Blue Revolution – global water primer

Thematic Investing

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Water: a global thematic megatrend

As part of our research on global megatrends, we update our thematic analysis on water with a Primer and Primer Picks reports. Water scarcity is a pressing people and planet issue – 768m people have no access to clean drinking water and 2.5bn have no access to proper sanitation. Freshwater accounts for only 2.5% of global water – and we have already reached peak water. Increasing water demand, water pollution and water stress mean that demand is set to overshoot supply by 40% in the next 20Y.

A perfect storm is brewing, water is the 21st century oil

The WEF has recognised water as one of top-three global risks for 2014. Further, 50% of the world's population will be living in conditions of "water stress" by 2030 and 40% in "severe water stress" by 2050. Globally, 45% of projected 2050 GDP is at risk and as many as 50 countries are potential locations for conflicts over water. Given how closely food, water and energy security are connected, an impending "perfect storm" of events appears to be looming for the food and energy sectors, in a world constrained by extreme weather and climate change.

Investors need to go blue, US$600bn market & 7%+ CAGR

Water is a US$600bn market today, which is delivering a CAGR of 7%, well above global growth rates. The S&P Global Water index has delivered a 10.4% annualised performance over 10Y, and outperformed the market as well as benchmark gold, and oil & gas indices on a 1Y, 3Y, 5Y and 10Y basis. We see the fastest 3-5Y growth coming from the lowest-hanging fruits (water treatment and recycling), countries incentivising private sector actors (Brazil, China, the US), the more "crop per drop" theme, smart metering and "big data"/technology-based solutions, and water-friendly forms of energy (wind and solar).

Four entry points for investors, US$1tn market (2020E)

We have mapped efforts to tackle the global dynamics of water supply and demand to highlight four entry points for investors wishing to play the "Blue Revolution" theme: 1) Treatment; 2) Management; 3) Infrastructure & Supply; and 4) Water-friendly Energy. We believe these entry points will represent a combined US$1tn+ market by 2020.

BofAML Global Water stock list & Primer Picks

Together with our sector analysts, we have updated our list to include over 90 global stocks covered by BofAML – including 30 new names – that have exposure to water-related themes and solutions. Our Buy-rated stocks with material exposure to the theme are detailed in an accompanying Primer Picks report, as is our full stock list.

Refer to important disclosures on page 132 to 133. Link to Definitions on page 131.

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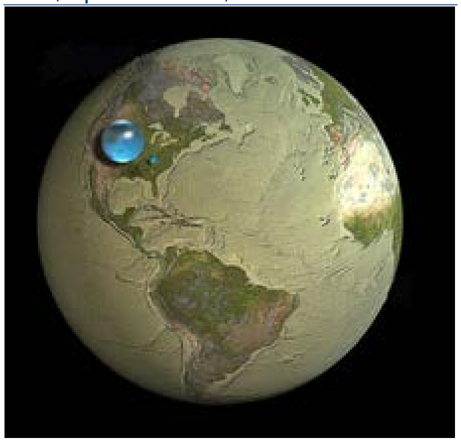
Peak water: the 21st Century oil

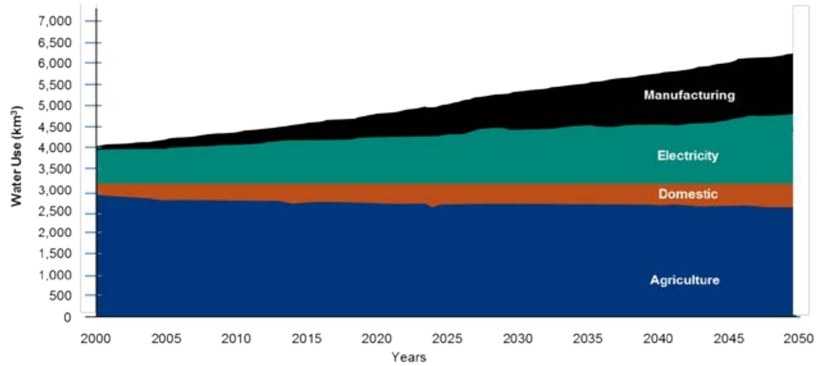
Water faces some of the toughest challenges of any natural resource or commodity – with significant supply and demand-side pressures. On the supply side, the world is facing a combination of insufficient freshwater, uneven distribution, widely varying quality, water losses, and adverse impacts from climate change. On the demand side, agricultural, industrial and municipal/residential usage is set to grow fast over the next 20 years.

Chart 1: Spheres represent all of the Earth's water, liquid freshwater, water in lakes & rivers



Source: US Geological Survey

Chart 2: Global water demand to 2050 (water use km^3)



Source: OECD, BofA Merrill Lynch Global Research

There is growing evidence that we may already have arrived at "peak water" globally – with the concept becoming an inevitability given the rate of extraction of certain water systems. By 2030, according to Water 2030, demand will overshoot water supply by 40%, and close to half of the world's population will be living in water-stressed areas. Water looks set to be a scarcer commodity than oil.

Table 1: Ten Global Risks of Highest Concern in 2014

No.	Global Risk
1	Fiscal crises in key economies
2	Structurally high unemployment/underemployment
3	Water crises
4	Severe income disparity
5	Failure of climate change mitigation and adaptation
6	Greater incidence of extreme weather events (e.g.
7	Global governance failure
8	Food crises
9	Failure of a major financial mechanism/institution
10	Profound political and social instability

Source: WEF 2014, BofA Merrill Lynch Global Research

Unless more sustainable water management practices are adopted, 45% of projected 2050 global GDP (at 2000 prices) – or US$63tn – could be at risk. However, if more sustainable behaviour and practice are adopted, more than 1bn people and approximately $17tn of GDP could escape exposure to risks and challenges from severe water scarcity (Source: Veolia and International Food Policy Research Institute (IFPRI)).

We believe that the global dynamics of water supply and demand mean that the water sector offers numerous growth opportunities for those with exposure to the value chain. By 2020, we estimate that the water industry could be worth well over US$1tn, with the fastest growth coming from the lowest-hanging fruits (water treatment and recycling), countries incentivising private sector actors (Brazil, China, the US), the more "crop per drop" theme, smart metering and "big data"/technology-based solutions, and water-friendly forms of energy (wind and solar).

BofAML Global Water Exposure stock list

Together with our sector analysts, we have created a list of over 90 global stocks covered by BofAML, based on our estimates of their current exposure to water-related themes and solutions, and the role that these could play in driving long-term growth.

BofAML Global Water Exposure stock list is not a recommended list either individually or as a group of stocks. Investors should consider the fundamentals of the companies and their own individual circumstances / objectives before making any investment decisions

BofAML Global Water Exposure stock list

We have mapped water opportunities and risks across a number of global sector value chains to highlight the diverse range of entry points for investors wishing to play the theme: 1) Water Treatment; 2) Water Management; 3) Water Infrastructure and Supply; and 4) Water-friendly Energy.

For each theme, together with our BofAML Global Research sector analysts, we have estimated the level and materiality of companies' exposure to water-related themes, and the role of water as a long-term growth driver. We have characterised each company's exposure as follows:

- **Low** – Water-related products, technologies, services, and solutions are not material to global revenues and/or growth but are one factor, among others, for the business model, strategy and R&D of the company.
- **Medium** – Water-related products, technologies, services, and solutions are an important factor for the business model, strategy and R&D of the company; material to sales and/or growth.
- **High** – Water-related products, technologies, services, and solutions are core to the business model, strategy and R&D of the company; material sales and/or growth driver; pure play (i.e., 100% of sales).

Although it is difficult to accurately gauge the link between such exposure and share price performance (as many factors outside the scope of this analysis are likely to play a role in short- and long-term price development), we still consider water-related exposure an important and positive point to track given that water is a thematic megatrend with a 25-50 year lifespan.

The aim of our Global Water Exposure stock list and its four underlying themes is to provide investors with information to identify company and sub-sector specific risks and opportunities that are inherent in the water theme.

Table 2: BofAML Global Water - Stocks in our coverage universe with exposure to Water Treatment

Company	Water Exposure*
Beijing Enteprises Water	High
China Everbright	High
Kemira	High
Kurita Water	High
Stericycle	High
Danaher	Medium
Danone	Medium
Ecolab Inc	Medium
Empresas ICA	Medium
Nestle (Reg)	Medium
NWS Holdings	Medium
Rexnord	Medium
Acciona	Low
Alfa Laval	Low
ALS Ltd	Low
BASF	Low
BV	Low
Doosan Heavy	Low
Dow Chemical	Low
DuPont	Low
Entegris Inc	Low
ICL	Low
IDEXX	Low
Kuraray	Low
Lanxess	Low
Nitto Denko	Low
Outotec	Low
Pall Corp	Low
SCI	Low
SGS	Low
Spirax-Sarco	Low
Thermo Fisher	Low
Toray	Low

Source: BofA Merrill Lynch Global Research
* Water exposure = BofAML estimates of current sales derived from water treatment-related products, services, technologies and solutions

Water treatment solutions

In our view, a number of stocks are well placed to benefit from the theme of water treatment through their involvement in areas such as wastewater, industrial treatment, chemicals, desalination, ballast water treatment, analysis, water quality, PV solar, bottled water, life science tools, and testing, inspection and certification, among other areas.

Increasing levels of water treatment will be an expanding area in the coming years given rising water scarcity and growing demand from the agriculture, residential and industrial sectors. Agriculture currently accounts for 70% of water use and demand looks set to rise on the back of changing diets. Industry will be under pressure to treat water as global demand rises from 22% of total demand towards the current 59% in developed markets. Municipal and residential water use is also growing on the back of urbanisation and EM growth.

There are significant low hanging fruit opportunities around water treatment with less than 3% of water globally being recycled. Water treatment covers the processes used to make water more acceptable for a desired end-use, such as drinking water, usage or re-usage by industry, in irrigation, or return to the natural environment. Moreover, this market is barely tapped with insufficient wastewater treatment around the world. For instance, wastewater reuse stands at only 2.41% of all water withdrawals globally (Source: FAO Aquastat). The estimate of total global water reuse is less than the water used each day by US toilets at home. The goal needs to be to move to best-practice levels of water reuse of up to 75% (e.g. Israel).

The municipal and industrial water and wastewater treatment market was estimated to be c.US$178bn in 2013 (Source: GWI). On the municipal side, the increasing burden of environmental regulations and the need to extract more value from the water cycle is driving the market. Growth in spending is being driven by the Asia Pacific market, with China overtaking the US as the world's largest spender (Source: GWI)

We anticipate that some of the largest opportunities will emerge around the US$50bn industrial water treatment market vis-à-vis sectors with heavy volumes and environmental constraints (utilities, oil & gas, mining), strict water constraints (FOB, cosmetics), variable effluents (petrochemicals, energy, breweries), as well as in emerging areas like ship ballast water treatment.

Desalination is also set to emerge as a US$41bn industry by 2025 (Source: Japanese Ministry of Economy), a fourfold increase over 20Y, with PV solar a long-term opportunity.

Bottled water is a US$101bn market, with a 5% CAGR to 2015E.

Table 3: BofAML Global Water - Stocks in our coverage universe with exposure to Management

Company	Water Exposure*
Itron	High
Melrose plc	Medium
Monsanto	Medium
Syngenta	Medium
Wolseley	Medium
Wolseley ADR	Medium
BASF	Low
Deere & Co	Low
Dow Chemical	Low
DuPont	Low
Duratex S.A.	Low
Hexagon AB	Low

Source: BofA Merrill Lynch Global Research
* Water exposure = BofAML estimates of current sales derived from water management-related products, services, technologies and solutions

Water management solutions

In our view, a number of companies are well placed to benefit from the theme of water management, vis-à-vis their involvement in areas such as "more crop per drop", irrigation, drought resistant seeds and crops, precision agriculture, "big data", smart metering and household water efficiency.

Water management has assumed greater importance in recent years as a strategy to improve efficiency and the sustainable use of resources. Water usage is growing faster than population growth – with US usage alone increasing 207% from 1950 to 2000 and per capita usage growing by 20% during the same period (Source: EPA). In a situation of growing water scarcity, fragmented water management (and conflicting interests of stakeholders) is no longer cost effective or sustainable in the long term. There is growing recognition that the current water crisis is as much a consequence of weak policies and poor management as natural scarcity. Effective water management enables users to cut their demand, mitigate the risks associated with its shortage and reduce the need for capex-intensive solutions.

Given that agriculture accounts for 70% of global water use –and up to 60% of this water is wasted, the "more crop per drop" theme will grow in importance in a climate change and extreme weather constrained world.

There is significant potential for the US$5.6bn irrigation market given that gravity flow/furrow irrigation accounts for 91% of irrigation globally, and low energy precision application still has extremely low global penetration. More efficient techniques such as mechanised irrigation offer hope and have captured close to 50% market share in some developed markets.

Farmers and stakeholders are becoming increasingly open to drought tolerant/resistant seeds and crops, which are more resistant to adverse extreme weather and environmental conditions like drought and water stress.

Precision agriculture and big data solutions are set to grow in importance in increasing agricultural production and profits with technology helping to optimise the use of farming practices and inputs including water, fertilisers, pesticides and seeds. The global market could be worth US$3.7bn by 2018, representing 13% CAGR growth (Source: MarketsandMarkets).

Leakage and non-revenue water costs utilities upward of US$20bn pa in lost revenues, which should create substantial downstream basic and smart meter demand from water utilities. We forecast a CAGR of 19% in water meter spending to 2016.

Water efficiency will become as important as energy efficiency as 70% of the global population becomes urban by 2050. This will mean that household water management will become increasingly important. The potential is huge – if all US households installed water-saving features, the dollar-volume savings would be US$11.3mn per day or more than US$4bn pa (Source: American Water Works Association).

Water infrastructure & supply solutions

In our view, a number of companies are well placed to benefit from the theme of water infrastructure and supply solutions, vis-à-vis their involvement in areas such as engineering, procurement, construction and consulting, pipes, pumps and valves, and water, wastewater and sewage treatment utilities.

Water and sanitation infrastructure requires US$11.7tn in global investment to 2030 (Source: McKinsey, E&Y). Crumbling and incomplete infrastructure in developed markets are a primary cause of this – with the US alone estimated to need US$335bn in public water investments over the next 20 years simply to address shortcomings and another US$335bn to improve systems (Source: US EPA). For EMs, the challenge is building out basic water infrastructure with water infrastructure 3x more expensive to build and maintain than electricity infrastructure (Source: IBM). Overcoming the neglect and under-financing of earlier years could cost 0.35%-1.2% of GDP pa over the next 20 years (Source: OECD).

The private sector will play an increasingly important role in developing and running water infrastructure and is expected to account for 30% of water investments in the next 3-5Y (Source: Global Water Fund). Full cost pricing - and increasing tariffs, taxes and transfers - are being used as tools to address funding gaps and to strike a balance between infrastructure and financing needs, improving service provision levels for stakeholders, and profitable growth opportunities for corporates.

Global water equipment capex is expected to be a US$655bn market from 2013-2018 with pipes (US$132bn), pumps (US$71bn), automation and control (US$63bn), valves and fittings (US$56bn) and aeration (US$33bn) accounting for the largest segments. There will be a significant increase in spending as the late cycle business returns to previous trends, with industrial spend outpacing municipal spend (Source: GWI Global Water Market 2014).

The global water utilities industry is expected to grow by 4.3% CAGR to reach US$891bn (vs. US$722bn in 2012) (Source: Reportlinker). Growth rates are low but stable for the highly fragmented sector where around only 10% of customers are served by investor-owned companies – and performance depends on regulatory factors as well as fundamental drivers of revenue and cost. But we see significant opportunities in Brazil and China – where water is increasingly a long-term secular growth story - as well as the U.S.

Table 4: BofAML Global Water - Stocks in our coverage universe with exposure to Water Infrastructure

Company	Water Exposure*
Aguas Andinas	High
Aguas Metropolit	High
American Water Works	High
Beijing Enterprises	High
COPASA	High
Guangdong Invest	High
Manila Water	High
Pentair Ltd	High
SABESP	High
Sabesp-ADR***	High
Severn Trent	High
United Utilities	High
EBARA	Medium
Kubota	Medium
Metro Pacific	Medium
Pennon	Medium
Rexnord	Medium
Suez Environnement	Medium
Veolia	Medium
Veolia ADR	Medium
AECOM Technology	Low
Chiyoda Corp	Low
Downer EDI	Low
Empresas ICA	Low
Flowserve	Low
HK&China Gas	Low
Keppel Corp	Low
Kinden	Low
Leighton Holdings	Low
Rotork	Low
Samsung Engineering	Low
Shanghai Indus	Low
UGL	Low
URS Corp.	Low
Voltas	Low
WorleyParsons	Low

Source: BofA Merrill Lynch Global Research
* Water exposure = BofAML estimates of current sales derived from water utilities related products, services, technologies and solutions

Water-friendly energy solutions

In our view, a number of companies are well placed to benefit from the theme of water-friendly energy solutions, vis-à-vis their involvement in areas such as wind, solar and geothermal energy, co-production of energy and water, exploiting synergies (e.g. combined power and desalination plants, CHP plants using alternative water sources for thermal power plant cooling, and energy recovery from sewage water), energy efficiency in agriculture and across the agrifood chain, and smart irrigation and precision agriculture, among others.

Table 5: BofAML Global Water - Stocks in our coverage universe with exposure to Water-Friendly Energy Solutions

Company	Water Exposure*
Acciona	High
China Longyuan	High
CPFL Energia S.A	High
Datang Renewable	High
EDP Renovaveis	High
Enel Green Power	High
ENPH	High
First Solar	High
Itron	High
NextEra Energy	High
NRG Energy	High
Pattern Energy	High
SCTY	High
Sun Edison	High
SunPower Corp.	High
Suzlon Energy	High
Trina Solar	High
Vestas	High
Yingli Green Energy	High

Source: BofA Merrill Lynch Global Research
* Water exposure = BofAML estimates of current sales derived from water-friendly energy-related products, services, technologies and solutions

Water and energy are interlinked and interdependent – with approximately 90% of global power generation water intensive. Moreover, today's power sector is largely designed for a water-rich world, which will become an increasingly unsustainable challenge in the coming years. Global water withdrawals for energy production – predominantly cooling water - amount to 583bn (c15% of the world's total withdrawals), of which 66bn m3 was consumed (Source: IEA). By 2035, water withdrawals could increase by 20% and consumption by 85% (manufacturing +400%, thermal electricity demand +140%), driven via a shift towards higher efficiency power plants with more advanced cooling systems (reduced water withdrawals but increased consumption) and increased production of biofuels (Source: IEA, UN).

With total energy water demand set to double by 2035, going forward, regulators and the energy sector will need to integrate water efficiency as a central component of policy frameworks, cooperation and integration among different sectors: This will be key given the increasing challenges posed by extreme weather and climate change, and growing competition for water from agriculture and industry.

From a water perspective, power generated from solar PV and wind is the most sustainable choice, having the lowest operational and lifecycle water consumption footprint (i.e. water use per unit of electricity generated). Issues remain regarding transmission constraints as well as regulatory, technical and operational factors – and their intermittent nature means that they will need to be supported by other water-intensive forms of energies to maintain load balance, until we see advances in energy storage.

The economics of cleantech are increasingly compelling with recent technological advancements in solar and wind along with rising cost of emissions and pollution controls closing the gap between renewable power generation and fossil fuels. As of 2013, wind, coal, and gas generation were in line with one another at around US$0.07-0.08/kWh, with PV solar at US$0.14/kWh (Source: BNEF).

Other water-friendly energy solutions - Geothermal power also holds out potential in a number of regions, as does co-production of energy and water, exploiting synergies (e.g. combined power and desalination plants, combined heat and power plants using alternative water sources for thermal power plant cooling, and energy recovery from sewage water, among others). Finally, energy efficiency in agriculture and across the agrifood chain, as well as smart irrigation and precision agriculture can reduce energy-related water use (Source: UN).

BofAML Global Water Exposure stock list

The BofAML Global Water Exposure list of stocks is not a recommended list either individually or as a group of stocks. Investors should consider the fundamentals of the companies and their own individual circumstances / objectives before making any investment decisions

We have created a BofA Merrill Lynch Global Research list of stocks which have exposure to water-related themes and that we consider should benefit long-term from global efforts to promote water-related solutions.

The aim of this stock list is to provide investors with information to understand company and sub-sector specific risks and opportunities inherent in the water theme. We have also provided factual overviews of other companies, outside our research coverage, that are exposed to water (see relevant sections of the report).

