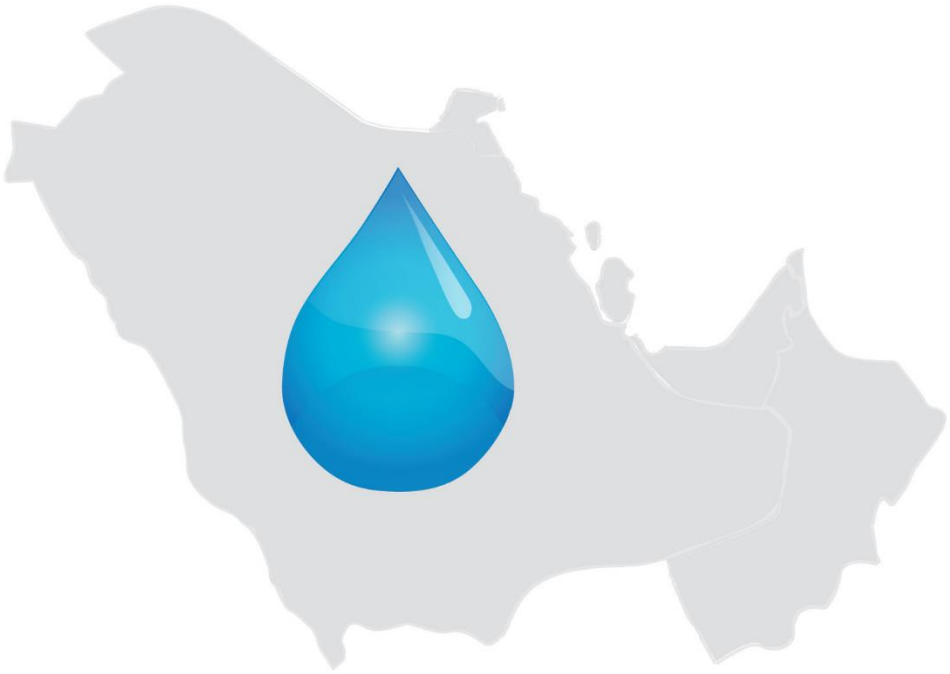
Marmore Infrastructure Reports 2013

Kuwait Water

Containing consumption and spurring investments



Research Highlights
Examining and analyzing the status of Kuwait Water sector highlighting the demand, supply and investment trends. The report also presents growth drivers and key learning points.

MARMORE
MENA INTELLIGENCE
A MARKAZ subsidiary

Research

M.R. Raghu CFA, FRM | Head of Research
rmandagolathur@markaz.com

Porcko P | Intern

Support

Jenevivu Lasrado | Secretary, Research
jlasrado@markaz.com

Fatima Priya | Office Manager - Administration, Research

Nael Aboul Huda | Manager, Media & Communications

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For further information, please contact 'Markaz' at P.O. Box 23444, Safat 13095, Kuwait; Email: info@e-marmore.com; Tel: 00965 22248280; Fax: 00965 22495741.

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1. Executive Summary

Globally fresh water presence is about 3% of the the total water present on Earth. Water is not evenly distributed over the globe. Fewer than 10 countries possess 60% of the total fresh water available and definetely GCC would be the other extreme, with countries like Kuwait possesing almost nill internal renewable water resources.

Kuwait recorded the highest water consumption per capita per day and the value was 500 litres.

Kuwait recorded the highest water consumption per capita per day and the value was 500 litres, which is very much indicative of its demand range. Kuwait in terms of its water withdrawal seems to be low at 374 m^3 per year per capita, but the availability of renewable water resources stands at 7 m^3 per year per capita, which is also very low compared to its GCC peers.

Potable water is mainly consumed by Muncipalities, as Potable water finds its use among residential places. Potable water consumption in 2011 stood at 128,236 MIG (Million Imperial Gallons). Muncipalities are mainly urban cities and the urban population in Kuwait has increased by 35% from 1990 to 2011. With increasing population and changing usage trends the consumption of potable water is estimated to be 142,230 MIG in 2015. This value along with percentage of withdrawal of Potable water to availabilty of renewable resources (2,465%), highlights the heat of demand for fresh water in near future.

Agriculture is also a major sector that withdraws substantial amount of water. Sulaibha farms are government owned farms, which are supplied with Brackish water. Brackish water is highly saline, which is not suitable for municipal consumption. Brackish water consumed in 2011 stands at 19,265 MIG. Though the arable land in hectares has decreased from 12 to 11 from 2002 to 2008, the crop produce has been exhibiting increasing trend. The crop production index, which is produce by keeping cultivated land area constant, has been increasing from 109.4 in 2008 to 155.3 in 2011. These all indicate the possibilities for an increase in withdrawal of water by agriculture sector.

Of other two sectors Industrial sector is a much smaller consumer of water. Water finds its use in refineries and water is lost in sludge and evaporation.

The refinery capacity has increased from 889.2 thousand barrels per day in 2009 to 936 thousand barrels per day in 2010. This sudden increase would really increase industry's demand for water.

The number of residential consumers is highest with a percentage of 93.3%, and most of the residential consumers are private.

On supply side there is very little or almost nill internal renewable water resources. The annual percipitation stands at 121 cm which is very meager when compared to the prevailing demand. Desalination and Sewage treatment plants are the alternative sources of water. Total desalination capacity as of 2010 is around 423.1 MIGD (Million Imperial Gallons per day). Sewage treatment plants are taken care by Ministry of public works. Sulaibha facility is the only plant producing RO treated wastewater as of 2011 and its output is 3,40,000 cm/day.

The number of residential consumers is highest with a percentage of 93.3%, and most of the residential consumers are private. Other consumers who belong to industrial,commercial, agriculture and service sectors form 6.7%. So a sudden depletion in the fresh water supply will affect the residential consumers by a much greater magnitude than other consumers.

The total investment in water sector between 2005 to 2014 stands at 5279 million USD.

MEW (Ministry of Elelectricity & Water) owns and operates all existing power and water production facilities, transmission networks and distribution systems in Kuwait and sells electricity and water . Water tariffs are categorized based on type of consumer. It is just 0.02 Kuwait Dinar (KD) per 1000 gallons for Sulaiba farms and it is 0.85 KD for state facilities and companies.

The total investment in water sector between 2005 to 2014 stands at 5279 million USD. Of all water sector investments,water treatment plants saw highest investment at 3402 million USD. In 2010 many projects were undertaken and finished. The Construction of Sabiya Distillation Plants Projects Stage I & Stage II, Shuaiba North Distillation Plants and Shuwaikh Reverse Osmosis Desalination Plant took place.

The Construction of Az-Zour North Distillation Plant Project is a huge and much awaited project in Kuwait. The purpose of this project is to supply & erect 15 multi stages Flash Distillation Units each of 17 MIGPD capacity with Recarbonation Plant, in addition to one Reverse Osmosis Desalination

Plant having 25 MIGPD capacity i.e. having total capacity of 280 MIGPD for the plant.

2. Industry Overview

Global fresh water presence is very meager. The value stands at 3% of total water present on the earth. The rest is seawater and undrinkable. Water is not evenly distributed over the globe. Fewer than 10 countries possess 60% of the world's available fresh water and they are Brazil, Russia, U.S., India, Columbia and the Democratic Republic of Congo. GCC region has less than 1% of total renewable water resources in the world.[1]

The agricultural segment consumes more than half of the water withdrawn in Kuwait.

Kuwait has almost non-existent local renewable water resources. The consumption of water in Kuwait is categorized into three categories:

- Agricultural,
- Industrial and
- Municipal.

The agricultural segment consumes more than half of the water withdrawn in Kuwait. Industrial water consumption is mostly used for oil extraction and in refining industries.[2] Water use is extensively seen in cooling towers present in these plants. Despite relatively low consumption compared to other segments, since oil refinery contributes massively to the GDP, the demand for water – in line with the growth of oil sector – is expected to increase. Municipal needs of water are mostly for drinking purposes. Kuwait recently recorded the highest per capita daily consumption of water in the world, which stood at 500 litres per day[3]. When compared to its GCC peers, such as Saudi Arabia which has the average daily water consumption per capita of 250 litres,Kuwait substaintially exceeds its cosumption of water. Additionally, Town cooling stations installed in the country also require water.

The present desalination capacity of plants in Kuwait as of 2010 stands at 423 MIG (Million Imperial Gallons) per day.

However, much of industrial and municipal needs are being met by desalinated water. The present desalination capacity of plants in Kuwait as of 2010 stands at 423 MIG (Million Imperial Gallons) per day. In total, there are six desalination plants in Kuwait.

