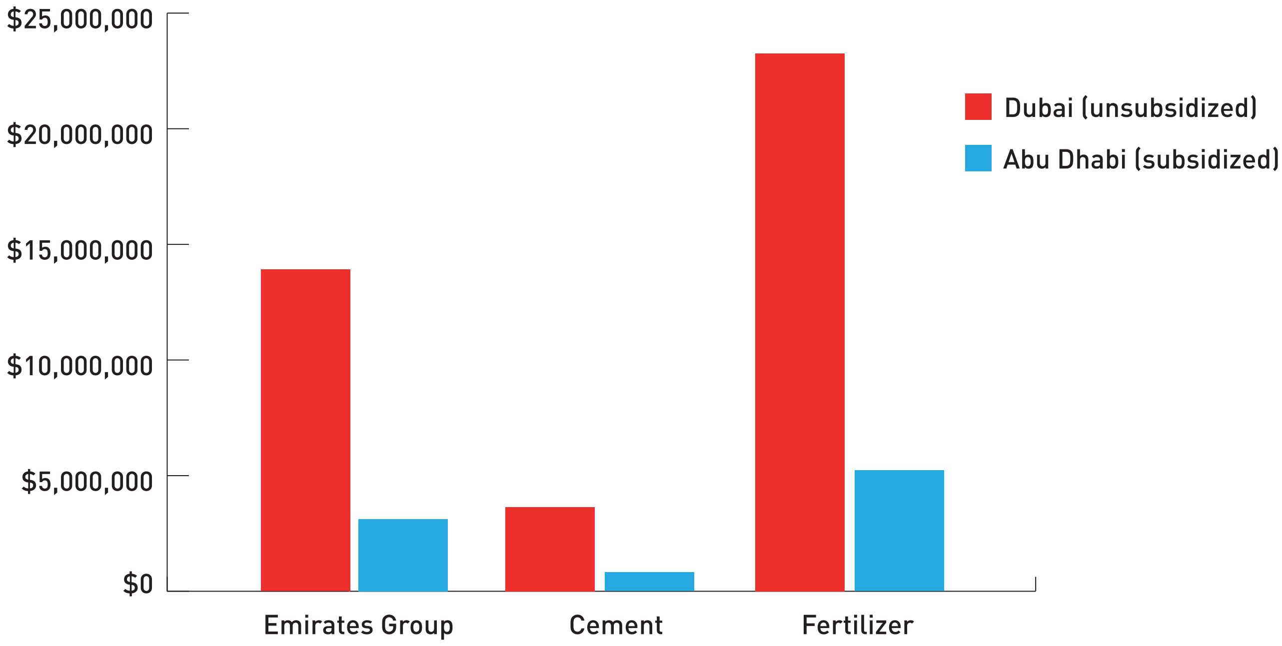


Figure 9

The differences were substantial in terms of amount - over US$15 million in the case of fertilizer and US$10 million for Emirates Group. However, the impact on different industries varies widely. A difference of US$10 million for Emirates Group might not overly worry their management as it comes to about 0.1% of operating profit. However for a tighter margin industry such as cement, an increase in costs of over US$2 million could put some of the companies we looked at in the region well into loss making territory. If, as we argue, price increases are expected, the bottom line is dented further so that those industries that take note of water management now could have a head-start on the competition in the coming years.

Conclusion

No other region in the world has the confluence of water scarcity pressure combined with renewable resources to drive innovative solutions to solve that problem. MENA and particularly the GCC countries have an opportunity to be world leaders within this space.

Energy and energy efficiency will need to be considered at all points in water supply side planning in the MENA region. Separation of water from power generation will increasingly need to be considered in order achieve this. In addition, MENA and in particular the Gulf countries will need to consider their role in renewable desalination. In many ways, both the onus and pressure is on them to take the lead in research and development as, ultimately, they will reap the rewards especially in an era of fuel uncertainty. Wastewater reuse due to its lower energy component and cost will become increasingly important in the region, as will a need for infrastructure investment.

In order to keep costs down, demand side management cannot be emphasized enough. Governments will need to balance their food security worries with overuse of their precious groundwater resources. Curtailing water use in agriculture will be key and, as stated above, could provide as much water as the desalination options more cost effectively. Tariffs need to be reviewed but in a manner that makes sense and prices need to result in a meaningful impact on demand and this will require a proper review of those that are actually paying tariffs and the impact of price on them.