Table 6: BofAML Global Water Exposure Stocks

BBG Ticker	Company	Location	Mkt. Cap US$m	BofAML Ticker	Water Sub-sector	Water Exposure
392 HK	Beijing Enterprises	Hong Kong	11,519	BJINF	Engineering & Construction	High
RXN US	Rexnord	United States	2,681	RXN	Engineering & Construction	Medium
ACM US	AECOM Technology	United States	3,117	ACM	Engineering & Construction	Low
6366 JP	Chiyoda Corp	Japan	3,772	CHYCF	Engineering & Construction	Low
DOW AU	Downer EDI	Australia	1,903	DNERF	Engineering & Construction	Low
ICA* MM	Empresas ICA	Mexico	1,003	ICAEF	Engineering & Construction	Low
KEP SP	Keppel Corp	Singapore	15,500	KPELF	Engineering & Construction	Low
1944 JP	Kinden	Japan	2,436	KNDEF	Engineering & Construction	Low
LEI AU	Leighton Holdings	Australia	6,755	LGTHF	Engineering & Construction	Low
028050 KS	Samsung Engineering	Korea, Republic Of	2,490	SGRGF	Engineering & Construction	Low
UGL AU	UGL	Australia	942	UGLLF	Engineering & Construction	Low
URS US	URS Corp.	United States	3,410	URS	Engineering & Construction	Low
VOLT IN	Voltas	India	627	VTSJF	Engineering & Construction	Low
WOR AU	WorleyParsons	Australia	3,850	WYGPF	Engineering & Construction	Low
ITRI US	Itron	United States	1,339	ITRI	Management	High
MRO LN	Melrose plc	United Kingdom	6,322	MLSPF	Management	Medium
MON US	Monsanto	United States	57,989	MON	Management	Medium
SYNN VX	Syngenta	Switzerland	33,464	SYENF	Management	Medium
SYT US	Syngenta AG-ADR	Switzerland	33,464	SYT	Management	Medium
WOS LN	Wolseley	United Kingdom	14,642	WOSCF	Management	Medium
BAS GR	BASF	Germany	100,400	BFFAF	Management	Low
DE US	Deere & Co	United States	31,979	DE	Management	Low
DOW US	Dow Chemical	United States	58,854	DOW	Management	Low
DD US	DuPont	United States	62,174	DD	Management	Low
DTEX3 BZ	Duratex S.A.	Brazil	3,236	XDRXF	Management	Low
HEXAB SS	Hexagon AB	Sweden	12,292	HXGBF	Management	Low
PNR US	Pentair Ltd	Switzerland	16,554	PNR	Pipes, pumps & valves	High
6361 JP	EBARA	Japan	3,204	EBCOF	Pipes, pumps & valves	Medium
6326 JP	Kubota	Japan	17,528	KUBTF	Pipes, pumps & valves	Medium
FLS US	Flowserve	United States	10,266	FLS	Pipes, pumps & valves	Low
ROR LN	Rotork	United Kingdom	3,992	RTOXF	Pipes, pumps & valves	Low
371 HK	Beijing Enteprises Water	Hong Kong	4,644	BJWTF	Treatment	High
257 HK	China Everbright	Hong Kong	6,462	CHFFF	Treatment	High
KRA1V FH	Kemira	Finland	2,296	KMRAF	Treatment	High
6370 JP	Kurita Water	Japan	2,601	KTWIF	Treatment	High
SRCL US	Stericycle	United States	9,935	SRCL	Treatment	High
DHR US	Danaher	United States	54,306	DHR	Treatment	Medium
BN FP	Danone	France	44,975	GPDNF	Treatment	Medium
ECL US	Ecolab Inc	United States	30,683	ECL	Treatment	Medium
ICA* MM	Empresas ICA	Mexico	1,003	ICAEF	Treatment	Medium
NESN VX	Nestle (Reg)	Switzerland	235,039	NSRGF	Treatment	Medium
659 HK	NWS Holdings	Hong Kong	5,621	NWSZF	Treatment	Medium
RXN US	Rexnord	United States	2,681	RXN	Treatment	Medium
ANA SM	Acciona	Spain	3,631	ACXIF	Treatment	Low
ALFA SS	Alfa Laval	Sweden	10,156	ALFVF	Treatment	Low
ALQ AU	ALS Ltd	Australia	2,668	CPBLF	Treatment	Low
BAS GR	BASF	Germany	100,400	BFFAF	Treatment	Low
BVI FP	BV	France	12,778	BVRDF	Treatment	Low

Table 6: BofAML Global Water Exposure Stocks

BBG Ticker	Company	Location	Mkt. Cap US$m	BofAML Ticker	Water Sub-sector	Water Exposure
034020 KS	Doosan Heavy	Korea, Republic Of	3,378	DOHIF	Treatment	Low
DOW US	Dow Chemical	United States	58,854	DOW	Treatment	Low
DD US	DuPont	United States	62,174	DD	Treatment	Low
ENTG US	Entegris Inc	United States	1,433	ENTG	Treatment	Low
ICL IT	ICL	Israel	10,752	ISCHF	Treatment	Low
IDXX US	IDEXX	United States	6,462	IDXX	Treatment	Low
3405 JP	Kuraray	Japan	3,938	KURRF	Treatment	Low
LXS GR	Lanxess	Germany	5,830	LNXSF	Treatment	Low
6988 JP	Nitto Denko	Japan	7,299	NDEKF	Treatment	Low
OTE1V FH	Outotec	Finland	1,756	OUKPF	Treatment	Low
PLL US	Pall Corp	United States	9,500	PLL	Treatment	Low
SCI SP	SCI	Singapore	7,649	SCRPF	Treatment	Low
SGSN VX	SGS	Switzerland	18,430	SGSOF	Treatment	Low
SPX LN	Spirax-Sarco	United Kingdom	3,879	SPXSF	Treatment	Low
TMO US	Thermo Fisher	United States	50,016	TMO	Treatment	Low
3402 JP	Toray	Japan	11,337	TRYIF	Treatment	Low
AGUAS/A CI	Aguas Andinas	Chile	3,762	XXSGF	Utilities	High
IAM CI	Aguas Metropolit	Chile	1,646	XVNFF	Utilities	High
AWK US	American Water Works	United States	8,147	AWK	Utilities	High
371 HK	Beijing Enteprises Water	Hong Kong	4,644	BJWTF	Utilities	High
CSMG3 BZ	COPASA	Brazil	1,664	CSAOF	Utilities	High
270 HK	Guangdong Invest	Hong Kong	5,802	GGDVF	Utilities	High
MWC PM	Manila Water	Philippines	1,117	MWTCF	Utilities	High
SBSP3 BZ	SABESP	Brazil	6,538	CSBJF	Utilities	High
SBS US	Sabesp-ADR	Brazil	6,247	SBS	Utilities	High
SVT LN	Severn Trent	United Kingdom	7,238	SVTRF	Utilities	High
UU/ LN	United Utilities	United Kingdom	8,571	UUGWF	Utilities	High
MPI PM	Metro Pacific	Philippines	2,713	MPCFF	Utilities	Medium
PNN LN	Pennon	United Kingdom	4,240	PEGRF	Utilities	Medium
SEV FP	Suez Environnement	France	9,409	SZEVF	Utilities	Medium
VIE FP	Veolia	France	8,744	VEOEF	Utilities	Medium
VE US	Veolia-ADR	France	8,744	VE	Utilities	Medium
3 HK	HK&China Gas	Hong Kong	23,613	HOKCF	Utilities	Low
363 HK	Shanghai Indus	Hong Kong	3,940	SGHIF	Utilities	Low
ANA SM	Acciona	Spain	3,631	ACXIF	Water-Friendly Energy	High
916 HK	China Longyuan	China	8,216	CLPXF	Water-Friendly Energy	High
CPFE3 BZ	CPFL Energia S.A	Brazil	7,376	XPFGF	Water-Friendly Energy	High
1798 HK	Datang Renewable	China	1,275	XGDRF	Water-Friendly Energy	High
EDPR PL	EDP Renovaveis	Spain	4,498	EDRVF	Water-Friendly Energy	Low
EGPW IM	Enel Green Power	Italy	13,158	XENLF	Water-Friendly Energy	High
ENPH US	ENPH	United States	323	ENPH	Water-Friendly Energy	High
FSLR US	First Solar	United States	6,971	FSLR	Water-Friendly Energy	High
ITRI US	Itron	United States	1,339	ITRI	Water-Friendly Energy	High
NEE US	NextEra Energy	United States	39,517	NEE	Water-Friendly Energy	High
NRG US	NRG Energy	United States	9,644	NRG	Water-Friendly Energy	High
PEGI US	Pattern Energy	United States	1,460	PEGI	Water-Friendly Energy	High
SCTY US	SCTY	United States	5,466	SCTY	Water-Friendly Energy	High
SUNE US	Sun Edison	United States	5,433	SUNE	Water-Friendly Energy	High
SPWR US	SunPower Corp.	United States	3,938	SPWR	Water-Friendly Energy	High
SUEL IN	Suzlon Energy	India	420	XZULF	Water-Friendly Energy	High
TSL US	Trina Solar	China	1,046	TSL	Water-Friendly Energy	High
VWS DC	Vestas	Denmark	7,176	VWSYF	Water-Friendly Energy	High
YGE US	Yingli Green Energy	China	852	YGE	Water-Friendly Energy	High

Source: BofA Merrill Lynch Global Research

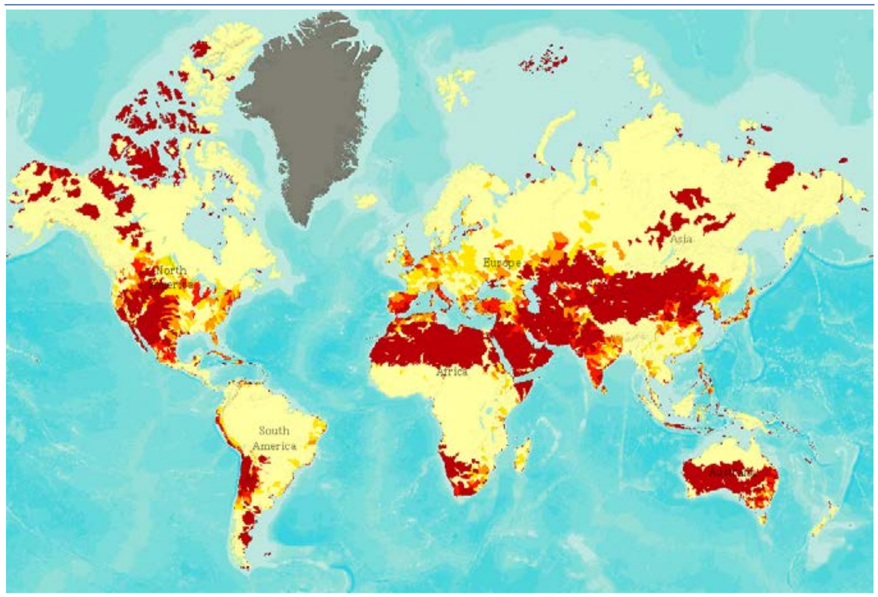
* Water exposure = BofAML estimates of current sales derived from water-friendly energy-related products, services, technologies and solutions

Water pressure, supply side challenges

"… water security is also the foundation for food and energy security and for overall long-term social and economic development. It underpins health, nutrition, equity, gender equality, well-being and economic progress, especially in developing countries but increasingly in some of the world's most developed countries." (Source: InterAction Council)

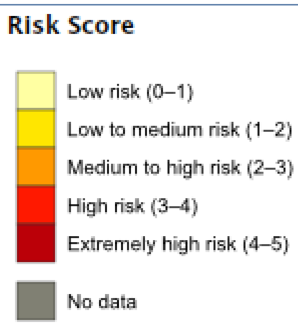
Global water supply has failed to keep pace with the rising world population, leading to chronic shortages in many regions around the world. The UN estimates that 3.3bn people live in areas of water scarcity or face economic water shortages. Supply side pressures are being further exacerbated by a lack of freshwater, its uneven distribution, widely varying quality, and emerging climate change risks. The map below estimates the degree to which freshwater availability is an ongoing concern (i.e. annual renewable supply of water withdrawn for human use). High levels of baseline water stress are associated with increased socioeconomic competition for freshwater supplies and heightened political attention to issues of water scarcity (Source: WRI).

Chart 3: Global baseline water stress



Source: World Resources Institute- Aqueduct Project, The Coca-Cola Water Risk Data were provided to the World Resources Institute by The Coca-Cola Company in support of the Aqueduct project. ISciences L.L.C. performed the hydrological modelling.. * The baseline water stress indicator estimates the degree to which freshwater availability is an ongoing concern. High levels of baseline water stress are associated with increased socioeconomic competition for freshwater supplies and heightened political attention to issues of water scarcity.

Chart 4: Baseline water stress



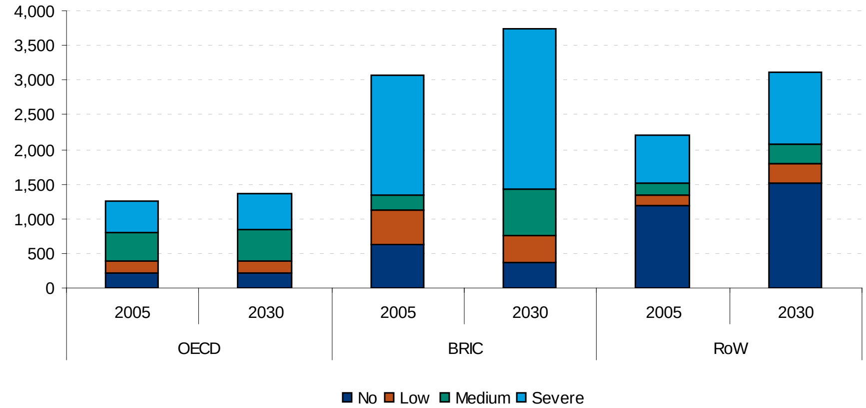
Source: World Resources Institute- Aqueduct Project

Every region of the world being impacted

Some areas are suffering from peak renewable water, peak non-renewable water, and peak ecological water (Source: Gleick et al, Proceedings of the National Academy of Sciences (U.S.))

Water scarcity already affects every continent. According to UN data, around 1.2bn people, or almost one-fifth of the world's population, live in areas of physical scarcity, and 500mn people are approaching this situation. Another 1.6bn people, or almost one quarter of the world's population, face economic water shortage (where countries lack the necessary infrastructure to take water from rivers and aquifers).

Chart 5: No. of people living in water stressed areas in OECD, BRIC & rest of world (mn)

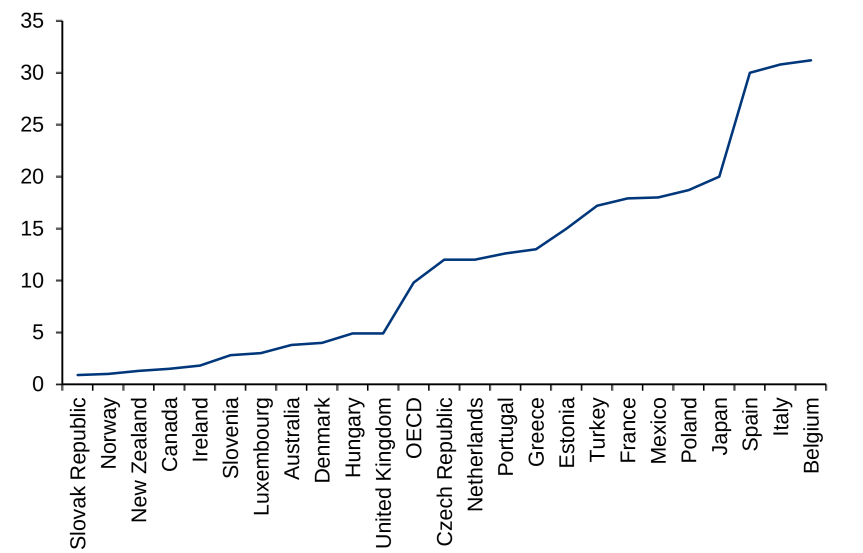


Source: UNEP, OECD

Not just an EM story, 35% of OECD is water stressed

An estimated 35%+ of the OECD's population is living in areas under "severe water stress" with large parts of Europe, North America, and Australia facing considerable water stress problems. The extent of water stress is illustrated in the graph below which lists the intensity of water use of OECD countries as measured by the total abstractions relative to total renewable resources.

Chart 6: Water stress in OECD countries (abstractions as % of renewable water resources)

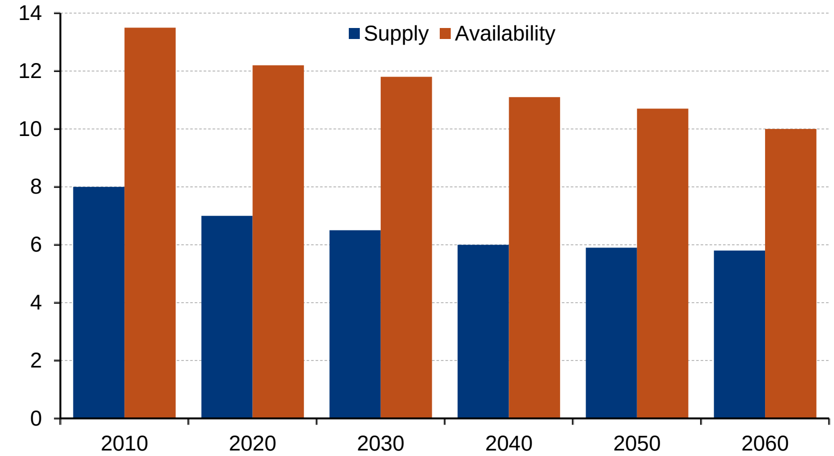


Source: OECD, BofA Merrill Lynch Global Research

$US115bn/yr in economic costs by 2060

The impact of groundwater depletion in the U.S. is evidenced by looking at Texas. Under a business as usual scenario, groundwater availability is expected to decrease by 25% or 3.6mn acre-feet (4,440mn m^3) according to the Texas State Water Plan 2012. The projected economic cost (i.e. foregone extractive uses) due to groundwater depletion is estimated at US$3bn/year by 2060. The overall - groundwater as well as surface water - unmet water demand would be 8.3mn acre-feet (10 238 million m3) by 2060, representing a gross economic cost of US$115bn annually (Source: OECD)

Chart 7: Groundwater overdraft in Texas, 2010-2060



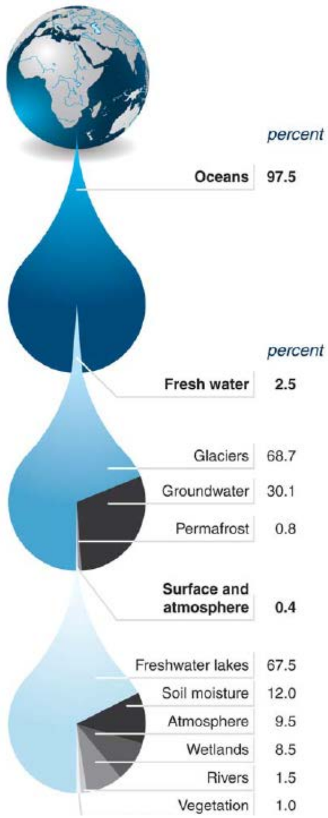
Source: OECD based on Texas Water Plan, BofA Merrill Lynch Global Research

30% of the Kansas portion of the Ogallala Aquifer has already been pumped out, and another 39% will get used up in the next half-century at existing rates (Source: PNAS)

Ogallala shows US situation is grim…

The largest known U.S. aquifer is the Ogallala which extends beneath the High Plains including the states South Dakota, Wyoming, Nebraska, Colorado, Kansas, Oklahoma, New Mexico, and Texas. The aquifer was formed approximately 10mn years ago from retreating glaciers, and has been a major source of water for these areas. However, groundwater mining of the Ogallala has caused a 10-50ft drop in depth in most regions, with several areas recording drops over 100ft. Given the impervious geological formation of the Ogallala and the decline of precipitation in the region, the aquifer cannot be replenished. This is of concern given the aquifer supplies 30% of the nation's irrigation water, sustaining 15% of domestic corn and wheat, and 25% of the cotton crop (Source: APEC). Farmlands on portions of Ogallala have already started shrinking due to water scarcity, and the High Plains region will face an unprecedented threat to its economic security once the aquifer is depleted.

Chart 8: Global freshwater distribution



Source: Office of the Director of National Intelligence (U.S.)

Freshwater, 2.5% of global water - insufficient

Freshwater accounts for 2.5% to 3% of the total water on the planet, most of which is locked in the two polar ice caps. Ground water, a critical source of potable water for the world's major cities, makes up about 30% of freshwater resources. Lakes, rivers, wetlands and different soil types account for only 1.2% of freshwater. Nevertheless, humans rely on these sources more than any other.

Freshwater has declined 37% since 1970

Freshwater availability will be increasingly strained going forward. There is clear evidence that groundwater supplies are diminishing, with an estimated 20% of the world's aquifers being over-exploited, some critically so (Source: UN). Deterioration of wetlands worldwide is also reducing the capacity of ecosystems to purify water. It is also estimated that freshwater ecosystems are estimated to have declined by 37% since 1970 – with certain segments such as tropical freshwater having declined by 70%. As a result, an estimated 2.7bn people are now living in water catchment areas (e.g., river basins) that experience water scarcity for at least one month per year (Source: WWF).

Uneven distribution, 10 countries have 60% of freshwater

In theory, there is enough water to satisfy all human needs on a sustainable basis. However, in practice, water is not distributed evenly across the globe. Ten countries possess close to 60% of the world's freshwater resources.

Table 7: 10 countries with most renewable freshwater

Country	Total renewable water (10m^3/person/yr)*
Brazil	8233
Russian Federation	4508
United States of America	3069
Canada	2902
China	2840
Colombia	2132
Indonesia	2019
Peru	1913
India	1911
Democratic Republic of the Congo	1283

Aquastat. * Total annual actual renewable water resources: Natural resources that, after exploitation, can return to their previous stock levels by natural processes of growth or replenishment

47 countries suffering from water stress to water scarcity

In many ways, it can be argued that water is the wrong quantity and quality in the wrong places – with 47 countries suffering from water stress and water scarcity:

- **18 countries facing water stress**: when annual water supplies drop below 1,700m^3 per person;
- **9 countries facing water scarcity**: when annual water supplies drop below 1,000m^3 per person; and
- **20 countries facing absolute water scarcity**: when annual water supplies drop below 500m^3.

Table 8: Countries suffering from water stress, water scarcity, and absolute water scarcity (m^3/inhabitant/year)

Water stress	m^3/p/yr	Water Scarcity	m^3/p/yr	Absolute Water Scarcity	m^3/p/yr
Poland	1608	Morocco	889.6	Oman	482.1
Comoros	1552	Rwanda	842.8	Saint Kitts and Nevis	444.4
Zimbabwe	1537	Syrian Arab Republic	795.5	Tunisia	429.2
India	1519	Kenya	718.1	Djibouti	325
Somalia	1500	Burkina Faso	715	Algeria	319.8
Republic of Korea	1435	Cyprus	690.9	Barbados	290.9
Burundi	1433	Egypt	682.5	Israel	231.3
Sudan and South Sudan	1411	Cape Verde	594.1	Occupied Palestinian Territory	196
Ethiopia	1410	Antigua and Barbuda	571.4	Jordan	145.1
Pakistan	1371			Malta	120.5
Haiti	1368			Singapore	114.2
Lesotho	1363			Libya	108.2
Czech Republic	1245			Maldives	92.59
Eritrea	1129			Bahrain	85.36
Malawi	1088			Saudi Arabia	83.61
Denmark	1073			Yemen	82.13
Lebanon	1049			Bahamas	56.98
South Africa	1013			Qatar	29.91
				United Arab Emirates	18.5
				Kuwait	6.916

Source: Aquastat, BofA Merrill Lynch Global Research

Widely varying water quality

Beyond water quantity, water scarcity is emerging as a direct consequence of water quality issues. Some of the key challenges are:

- Urban areas are facing water pollution issues arising from inappropriate land use activities and poor water treatment;
- Chemical fertiliser run-offs are creating excessive nutrient concentrations in seas and oceans (+10-20% in the next 30 years);
- Irrigation is reducing the capacity of rivers to transport sediments; and
- Water sources are often used as little more than open sewers. In emerging markets, where wastewater treatment is either inadequate or non-existent.

Inadequate water treatment = water quality concerns

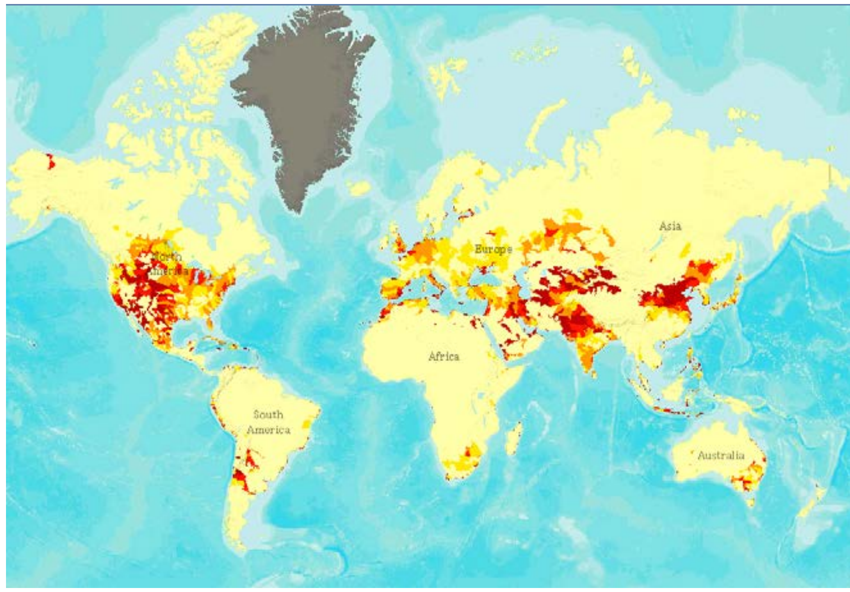
The Water Reuse Index map below estimates the fraction of renewable freshwater supply that has been previously withdrawn and discharged as upstream wastewater. It measures the degree to which water quality is an ongoing concern (Source: WRI).

Table 9: Water Reuse Index

Risk Score
Low risk (0-1)
Low to medium risk (1-2)
Medium to high risk (2-3)
High risk (3-4)
Extremely high risk (4-5)
No data

Source: World Resources Institute Aqueduct Project

Chart 9: Water Reuse Index



Source: Source: World Resources Institute- Aqueduct Project. The Coca-Cola Water Risk Data were provided to the World Resources Institute by The Coca-Cola Company in support of the Aqueduct project. ISciences L.L.C. performed the hydrological modelling.