[1] Facts & Trends, World Business Council for sustainable development
[2] FAO Aquastat
[3] Kuwait Institute for Scientific Research

In 2011, the total treated water output amounted to 3.4 L m^3/day[1].

The Ministry of Electricity and Water (MEW) is solely repsonsible for water production, distribution and tariff collection. All desalination water plants in Kuwait are annexed with power plant facilities. Kuwait has a subsidized pricing scheme and this is most liberal compared to other GCC countries. The total revenue earned by the MEW in 2008 through water distribution was around 32.9 million KD[4].

In addition to water desalination, sewage water treatment also caters to water demands. In 2011, the total treated water output amounted to 3.4 L m^3/day[5]. The Minsitry of Public Wroks is responsible for managing sewage water treatment operations in Kuwait.

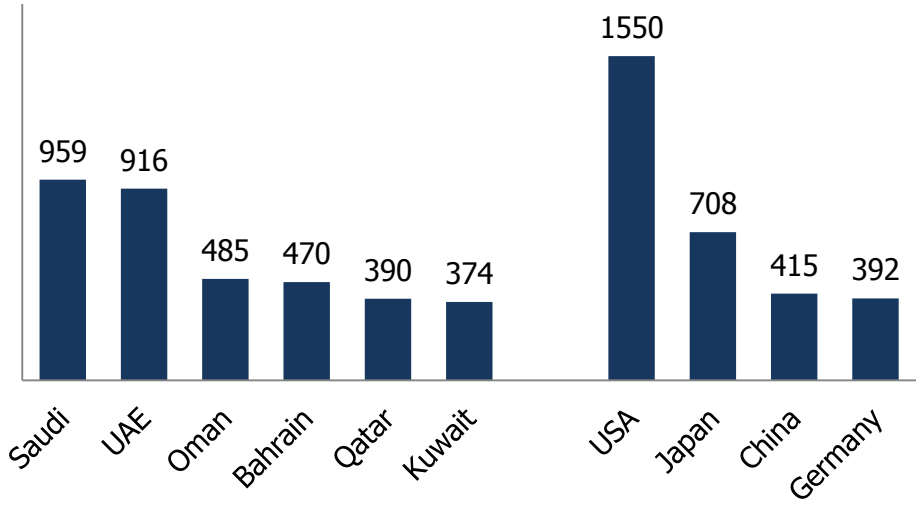
[4] Ministry of Electricity & Water, yearbook 2009
[5] Evaluating The Kuwait Waste water demand management strategy, Ministry of Public works.

3. Demand Dynamics in Kuwait

Kuwait's water withdrawal per capita may seem relatively modest as compared to other peer GCC countries and developed nations.

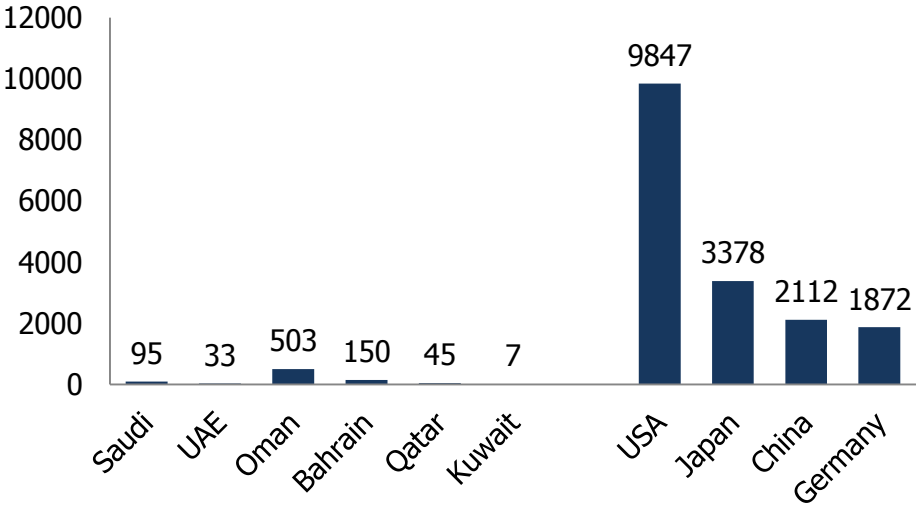
GCC is one of the most arid regions in the world. In stark contrast to the region's oil abundance, water is an extremely scarce resource. Although Kuwait's water withdrawal per capita may seem relatively modest as compared to other peer GCC countries and developed nations, considering its almost non-existent renewable water resources, this may translate into excessive water usage. Water tariffs in Kuwait are highly subsidized and hence usage pattern are unlikely to change in near future.

Figure 3.1: Total water withdrawal per capita (m^3/yr)



Source: FAO Aquastat.
Note: Figures correspond to different time periods.

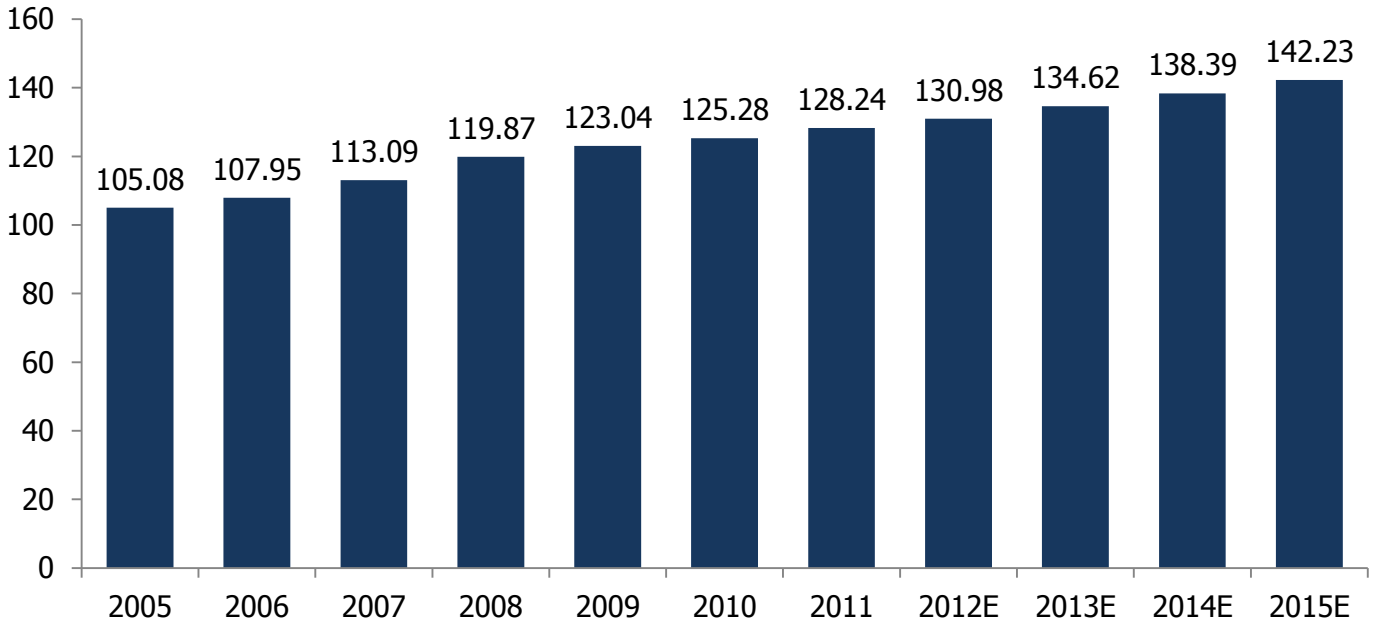
Figure 3.2: Total renewable water resources per capita(m^3/yr)



Source: FAO Aquastat.
Note: Figures correspond to different time periods.

Potable water is mainly consumed by residents of Kuwait. Between 2005 and 2011 the consumption of potable water grew by 22% approximately. This increase in usage is because people continue to treat water as an infinite source and also water is available to them at highly subsidized cost. The total potable water consumption in Kuwait in 2011 stood at 128,236 MIG.