Finally, change will also need to be driven by private sector investment and awareness. There are huge investment opportunities in the desalination and wastewater sectors as highlighted throughout this paper. Less publicized is the need to recognize that water recycling is not just a government problem, it will be a profit problem in the near future if immediate action is not taken by water intensive industries. Even now when water is heavily subsidized, water conservation and recycling is a source for savings for the private sector. In the future, as governments start having to implement policies to recover some of the costs of providing water to a growing population, those private sector companies that have planned for this, whether through conservation or their own water recycling and production techniques, will come out on top.

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www.worldwater.org

Appendix 1
Water Tariffs GCC

Country (unit)	Consumption Block	US$/Cu M
KSA (cu m)	1–50 cu m	0.03
	51–100 cu m	0.15
	101–200 cu m	0.53
	201–300 cu m	1.07
	>300	1.6
Bahrain (cu m)	1–60 Residential	0.66
	61–100 Residential	2.11
	100+ Residential	5.28
	1–450 Non-residential	7.92
	450+ Non-residential	10.56
Qatar (cu m)	Flat Residential*	1.21
	Flat Commercial	1.43
	Flat Industrial	1.21
	Flat Government	1.92
Dubai, Sharjah	1–6,000 gallons (1-23 cu m) Residential	2.11
	6,001–12,000(23-45 cu m) gallons Residential	2.38
	12,000+ (>45 cu m) gallons Residential	2.64
	1–10,000 (1-38 cu m) gallons Commercial	2.11
	10,001–20,000 (39 - 76 cu m) gallons Commercial	2.38
	20,000+ (>76 cu m) Commercial	2.64
Oman (gallons)	1–500 (1-2 cu m) gallons Residential	1.37
	>500+ (>2 cu m) gallons Residential	2.40
	Flat Commercial	2.06
Abu Dhabi	Residential	0.59
	Industrial/Commercial	0.59
	Government and Schools	0.59
	Tanker Distribution (Remote Areas)	0.30
Kuwait	State Facilities and Companies	0.75
	Industrial Companies	0.02
	Farms(Distilled Water)	0.002
	State Facilities and Companies (Distilled Water)	0.094

Source NCB 2009 and CEBC research

[i] http://www.ecomena.org/csp-desalination-mena

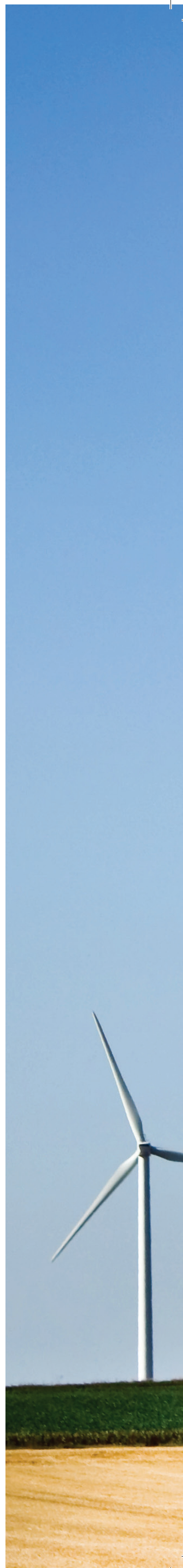
[ii] http://www.navigantresearch.com/wp-assets/uploads/2010/06/DESAL-10-Executive-Summary.pdf

[iii] http://www.bbc.co.uk/news/business-22598906

[iv] http://gulfnews.com/news/gulf/uae/environment/abu-dhabi-targets-zero-water-wastage-in-1-year-1.1163068

[v] The tariff rates for this calculation are set out in Appendix 1.

[vi] For fertilizer, the figures used were taken from a 1993 study by Peter Gleick and reduced by 33% on the assumption that efficiency will have improved since then. World Nitrogen Fertilizer production is based on ammonia and ammonia is basically a mixture of water air and energy. Based on industry estimates, cement uses 150 litres of water per tonne of cement produced. See http://www.globalcement.com/news/item/1772-analysis-gimmie-water-water-



About Clean Energy Business Council (CEBC)

The Clean Energy Business Council (CEBC) is a non-profit, non-governmental association that brings together leading local and international organisations in the MENA clean energy sector from both the private and public spheres.

CEBC seeks to become the leading forum for local, international corporations and government entities focused on the development and deployment of clean energy in the MENA region. It also aims to promote constructive dialogue and collective action by all stakeholders in order to guide public policy and private investment in the region's nascent clean energy sector.

CEBC constantly strives to provide its members with updates on the latest developments in clean energy policy, research, and technology and opportunities to grow their organizations and network with high-level industry players.

Thank you to all of our CEBC Members who contributed to this paper, with a special thanks to Ambata, Ernst & Young, Bloomberg New Energy Finance and John Cunneen. If you have any comments or queries related to this or any other aspect of CEBC's work please email info@cleanenergybusinesscouncil.com

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