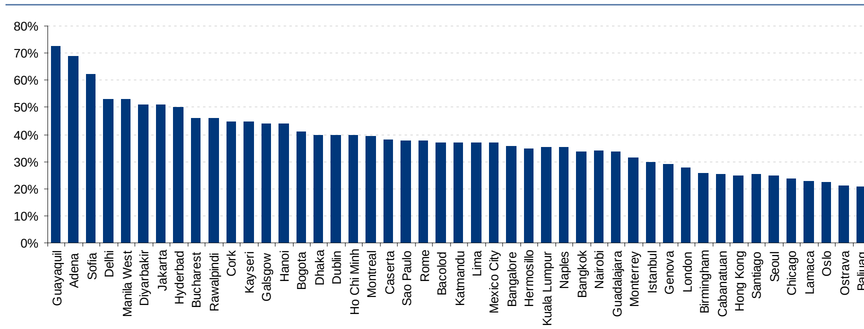
US$20bn in lost water

More than 50m m^3 per day is lost through leakage. A further 30m m^3 per day is not paid for. The total cost to water utilities worldwide is estimated at more than US$20bn+ per annum (Source: World Bank)

Water loss or non-revenue water (NRW) – physical, commercial and unbilled authorise consumption – is a considerable problem around the world. Two-thirds of the volume of water lost is in low- and middle-income countries, where every drop of water and revenue is desperately needed to meet burgeoning demand. For instance, in Asia, NRW averages 30% across cities and is as high as 65% in some urban areas, leading to losses of US$9bn per year (Source: ADB).

Developed markets also face an NRW challenge with studies showing that water leakages from distribution networks are as high as 50% in certain areas of Europe; and the American Society of Civil Engineers estimating that 26.5m m^3 of safe drinking water (or 15% of the total) is lost every day in the US as a result of its antiquated distribution systems.

Chart 10: Urban water networks with NRWs of 20%+



Source: Smart water Networks Forum

Climate change is making things worse

South Asia, Africa and the Mediterranean are most vulnerable to climate change-related water impacts

In March 2014, the UN Intergovernmental Panel on Climate Change (IPCC) published the most comprehensive assessment to date of the impacts of climate change on the world. The report sets out the IPCCs views that there is robust evidence and high agreement that “freshwater-related risks of climate change increase significantly with increasing greenhouse gas concentrations" and that "climate change over the 21st century is projected to reduce renewable surface water and groundwater resources significantly in most dry subtropical regions".

Exacerbating supply-side water pressure

Climate change is exacerbating supply-side water pressure in three ways: water quality, water quantity and water timing. As temperatures rise:

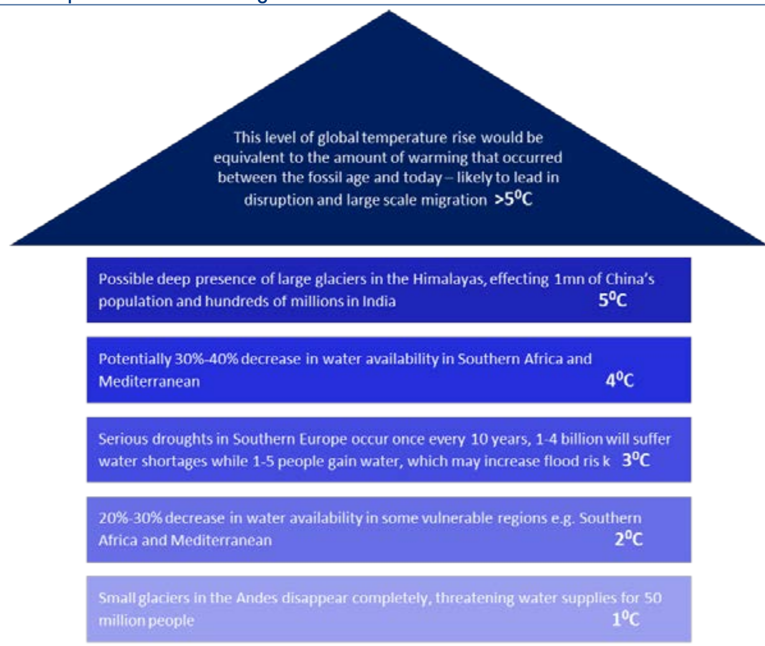
- **The hydrological cycle is expected to change**, accelerating the rate of evaporation from land and sea. This will lead to an increase in flooding (as the atmosphere holds more moisture) and droughts (reduced water availability in low precipitation areas) and to changes in the geographical distribution and timing of precipitation.

- **Rainfall patterns will change**: Rainfall is expected to rise in the tropics and higher latitudes, but decrease in the already dry semi-arid to arid mid-latitudes and in the interiors of larger continents.

- **Sea levels will rise** and coastal communities could lose up to 50% or more of their freshwater supplies.

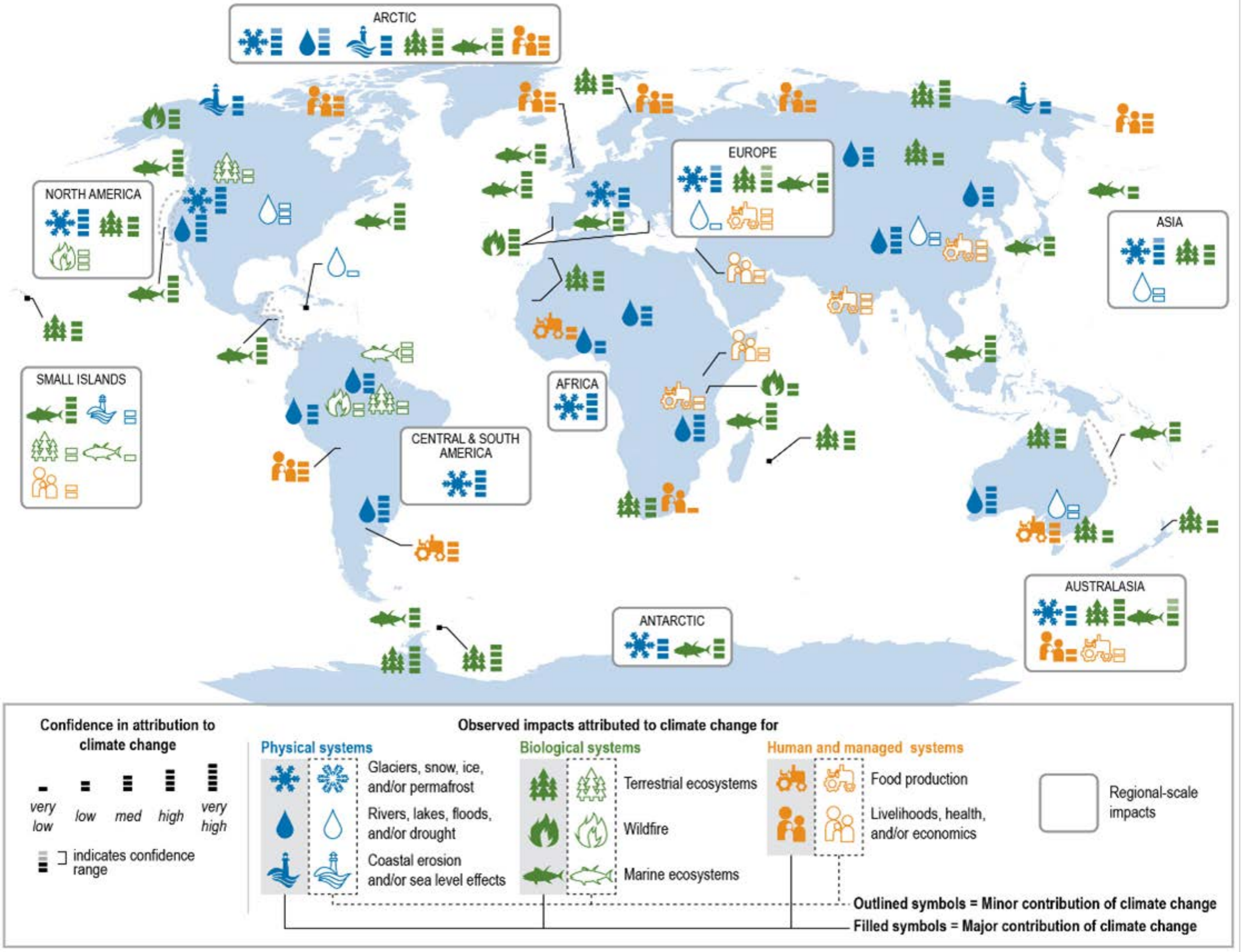
- **Saltwater intrusion of freshwater aquifers will become a growing threat** to drinking water supplies (e.g., in the US eastern seaboard and in other low lying settlements).

Chart 11: Impact of climate change on water



Source: WaterAid, BofA Merrill Lynch Global Research

Chart 12: How global climate change impacts various parts of the world



Source: IPCC, BofA Merrill Lynch Global Research

Thematic Investing: Extreme weather primer – weathering the perfect storm 12 September 2013

Unprecedented extreme weather here to stay

In our series of reports on Global Drought, we examined the growing body of scientific evidence pointing to the worsening of droughts, heat waves and floods in the coming century because of global warming.

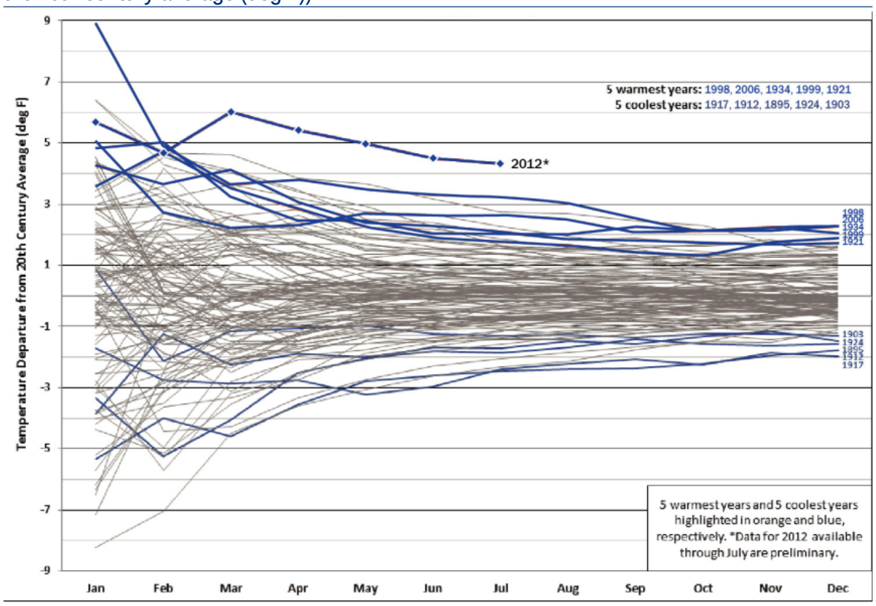
- **2013 Australia, India & Namibia**: Australia saw its hottest year on record with average temperatures 1.2 degree Celsius above normal. Failed monsoon rains and soaring temperatures in the outback effected cattle farmers and caused bushfires.

- Millions of people in western India suffered their worst drought in more than four decades. Two successively poor monsoons and lacking infrastructure affected people in over 10,000 villages leading to famine.

- Namibia is especially susceptible to the effects of climate change as it is a dry country. In 2013 the country witnessed its worst drought in 30 years. Almost one million people out of Namibia's 2.3 million population faced moderate to serious levels of food insecurity. The Namibian government estimated that the harvest would yield 42% less than 2012.

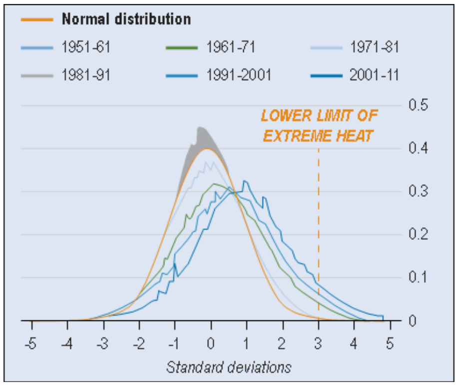
- **2012 US drought**: The US underwent the worst drought since at least 1956. July 2012 was the hottest month in the lower 48 US states in records going back to 1895, capping the hottest 12 months ever in the continental US.

Chart 13: 2012 was the warmest year since 1895 (in terms of temperature departures from the 20th century average (deg F))



Source: NOAA's National Climatic Data Center., BofA Merrill Lynch Global Research Year-to-date temperature anomalies for contiguous US – January 1895 – July 2012

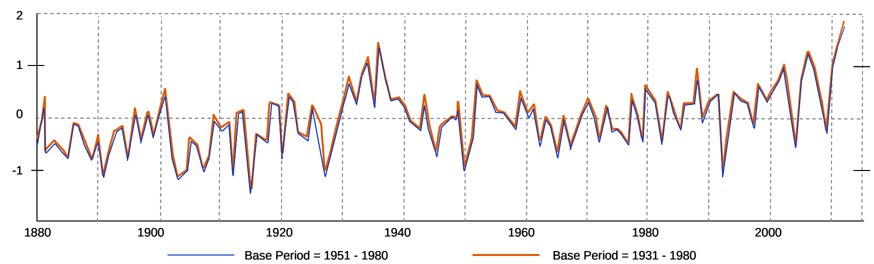
Chart 14: Global temperature deviations from June to August (frequency)



Source: Goddard Institute for Space Studies, BofA Merrill Lynch Global Research. Temperature deviations from the 1951+-1980 reference period in 250km wide cells around the Earth's surface

- **Global temperatures on the rise**: The year 2013 ties with 2003 as the fourth warmest year globally since records began in 1880. This marks the 37th consecutive year (since 1976) that the yearly global temperature was above the 20th century average (Source: NOAA).
- **Extremes are much more frequent and more intense worldwide**: Extremely hot temperatures covered about 0.1% to 0.2% of the globe from 1951 to 1980. But in the past three decades, while the average temperature has slowly risen, the extremes have soared and now cover about 10% of the globe.

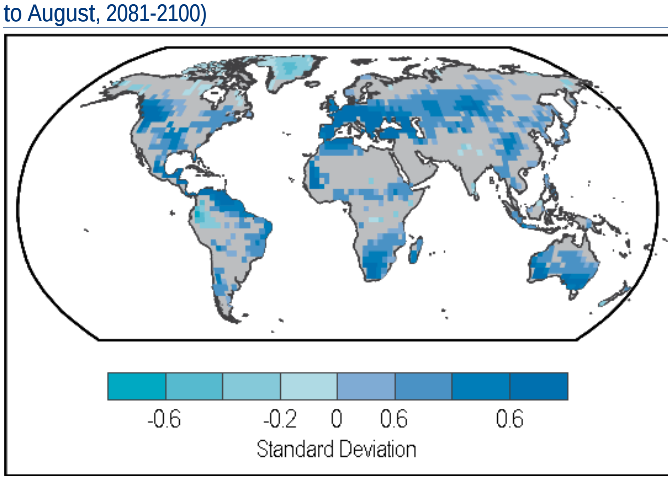
Chart 15: US Jun-Jul-Aug surface temperature anomaly (⁰C)



Source: NASA Goddard Institute for Space Studies, BofA Merrill Lynch Global Research

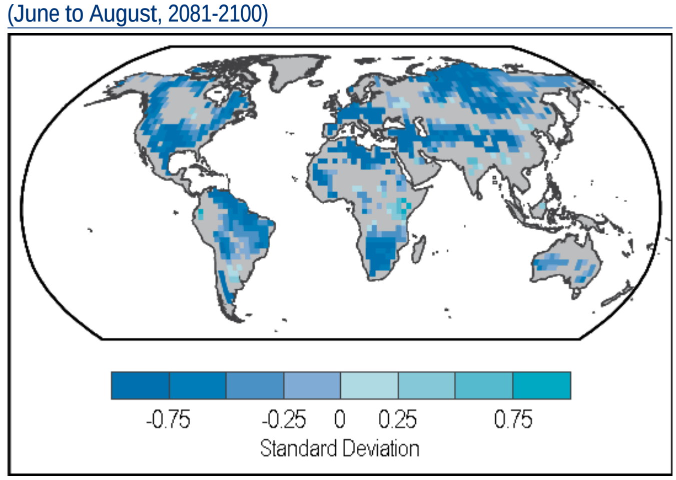
- **Extreme weather is becoming part of the new normal**: While it is all too easy to link any and all incidents of extreme weather events to climate change, scientific evidence increasingly points to the worsening of droughts, heat waves and floods in the coming century because of global warming.

Chart 16: Projected changes in dryness: consecutive dry days (June to August, 2081-2100)



Source: UN IPCC, BofA Merrill Lynch Global Research. Consecutive dry days = days with precipitation; <1 mm.

Chart 17: Projected changes in dryness: soil moisture anomalies (June to August, 2081-2100)



Source: UN IPCC, BofA Merrill Lynch Global Research. Soil moisture anomaly = anomaly in water stored in or at the land surface and available for evapotranspiration

Water pressure, demand-side challenges

From 2000 to 2050, global water demand is set to change by:

+406% for manufacturing
+144% for electricity
+127% for domestic
+63% for livestock
-14% for irrigation (Source: OECD)

The necessity for water is such that all individuals and industries are water dependent. Approximately 3,800km^3 (3.8tn m^3) of freshwater is extracted from aquatic ecosystems globally every year (Source: InterAction Council).

Table 10: Sources of global freshwater use

	Surface water	Ground water	Drainage water returns	Wastewater reuse	Desalination	Groundwater (non-renewable)	Total
All uses	73	18	5	2	0.3	1	100
Drinking water	48	46	0	0	4	3	100
Irrigation	71	17	7	4	0	1	100
Energy and industry	87	12	0	0	0	0.3	100

Source: Aquastat, BofA Merrill Lynch Global Research

Agriculture is the largest single user of freshwater in the world, accounting for 70% of total water use. Industry and energy are the second-largest users and domestic users make up the rest.

Table 11: Freshwater use on earth

	km3/year	% renewable water	% water withdrawals
Renewable freshwater	43,569	100	
Total water withdrawals	3,829	9	100
Of which:			
Irrigated agriculture	2,663	6	69
Industry (incl. energy)	784	2	21
Domestic (urban)	382	1	10

Source: OECD based on WWAP, BofA Merrill Lynch Global Research

We anticipate growing demand-side pressures across the three largest users, with competition and trade-offs becoming increasingly likely.

Table 12: Global water demand 2000 vs. 2050 (km3)

		Irrigation	Domestic	Livestock	Manufacturing	Electricity
OECD	2000	397.071	152.744	7.88447	91.5695	343.555
	2050	230.441	161.539	8.48667	149.195	327.028
% change		-41.96%	5.76%	7.64%	62.93%	-4.81%
BRICs	2000	1453.96	123.241	12.7107	103.941	133.112
	2050	1313.78	447.001	19.0103	855.661	627.474
% change		-9.64%	262.70%	49.56%	723.22%	371.39%
RoW	2000	533.182	72.6556	6.92225	40.7285	91.4932
	2050	504.815	181.664	17.4766	190.975	432.043
% change		-5.32%	150.03%	152.47%	368.90%	372.21%
World	2000	2384.21	348.64	27.5174	236.238	568.16
	2050	2049.04	790.204	44.9735	1195.83	1386.54
% change		-14.06%	126.65%	63.44%	406.20%	144.04%

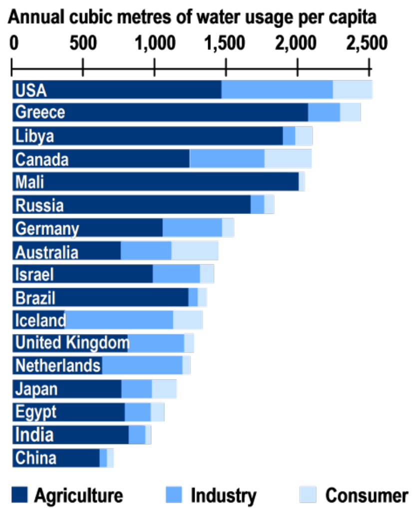
Source: OECD, BofA Merrill Lynch Global Research

Agriculture - today's biggest consumer

The daily drinking water requirement per person is 2-4l, but it takes 2,000-5,000l to produce one person's daily food requirements (Source: FAO)

According to the FAO, it takes 1,000x more water to feed a population via agriculture than it does to satisfy thirst. This is leading to growing demand-side water pressure as food demand is expected to increase by 50% by 2025 to 2030 – meaning another 1,000km^3 (1tn m^3) of water per year – equal to the annual flow of 20 Niles or 100 Colorado Rivers (Source: InterAction Council). This will significantly exacerbate the imbalance between water demand and supply. By 2050 food demand is expected to have increased by 70%. (Source: Bruinsma)

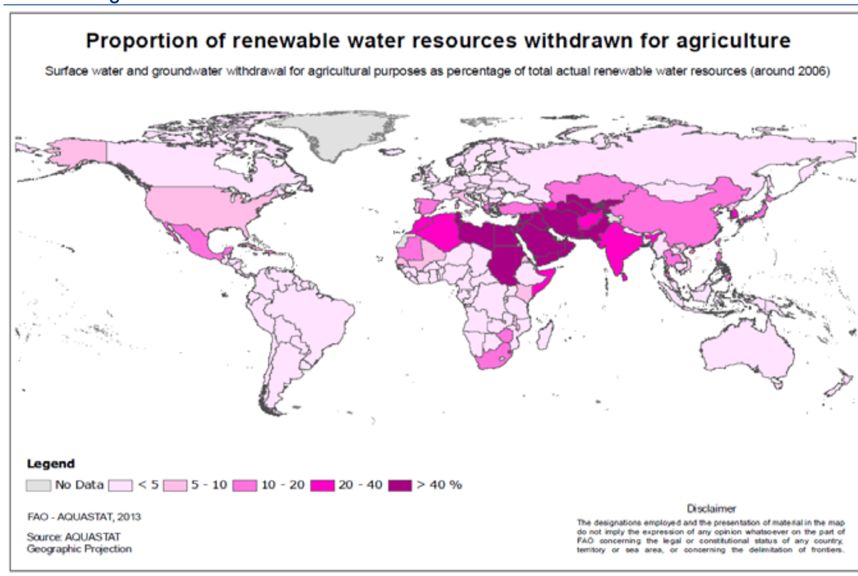
Chart 18: Farming accounts for the bulk of water use



Source: UN, BofA Merrill Lynch Global Research

- **Farmers are extracting water at an unsustainable rate** as the area irrigated by groundwater has increased on the back of more reliable water delivery, a decline in extraction costs, and government subsidies for power and pump installation and water itself. Irrigated crop yields are about 2.7 times those of rainfed farming, hence irrigation will continue to play an important role in food production. The area equipped for irrigation increased from 170 million ha in 1970 to 304 million ha in 2008 (Source: UN)

Chart 19: Agricultural water withdrawals as a % of total renewable water resource



Source: FAO (Withdrawals are critical when higher than 40% and indicative of water stress at 20-40%)

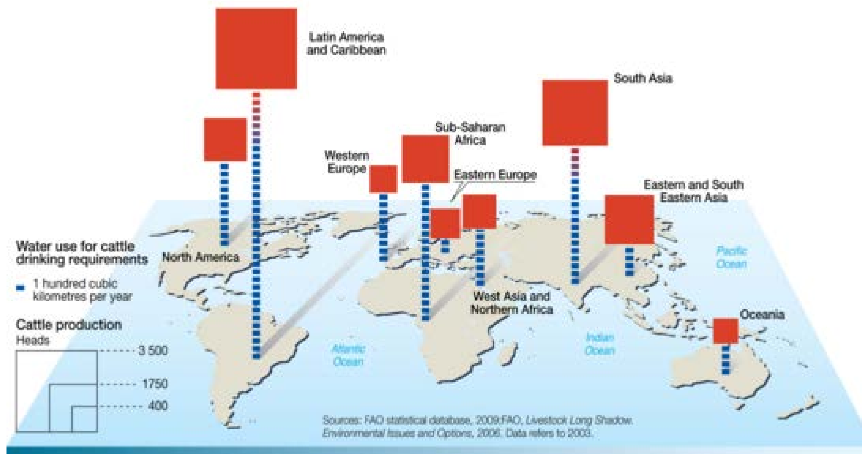
Table 13: Estimated virtual water requirements for different crops

Crop	m^3 water/ton crop*
Beef	16,726
Pork	5,469
Cheese	5,288
Poultry	3,809
Eggs	3,519
Rice	2,552
Soybeans	2,517
Wheat	1,437
Maize	1,020
Milk	738
Potatoes	133

Source: BofA Merrill Lynch Global Research. * Average based on Hoekstra & Hung, Chapagain & Hoekstra, Zimmer & Renault, and Oki et al

- **Water intensity varies depending on the crop or livestock.** Farming livestock is more water intensive than farming crops. It takes 15,500l of water to produce 1kg of beef, compared with 1,500l for 1kg of grain. However, we expect increasing demand for food to come from higher protein-based sources rather than more subsistence-based diets. Using current practices, the amount of water required for agricultural evapotranspiration to feed the world's population would increase from 7,130km^3 currently to between 12,050km^3 and 13,500km^3, an increase of 70-90% by 2050. .