Figure 3.3: Total Potable water consumption (in 1000MIG)

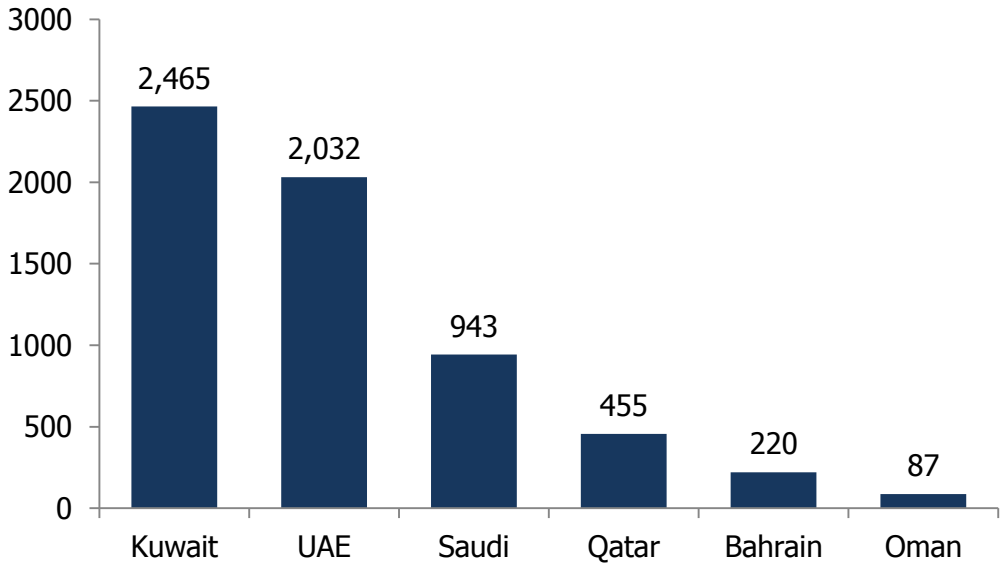


Source: Annual statistics abstract,2011. Markaz research.

As freshwater availability is low, the proportion of freshwater withdrawal to total renewable water resources is very high with Kuwait withdrawing 20 times more freshwater than actual recharged water on a long-term basis - indicating that more water is withdrawn than annually renewed, thus depleting the freshwater resources.

Figure 3.4: Total freshwater withdrawal as % of total actual renewable water resources

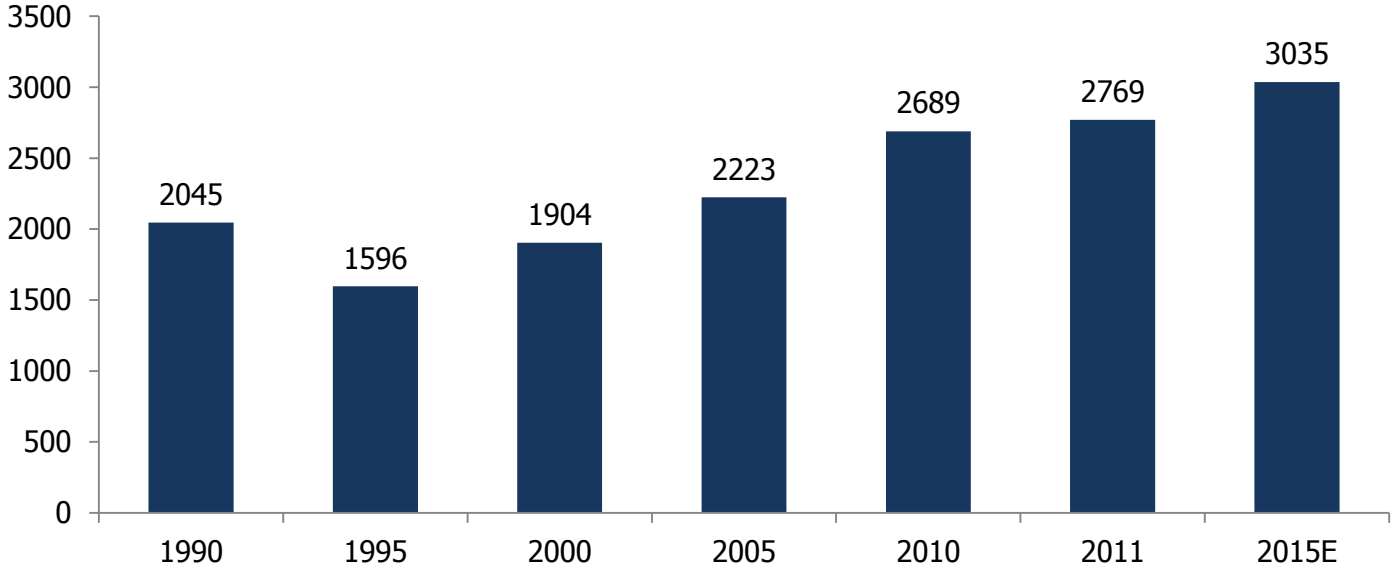
Kuwait has over 98% of urban population that tend to use water generously.



source: FAO Aquastat
Note: Figures correspond to different time periods

The GDP per capita in Kuwait is amongst one of the highest at USD 43,800[6] (2012 est). Additionally Kuwait has over 98% of urban population that tend to use water generously. Wealthy populaltion combined with high subsidies result in less emphasis given by residents to conserve water usage practice.

Figure 3.5: Total urban population in Kuwait in Thousands



Source: United Nations, Department of Economics and Social Affairs.

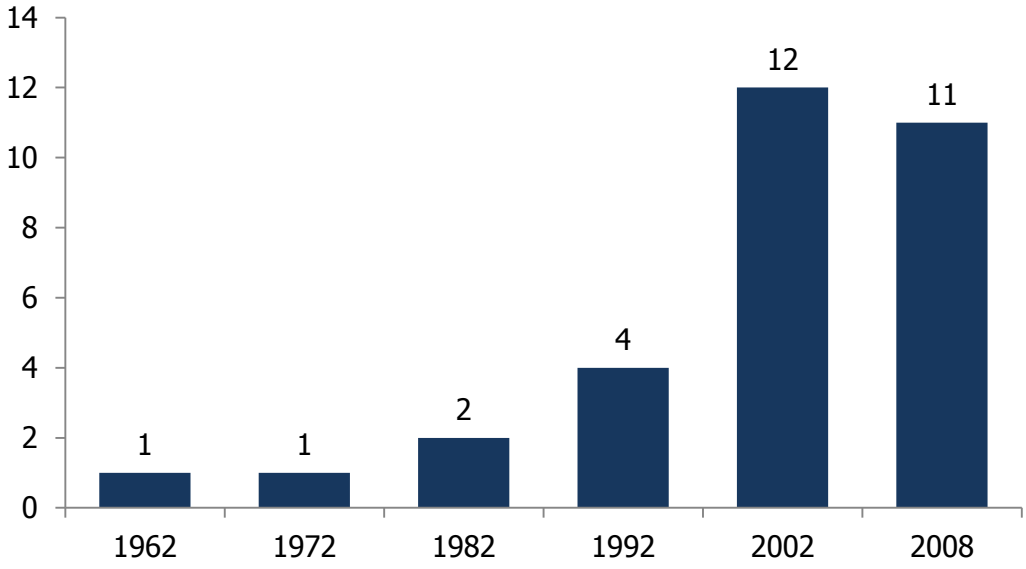
[6] World Factbook

All residents in urban areas are well connected to water supply lines, but there is a difference between the quantity of water supplied to urban network and the metered quantity of water used by consumers. This difference is called Unaccounted for water(UFW). The percentage of UFW stood at 40% and leakage percentage was 17%.These were estimates found by a firm SETEC engineering and were provided to Kuwait ministry of Electricity and water. By 2011 the percentage of UFW was still above 30% among GCC countries[7].

By 2011 the percentage of UFW was still above 30% among GCC countries.

The agricultural sector in Kuwait has the largest share of water consumption. Between 1962 and 2008, the arable land in Kuwait has increased by 11.3 times, indicating increased emphasize given to agriculture.

Figure 3.6: Arable Land in Hectares



Source: FAO Aquastat

The percentage of the agricultural land to the total land remains constant for the past five years at 8.5%, but due to reducing renewable water resources demand for water look formidable.

However, the percentage of the agricultural land to the total land remains constant for the past five years at 8.5%[8], but due to reducing renewable water resources demand for water look formidable.

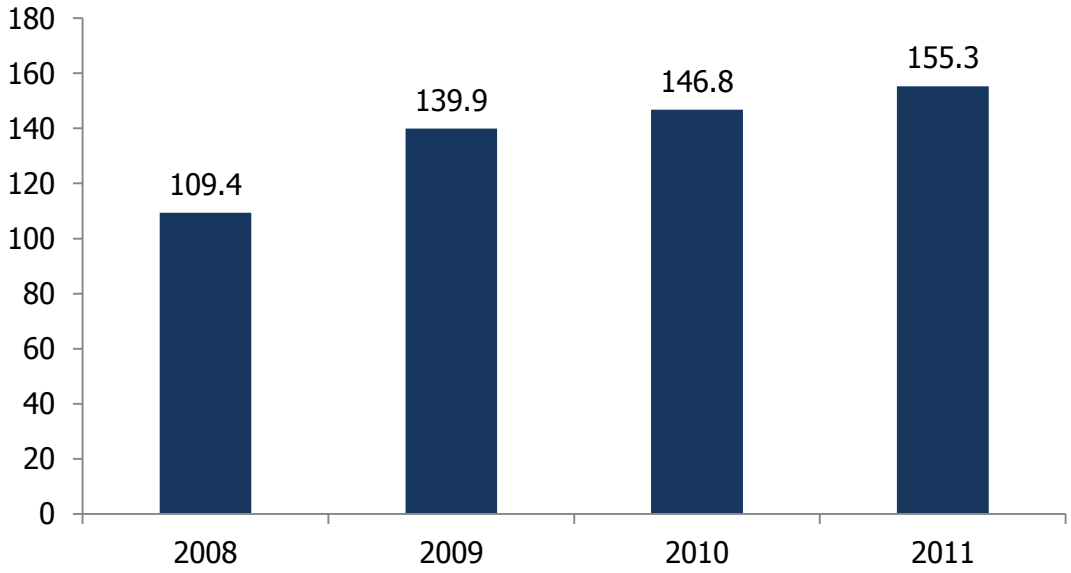
The crop production index has increased over the years, indicating increasing efficiency in producing more crop from the same size of land. This suggests that efforts are being made to produce more crops internally.

[7] Urban Water Management in the GCC, Arabian Gulf University
[8] World Bank

Such an initiative, assures the priority of the government towards agriculture, which urges higher demand for water. Unlike oil exports and crude oil refining agriculture does not fetch huge revenues. This is evident by the GDP contribution made by the sector. So any option of providing water for Agriculture should be evaluated in terms of the returns that it provides. With agriculture returns not so lucrative, there is always a check for providing water cheap.

Agriculture should be evaluated in terms of the returns that it provides. With agriculture returns not so lucrative, there is always a check for providing water cheap.

Figure 3.7: Kuwait - Crop Production Index



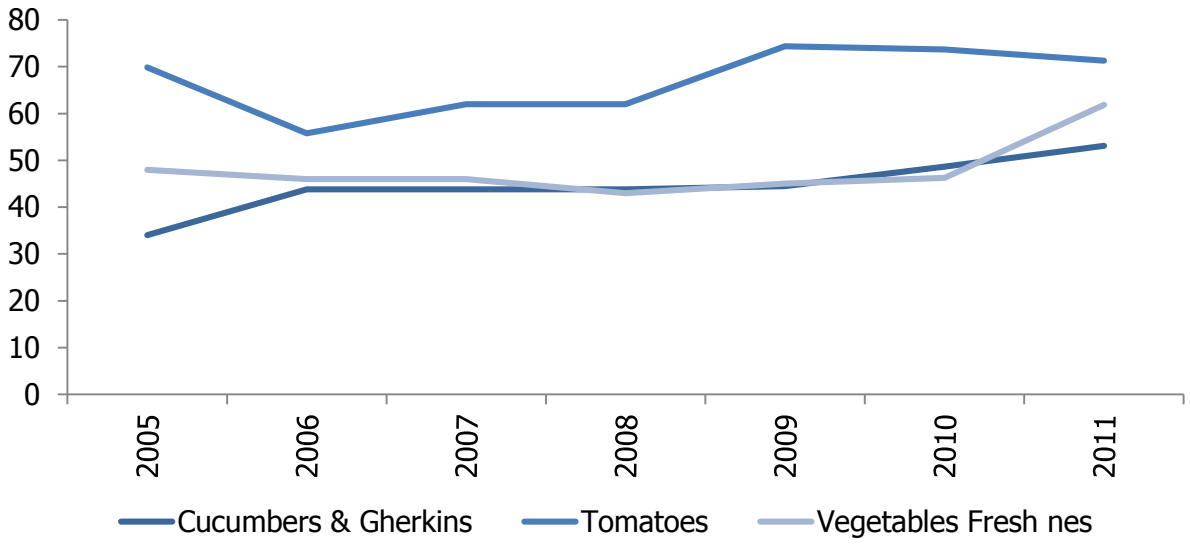
Source: World Bank

The top three crops produced in Kuwait include cucumber & gherkins, tomatoes and some vegetables.

It is evident that the agricultural sector has grown in Kuwait which has translated into the increase in production of crops. The top three crops produced in Kuwait include cucumber & gherkins, tomatoes and some vegetables. Except cucumber & gherkins, both tomatoes and vegetables produce are growing and expected to grow further in future. For tomatoes the water requirement stands at 400-600 mm for a cultivation period of 90-120 days, and for cucumber the water need is 5.5 mm/day[9].

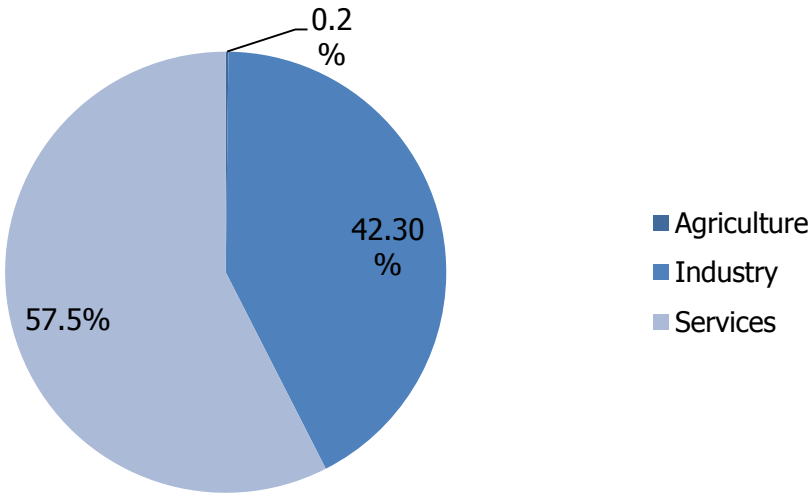
[9] FAO

Figure 3.8: Production of top three crops in Kuwait in 1000 tonnes



Source:FAO

Figure 3.9: GDP Contribution Sector Wise



Source: CIA-World Factbook

Significant quantities of water — primarily for processing and cooling are needed to produce fuel. Refineries in USA use about 1 to 2.5 gallons of water for every gallon of product.

Industrial consumption of water amounts to only 2.278% of total consumption. Most of the water used is attributed to cooling purposes. Apart from cooling stations placed inside municipalities, they are used in oil refineries. Significant quantities of water — primarily for processing and cooling — are needed to produce fuel. Refineries in USA use about 1 to 2.5 gallons of water for every gallon of product, meaning that the United States, which refines nearly 800 million gallons of petroleum products per

Water requirement as a percentage of total withdrawal might seem minute but the importance of Petroleum refinery can be felt by the total oil exports.

day, consumes about 1 to 2 billion gallons of water each day to produce fuel[10] . All GCC countries have advanced refineries which are on par with USA refineries, also have losses by evaporation in cooling towers. Out of 5,492 gallons of fresh water supplied per minute, about 4900 gallons of water is lost due to evaporation in cooling towers[11].

Water requirement as a percentage of total withdrawal might seem minute but the importance of Petroleum refinery can be felt by the total oil exports. Oil exports in 2012 was KD 31.6 billion , which forms most of kuwait exports. Therefore, though the industry's requriement is relatively small in terms of total share of water consumption, the necessity of its smooth running escalates the demand for water.

[10] USDOE, 2006
[11] API Internal report 2009

4. Water Supply Sources in Kuwait

Due to the extremely high evaporation losses and the high deficit in soil moisture, only a small percentage of the precipitation infiltrates into the groundwater supply.

The prevailing hyper-arid climate of Kuwait is not favourable to the existence of any river systems in the country. There are no permanent rivers or lakes, but small wadis develop in the shallow depressions in the desert terrain. Surface runoff sometimes occurs in the large wadi depressions during the rainy season. Flash floods are reported to last from only a few hours to several days. Due to the extremely high evaporation losses and the high deficit in soil moisture, only a small percentage of the precipitation infiltrates into the groundwater supply. Internal renewable groundwater sources are negligible[12].