Chart 20: Converting water into red meat



Source: UN FAO, UNEP

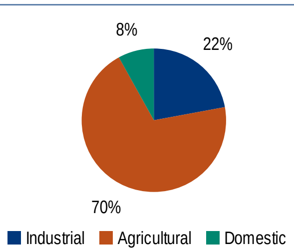
By 2025, the oil sector could be producing 5x more water than oil, with onshore crude oil having a ratio of up to 12x largely on the back of ageing wells and increased unconventional O&G such as EOR, shale gas and oil sands (Source: GWI)

Industry - tomorrow's biggest user

Demand from industry represents around 22% of global total demand, rising to as much as 59% in developed markets. Industrial water use arises as a raw material and as a constituent of the product itself as well as from cleaning, heating and cooling and power generation. Usage is expected to rise significantly as:

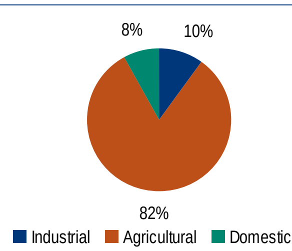
- **Emerging markets divert water from agriculture to industry** as they ramp up their economic growth efforts via large-scale industrialisation and industry and energy (especially coal) accounting for a disproportionately higher use of freshwater. Worryingly, this is often being carried out with scant regard for the environmental or social impact.

Chart 21: World water use



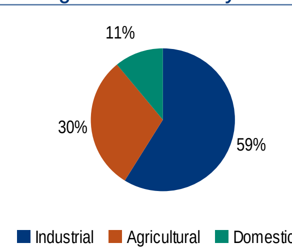
Source: World Bank, BofA Merrill Lynch Global Research

Chart 22: Low- & middle-income country use



Source: World Bank, BofA Merrill Lynch Global Research

Chart 23: High-income country use



Source: World Bank, BofA Merrill Lynch Global Research

- **Energy infrastructure is highly dependent on water** – gas, coal and nuclear plants, in the US for example, consume an estimated 20% of non-agricultural water. In China, coal-fired electricity currently uses more than 114tn litres of water, c.20% of the country's total consumption, rising to 40% over the next decade if current trends continue.

- **Mining infrastructure is highly dependent on water** with over 2bn gallons of water per day used in the US alone – the processing of a ton of ore requires 1.5 tons of water. Tailings and acid rock drainage are also becoming major issues.
- **Unconventional oil & gas extraction increases** – the oil industry currently produces 2.5x more water than oil; by 2025, it will produce 5x more water than oil, according to Global Water Intelligence (GWI). Usage is expected to increase via shale gas and the process of hydraulic fracturing or, "fracking", which can use as much as 5m gallons of water per well and poses a growing risk to freshwater supplies. As well as the risk to groundwater, if improperly handled, this fluid could potentially harm surface water assets.

Table 14: Energy-water relationship

Energy element	Connection to water use / scarcity	Connection to water quality
Energy Extraction and Production		
Oil and Gas Exploration	Water for drilling, completion and fracturing	Impact on shallow groundwater quality
Oil and Gas Production	Surface water and groundwater for cooling and scrubbing	Produced water can impact surface and groundwater
Coal and Uranium Mining	Mining operation can generate large quantities of water	Tailings and drainage can impact surface water and groundwater
Electric Power Generation		
Thermal electric (fossil, biomass, nuclear)	Surface water and groundwater for cooling and scrubbing	Thermal and air emissions impact surface waters and ecology
Hydro-electric	Reservoirs lose large quantities to evaporation	Can impact water temperatures, quality and ecology
Solar PV and Wind	None during operation; minimal water use for panel and blade washing	
Refining and Processing		
Traditional Oil and Gas refining	Water needed to refined oil and gas	End use can impact water quality
Biofuels and Ethanol	Water for growing and refining	Refinery waste-water treatment
Synfuels and Hydrogen	Water for synthesis or steam reforming	Wastewater treatment
Energy Transportation and Storage		
Energy Pipelines	Water for hydrostatic testing	Wastewater requires treatment
Coal Slurry Pipelines	Water for slurry transport, water not returned	Final water is poor quality, requires treatment
Barge Transport of Energy		Spills or accidents impact water quality
Oil and Gas Storage Caverns	Slurry mining of caverns requires large quantities of water	Slurry disposal impacts water quality and ecology

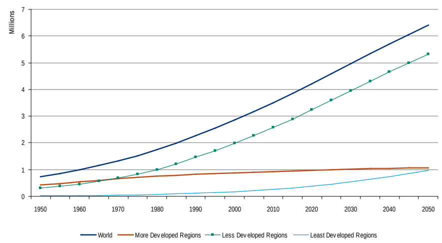
Source: BofA Merrill Lynch Global Research

Residential & municipal - set to grow fast

While water for domestic use is the smallest demand segment of freshwater resources, there are some significant long-term drivers of growth:

- **The world's population is estimated to grow by 50%** to approximately 9bn by 2050, while the world's water resources will remain constant. Intuitively, we expect there to be significant growth in the high(er)-income brackets associated with greater water use.
- **Urbanisation is placing growing demands on groundwater** and, by 2025, 5bn people will be living in urban areas while 70% of the world's population will be living in cities by 2050 according to the UN. The prospect of "mega-regions" stretching hundreds of kilometres across countries could push water resources and infrastructure to their limits, especially as groundwater recharge rates have slowed. This will have an impact on water quantity and quality, with increasing demand for efficient water infrastructure systems.

Chart 24: Global urban population 1950-2050 (bn people)



Source: UNpopulation

Table 15: Top 10 Megacities 2011-2025 (population in millions)

City	Country	Population – 2011	City	Country	Population - 2025
Tokyo	Japan	37.2	Tokyo	Japan	38.7
Delhi	India	22.7	Delhi	India	32.9
Mexico City	Mexico	20.4	Shanghai	China	28.4
NYC	USA	20.4	Mumbai	India	26.6
Shanghai	China	20.2	Mexico City	Mexico	24.6
São Paulo	Brazil	19.9	NYC	USA	23.6
Mumbai	India	19.7	São Paulo	Brazil	23.2
Beijing	China	15.6	Dhaka	Bangladesh	22.9
Dhaka	Bangladesh	15.4	Beijing	China	22.6
Kolkata	India	14.4	Karachi	Pakistan	20.2

Source: UNpopulation, BofA Merrill Lynch Global research

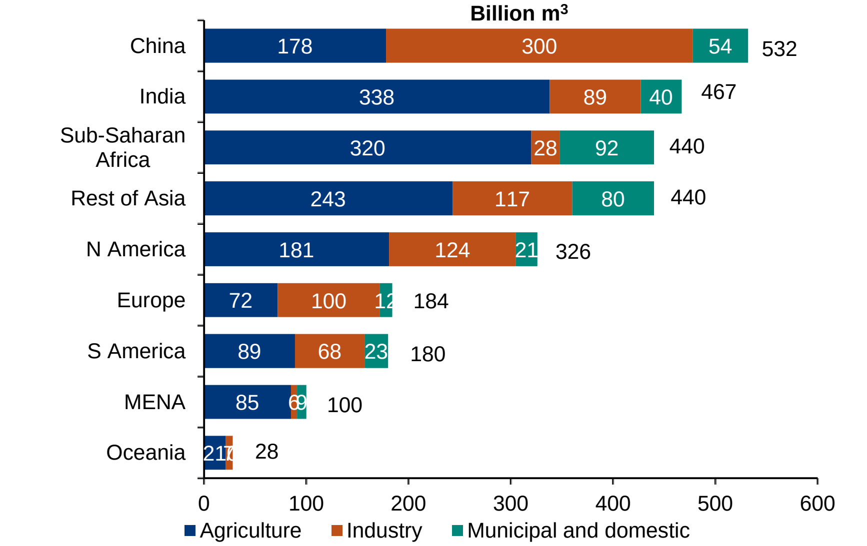
Table 16: From 2005 to 2030, water demand will increase

Percentage	Region
283	Sub-Saharan Africa
109	Oceania
95	South America
61	China
58	India
50	Europe
47	MENA
43	North America

Source: Water 2030

- **More water-intensive commodities and foodstuffs** as a result of rising prosperity. As developing nations shift their appetite from subsistence- (starch) to protein-based (meat, dairy) diets, their water requirements are likely to increase markedly.
- **Property will amplify demands** for improved water quality for greater recreational and amenity uses and for the preservation of biodiversity.

Chart 25: Expected increase in global water demand by 2030

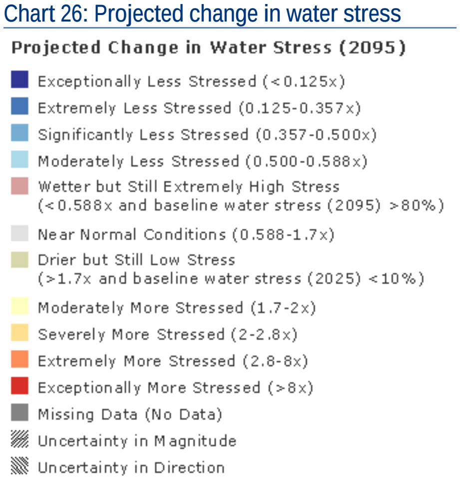


Source: 2030 Water Working group

Long-term changes in water stress

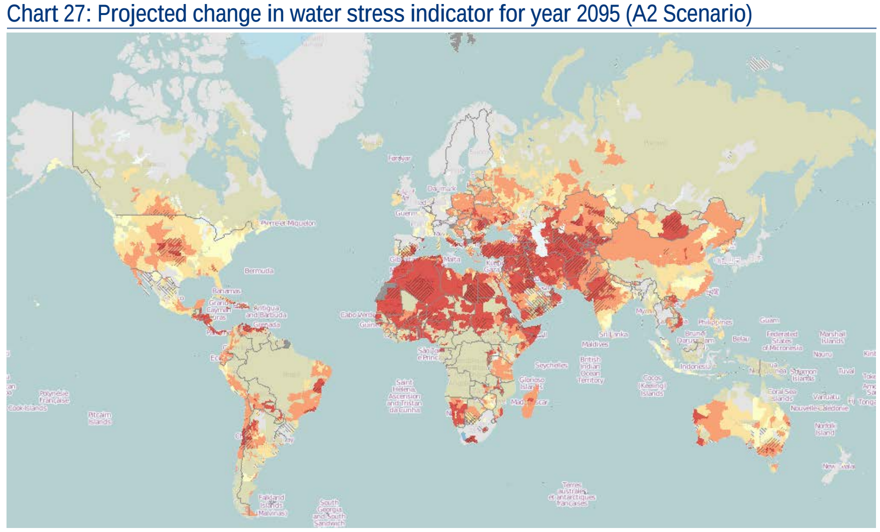
The map below projects the changes in water stress to 2095 due to shifting climate, population, and economic development. We have used the WRI-Aqueduct project's A2 scenario – which can be characterised as a "worst case" – where we see continuously increasing population and economic development, but slow and fragmented technological change.

Chart 26: Projected change in water stress



Source: World Resources Institute- Aqueduct Project,

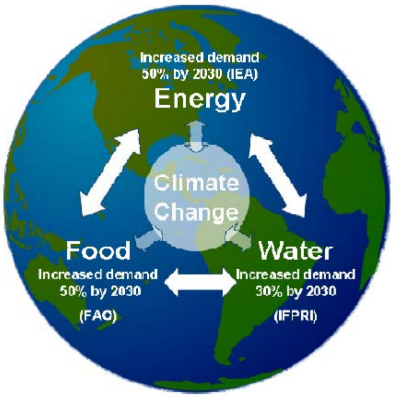
Chart 27: Projected change in water stress indicator for year 2095 (A2 Scenario)



Source: World Resources Institute- Aqueduct Project. Water Risk Data were provided to the World Resources Institute by The Coca-Cola Company in support of the Aqueduct project. ISciences L.L.C. performed the hydrological modelling. * A2 Scenario describes a very heterogeneous world. Underlying theme is self reliance and local identities. Continuously increasing population, Economic development and technological change is fragmented and slow.

A perfect storm, the water–energy–food nexus

Chart 28: A perfect storm of global events?



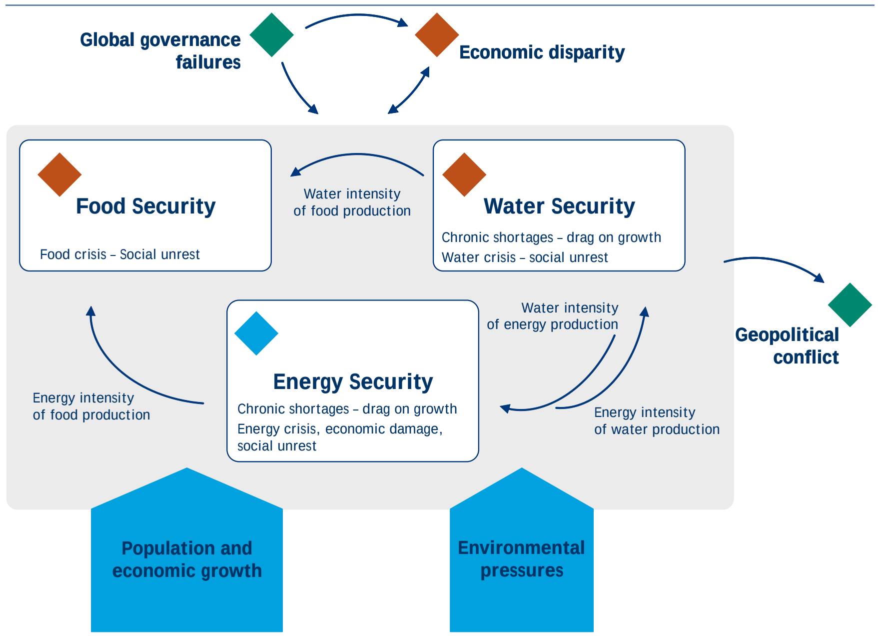
Source: HM Treasury, FAO, IEA, IFPRI, BofA Merrill Lynch Global Research

In our view, water stress and scarcity – as well as climate change and extreme weather – underscore increased long-term challenges for food, water and energy security. By 2030 global food demand is set to increase by 50%, water demand by 40% and energy demand by 50%, according to international organisation forecasts.

Food, energy and water security are linked by a series of sometimes reciprocal inputs, and influenced by other factors such as population, economic growth and environmental pressures along with the two overarching factors of global governance failures and economic disparity. Trade-offs between the three resources, as well as between users in the form of resource rationing, will, in our view, become an increasingly important issue, as will managing these trade-offs.

As the UK's former Chief Scientific Advisor Sir John Beddington stated, "This threatens to create a perfect storm of global events," which poses key questions for governments, stakeholders, corporates and investors. These include whether we can feed 9bn people equitably, healthily and sustainably; cope with the demands on water; provide enough energy to supply the growing population coming out of poverty; and whether can we do this while mitigating and adapting to climate change.

Chart 29: Water-energy-food nexus



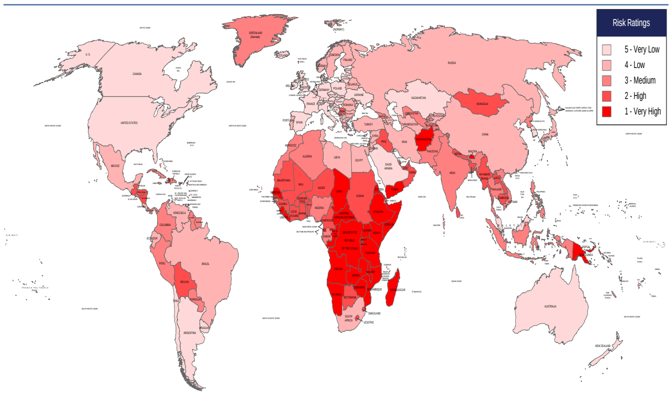
Source: World Economic Forum

Global food crisis, demand to increase 40% by 2030

Demand for cereals (for food and animal feed) is projected to reach 3bn tonnes by 2050. Annual cereal production will have to grow by 1bn tonnes and meat production by over 200mn tonnes to reach a total of 470mn tonnes in 2050, 72% of which will be consumed in EMs (**Error! Reference source not found.**) (Source: UN)

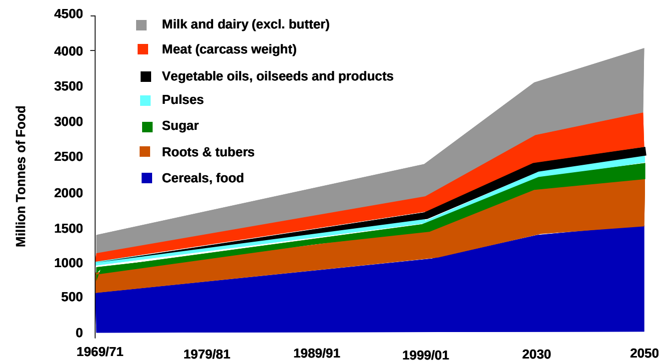
Global food demand – as reflected by total crop and livestock demand and production – could rise by 40% by 2030 and double by 2050 – meaning that a 70% increase in production output would be needed to feed the world. Overall demand for agricultural products is expected to grow 1.1-1.5% pa to 2050. Population growth, increases in per-capita consumption and changes in diets leading to the consumption of more livestock products are the main drivers of such expected changes. We expect demand for meat to grow by 85% to 2030 – posing significant water challenges as it takes 15,500l of water to produce 1kg of beef, compared with 1,500l for 1kg of grain.

Chart 30: Global food issues & needs



Source: BofA Merrill Lynch Global Research (WDWW (Who Does What Where) Geographical Risk Screening Model)

Chart 31: World food requirements to 2050



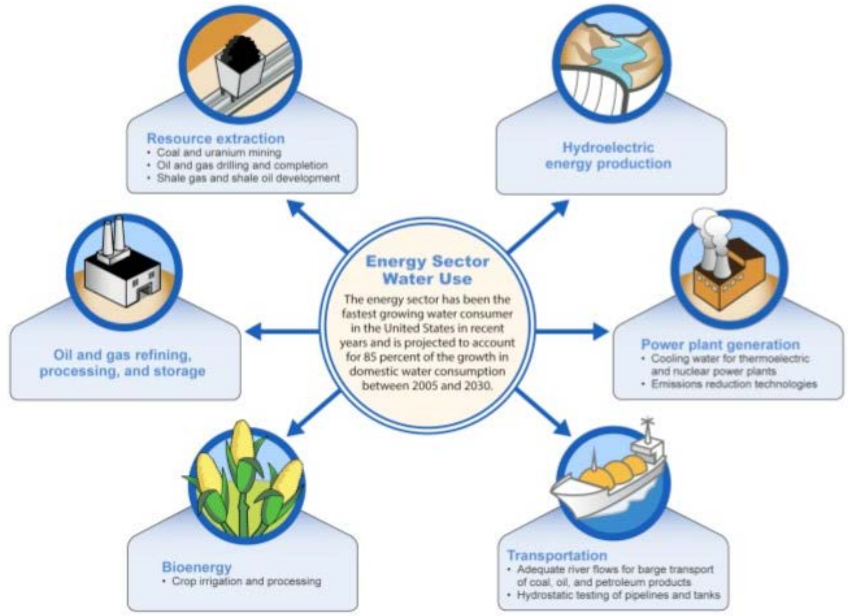
Source: FAO, BofA Merrill Lynch Global Research

Global energy crisis, demand to increase 50% by 2030

Short-term variations in economic growth have only marginal impacts on long-term energy and climate change trends

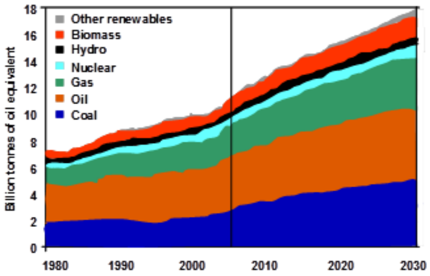
The world is facing a global energy crisis, with close to 9% of GDP being spent on energy. Primary energy demand is expected to increase by up to 50% by 2030 (Source: IEA) with demand to grow for all energy sources including coal, oil, natural gas, nuclear, hydro and renewables. Emerging markets will account for 90% of the projected growth in global energy demand, according to the IEA. As a result, energy-related CO_2 emissions are likely to increase by 20%, following a trajectory consistent with a long-term rise in the average global temperature in excess of 3.5°C – and potentially resulting in irreversible climate change, according to the IEA.

Chart 32: Energy sector water use



Source: Government Accountability Office (US),US DOE, Congressional Research Service

Chart 33: World primary energy demand to 2030

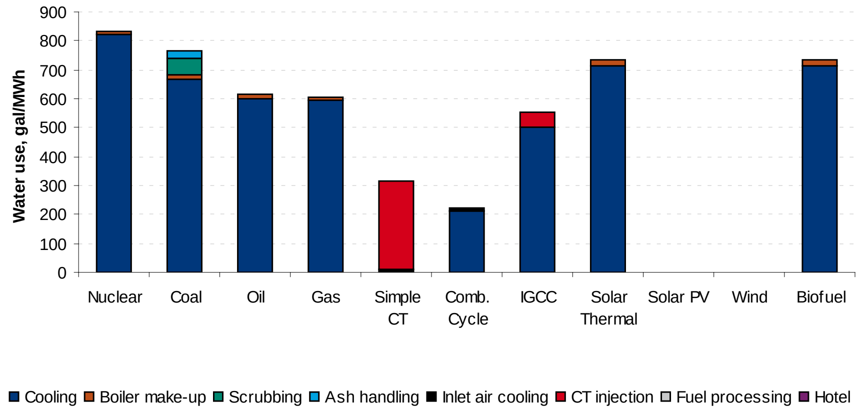


Source: IEA, BofA Merrill Lynch Global Research

- **Water & growing energy needs**: The IEA forecasts that the world economy will demand at least 40% more energy by 2030. This will require the installation of larger and more efficient power generation plants, which means massive water use. Gas-fired plants consume the least amount of water per unit of energy produced; coal- and oil-fired plants consume up to twice as much as gas-fired, and nuclear consumes up to three times as much. The future is unclear, with IGCC (integrated gasification combined cycle) able to reduce a coal plant's water consumption by half, but CCS (carbon capture and storage) potentially increasing a coal plant's water consumption by 30-100%.