Table 4.1: Water Withdrawal by source(10^9M3/Yr)

	Freshwater			Produced Water			
	Surface Water	Ground Water	Total Fresh Water	Desalinated Water	Reused Treated Wastewater	Total Water Produced	Total Water Resources
Saudi	1.1	21.54	22.64	1.033	0.166	1.199	23.839
UAE	0	3.048	3.048	0.95	0.248	1.198	4.246
Kuwait	0	0.493	0.493	0.42	0.078	0.498	0.991
Qatar	0	0.264	0.264	0.18	0.043	0.223	0.487
Oman	0	1.212	1.212	0.109	0.037	0.146	1.358
Bahrain	0	0.255	0.255	0.102	0.016	0.119	0.374
GCC	1.1	26.812	27.912	2.795	0.588	3.383	31.295

Source: FAO
Note: Various dates ranging from 2003-2007

Developing Ground Water

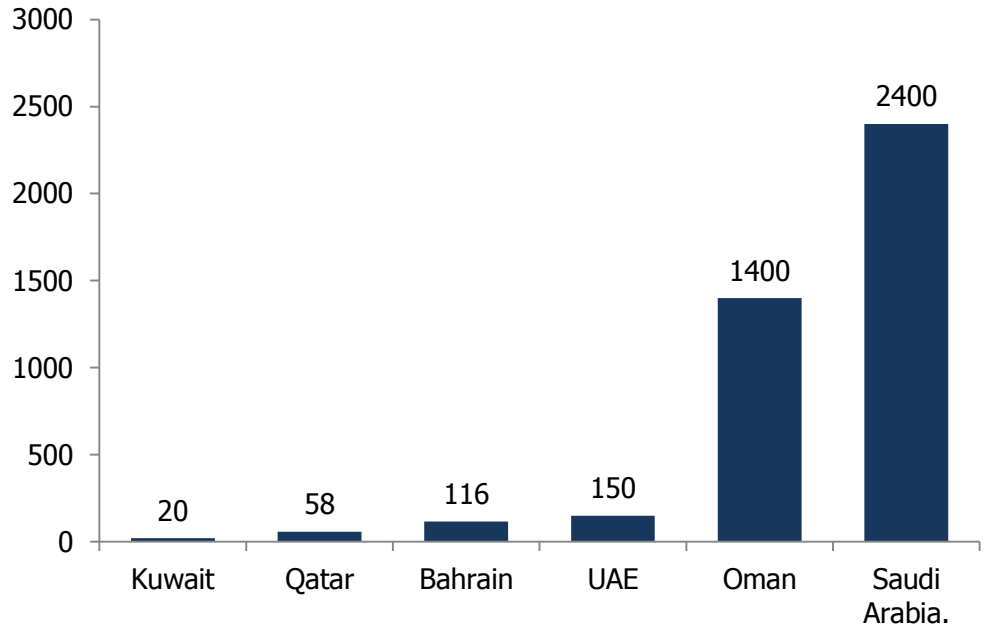
All GCC countries have a limited number of large, deep aquifers. Since the amount of groundwater abstraction is far greater than the amount of recharge, aquifer levels have rapidly depleted, and the groundwater has increased in salinity. It is estimated that this water resource availability will shrink by one-half of its current size by 2030[13].

Of all the GCC countries, Kuwait has the least renewable water resources. There are two major aquifers in Kuwait: the Kuwait group (upper layer)

[12] FAO Aquastat
[13] World Bank

and the Damman group (lower layer). Groundwater inflow has been estimated at about 20 million m³/year through lateral underflow from Saudi Arabia.[14]

Figure 4.1: Total renewable water resources (M m3/yr)



Source: FAO AQUASTAT
Note : Figures correspond to different time periods.

Desalination

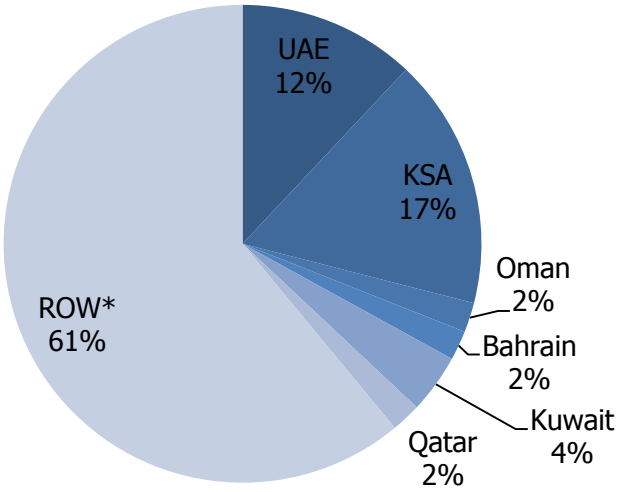
Faced with the extreme scarcity of groundwater, the GCC nations are focusing on increasing supply of water through desalination.

The power and water desalination Industry in the Gulf (GCC) nations is characterized by a limited source of supply struggling to cater to the escalating demand fuelled by increasing population and improved standards of living. Spurred by a buoyant economy and population growth, UN-FAO forecasts over $250 billion will be invested in GCC water and desalination projects, over the next decade. Whilst privatization occupies the centre stage in the overhauling process of power and water sector, the initiatives towards alternative energy sources will enable GCC nations to diversify their economic growth from predominantly oil based economies. New power plants often include desalination components. Faced with the extreme scarcity of groundwater, the GCC nations are focusing on increasing supply of water through desalination.

[14] FAO Aquastsat

Figure 4.2: Desalinated water productivity of GCC countries

Kuwait was the first country in the world to adopt desalting water as the main source of fresh water in the world.



Source: Desalination Data base

*Rest of the world

Kuwait was the first country in the world to adopt desalting water as the main source of fresh water in the world. It was also the first to use the multi stage flash MSF desalting system in its present design in 1960.[15]

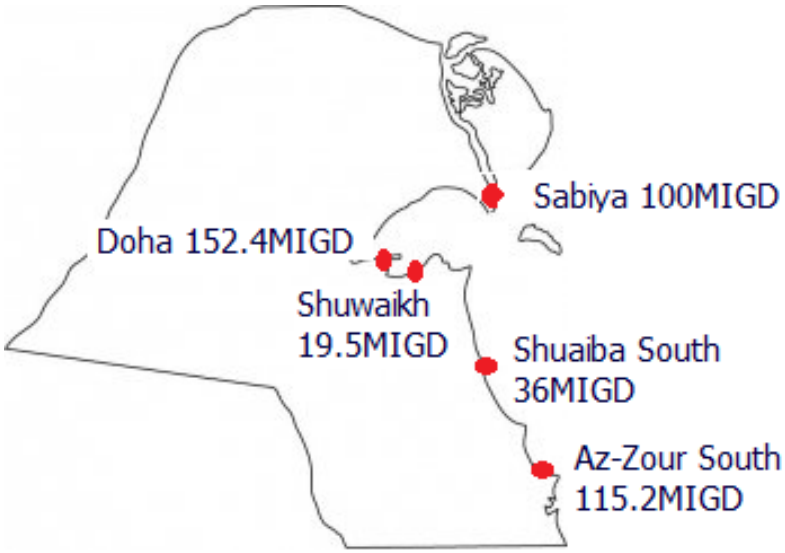
Table 4.2: Kuwait Installed seawater desalination capacity in 2010

Facilities (Technology)	Seawater Desalination Capacity (MIGD)
Az-Zour South	115.2
Doha East	42
Doha West	110.4
Sabiya	100
Shuwaikh	19.5
Shuaiba South	36

Source: State of Kuwait, Partnership Technical Bureau
Note: MIGD- Million Imperial Gallons per day

[15] United Nations University

Figure 4.3: Desalination Plants in Kuwait



In kuwait all the present desalination plants are MSF plants.

In kuwait all the present desalination plants are MSF plants. But MSF plants have huge energy requirements. There is one upcoming desalination plant Az-Zour North 5, which will be a desalination plant using RO technology.

Table 4.3: List of technology used by respective desalination plants in Kuwait

	Facilities	Technology
Existing	Az-Zour South	MSF
	Doha East	MSF
	Doha West	MSF
	Sabiya	MSF
	Shuwaikh	MSF
	Shuaiba South	MSF
Planned	Az-Zour North 5	RO

Source: State of Kuwait, Partnership Technical Bureau

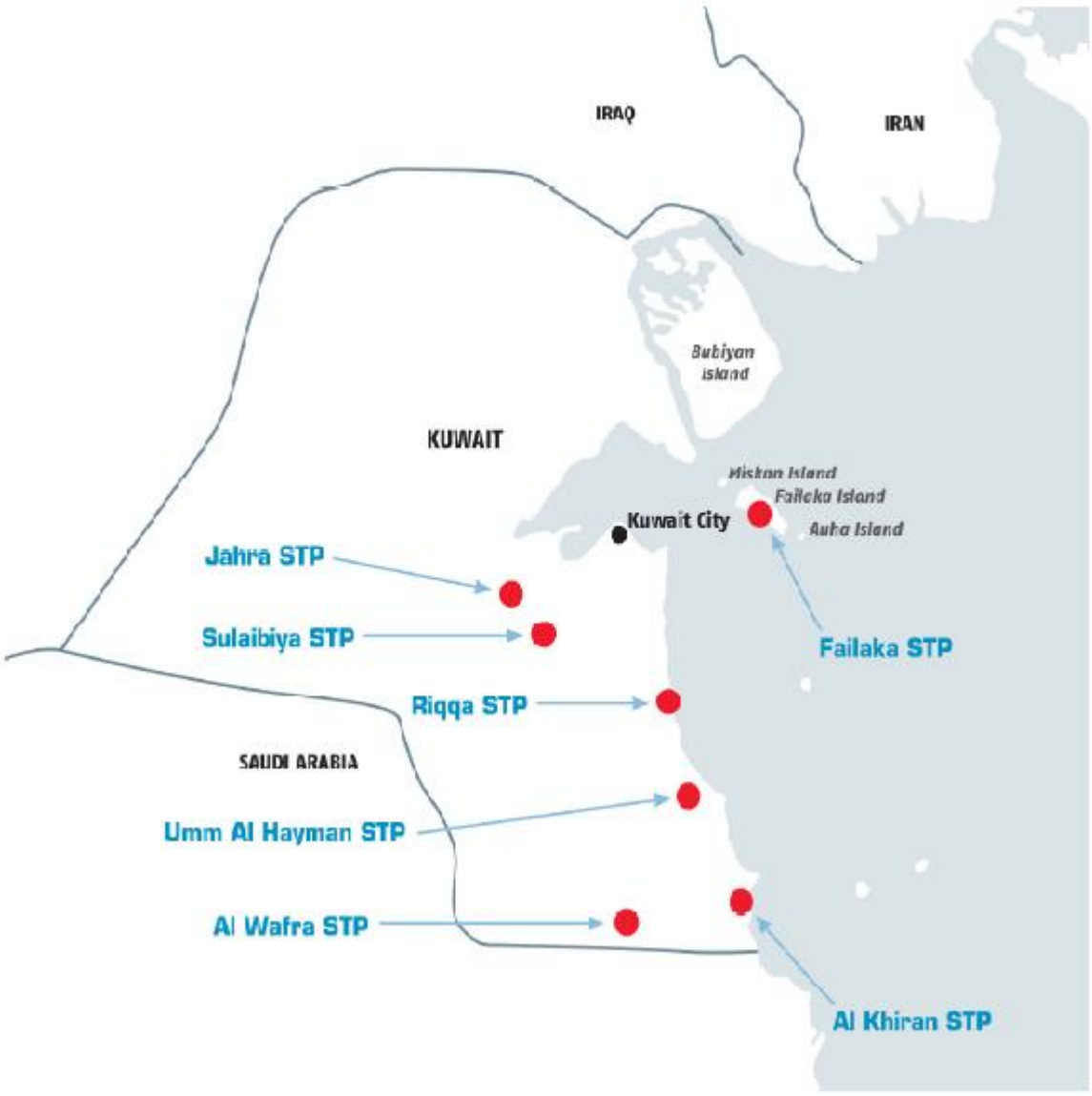
Wastewater Treatment

Over 90 percent of the population is connected to a central sewerage system.

Over 90 percent of the population is connected to a central sewerage system[16]. This offers an important potential for treated wastewater reuse that can contribute to alleviating the water shortage problem. However, various conditions affect the quality and quantity of sanitary sewage from the time it enters the local collector sewers until it is converted to sludge and treated sewage effluent at the sewage treatment plants.

[16] FAO Aquastat

Figure 4.4: Existing Sewage treatment plants, 2010



Sulaibiya

The Sulaibiya plant is the only privately owned facility in Kuwait. With a design capacity of 425,000 cm/d, it is also the largest wastewater and reclamation plant in the world.

The Sulaibiya plant is the only privately owned facility in Kuwait. With a design capacity of 425,000 cm/d, it is also the largest wastewater and reclamation plant in the world. The $390m project was commissioned in late 2004 by the UtilitiesDevelopment Company (UDC).Overall responsibility for operating the plant rests with Kharafi National. Sulaibiya was built partly to resolve problems related to the Ardiya wastewater treatment plant. The state's oldest wastewater facility now acts as a preliminary treatment plant for Sulaibiya. Sewage is screened and degreased at Ardiya before being pumped through a 25km pipeline to the

The Sulaibiya plant is the Like most other STPs in Kuwait, Sulaibiya has been operating above design capacity in in recent years.

Sulaibiya plant for further treatment. There are effectively two plants located at Sulaibiya – a tertiary waste water treatment plant, and an ultrafiltration and reverse osmosis (RO) plant. As a result of its RO capability, the complex is the only STP in the state to produce potable water, although as a result of cultural sensitivities, it is used for non-potable use, such as agriculture. MPW is committed to buying all the output of the plant: it pays KD 0.18 ($0.66) a cubic metre for the treated water, but sells it on to consumers at just KD0.04 ($0.16). Like most other STPs in Kuwait, Sulaibiya has been operating above design capacity in in recent years. Throughput averaged 430,000 cm/d in 2010, which was well down on the 2008 peak of 500,000 cm/d. As a result of the overloading, UDC started discussions with the government in late 2008 about expanding the plant to 600,000 cm/d.[17]

Umm al-Hayman

The Umm al-Hayman project has had a lengthy history. Originally, it was under the responsibility of MPW, which awarded a design contract to Beirut-based Dar al-Handasah in 2008. However, in the same year, the government established the Partnerships Technical Bureau (PTB) to undertake the state's public-private partnership (PPP) programme. This called for 32 major projects to be implemented by the private sector including the planned $1.6bn Umm al-Hayman scheme.

Table 4.4: Waste water treatment palnts by 2011

Plant	Design Capacity(cm/d)	Wastewater Received*	TSE produced*	RO treated wastewater(cm/d)
Sulaibiya	425000	430000	0	3,40,000
Riqqa	180000	230000	230000	0
Al-Jahra	65000	120000	120000	0
Umm al-Hayman	27000	20000	20000	0
Kabad	250000	na	0	0

*Values in 2010
Note : TSE – Total Sewage Effluents
Source: GCC Wastewater Projects Market 2012 report,MEED.

[17] GCC Waste water Projects Market 2012 report, MEED.

5. Water Usages In Kuwait

Farmers are only allowed to withdraw water from the Kuwait group aquifer.

The number of residential consumers is highest with a percentage of 93.3%, and most of the residential consumers are private. Other consumers who belong to industrial,commercial, agriculture and service sectors form 6.7%. So a sudden depletion in the fresh water supply will affect the residential consumers by a much greater magnitude than other consumers. Farmers are only allowed to withdraw water from the Kuwait group aquifer. The water used for livestock purposes is pumped by the Ministry of Electricity and Water (MEW) from the Damman group aquifer through deep artesian wells. Overdrafting of brackish groundwater over the past decades has led to high drawdown and at times even depletion as well as increased salinity levels. Its use for agriculture is limited to plant species that tolerate high salinity levels.

Table 5.1: Number of fresh water Consumers

	2006			2007			2008		
	Govt	Private	Total	Govt	Private	Total	Govt	Private	Total
Residential	1390	130663	132053	1296	138594	139890	1309	139932	141241
Commercial	15	3720	3735	15	4272	4287	189	4436	4625
Industrial	2	537	539	2	758	760	295	540	835
Agriculture	1	536	537	1	551	552	506	51	557
Services	48	356	404	46	411	457	109	304	413

Source:Ministry of Electricity & Water, Kuwait

The brackish water is used for blending with distilled water, agricultural landscapes, public parks and household purposes while fresh water is for human use.

The water distribution system in Kuwait comprises of two networks - one for fresh water and the other for brackish water. Brackish water is a type of water that is highly saline but not as saline as Seawater. Each system has its own underground reservoirs, pumping stations and elevated towers .The brackish water is used for blending with distilled water, agricultural landscapes, public parks and household purposes while fresh water is for human use. The water produced from distillation plants or ground wells is pumped to underground reservoirs then to distribution networks and elevated towers located in several areas to secure public needs at peak hours[18].

[18] Ministry of Electricity & Water, Kuwait.