Coal-fired electricity accounts for 20% of non-agricultural water use in the US and in China could account for 40% of all water use over the next decade

Chart 34: Water use by plant type



Source: EPRI, BofA Merrill Lynch Global Research

- **Energy, water & growing food needs**: In recent years, up to 40-60% of crops such as corn and sugarcane have found new applications in the production of biofuels. The most water-intensive aspect of biofuel production is growing the feedstock. When the feedstock is irrigated corn or soy, water consumption per gallon of fuel produced can exceed the water consumption for refining oil by a factor of one thousand. Government targets for the use of biofuels pose challenges for global freshwater resources, in the form of stringent management of irrigation techniques, innovative methods of processing and debates surrounding new technologies such as GM crops.

The anticipated water requirements for energy production will increase by 11.2% by 2050 if current consumption modes are kept. Under a scenario that assumes increasing energy efficiency of consumption modes, WEC (2010) estimates that water requirements for energy production could decrease by 2.9% until 2050.

Table 17: Population, energy consumption and water consumption for energy, 2005-2050

World	2005	2020	2035	2050
Population (mn)	6290	7842.3	8601.1	9439
Energy consumption (EJ)	328.7	400.4	464.9	518.8
Energy consumption (GJ/capita)	52.3	51.1	54.1	55
Water for Energy (bn m3/yr)	1815.6	1986.4	2087.8	2020.1
Water for Energy (m3/capita)	288.6	253.3	242.7	214
With improved energy efficiency				
Water for Energy (bn m3/yr)	1815.6	1868.5	1830.5	1763.6
Water for Energy (m3/capita)	288.6	238.3	212.8	186.8

Source: World Energy Council

Water wars, growing risk of unrest & conflict

"Water is now playing a determining role in international, national and trans-boundary conflicts" IAC Secretary-General Thomas Axworthy, President & CEO of the Walter and Duncan Gordon Foundation

"Competition for resources, including… water, will worsen tensions in the coming years and could escalate regional confrontations into broader conflicts" – US DoD *Quadrennial Defense Review 2014*

"Whisky is for drinking, water is for fighting" – Mark Twain

A large proportion of the world's freshwater is shared with 214 major river systems shared by 2+ states and 19 countries receiving >50% of their water from outside their borders. The cross-border nature of water and growing global water stress are likely to contribute to growing instability at national, regional and even international levels. In addition to water shortages, poor water quality/treatment, and droughts and flooding, potential political disputes over water access are likely to be exacerbated by global challenges like climate change, corruption, environmental degradation, hydro power (c.45,000 dams globally), poverty, poor governance, population growth, social tensions and urbanisation.

These areas of potential conflict are likely to lead to growing domestic unrest with farmers, industry, cities, and environmentalists all fighting for a "fair share" – as well as national, regional and global instability. While many see this as an EM issue, the current California drought shows that it is also hitting many developed markets. This led the U.S. Office of the Director of National Intelligence in 2012 to point to the growing use of water as a political tool over the next 10 years; for example, using water as leverage, water as a weapon and water terrorism. These sentiments were echoed in the US DoD's *Quadrennial Defense Review 2014* which stated that "competition for resources, including… water, will worsen tensions in the coming years and could escalate regional confrontations into broader conflicts – particularly in fragile states." As many as 50 countries could be at risk.

Water security increasingly matters

"Water security is a major policy challenge confronting governments around the world. In the absence of significant reforms of water and water-related policies, the outlook for water is pessimistic. Water security in many regions will continue to deteriorate due to increasing water demand, water stress and water pollution." – OECD ('Water Security for Better Lives)

Water security - managing water risks, including risks of water shortage, excess, pollution, and risks of undermining the resilience of freshwater systems – is becoming increasing central to long-term risk management. According to the OECD, achieving water security means maintaining acceptable risk levels for four key water risks:

- **Risk of shortage (including droughts)**: Lack of sufficient water to meet demand (in both the short- and long-run) for beneficial uses by all water users (households, businesses and the environment).
- **Risk of inadequate quality**: Lack of water of suitable quality for a particular purpose or use.
- **Risk of excess (including floods)**: Overflow of the normal confines of a water system (natural or built), or the destructive accumulation of water over areas that are not normally submerged.
- **Risk of undermining the resilience of freshwater systems**: Exceeding the coping capacity of the surface and groundwater bodies and their interactions (the "system"); possibly crossing tipping points, and causing irreversible damage to the system's hydraulic and biological functions.

Rising social unrest in EMs

Water stress and shortages are exacerbating social unrest in many emerging markets where capital-intensive infrastructure projects, such as dams and changes to water supply infrastructure, are being undertaken. In the former case, project sites have been the scene of many violent confrontations between communities and governments. Changes to community water or tariff increases have also led to significant social unrest. Finally, tensions between agricultural and residential vs. industrial and commercial users are on the rise, particularly in many water stressed regions.

Table 18: Examples of recent water unrest

Year	Country	Overview
2014	Canada	Massive fights break out over bottled water following West Virginia water contamination
2014	South Africa	Two protesters killed for protesting after a week without water
2013	Iran	Hundreds of farmers destroy pipeline carrying water out of their town
2013	Argentina	Protests due to water shortages led to Buenos Aires declaring a state of emergency
2013	Tanzania	Conflict between farmers and herders over shared river basin
2012	Ecuador	Over 25,00 people protest over the threat of mining to local water supplies
2012	India	Fights and protests over water cuts and poor monsoon
2009-14	China	Violent clashes over water pollution
2010	Pakistan	100 killed and scores injured after fighting over irrigation water between tribes.
2010	Pakistan	A water dispute in Pakistan's tribal region leads to 116 deaths
2010	India	Violent protests and injuries after a protest over erratic water supply in New Delhi
2009	China & India	China tries to block a US$2.9bn ADB loan to India on the grounds that part of it was destined for water projects in a disputed area.
2009	Ethiopia & Somalia	Three killed and a community driven from their homes after a borehole dispute.
2009	India	A family in MP state is killed by a mob after illegally drawing water from a municipal pipe.
2009	India	One person killed after hundreds protest over water rationing & cuts in Mumbai.
2009	Koreas	North Korea releases 40m m3 of water from a dam, causing flash flooding and deaths in South Korea.
2008	Nigeria	Violence after a protest over the price of water.
2008	Pakistan	Taliban threaten to blow up Warsak Dam, Peshewar's main water supply.
2007	Israel	Israel's sanctions against Gaza cause water deprivation.
2007	Australia	Sydney man charged with murder after an alleged fight over water restrictions
2007	Sudan	Four villagers killed after a dam protest.

Source: Press sources, BofA Merrill Lynch Global Research

US water conflicts

"Water has been seen as a zero-sum game - agriculture against urban, north against south. We're going to have to figure out how to play a different game… We can't afford years of litigation and no real action" – US President Obama

Water use, drought conditions and extreme weather have put stress on freshwater resources in many U.S. states, and set off a string of contentious battles over water. To compound matters, many water-stressed states – California, Texas, Oklahoma, Colorado, Wyoming, New Mexico – are all expected to experience 20% or higher population growth by the end of this decade. The anticipated population growth and ensuing growth of industry will further deplete the states' freshwater aquifers.

Increasing number of river basins at risk

US water law – based on the law of the river – is inherently complex, and water stress and availability is causing increasing conflict over states affected by long-standing, multi-state compacts establishing precise water allocations for each:

- **Red River Basin** – In 2013, Texas and Oklahoma took their water disputes to the US Supreme Court over "equitable" access to the Red River, which serves the states of Texas, Oklahoma, Arkansas and Louisiana. The Supreme Court ultimately affirmed Oklahoma's sovereignty over water within its borders (Source: Tarrant Water District v. Herrman).

- **Rio Grande Basin** – In Jan 2014, the US Supreme Court allowed Texas to proceed with its lawsuit against New Mexico regarding violations of an agreement apportioning water from the Rio Grande Basin between Texas, New Mexico, and Colorado signed in 1938 (Source: Texas v New Mexico and Colorado).

States that draw water from the Colorado River should anticipate “significant shortfalls between projected water supplies and demands” over the coming decades (Source: Bureau of Reclamation)

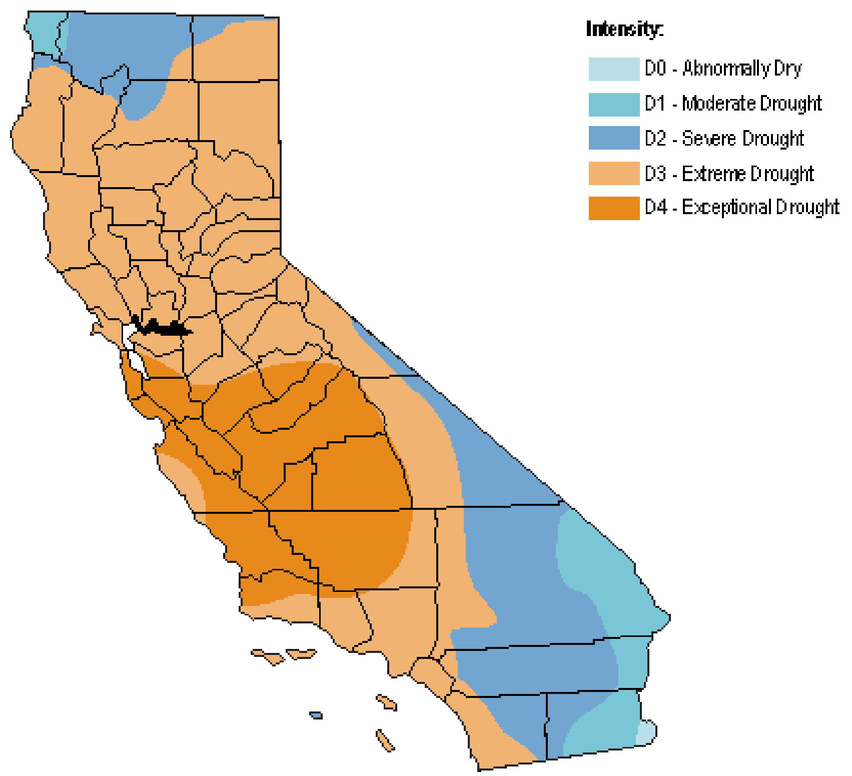
- **The Colorado River Basin** – supplies water to seven states and Mexico. The Colorado River Compact, signed in 1922, allocates the water from the Basin into two tiers, the Upper Division – Colorado, New Mexico; Utah, Wyoming, and the Lower Division – California, Arizona, and Nevada. Each Division would be entitled to 7.5mn acre-feet per year. Studies by the Bureau of Reclamation and the Arizona Department of Water Resources in 2012 and 2013 concluded that there could be significant shortfalls to the water supplies from the Basin in the coming decades. Considering that the pact divided water in absolute quantities available instead of percentages, it is still unclear who would suffer who the water shortfall (cf. *California drought* below).

California drought & the declining Sierra Nevada snowpack

99.8% of California is in a state of moderate to exceptional drought (at 18/03/14) – US Drought Monitor

California is currently suffering from an unprecedented three year precipitation deficit, with 2013 closing as the driest year in recorded history for many areas and over 90% of the state suffering severe to exceptional drought (Source: Western Regional Climate Center/US Drought Monitor). On January 17, 2014 Governor Jerry Brown declared a drought state of emergency for the state, the third since 1987.

Chart 35: California drought overview at March 18, 2014



Source: U.S. Drought Monitor

Sierra Nevada snowpack on the decline

99.8% of California is in a state of moderate to exceptional drought (at 18/03/14) – US Drought Monitor

Over two thirds of California’s population relies on the fresh water supply from the Sierra Nevada snowfields, which delivers 3.6tn gallons of water annually, including via the Colorado Rover. The water is transferred from the north to the south, through 1,200 miles of pipelines and aquifers that comprise networks in the State Water Project and the Central Valley Water Project. This provides irrigation for 40% of California’s 82,000 farms, 24mn of the state’s 38mn residents, as well as its industries. As of December 2013, the water content of the snowpack was about 20% of normal for that time of the year. Under current climate change and drying trends, the state Department of Water resources has predicted that the snowpack will be reduced by a quarter by the end of the century. Much of the decline can be attributed to the erratic snowfall of the Sierra Nevada, as on agriculture and industries such as oil & gas.

International unrest & conflict is likely

There were 1,831 water conflicts over trans-boundary basins from 1950–2000

Water issues are already inherently geopolitical with two in every five people living in international water basins. Positively, history shows that trans-boundary water tensions have led to more water-sharing agreements than violent conflicts (Source: Office of the Director of National Intelligence). While no nations have ever gone to war solely on the grounds of water, there were 1,831 water conflicts over trans-boundary basins from 1950–2000 (Source: Aaron Wolf et al). However, in the coming years we anticipate that the supply vs. demand imbalance and climate change-fuelled instability could manifest in a growing risk of conflicts and even wars being fought over water.

Global nature of water - susceptibility to conflict

A large proportion of the world's freshwater is shared – with 214 major river systems shared by two or more states and 19 countries receiving 50%+ of their water from outside their borders. Almost 96% of the planet's freshwater resources are to be found in underground aquifers, most of which straddle national boundaries. Of these, 273 are shared aquifers: 68 are on the American continent, 38 in Africa, 65 in Eastern Europe, 90 in Western Europe and 12 in Asia. Disputes are likely to be focused on trans-boundary aquifers.

Chart 36: River basins shared by two or more nations

Source: Pacific Institute for Studies in Development, Environment, and Security

Table 19: Surface water interdependence

International basins	# countries
Danube	17
Congo and Niger	11
Nile	10
Rhine and Zambezi	9
Amazon and Lake Chad	8
Aral Sea, Ganges-Brahmaputra-Meghna, Jordan, Tigris and Euphrates, Mekong	6
La Plata, Neman and Vistula	5
Indus	4
Rhone, Volga	3

Source: ESCP, BofA Merrill Lynch Global Research

Chart 37: Examples of transboundary aquifers

Source: UNESCO

Lack of transboundary legal frameworks

Worldwide, few transboundary river and lake basins are governed by basin agreements and treaties. In addition to the lack of a global legal framework to manage transboundary waters, only 34 countries have ratified or joined the 1997 U.N. Watercourses Convention after 17 years. The convention needs 35 countries to ratify to enter into force.

Poor irrigation practices

Diffuse pollution from agricultural land continues to be of critical concern throughout many of the world's river basins. Eutrophication from agricultural runoff ranks among the top pollution problems in Canada, the USA, and Asia and the Pacific. Australia, India, Pakistan and many parts of the arid Middle East face increasing salinization as a result of poor irrigation practices (Source: MA, 2005).

Climate change could act as a trigger

While climate change does not drive political instability *per se*, it will affect drought patterns and glacier melt – thus decreasing water resources and exacerbating existing socio-economic, cultural and historical factors vis-à-vis shared water resources, potentially triggering conflicts.

"… We judge that as water shortages become more acute beyond the next ten years, water in shared basins will increasingly be used as leverage; these of water as a weapon or to further terrorist objectives also will become more likely beyond 10 years." – U.S. Office of the Director of National Intelligence

Three major water risks over the next 10Y

In 2012, the US Office of the Director of National Intelligence recently set out three potential drivers of conflict, or water being used as a political tool over the next 10 years. Their views were reiterated in the US DoD's *Quadrennial Defense Review 2014* which stated that "competition for resources, including... water, will worsen tensions in the coming years and could escalate regional confrontations into broader conflicts."

- **Water as leverage**: A number of states will exert leverage over their neighbours to preserve their water interests. This leverage will be applied in international forums and include pressuring investors, NGOs, and donor countries to support or halt water infrastructure projects. States will also use their inherent ability to construct and support major water projects to obtain regional influence or preserve their water interests.
- **Water as a weapon**: The use of water as a weapon will become more common with more powerful upstream nations impeding or cutting off downstream flow. Water will also be used within states to pressure populations and suppress separatist elements.
- **Water terrorism**: Physical infrastructure (including dams) is a convenient and high-publicity target for extremists, terrorists, and rogue states threatening substantial harm and will become more likely beyond the next 10 years. Even if an attack is less than fully successful, the fear of massive floods or loss of water resources would alarm the public and cause governments to take costly measures to protect the water infrastructure. Desalinization facilities or critical single point failure water canals or pipelines would likewise be targets for terrorists.

"the next war in the Middle East will be fought over water, not politics" – Boutros Boutros-Ghali, former UN Secretary General

30 countries on three continents at high risk

We have identified up to 30 countries on three continents as potential areas for conflict over water, including some located in Central Asia, Jordan River, Mekong Basin, Nile Basin, South Asia and Tigris-Euphrates. Some stakeholders say that as many as 50 countries on five continents may be facing such risks. Some stakeholders believe that up to 50 countries on five continents could be at risk. It is important to stress that the risks of conflict is not limited to EMs, with Canada's

Ambassador to the U.S. Gary Doer recently stating that Canada must prepare for diplomatic water wars with the U.S. and that water diplomacy would make the debate about Keystone XL pipeline "look silly."

Table 20: Illustrations of potential water conflicts

Region	Water basin	Countries	Overview of potential conflicts
Africa	Nile Basin	Burundi, DR Congo, Egypt, Eritrea, Ethiopia, Kenya, Rwanda, South Sudan, Sudan, Tanzania, Uganda	• Land use – Rising demand for irrigation, large-scale farming (leased), dams • Population growth – Water needs to grow as population reaches 654m by 2030 • Water access – Egypt & Sudan hold rights to Nile's waters but 11 countries seeking greater access to region's #1 water source
Middle East	Jordan River	Israel, Jordan, Palestine	• Climate change – arid climate furthering water stress • Environment – discharge of untreated and poorly treated sewage; overexploitation and groundwater pollution
	Tigris-Euphrates	Iran, Iraq, Syria, Turkey	• Climate change / Environment – Increasing desertification; extreme heat and water evaporation; contamination from pesticides, discharge of untreated sewage & excess salinity (low water levels) • Dams / Land use – Iraqi claims that hydro dams & irrigation have reduced water flow • Politics – Iran, Iraq & Syria want more equitable access & control from Turkey (where 98% of water originates)
Asia	Central Asia (Amu Daria & Syr Daria)	Kazakhstan, Kyrgyzstan, Tajikstan, Turkmenistan, Uzbeskistan	• Land use – Thirsty corps such as cotton & grain are main livelihood • Population growth – Kazakhstan, Turkmenistan, Uzbekistan • Politics – Lack of progress on new system to replace Soviet water management system • Water access – Kyrgyzstan & Tajikistan want greater control for hydro and irrigation
	Mekong River	Cambodia, China, Laos, Myanmar (Burma), Thailand, Vietnam	• Dams – Most countries have been planning dams since 1980s; Cambodia, Laos, Thailand & Vietnam argue China's dam building on upper Mekong diverts/stores more than its fair share of water; environmental impacts to agriculture, fisheries, food because of plans by Cambodia & Laos to build 10 dams along Lower Mekong • Politics – National interests remain barrier to joint river management
	South Asia (Brahmaputra, Tsangpo)	Bangladesh, China, India	• Climate change/Dams/Environment – China building up to 28 dams in Tibet along Tsagpao; India & Bangladesh concerned China may divert water to its arid north; drought in western China flooding in east and south; industrialisation, urbanisation and water quality
	South Asia (Indus)	India, Pakistan	• Dams – Both countries building hydro dams in disputed Kashmir along Kishanganga; Pakistan fears disruption of water flow; India planning new projects to boost energy supply

Source: Thomson Reuters Foundation, BofA Merrill Lynch Global research

Problems of corruption

Corruption in the water sector is a root cause and catalyst for the global water crisis. Leading anti-corruption stakeholder group, Transparency International (TI), has identified a range of problems throughout the industry's value chain from policy design and budgeting to building, maintaining, and operating water networks to petty bribery in water delivery to procurement-related looting of irrigation and hydropower funds.

TI's International Bribe Payer's Index also identifies public works and construction companies that are perceived – i.e., viewed as paying bribes – as the most corruption-prone, and thus most likely to exert undue influence on the policies, decisions and practices of governments. While developing markets have experienced the most problems, corruption has allegedly plagued the tendering of water contracts in the US, France and Italy, according to TI.

Poor are paying the greatest price

Water sector corruption in developing countries increases household connection costs by up to 30% and costs the industry US$48bn in annual losses

The poor already bear the greatest burden of water scarcity – and pay the price of corruption in drinking water and sanitation as it drains investment from the sector, increases prices and decreases water supplies. In India, for example, corruption is estimated by TI to add at least 25% to irrigation contracts with the proceeds supporting a corrupt system of political handouts and compromised oversight. One perverse result is that poor households in Jakarta, Lima, Manila or Nairobi spend more on water than residents of London, New York City or Rome. Another is that corruption leads to poor outcomes, with TI estimating that in China, bribery is responsible for pollution in some 90% of aquifers in cities and 75% of urban rivers.

Active water cooperation between countries reduces the risk of war

Water as an opportunity for cooperation

Water challenges have historically brought divergent actors together including the Mekong Commission, Israel-Jordan "picnic" talks and the Indus River Commission. Current examples of joint-water governance include Euphrates Tigris Initiative for Co-operation (academic-sponsored initiative to enhance dialogue and cooperation via advocacy, research and education); Good Water Neighbours (cross-border peace-making programme); Nile Basin Discourse (multi-stakeholder meetings in each basin country); and Nile Basin Initiative (government ministers meet to find a legal framework for equitable water use).

Emergence of international "hydro-diplomacy"

Water conflict and "hydro-diplomacy" are likely to become a growing topic for international organisations, such as the following:

- **The United Nations** is aiming to improve understanding of water resources and foster effective water management and facilitate dispute resolution via its Potential Conflict to Co-operation Potential mission. However, it has been unable to agree on whether the UN Security Council should address water conflict or not. Earlier in the year, Russia and China, backed by many developing countries, rejected the notion that the issue even belongs on the Security Council agenda.

- **The World Trade Organization** can arbitrate water disputes between its member states when the disagreements are commercial in nature. Owing to water's role in agriculture, this can arise via virtual water and water used in the production of goods and services but not directly traded between countries.

"When the well's dry, we know the worth of water" – Benjamin Franklin, Poor Richard's Almanac (1746)

High costs of free water, higher prices are a must

Water is often viewed as a free or cheap resource, or is not subject to market forces - inevitably meaning that it suffers from the tragedy of the commons with overuse and/or highly inefficient use the norm. This needs to change especially given that water costs are significant, with water infrastructure 3x more expensive to build and maintain than electricity infrastructure (Source: IBM), along with costs associated with demand, transport, treatment and price subsidies. Yet many municipal suppliers do not charge enough for water to meet even their basic operational and maintenance costs. As an example of inefficient pricing, water revenues in New Delhi are less than 20% of what the municipality spends each year to provide water.

While water will never be a wholly commercial product, higher water prices or full cost recovery pricing are clear incentives for efficient water use. They are also key to increasing cost recovery in the water sector, and enhancing the financial sustainability of urban water supply systems. This would be beneficial for the entire water sector from an investment perspective, as well as for many of the world's poor, although striking a balance with affordability and social equity will be key to maintaining licence to operate. Brazil is a good example of a country striking this balance (cf. *Water Infrastructure & Supply* section). We also need to explore new market-based mechanisms such water trading, water marketing, wand water banking, which would explicitly or implicitly incorporate infrastructure, maintenance, provision and administration costs into the water price.

Global water tariffs on the rise

Global water tariffs rose by an average of 3.7% between July 2012 and July 2013 at constant exchange rates compared with 3.6% for 2011-12, 6.8% for 2010-11 and 8.5% for 2009-10 (Source: GWI). The average water and wastewater tariff for the 346 cities in the 2013 GWI Water Tariff Survey is US$2.11 per m^3 (vs.US$1.98 per m^3 in 2012). On average, the water tariff represents 54.9% of the combined tariff, while wastewater accounts for the remaining 45.1%, although in North America, users are charged more on a volumetric basis for wastewater services than for water supply (Source: GWI).

Table 21: Average 2013 tariffs (US$/m3) & water usage in selected major countries

Country	Combined tariff	Water tariff	Wastewater tariff	Change %	Domestic use 1/head/day	No. of cities
Denmark	$8.45	$3.88	$4.56	0.4%	131	2
Australia	$6.17	$3.22	$2.95	6.7%	340	5
Germany	$5.80	$3.08	$2.72	0.9%	127	10
United Kingdom	$4.40	$2.15	$2.24	3.5%	150	8
France	$4.34	$2.37	$1.97	1.1%	150	7
Canada	$3.54	$2.07	$1.47	8.6%	274	5
Czech Republic	$3.64	$1.87	$1.77	8.0%	88	3
United States	$3.35	$1.48	$1.87	7.5%	340	51
Poland	$3.10	$1.41	$1.69	5.0%	125	6
Japan	$2.15	$1.22	$0.93	-0.1%	373	13
Portugal	$2.44	$1.69	$0.75	0.7%	161	3
Spain	$2.21	$1.52	$0.69	10.8%	265	6
Turkey	$1.73	$1.29	$0.44	11.2%	217	8
Italy	$1.75	$0.88	$0.87	3.7%	190	6
Russia	$1.02	$0.63	$0.40	15.0%	248	13
South Korea	$0.83	$0.60	$0.24	1.6%	183	7
Mexico	$0.83	$0.70	$0.13	9.0%	183	11
China	$0.51	$0.37	$0.14	1.0%	95	25
India	$0.14	$0.13	$0.01	3.9%	139	17

Source: Global Water Intelligence, BofA Merrill Lynch Global Research

Governments under budgetary challenges

Cash-strapped governments around the world are becoming unwilling to foot the bill for domestic water use – with reduced subsidies for local utilities becoming increasingly common (Source GWI).

Governments charging more for big users

Governments are starting to introduce measures to better manage water supply – including cost increases for large users. For example, in 2008 Portugal started taxing major water users in agriculture and industry. And in June 2012, China announced it would impose higher water charges for water-intensive industries and encourage the use of recycled water. Singapore is also pricing water to reflect its scarcity (Source: KPMG).

Water utilities recognising need to curb water use

An October 2012 survey by Oracle Corp (which provides smart metering management services for utilities) of 244 senior water utility executives found that wasteful behaviour by end users was the biggest barrier to meeting rising demand. The study showed 49% of respondents believe water pricing structures need to change to prompt end users to conserve water.

High water price - economic development link

There is a correlation between economic development and high(er) water prices: 16 of the 20 countries with an average combined tariff >US$3.00 per m^3 have a per-capita GDP of >US$35,000. Higher tariffs are needed to support well-developed water supply networks and to treat the wastewater that is produced (Source: GWI).

Table 22: Top 10 water & wastewater tariffs (July 2012-July 2013)

	Top 10 combined water and wastewater tariff increases			Top 10 combined water and wastewater tariffs	
1	Kathmandu (Nepal)	82.5%	1	Aarhus (Denmark)	$9.51/m^3$
2	Almaty (Kazakhstan)	77.3%	2	Essen (Germany)	$7.83/m^3$
3	Guadalajara (Mexico)	48.2%	3	Copenhagen (Denmark)	$7.38/m^3$
4	Bandung (Indonesia)	35.7%	4	Newark (United States)	$7.17/m^3$
5	Zapopan (Mexico)	35.4%	5	Seattle (United States)	$6.70/m^3$
6	Tashkent (Uzbekistan)	26.5%	6	Honolulu (United States)	$6.70/m^3$
7	Seville (Spain)	23.9%	7	Portland, OR (United States)	$6.64/m^3$
8	Chihuahua (Mexico)	23.7%	8	Perth (Australia)	$6.59/m^3$
9	Wuhan (China)	22.1%	9	Dortmund (Germany)	$6.48/m^3$
10	Belgrade (Serbia)	22.1%	10	Berlin (Germany)	$6.43/m^3$

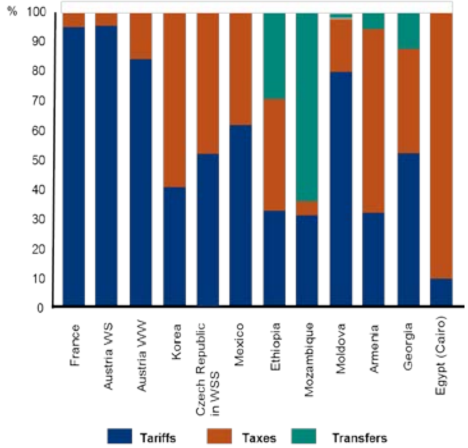
Source: Global Water Intelligence

“Water is not a commercial product like any other, but, rather a heritage which must be protected, defended and treated as such” – EU Water Framework Directive’s 1st paragraph

Fuller cost but stakeholder-friendly recovery is key

Higher water prices could raise incentives for efficient water use, increase cost recovery in the water sector, and enhance the financial sustainability of urban water supply systems. We would see this as largely beneficial for the entire water sector from an investment perspective. It could also be beneficial to many of the world’s poor, who are not connected to municipal water supplies and who have no choice but to pay for informal purchases, which are up to 50x the price that middle- and high-income households pay.

Chart 38: Global approaches to water finance



Source: OECD, BofA Merrill Lynch Global Research

In September 2012, Suez Environnement introduced its 'eco-social' water tariff scheme, which came into effect in October in the Dunkirk region of France

In Europe, the Water Framework Directive, adopted in 2000, requires member states to impose pricing policies to encourage users to consume water more efficiently. However, many markets have no such policy. Moreover, there is no generally accepted pricing mechanism and countries tend to use a mix of three different mechanisms to finance and operate water infrastructure:

- Users can be charged a tariff for the water provided to them;
- Tax revenue can be used to subsidise opex and capex costs; and
- Transfer payment such as grants can be sourced from other countries.

Factors that need to be taken into account include public vs. private usage, abundant vs. scarce supply, supply to households vs. industry vs. agriculture and institutional capacity.

Affordability and social equity are key but difficult to achieve

Prices also need to be balanced with affordability and social equity to ensure that lower income and vulnerable consumers are not priced out of the market. This will be key to avoiding social unrest and political opposition (even in developed markets), and for utilities to maintain their licence to operate. This is no easy challenge given the pressing water infrastructure and O&M needs.

Social equity is still a concern

Despite the recession, some governments have stepped in to prevent overcharging, reduce water tariffs or refund excessive water bills. Social tariffs are also being seen as a compromise solution which could facilitate a sustainable financial model by charging tariffs that depend on income, size of household and usage – and creating disincentives to overuse:

Social tariffs are also being seen as a compromise solution which could facilitate a sustainable financial model by creating disincentives to overuse:

- **Passport tariffs** could reduce charges for one or more defined household groups, such as lower-income and/or other vulnerable groups.
- **Block tariff** refers to any general metered tariff in which the first "block" of water used is provided at a lower price than that of subsequent blocks

Market-based mechanisms needed

Beyond pricing, there is an increasing call from many stakeholders for market-based mechanisms for water – policy instruments that use markets, price and economic variables to provide incentives for efficient water use. Water trading, water banking, and water transfers are three examples.

Table 23: Possible market based mechanism for water security management

Water security issue	Recommended market-based instruments	Advantages of use
Water supply	Marginal social cost pricing, incorporating the scarcity value of water	Signals the optimal time to invest in water infrastructure so that supply is augmented efficiently
	International and regional water markets	Allows trade of water from areas of surplus to increase the water supply in areas of scarcity
Water demand	Regional water markets	Allows trade of water from low to high value uses creating incentives to use water efficiently and reduce demand
	Marginal social cost pricing, incorporating the scarcity value of water	Reduces demand for water during periods of scarcity
Water quantity	Buy-backs of water user's rights	Secures water for environmental flows and offsets economic losses
Water quality	Emission permit trading for point and non point pollution	Allows pollution to be reduced from the lowest cost sources
	Emission taxes	Creates ongoing incentive for all sources to reduce pollution

Source: OECD

Water trading

Water is not the new carbon in the sense that water trading would probably be local or regional because of its physical characteristics and the difficulty of transporting it over long distances

An alternative to traditional pricing would be water trading, whereby the price would be determined by market forces. Many believe water trading has the potential to limit the impacts of water scarcity as it would encourage users to understand the economic value of water and to use it more efficiently. This could work as follows:

Water is not the new carbon in the sense that water trading would probably be local or regional because of its physical characteristics and the difficulty of transporting it over long distances

- A facility that reduces initial demand or improves the quality of discharge against an established baseline might trade excess demand or allocate it to another facility
- A facility that reclaims water and provides it to an external reuse application might use the corresponding reduction in demand to offset its own water intake.

Some of the western states of the US, Chile, South Africa, and Spain's Canary Islands already have water trading schemes, while Australia’s is considered to be the most developed (see below). Informal water trading schemes also exist in parts of South Asia and China is looking at expanding its pilot water rights trading system programme in Ningxia-Hui and Inner Mongolia Autonomous regions.

Other forms of water trading include treated wastewater trading, which would create a financial incentive for suppliers to install treatment technologies

A hypothetical model for trading

A hypothetical trading structure would be the development of a regional cap-and-trade system in water abstraction licences: a pre-assigned abstraction limit would define the volume of water that licence holders would be allowed to abstract in a particular region.

Table 24: Hypothetical water trading model

Factor	Overview
Area under coverage	Defined by the watershed in which the body of water drains
Allowances	Distributed via competitive auctions held at the beginning of each year. The highest bidding firms to receive allowances up to a limit set during an initial consultation period. The total no of licences will be reduced in a systematic fashion once the market has been established
Auction proceeds	Will go towards the funding of R&D
Fully developed market	futures, forwards and options may be purchased to secure supplies in advance of predicted water shortages

Source: BofA Merrill Lynch Global Research

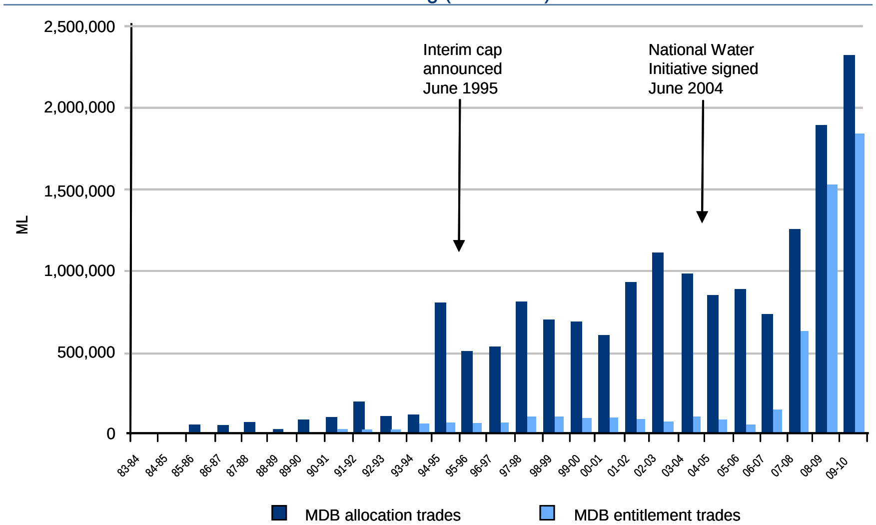
By 2010, the water rights market was valued at up to A$2.8bn

The Australian precedent

Australia has been constructing a market for water trading since 1983. Under the country's National Water Initiative, land and water rights were separated – allowing water entitlements (permanent) and seasonal allocations (temporary) to be transferred between different entities within the Murray-Darling Basin, which covers one-seventh of the Australian continent and includes four states. Currently, water is traded mostly over-the-counter through water brokers, water exchanges and message boards.

In 2012, the National Water Commission said that "Australia's water markets have allowed water to be reallocated to where the need is greatest and reduced the impact of the drought on regional production… [and] of maximising the economic, social and environmental values of scarce water resources."

Chart 39: Increases in Australian water trading (1984-2010)



Source: Australian Government – National Water Commission, BofA Merrill Lynch Global Research

Many challenges remain

While there is scope for water trading, it is currently constrained in many markets by the nature of the underlying commodity, a lack of incentives to buy or sell water, complexity in the process of agreeing a bulk supply, and the lack of a clear pricing model around marginal costs (Source: E&Y and Severn Trent).

If we take the UK as an example, regulators are keen to promote water trading to relieve local pressure on water resources. Yet, under current pricing policies, the buyer of water is subject to operating cost efficiency adjustments despite not having ultimate control of the costs. A solution to this problem would be to remove the capital expenditure and operational expenditure costs associated with bulk supplies from the price review process; we do not expect this to be considered until the next pricing review at the earliest.

Water banking

Water banking is the practice of forgoing water deliveries during certain periods, and "banking" the right to use the forgone water in the future, or saving it for other users in exchange for a fee or delivery in kind. It makes sense where there is significant storage capacity to facilitate such transfers of water. Spain has been planned to create a public water bank in each hydrographical basin, which would allow historical water resources to be re-allocated according to criteria of equity, efficiency, and sustainability. A 2012 study by the Public Policy Institute of California found that water banking could promote conservation, local infrastructure development and cooperation among water agencies.

Cross-border water trading, controversial

Water is classed as a commodity under NAFTA but Canada has taken a strong position against water exports

The proposal to export water from its natural basins has sparked fierce resistance from stakeholders in some parts of the globe. The Great Lakes region in North America has established laws and regulation to ban the practice. Other water-rich nations, such as Russia, have welcomed the idea. Bulk water transfers are not new. For instance, Singapore imports water from neighbouring Malaysia and Lesotho sends water to South Africa via the Highlands Project. Alaska is the first jurisdiction to permit the commercial export of bulk water, and there are schemes at the planning stage which propose transporting water from Alaska to China by tanker.

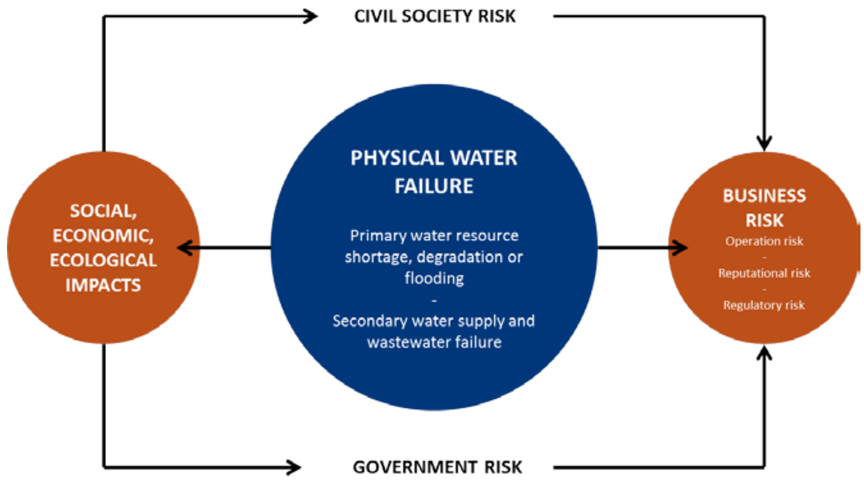
International bulk water trading

Alaska is the first jurisdiction to permit the commercial export of bulk water, and there are schemes which propose transporting water from Alaska to China by tanker

The transfer of water by tanker is a more recent development. Depending on the supply-side issues in the tanker market, water stressed areas in the Middle East, northern China, southern India and parts of Africa could provide sufficient demand to create a market for bulk water shipments. Hoping to identify the regulatory stance on the concept, the New Zealand government submitted an unofficial request to the WHO early in 2009 for guidance on the management and monitoring of the safety of large volumes of water carried by marine vessels. In response, the WHO suggested monitoring at each stage of the transfer to ensure that the quality of water remains above regulatory standards. If transport costs relative to the value of the cargo are favourable, we do not think it would be fanciful to imagine tankers transporting water across the globe.

A priority for investors, corporates & stakeholders

Chart 40: Inter-relationship of water risks among business, government and society



Source: SABMiller Plc and WWF-UK (2009)

Investors, water is a preferred sector

S&P Global Water (annualised performance) - 1Y: 20.3%; 3Y: 13.7%; 5Y: 19.3%; 10Y: 10.4%

Investors are increasingly looking at water as a long-term investment theme which offers steady inflation-protected returns, is less linked to economic growth than other infrastructure investments, and acts as an alternative to low bond yields and volatile equity markets.

Table 25: Observation on water performance

	Absolute performance observations				Annualised performance observations			
	1 Y	3 Y	5 Y	10 Y	1 Y	3 Y	5 Y	10 Y
S&P Global Water	20.3%	46.8%	141.2%	169.2%	20.3%	13.7%	19.3%	10.4%
MSCI AC World	12.8%	25.2%	105.5%	59.1%	12.8%	7.8%	15.5%	4.8%
Thomson Reuters Global Gold	-30.1%	-50.2%	2.8%	66.9%	-30.1%	-14.5%	0.5%	5.3%
Stoxx Global 1800 Oil & Gas	7.6%	5.8%	63.1%	111.4%	7.6%	1.9%	10.3%	7.8%

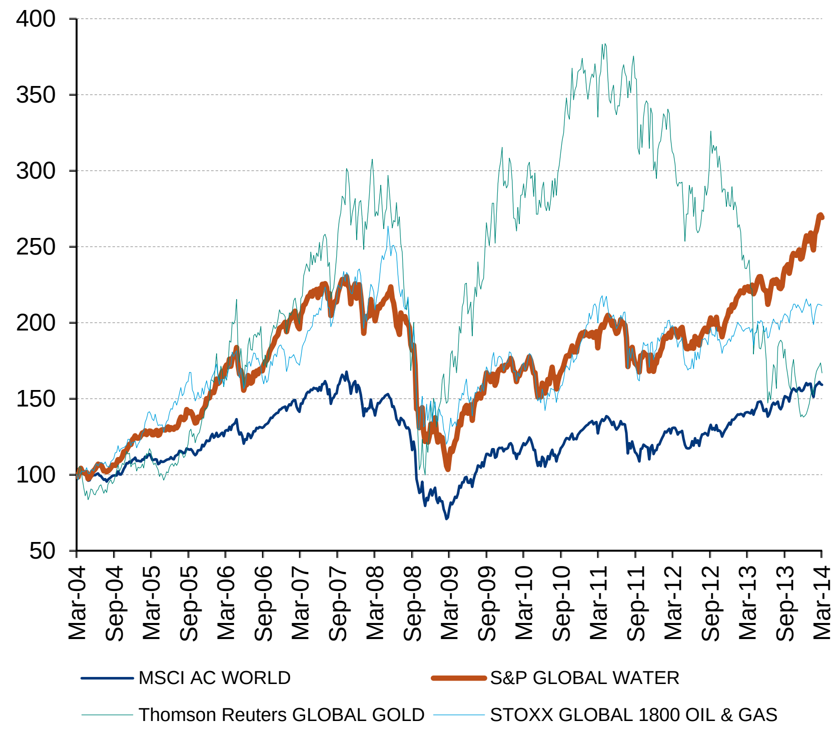
Source: BofA Merrill Lynch Global Research, Datastream (at 20/03/2014)

Strong 10Y performance track record

Inflation-protected returns, less linked to economic growth, alternative to low bond yields and volatile equity markets

We note that the S&P Global Water index (SPGYAQD) - of 50 global companies involved in water related businesses - has consistently outperformed a range of sample benchmark indices including the MSCI AC World, as well as other "precious commodity" indices such as Thomson Reuters Global Gold and STOXX Global 1800 Oil & Gas.

Chart 41: 10Y S&P Water performance



Source: BofA Merrill Lynch Global Research, Datastream

Growing private sector involvement

There is growing private sector involvement in water and wastewater – with the private sector likely to account for 30% of investments by 2016 compared to 19% today (Source: Global Water Fund).

Governments realising that they can't do it alone

Given the significant water management challenges (structural decrease in volumes in mature countries, reinforcement of water quality requirements, growing water stress in some specific areas, capex requirements to expand & comply with regulation, difficult financing access for local authorities) (Source: Suez) - many countries are seeking out the private sector to modernise and expand their water and sanitation infrastructure and/or to improve the efficiency of water systems.

Table 26: Water - diversified end markets for investors

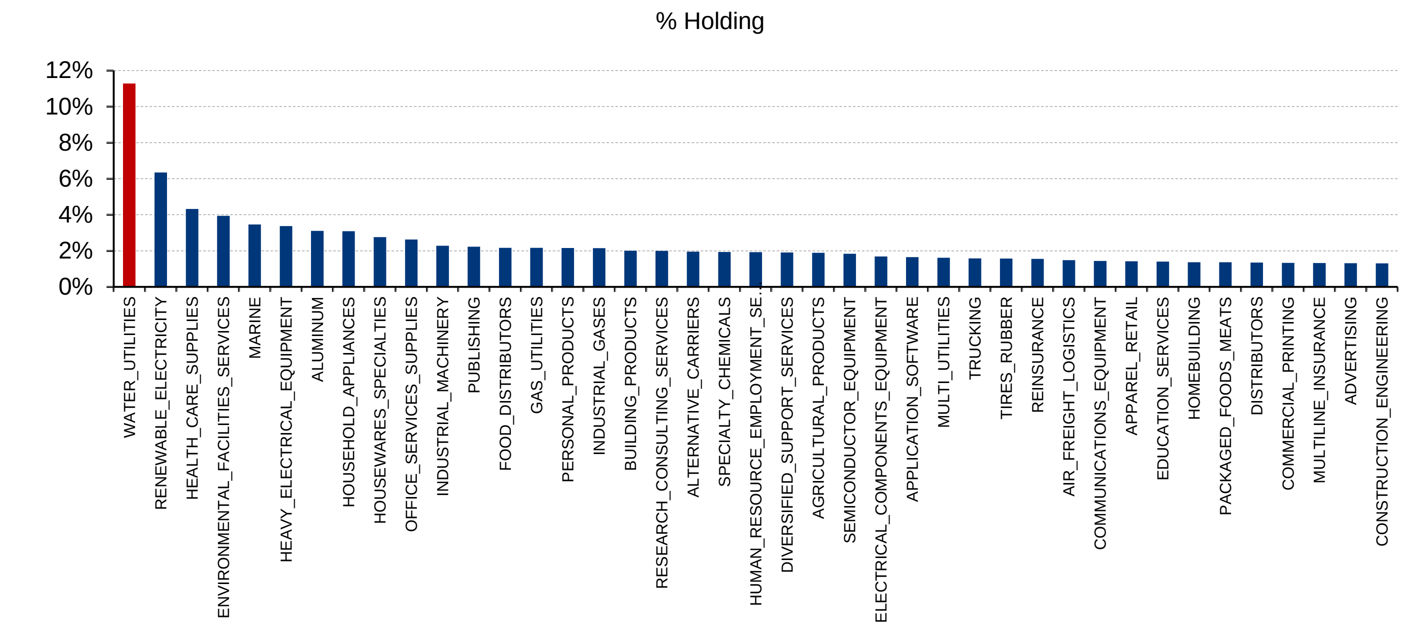
	Industrial	Public Utility	Commercial	Residential	Agriculture
Cycle	-Late/less cyclical	-Non-cyclical	-Late cycle	-Early cycle	-Mid cycle
Fundamentals	-Operation critical	-Growing tariffs	-Green regulation	-Energy efficiency	-Growing demand
	-Aftermarket & replacement	-Aftermarket & replacement	-Strong replacement	-Strong replacement	-Strong replacement

Source: Xylem, BofA Merrill Lynch Global Research

Water is thematic & ESG investors preferred sector

Water is the number one held GICS3 sector among the world's top 500 ESG (Environment, Social, and Governance) and thematic-focused funds as shown by our BofAML ESG & Thematic Consensus model, which analyses the funds' sector and stock holdings.