Brackish water consumers are relatively less compared to fresh water consumers. The large difference could be found in the residential category. The total brackish water consumers are little more than 50% of total fresh water consumers as Brackish water cannot be used for drinking, bathing purposes. Brackish water is also mixed with fresh water output from desalination plants and appropriate consumers are supplied such water.

Table 5.2 : Number of Brackish water Consumers

	2006			2007			2008		
	Govt	Private	Total	Govt	Private	Total	Govt	Private	Total
Residential	241	77712	77953	211	78189	78400	211	78181	778392
Commercial	7	624	631	5	597	602	5	593	598
Industrial	0	52	52	0	44	44	6	17	23
agriculture	4	634	638	3	675	678	37	702	739
Services	10	44	54	9	68	77	11	44	55

Source:Ministry of Electricity & Water, Kuwait

6. Market Structure & Tariffs

MEW owns and operates all existing power and water production facilities and also sells electricity and water to serve demand of industrial, commercial and domestic consumers.

MEW(Ministry of Elelectricity & Water) owns and operates all existing power and water production facilities, transmission networks and distribution systems in Kuwait and sells electricity and water to serve the demand of industrial, commercial and domestic consumers. There are various working sectors under this Ministry to carry over the respective functions allocated to the respective sectors.

Table6.1: Working Sectors in Ministry of Electricity & Water

Working Sectors
Water Operation and maintenance Sector
Water Distillation and Power plants operation and Maintenance sector
Water Projects Sector
Water distillation and power plants project sector

Source: Ministry of Electricity & water

Pumping to the distribution networks is monitored and supervised by the "Water Control Center" in Shuwaikh[19]. The distribution networks consists of main pumping and distribution lines and subsidiary networks.

Table 6.2: Water Rates collected by Ministry of Electricity & Water

Fresh Water Rates	State facilities & Companies	850 fils/1000 gallons
	Supported Industrial Companies	250 fils/1000 gallons
Saltwater Rates		1KD/1000 gallons
Distilled water rates	State facilities & Companies	100 fils/1000gallons
	Sulaibiah farms	20 fils/1000gallons

Source: Ministry of Electricity & water
Note : 1000fils = 1Dinar,

Water pricing scheme in Kuwait clearly suggests that water prices lay no pressure on judicial use of water.

Water pricing scheme in Kuwait clearly suggests that water prices lay no pressure on judicial use of water. But different type of consumers are charged with different prices. Agricultural use is charged lower compared to others, this encourages internal production and it keeps input costs balanced. But when compared to Saudi Arabia, a country with much larger water resources per capita has a pricing scheme, that has a check on the quantity of usage. The existence of slabs across which tariffs increase, will restrain people in Saudi from overuse of water. So, a similar pricing scheme will help Kuwait in imposing better water usage practices among its citizens.

[19] Ministry of Electricity & Water, Kuwait.

Table 6.3: Saudi Arabia Water Tariffs

Slab(m3)	Riyal/m3
1 to 50	0.1
50 to 100	0.15
100 to 200	2
200 to 300	4
Over 300	6

Source: Dynamic Energy and Water solutions

Waste water treatment is taken care by Ministry of Public works. Plans for Kuwait's first sanitary systems date back to 1955, although it was not until a decade later that the first integrated network, centring on a sewage treatment plant at Ardiya began operating. Since then, the sector has grown substantially. More than 98 per cent of the state's population is now connected to the network, which following the completion of the 250,000-cubic-metre-a-day (cm/d) Kabad plant in 2011, was served by five major STPs (Sewage Treatment Plant)with total design capacity of 947,000 cm/d. In addition, there were three small-scale plants at Khiran, Wafra and Failaka[20].

[20] Meed report

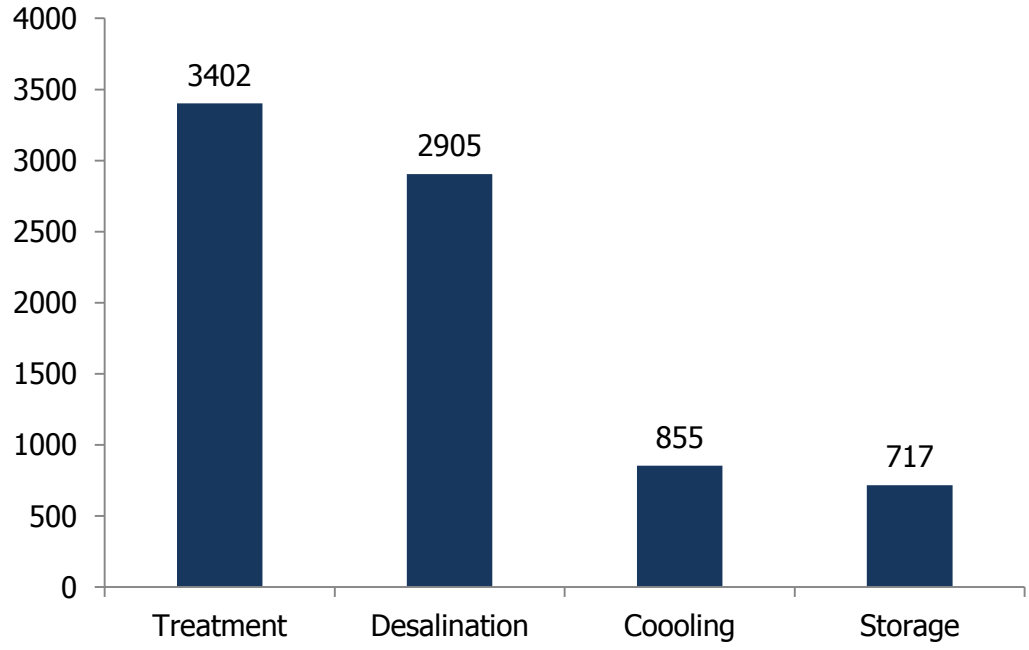
7. Investments in Water Sector

The investments in storage sectors of water is the lowest with the value of investment at USD 717 m.

Investments in Water sector is dominated by "treatment" sub-sector, where the total value stands at USD 3,402 million . These are attributed to construction plans in Umm al-Hayman sewage treatment plant.

The investments in storage sectors of water is the lowest with the value of investment at USD 717 m. The value of investment into the desalination sector stands at USD 2,905 m where most of the investments are into the Az-Zour north power and desalination plant. In cooling sector the investment stands at USD 855 m, where an investment of USD 305 m is made on Seawater cooling stations at Shuaiba power and desalination plantswhile an investment of USD 550 m is made on district cooling plants at Al-Shadidiyah and Shuaiba districts.

Figure 7.1: Investments in Water Projects utility-wise in Kuwait (US $m)

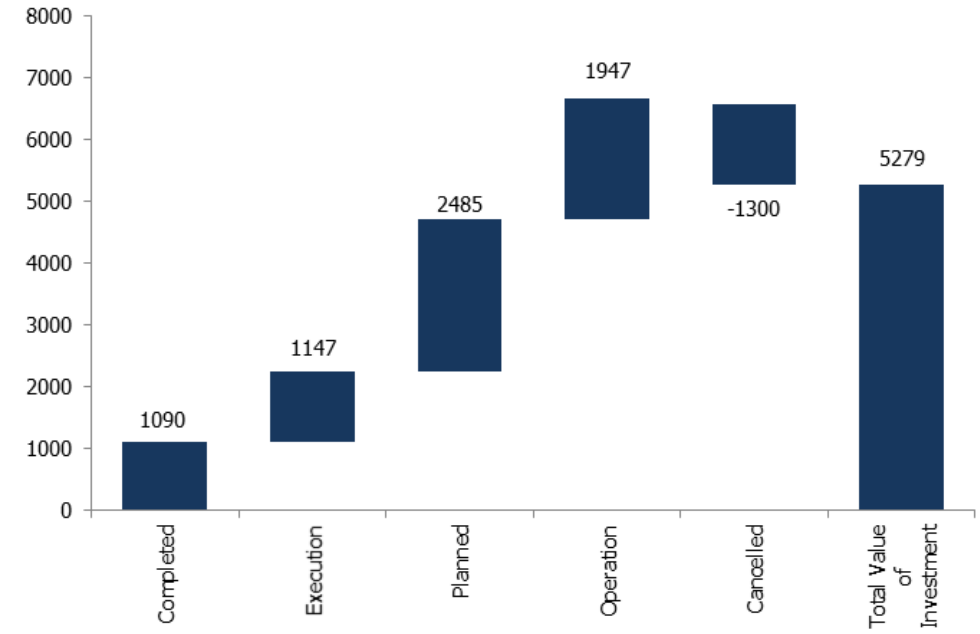


Source : MEED

The value of investments on projects that are completed stands at USD 1,090m.