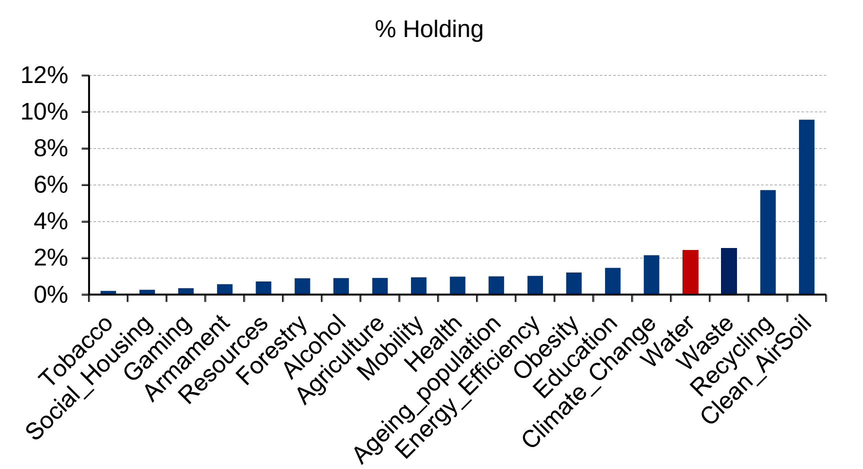
Chart 42: BofAML's ESG & Thematic Consensus – Sector Preferences



Source: BofAML Global Research

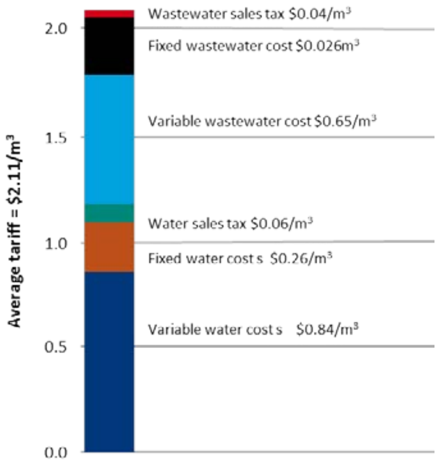
Even after taking this specific sector allocation into account, there is still an investor preference for water-related stocks. From a thematic perspective, water is the fourth preferred thematic megatrend.

Chart 43: BofAML ESG & Thematic Consensus – a "pure" thematic view on sectors



Source: BofAML Global Research

Chart 44: What makes the average water tariff?

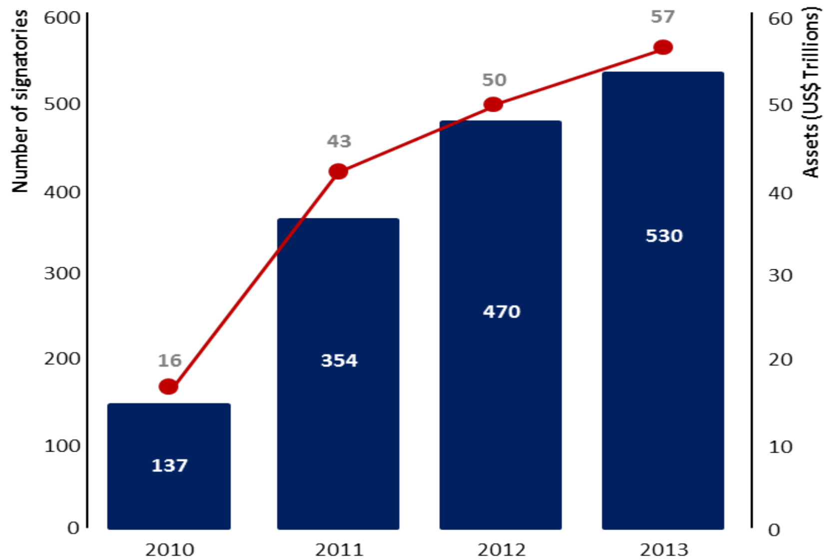


Source: Global Water Intelligence

Water as a risk, $57tn in AUM of investor interest

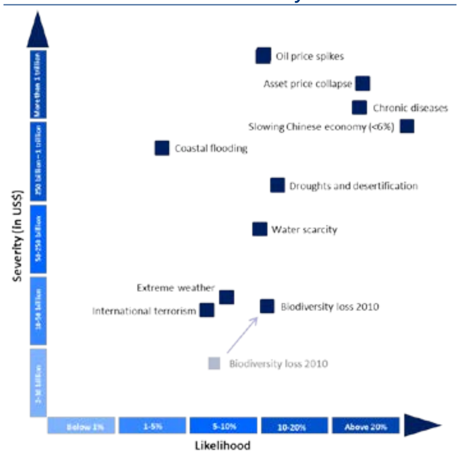
530 investors representing US$57tn worth of assets are also active in seeking better disclosure on water-related risks via the Carbon Disclosure Project (CDP). The CDP's 2013 Global Water Report shows a 13% increase in the number of investors requesting water information from its investee companies.

Chart 45: CDP "Water Disclosure" investor signatories (US$tn AUM)



Source: CDP, Deloitte, BofA Merrill Lynch Global Research

Chart 46: Water and biodiversity risks



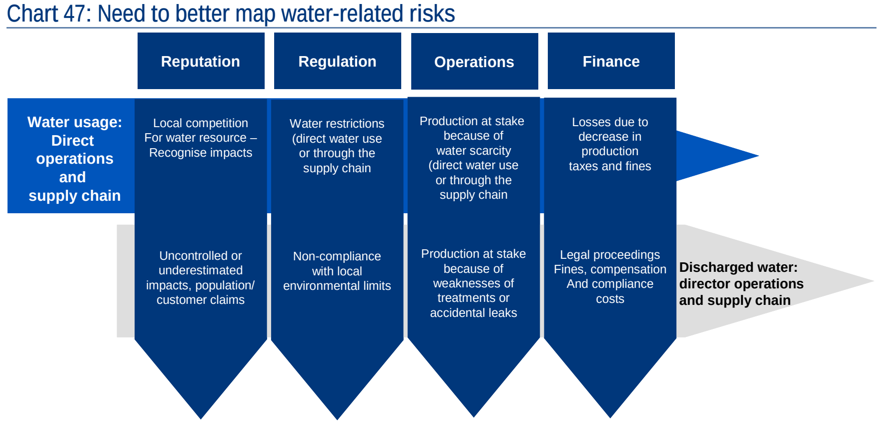
Source: World Economic Forum Global Risks 2010 report

Physical, reputational, regulatory & legal risks

Investors are also looking at water from a physical, reputational, regulatory and legal risk perspective, focusing on issues such as:

- **Negative impacts from water** including operational disruptions from drought and flooding, poor water quality leading to higher pre-treatment costs, increases in water prices and fines and legal costs.
- **High-impact sectors** which use large volumes of water and wastewater such as the agriculture, beverage, energy, electronics, food, mining, textile and utilities sectors.
- **Best practice** initiatives such as awareness of water-related risks in terms of business decision making, improving water management and efficiency in internal operations and the supply chain, disclosing corporate water performance and targets, and subsequent efficiency improvements.

Chart 47: Need to better map water-related risks



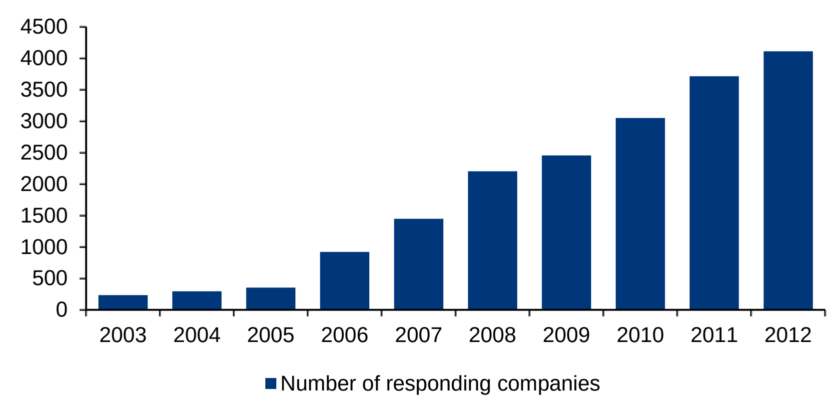
Source: Ernst & Young, BofA Merrill Lynch Global Research

Corporates - water strategy is lacking

"Many companies have not yet fully grasped the importance of strategic planning or communication in relation to long-term water supply mitigation and use. Investors are becoming more aware of the risks and opportunities that water scarcity represents within their portfolios and are increasingly looking for companies to build responses into their longer-term strategies." – KPMG UK's head of climate change and sustainability

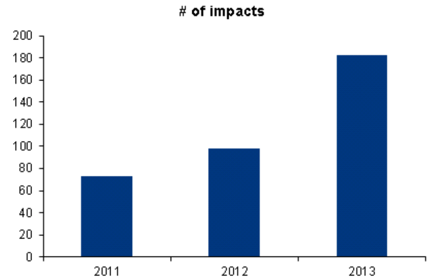
Despite significant improvements over the last few years, an estimated 60% of the world's largest 250 companies across 34 countries do not have a long-term water strategy to tackle the global water scarcity challenge, despite discussing the issue in their reporting (Source: KPMG).

Chart 48: Number of global companies disclosing water use



Source: Carbon Disclosure Project 2013

Chart 49: Total number of detrimental impacts experienced in past 5 years (# of impacts)

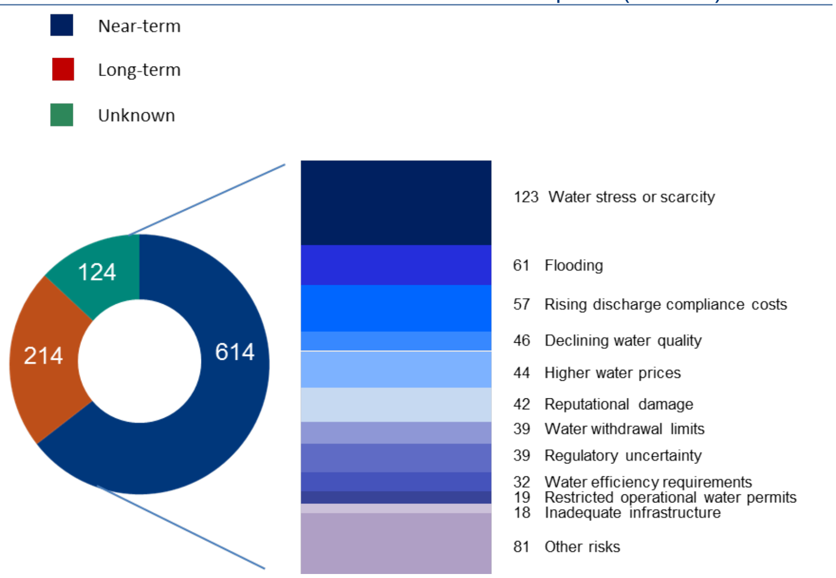


Source: CDP Global Water Report 2013

53% of respondents experiencing detrimental impacts

The CDP's Global Water Report shows that for the 305 companies listed on the FTSE Global Equity Index Series (Global 500) – operating in sectors that are water intensive or exposed to water-related risks – the corporate reaction is fairly slow moving. Despite growing investor interest, the response rate has remained stagnant YoY at c.60% or 184 companies. This is somewhat worrying given that 53% of respondents have experienced detrimental water-related impacts on operations, such as business interruption and property damage from flooding.

Chart 50: Timeframe of risks and near-term substantive risks reported (# of risks)*



Source: CDP Global Water Report 2013.

"These findings suggest that water is not receiving the boardroom attention that the risks and opportunities related to water imply it should be" – CDP's Global Water Report

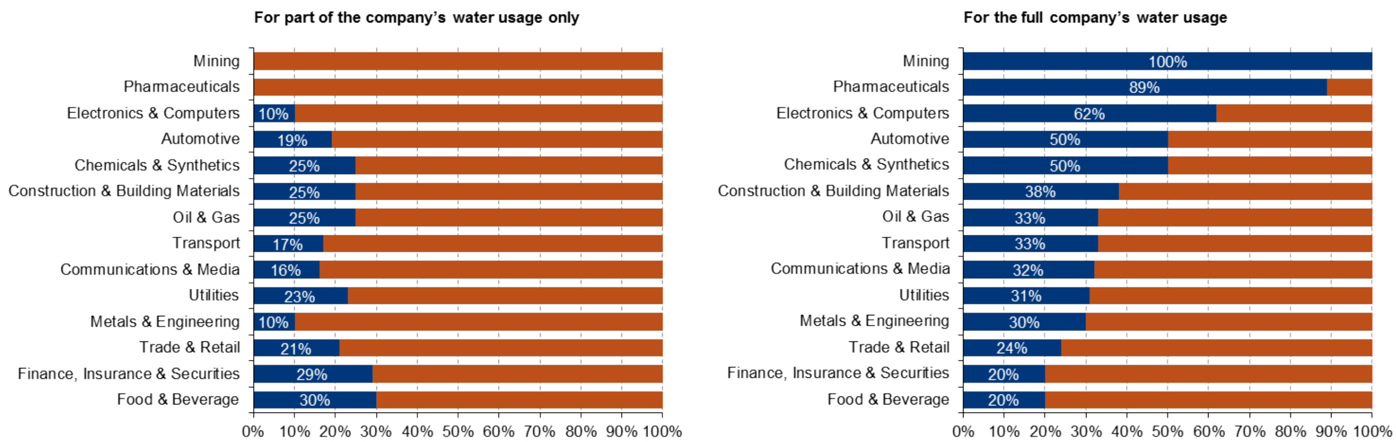
Insufficient attention at board & senior management level

The proportion of CDP respondents with board-level oversight of their water-related policies, strategies, or plans remains largely unchanged over the last two surveys at 58%.

Positive momentum on supply chain

Companies are becoming increasingly aware of the significance of water-related risk, such as business interruption due to inadequate public infrastructure, supply chain disruption due to water scarcity and reputational damage. 70% of CDP respondents report exposure to water-related risks that could substantively affect their business. In two years, the percentage of companies recognizing the risks that water presents has increased by 17%. 62% of companies expect supply chain risks to materialise within the next 5 years.

Chart 51: Reported water footprinting by G250 companies*

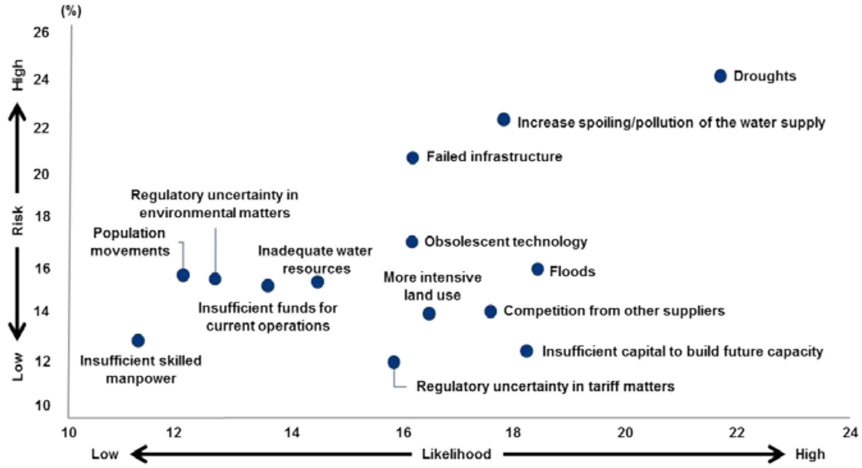


Source: KPMG, BofA Merrill Lynch Global Research. * G250 = World's largest 250 companies

Water pressure, companies facing record penalties

Companies are also facing increasing regulatory pressure on water. In March 2014, Alpha Natural Resources Inc. one of the U.S.' largest coal producers, agreed a settlement with the DoJ, EPA and there states to pay a US$27.5mn fine for violations of the Clean Water Act between 2006 and 2013. The EPA said that it is the largest civil settlement over water-pollution permits under the Clean Water Act. The company also said that it will spend cUS$200mn to reduce toxic discharges into waterways in five Appalachian states.

Chart 52: Water company executives' top concerns in terms of their severity and risk



Source: EIU and Oracle Utilities, BofA Merrill Lynch Global Research

Stakeholders - water matters

UN recognises water at core of sustainable development

The UN has consistently regarded water as being at the core of sustainable development:

"We commit to the progressive realization of access to safe and affordable drinking water and basic sanitation for all, as necessary for poverty eradication, the empowerment of women and to protect human health…" – Rio +20

The UN resolution "declares the right to safe and clean drinking water and sanitation as a human right that is essential for the full enjoyment of the right to life"

- **2012 United Nations Conference on Sustainable Development (UNCSD), or Rio+20 summit** – The third international conference on sustainable development "reiterate[d] the importance of integrating water in sustainable development and underline[d] the critical importance of water and sanitation within the three dimensions of sustainable development."

- **Recognition of clean water as a human right** – In 2010, the UN General Assembly adopted a resolution declaring a human right to clean drinking water and sanitation by a vote of 122 in favour, none against and 41 abstentions. Brazil, China, France, Germany, Russia and Spain were among those supporting the resolution.

UN MDGs on track for water but falling short on sanitation

In 2000, governments committed to a wide range of UN Millennium Development Goals (MDGs) with the aim of reducing poverty and child mortality by 2015. The MDGs include two specific goals related to water:

- **To halve the proportion of people unable to access or afford safe drinking water; and**

- **To stop the unsustainable exploitation of water resources** by developing water management strategies at local, regional and national levels to promote both equitable access and adequate supplies.

Table 27: The impact of water, sanitation and hygiene on development goals

Sector & MDG	Impact of water, sanitation and hygiene (WASH)
Health, Nutrition, HIV/AIDS (MDGs 4, 6)	• 88% of diarrheal deaths are attributable to poor WASH • Nutrition compromised by diarrhoea and intestinal worm infestations • Hand washing is linked to reductions in acute respiratory infections • Improved WASH helps reduce helminths, guinea worm, fluorisis and arsenicosis • Avoid opportunistic infections
Education (MDG 2)	• 443m school days missed pa due to water and sanitation-related diseases • Improving WASH in schools has an impact on enrolment and retention
Poverty (MDG 1)	• 5.5bn productive days per year are lost due to water & sanitation issues
Gender Equity (MDG 3)	• Women and girls spend many hours collecting water • Lack of sanitation in schools is a barrier to girls' attendance

Source: The Global Water Crisis, Papers for the InterAction Council, 2011-2012

783m people lack access to an improved source of drinking water and 2.5bn to improved sanitation (Source: UN)

The 2013 update on progress towards the water-specific goals reports that the drinking water target has been surpassed although 768m people still lack access to an improved source of drinking water and that, at the current pace, 605m will still lack access in 2015. When it comes to sanitation, 2.5bn people have no access to improved sanitation services. One in seven of those without access to adequate sanitation services lives in a rural area. At the current rate of investment progress, the MDGs for sanitation will be missed by half a billion people. Most of these people live in sub-Saharan Africa and Asia (Source: WHO/UNICEF).

Water-human development link

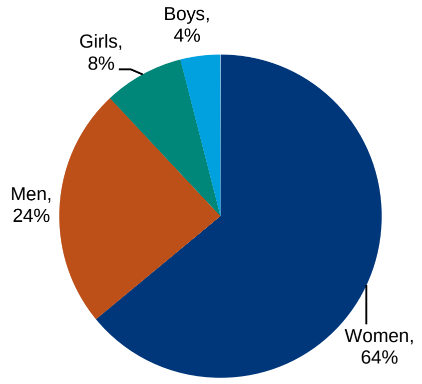
The provision of water services is intimately linked with development. Most of the benefits obtained from (and the costs incurred by) investing in water and water management are external to the agencies and firms making the investments. Better access to and more widespread availability of water expands the productive capacity of the economy by, for example, increasing the productivity of land or labour, and improving the quality of crops, energy and other products. Improving basic sanitation and access to safe drinking water leads to healthier lifestyles. Improved health means fewer lost working days – and increased productivity. According to the World Health Organization (WHO), 80% of diseases in the developing world are caused by unsafe water, poor sanitation and a lack of hygiene education.

Table 28: Overall benefits of achieving the MDGs for water and sanitation

Types of benefit	Breakdown	Monetized benefits (in US$)
Times saved by improving water and sanitation services	20 billion working days a year	US$63 billion a year
Productivity savings	320 million productive days gained in the 15-59 age group 272 million school attendance days a year 1.5 billion healthy days for children under five	US$9.9 billion a year
Health-care savings		US$7 billion a year for health agencies US$340 million for individuals
Value of deaths averted, based on discounted future earnings		US$3.6 billion a year
Total benefits		US$84 billion a year

Source: OECD (2010); Pruss-Ustun et al (2008); Hutton and Haller (2004), BofA Merrill Lynch Global Research

Chart 53: Responsibility for collecting drinking water

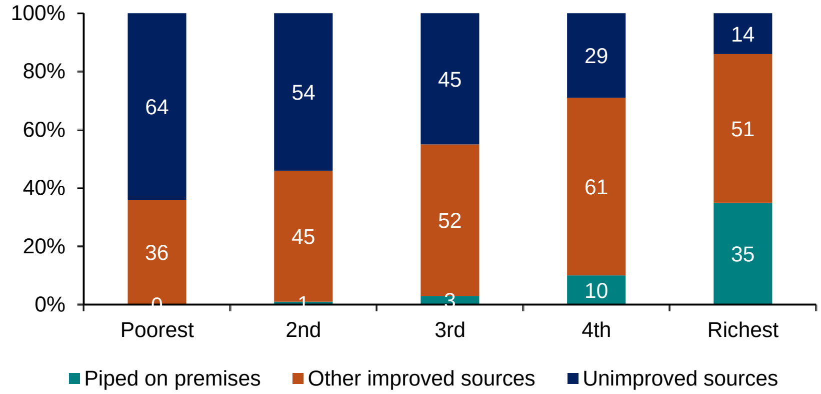


Source: UN/WHO

More than 80% of Americans support recycled water for "toilet-to-turf" uses that require non-potable water. Those uses include power generation, industrial processing and manufacturing and flushing toilets (Source: GE)

People who do not have access to water from a safe facility that is located nearby pay a high opportunity cost for collecting the minimum amount they need to satisfy their basic needs. This opportunity cost is effectively paid in terms of lost time, lost school days and lost working days. Making water available to the poor is a means of freeing up human capital that can then be put to creating wealth.

Chart 54: The richest quintile is more than twice as likely than the poorest quintile to use improved drinking water



Source: United Nations

Growing stakeholder awareness of water

There is also growing stakeholder awareness of the challenges around water, with government and consumer polls of citizens showing that consumers have a high level of awareness of the demand-side pressures on water. For example, an October 2012 survey by General Electric showed that two-thirds of Americans polled support re-using water to help protect the environment and stem scarcity issues forecast for 36 US states next year. Understanding the water lifecycle lag – i.e., where their water comes from – was even higher among those polled in China and Singapore.