The value of investments on projects that are completed stands at USD 1,090m, which is only 20.6% of the total value of investments.On the other hand the value of investments planned is 47% of the total investment.. The value of investments of projects in execution stage is about USD 1,057m.

Figure 7.2: Kuwait Water- Value of investments and stages from 2005-2014(US$M)



Source: MEED

8. Kuwait Project Scenarios

The Construction of Sabiya Distillation Plants Projects Stage I & Stage II took place, the purpose of this project is to supply and erect four Distillation Units each having 12.5 MIGPD capacity i.e. with maximum capacity of 50 MIGPD

Kuwait has always been a pioneer in water management project. In 2010 many projects were undertaken and finished. The Construction of Sabiya Distillation Plants Projects Stage I & Stage II took place, the purpose of this project is to supply and erect four Distillation Units each having 12.5 MIGPD capacity i.e. with maximum capacity of 50 MIGPD and also erect a Recarbonation Plant for treatment of the distilled water produced from stage I and stage II Distillation Units. It also included construction of Sea water intake and out fall structures for Sabiya Distillation Units Plants including all the future distillation plants. Subsequently construction of Sabiya Distillation Project Stage III was done. The purpose of this project is to supply and erect four Distillation Units each having 12.5 MIGPD i.e. with maximum capacity of 50 MIGPD in addition to Recarbonation Plant. Construction of Shuaiba North Distillation Plants was also carried over. The purpose of this project is to supply & erect three distillation Units each having 15 MIGPD i.e. with maximum capacity of 45 MIGPD in addition to Recarbonation Plant.T Construction of Shuwaikh Reverse Osmosis Desalination Plant followed with an aim to supply and erect Reverse Osmosis Desalination Plant having total capacity of 30 MIGPD with Recarbonation Plant.[21]

The purpose of Az-Zour North Distillation Plant project is to supply & erect 15 multi stages Flash Distillation Units each of 17 MIGPD capacity with Recarbonation Plant.

Future Projects:

The Construction of Az-Zour North Distillation Plant Project is a huge and much awaited project in Kuwait. The purpose of this project is to supply & erect 15 multi stages Flash Distillation Units each of 17 MIGPD capacity with Recarbonation Plant, in addition to one Reverse Osmosis Desalination Plant having 25 MIGPD capacity i.e. having total capacity of 280 MIGPD for the plant. This is scheduled to be constructed in 3 stages. Tender Specification Documents for stage I and II were issued in first half and second half respectively of year 2009.Each stage consists of 6 distillation plants each of 17 MIGPD , having a total capacity of 102 MIGPD. Stage I was expected to come to service in year 2012 and stage II was expected

[21] Ministry of Electricity & Water. Kuwait.

to come to service in 2013. But presently the estimates are that the Phase I will comercially start its operations by 2015[22].

[22] PTB, Partnership Technical Bureau Kuwait

9. SWOT

Strength:	**Weakness:**
1) Kuwait being an Oil rich economy will have plenty of resources to invest in water sector. 2) Kuwait borders Persian Gulf with 195 km of coast, which when compared to its land area is a very long coastal line. This helps in stationing desalination plants close to municipalities. It reduces cost of pumping and distribution of distilled water. 3) Heavy presence of oil makes power generation easy. More power, promises more desalination possibilities.	1) Total internal renewable water resources is almost nil. 2) Highly arid climate, water loss heavy by evaporation. Available ground water is highly saline. 3) Precipitation stands at 121 mm/year, which is very low. 4) It is likely that water prices in future will go up, and the present agricultural output might further decrease.
Opportunities:	**Threat:**
1) In near future with increased demand, water prices might become lucrative. Thus firms producing water will benefit. 2) With Public Private Partnerships opening up, there will be an increase in inflow of investments. 3) Power projects and desalination plants coexist, so power generation provides additional profits. 4) For private firms, the burden of subsidies is not borne by them. Subsidized water rates don't affect their business.	1) Oil is a non-renewable resource, hence with oil exhaustion, the power production capacities might come down. Due to this the desalination plants production will also drop. 2) Desalination causes environmental damages. 3) Change of technology in Desalination, forces more capital investments.

10. APPENDIX

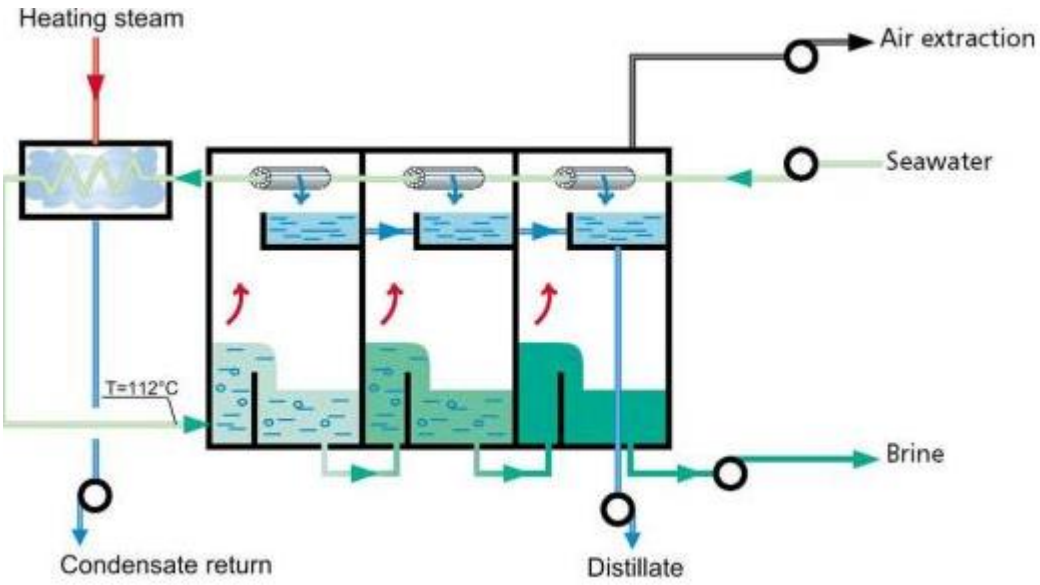
Technologies used in desalination:

Different desalination technologies have been commercially used including: 1) thermal technologies such as Multi Stage Flash (MSF) and Multiple Effect Distillation (MED); and 2) Membrane Technologies such as Sea Water Reverse Osmosis(SWRO), Brackish Water Reverse Osmosis (BWRO) and Electro Dialysis or Electro Dialysis Reverse (ED/EDR).

Multi-stage flash distillation (MSF)

is a water desalination process that distills sea water by flashing a portion of the water into steam in multiple stages of what are essentially countercurrent heat exchangers. The plant has a series of spaces called stages, each containing a heat exchanger and a condensate collector. The sequence has a cold end and a hot end while intermediate stages have intermediate temperatures. The stages have different pressures corresponding to the boiling points of water at the stage temperatures. After the hot end there is a container called the brine heater.

Figure 10.1: Multi-Stage Flash Distillation working layout



When the plant is operating in steady state, feed water at the cold inlet temperature flows, or is pumped, through the heat exchangers in the stages and warms up. And the steam formed in each stage condenses on the heat exchanger tubes. The reason for letting the evaporation happen

in multiple stages rather than a single stage at the lowest pressure and temperature, is that in a single stage, the feed water would only warm to an intermediate temperature between the inlet temperature and the heater, while much of the steam would not condense and the stage would not maintain the lowest pressure and temperature.

Reverse osmosis

is another method of desaliantion. Although RO currently represents the leading world market technology, mainly due to its lower specific energy consumption, however, thermal desalination (MSF and MED) still represents the main technology in the GCC countries. This is mainly due to the Gulf water's poor quality known as 4 H: High salinity, High Turbidity, High temperature and High marine life[23]. The percentage of RO plants in GCC countries is only 32% as compared to thermal plants(i,e MSF) percentage is 68%.

Table 10.1: Stages involved in Reverse Osmosis distillation process

Pretreatment	Pretreatment is done to avoid accumulation of material on membrane surface, as it fouls and hampers the productivity.
Building Pressure	High Pressure pump supplies pressure needed to push water through the membrane.
Reverse Osmosis	It happens through a membrane assembly. The Solute(salt and other elements) remain on the membrane and the Solvent(Water) passes to other side of the membrane
Re-mineralization and PH adjustment	To make the water ready to use.
Disinfection	RO is an effective barrier to pathogens, however a secondary protection is required against compromised membranes and downstream problems.

23 WHO, World Health Organization: Guidelines for Drinking-water Quality, Fourth Edition.

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