SE4All, the growing water-energy link

Water and energy are interlinked and interdependent – with 90% of global power generation water intensive. Global water withdrawals for energy production accounted for 15% of all water withdrawals, and this number is set to increase 20% by 2035 (Source: IEA, UN). The United Nations launched the Sustainable Energy for All initiative in September 2011 in order to bring together business, governments, investors, community groups and academia to move towards sustainable energy for the world. The objective of the initiative is to:

- Ensure universal access to modern energy services
- Double the rate of improvement in energy efficiency
- Double the share of renewable energy in the global energy mix

Businesses and investors have committed more than US$50bn towards SE4All's objectives. The initiative has participation from more than 50 governments, benefitting more than 1 billion people. SE4All functions by developing processes for shared learning and accountability, as well as creating an Action Agenda in which stakeholders can make concrete commitments to move towards sustainable energy by 2030. Specific high-impact initiatives include: electric vehicles, energy efficiency in buildings, smart grids, renewable energy procurement, energy-smart foods, and fuel efficiency standards.

Water treatment solutions

In our view, a number of stocks are well placed to benefit from the theme of water treatment through their involvement in areas such as wastewater, industrial treatment, chemicals, desalination, ballast water treatment, analysis, water quality, PV solar, bottled water, life science tools, and testing, inspection and certification, among other areas.

Increasing levels of water treatment will be an expanding area in the coming years given rising water scarcity and growing demand from the agriculture, residential and industrial sectors. Agriculture currently accounts for 70% of water use and demand looks set to rise on the back of changing diets. Industry will be under pressure to treat water as global demand rises from 22% of total demand towards the current 59% in developed markets. Municipal and residential water use is also growing on the back of urbanisation and EM growth.

There are significant low hanging fruit opportunities around water treatment with less than 3% of water globally being recycled. Water treatment covers the processes used to make water more acceptable for a desired end-use, such as drinking water, usage or re-usage by industry, in irrigation, or return to the natural environment. Moreover, this market is barely tapped with insufficient wastewater treatment around the world. For instance, wastewater reuse stands at only 2.41% of all water withdrawals globally (Source: FAO Aquastat). The estimate of total global water reuse is less than the water used each day by US toilets at home. The goal needs to be to move to best-practice levels of water reuse of up to 75% (e.g. Israel).

The municipal and industrial water and wastewater treatment market was estimated to be c.US$178bn in 2013 (Source: GWI). On the municipal side, the increasing burden of environmental regulations and the need to extract more value from the water cycle is driving the market. Growth in spending is being driven by the Asia Pacific market, with China overtaking the US as the world's largest spender (Source: GWI)

We anticipate that some of the largest opportunities will emerge around the multi-billion dollar municipal and industrial water treatment market vis-à-vis sectors with heavy volumes and environmental constraints (utilities, oil & gas, mining), strict water constraints (FOB, cosmetics), variable effluents (petrochemicals, energy, breweries), as well as in emerging areas like ship ballast water treatment.

Desalination is also set to emerge as a US$41bn industry by 2025 (Source: Japanese Ministry of Economy), with PV solar a long-term opportunity.

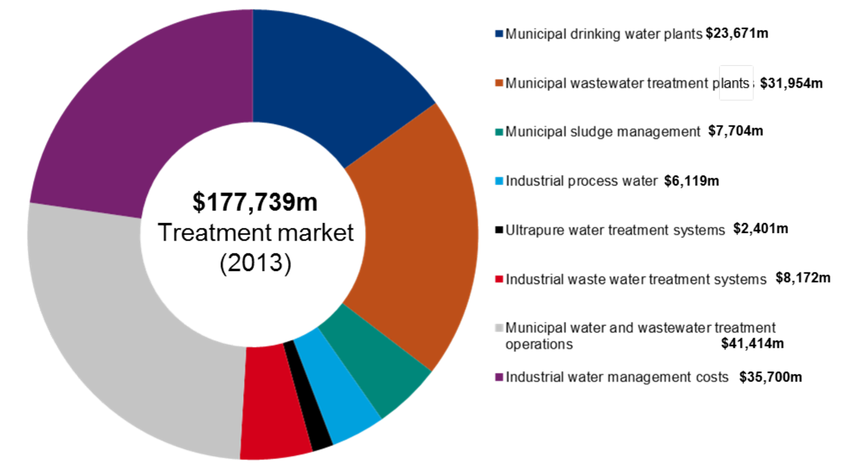
Bottled water is a US$101bn market, with a 5% CAGR to 2015E.

Table 29: BofAML Global Water - Stocks in our coverage universe with exposure to Water Treatment

Company	Water Exposure*
Beijing Enteprises Water	High
China Everbright	High
Kemira	High
Kurita Water	High
Stericycle	High
Danaher	Medium
Danone	Medium
Ecolab Inc	Medium
Empresas ICA	Medium
Nestle (Reg)	Medium
NWS Holdings	Medium
Rexnord	Medium
Acciona	Low
Alfa Laval	Low
ALS Ltd	Low
BASF	Low
BV	Low
Doosan Heavy	Low
Dow Chemical	Low
DuPont	Low
Entegris Inc	Low
ICL	Low
IDEXX	Low
Kuraray	Low
Lanxess	Low
Nitto Denko	Low
Outotec	Low
Pall Corp	Low
SCI	Low
SGS	Low
Spirax-Sarco	Low
Thermo Fisher	Low
Toray	Low

Source: BofA Merrill Lynch Global Research
* Water exposure = BofAML estimates of current sales derived from water treatment-related products, services, technologies and solutions

Chart 55: Water & wastewater treatment: industrial & municipal market (2013)

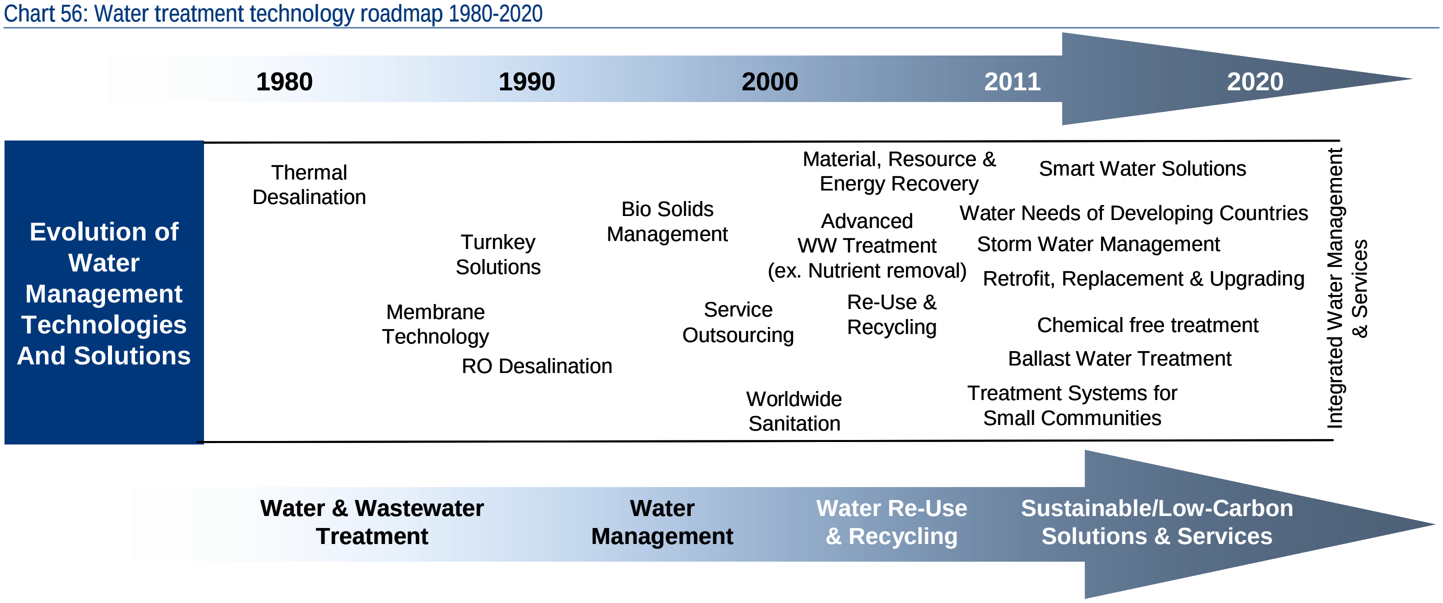


Source: GWI

Potable water, a global push

Water purification is the removal of contaminants from untreated water to produce potable water (i.e., pure enough for human consumption) and its post-treatment conveyance and distribution. Substances that are removed during the process of drinking water treatment include suspended solids, bacteria, algae, viruses, fungi, minerals such as iron, manganese and sulphur, and other chemical pollutants such as fertilisers.

Chart 56: Water treatment technology roadmap 1980-2020



Source: Frost & Sullivan, BofA Merrill Lynch Global Research

A global challenge

For 1.2 billion people across the globe, access to safe drinking water remains out of reach. For those with access to treated water, especially in urban areas, quality concerns are growing. The main drivers of water purification treatment are the rapid growth of urban areas and new drinking water standards in Europe and North America. In 2009, the American Society of Civil Engineers produced a report on drinking water and wastewater infrastructure standards in the US, awarding the lowest grade possible. Confirmation of these results came from EPA, which suggested that US$203bn would be required over 20 years simply to address infrastructure shortcomings.

Standards vary widely across the world

WHO guidelines are generally followed as the baseline for drinking water quality requirements – with each country or territory or water supply body also able to set more stringent guidelines:

- **The European Drinking Water Directive** acts as a benchmark for all EU member states. While the member states are allowed to include additional requirements, they are not allowed to lower standards.
- **The Safe Drinking Water Act in the US** requires EPA to establish National Primary Drinking Water Regulations for various contaminants that may have adverse effects if ingested.
- **China's classification system** uses grades: Grade I refers to the natural water resources protected by the states, Grades II and III refer to the natural water resources that could be used to make drinking water and to sustain the aquatic eco-system. Grade IV water is deemed suitable only for industrial use, and Grade V water is only for agricultural use.

Table 30: Summary of selected national water agencies

Country	Industry bodies	Description
England & Wales	Ofwat	Economic regulator
	Drinking Water Inspectorate	Monitors the quality of drinking water
	Environment Agency	Scrutinizes the companies' environmental performance
	Defra	Oversees water policy and regulation
Scotland	Water Industry Commission for Scotland	Economic regulator
	Drinking Water Quality Regulator for Scotland	Regulates drinking water standards
	Scottish Environmental Protection Agency	Evaluates environmental performance
Australia	National Water Commission	Responsible for driving water reform in Australia
Canada	Canadian National Water and Wastewater Benchmarking Initiative	Tracks and reports the performance of water and wastewater utilities
Portugal	Instituto Regulador de Aguas e Residuos	Responsible for local distribution systems and the retail function
USA	National Association of Water Bodies	Association of privately owned water companies
	United States Environmental Protection Agency	Monitors the quality of drinking water

Source: BofA Merrill Lynch Global Research

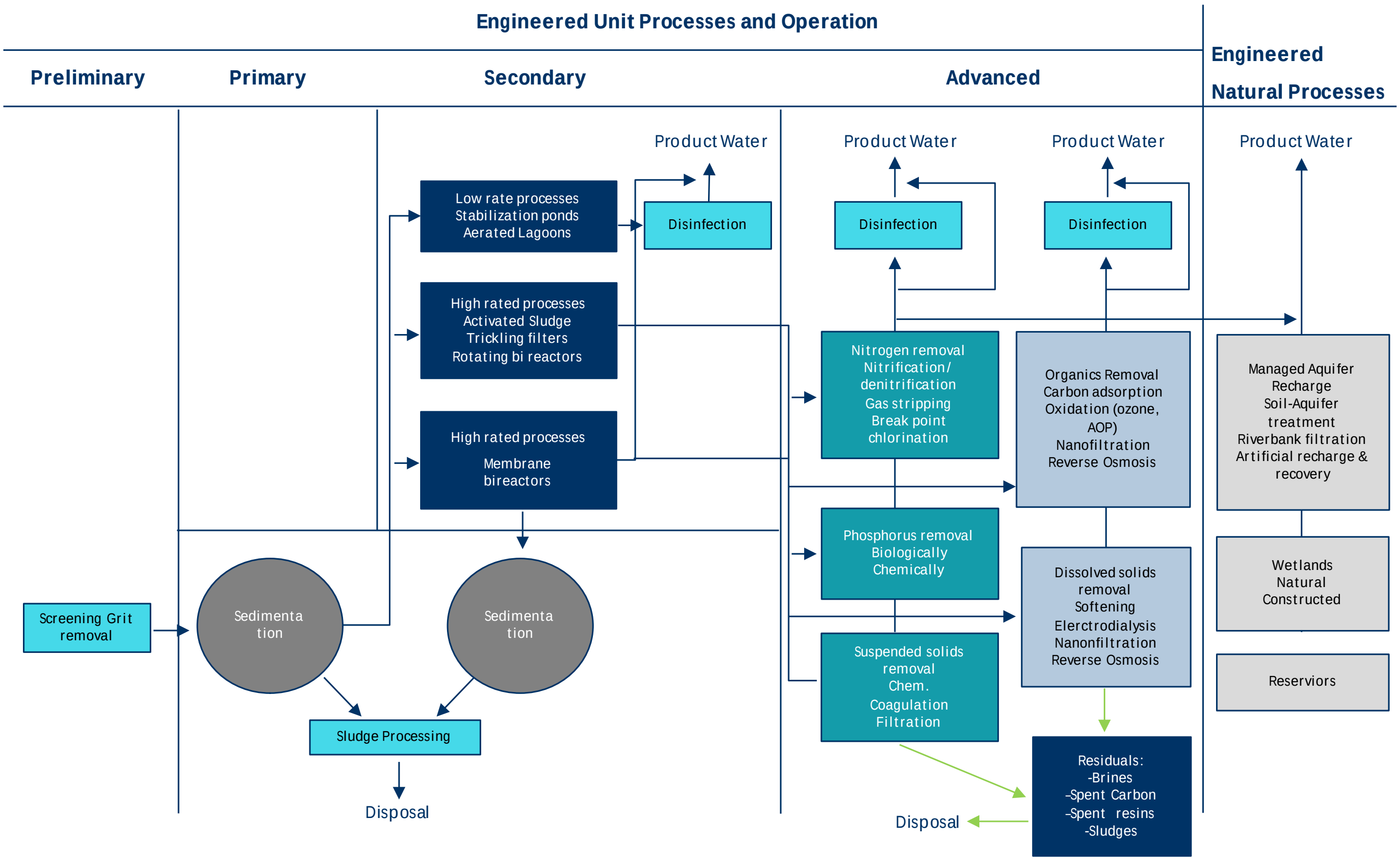
In the US, ageing wastewater management systems discharge billions of gallons of untreated sewage into local surface waters each year

In China, an estimated 70% of lakes, rivers and reservoirs are polluted

Wastewater and sewage treatment

Sewage treatment is the process that removes the majority of the contaminants from wastewater or sewage and produces both a liquid effluent suitable for disposal to the natural environment and sludge. To be effective, sewage must be conveyed to a treatment plant by appropriate pipes and infrastructure and the process must be subject to regulation and controls. Some wastewaters require different and sometimes specialised treatment methods. At the simplest level, treatment of sewage and most wastewaters is carried out through the separation of solids from liquids, usually by sedimentation. By progressively converting dissolved material into solids, usually a biological floc that is then settled out, an effluent stream of increasing purity is produced.

Chart 57: Treatment processes commonly used in water reclamation



Source: National Research Council , BofA Merrill Lynch Global research

New technologies gaining on chlorination

There is no unique solution and municipalities or water utilities will use different processes according to the water source or season. Chlorination was the dominant technology in the disinfection sector for close to 100 years, accounting for 80% of the market. Now, other technologies including ozone treatment, membrane filtration and ultraviolet (UV) treatment are becoming more widespread as concerns about chlorine use grow.

Table 31: Water purification processes & technologies

Process	Overview
Pre-chlorination	Algae control and arresting any biological growth
Aeration	With pre-chlorination for removal of dissolved iron and manganese
Coagulation	For flocculation
Coagulant aids (polyelectrolytes)	To improve coagulation and for thicker floc formation
Sedimentation	For solids separation (i.e., removal of suspended solids trapped in the floc)
Filtration	Removing particles from water
Desalination	Process of removing salt from the water
Disinfection	For killing bacteria

Source: BofA Merrill Lynch Global research

"Wastewater reuse is poised to become a legitimate part of the nation's water supply portfolio given recent improvements to treatment processes" - R. Rhodes Russell, chair of the National Research Council committee on water reuse

Water reuse must become new supply source

There are long-standing psychological barriers to water reuse stemming from "toilet to tap" concerns or fears. However, we are starting to see a change in mind set off the back of:

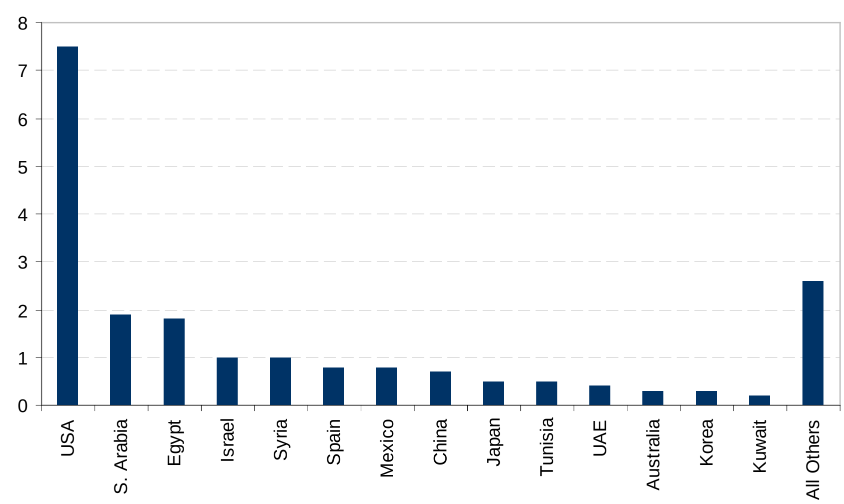
- **Advances in technology and design** – such as treating municipal wastewater and reusing it for drinking water, irrigation, industry, and other applications – could significantly increase total available water resources, particularly in areas facing water shortages.
- **Reuse of treated wastewater**, also known as reclaimed water, to augment drinking water supplies has significant potential to help meet future needs.
- **Possible health risks of exposure** to chemical contaminants and disease-causing microbes from wastewater reuse do not exceed, and in some cases may be significantly lower than, the risks of existing water supplies (Source: National Research Council).

Local history, geography, and cultural influences play an important role in the types of reuse practices adopted in different countries

Kuwait, Israel, Qatar, Singapore & Cyprus leading the way

Globally, major water reuse facilities are in place in at least 43 countries around the world, with approximately 13 BGD (50mn m3/d) of wastewater reused worldwide. Of this amount, 5.5 BGD (21 million m3/d) of treated municipal wastewater was reused globally. Although the US reused the largest volume of treated wastewater, the per-capita water re-use leaders are Kuwait, Israel, Qatar, Singapore and Cyprus – where water reuse represented >10% of total water extraction. In Israel, for instance, approximately 75% of wastewater is reused, with almost all of it going for agricultural irrigation (Source: National Research Council).

Chart 58: Global reuse of treated wastewater (21 million m3/d)



Source: National Research Council, BofA Merrill Lynch Global Research

More than 80% of Americans support recycled water for "toilet-to-turf" uses that require non-potable water. Such uses include power generation, industrial processing and manufacturing and flushing toilets (Source: GE)

Growing stakeholder acceptance of toilet to turf water use

2012 and 2013 surveys by General Electric showed that two-thirds of Americans polled support re-using water to help protect the environment and address the scarcity issues projected for 36 US states next year. Understanding of the water lifecycle lag – i.e., where their water comes from – was even higher among those polled in China and Singapore. 90 percent of Chinese survey participants were concerned with water quality and the availability of clean water for future generations. China also ranked the highest in understanding the connection between water and energy; as many as 93 percent of the Chinese people surveyed understand that water delivery is dependent on energy and that water is needed to generate energy.

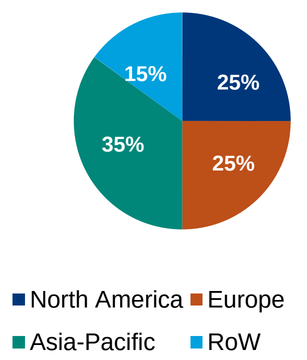
Water treatment chemicals market

One of the first steps in water treatment is the addition of chemicals to assist in the removal of organic and inorganic particles suspended in municipal and industrial water and wastewater. Given growing global water treatment regulation and needs in EMs, this will mean increasing use of coagulants and flocculants, corrosion inhibitors, scale inhibitors, biocides, chelating agents, anti-foaming agents, and pH adjusters, among other chemicals.

Consumption growing at 3.5% CAGR to 2018

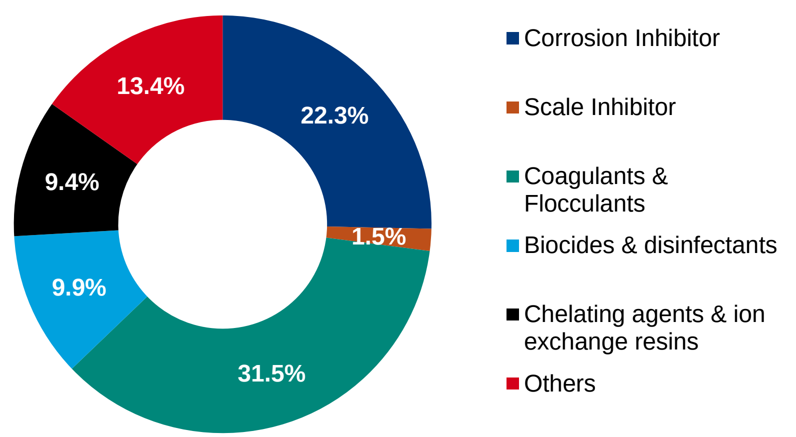
Water treatment chemicals market consumption is expected to grow from an estimated 12.8bn lbs in 2013 to 15.3bn lbs by 2018, or a CAGR of 3.5%.Whiel coagulants and flocculants are the key chemicals in terms of consumption, corrosion and scale inhibitors represent the highest value share of the market, while biocides and disinfectants are gaining importance in developed markets as a reverse osmosis chemical (Source: MarketsandMarkets).

Chart 59: Water treatment chemicals market consumption by region 2012



Source: MarketsandMarkets

Chart 60: Water treatment chemicals by type 2012



Source: MarketsandMarkets

Highly fragmented market, fast growth from China

The global water treatment chemicals market is fragmented – with the market highly mature in developed markets and subject to consolidation, but still at an early stage of development in EMs. (Source: MarketsandMarkets). Leading companies with exposure include AkzoNobel, Ashland Water Technologies, BASF, Dow Chemical, Ecolab, GE Water, Kemira, Kurita Water, Lonza Group, and Veolia, among others. China is expected to see some of the fastest growth with the market reaching an estimated $US3.3bn by 2018 (Source: Research and Markets).

The expansion of industries with special water requirements for either quality or reliability will drive growth in this market

Industrial water treatment, $50bn opportunities

Water scarcity and regulation are driving water reuse in industry – and industrial wastewater treatment is becoming a multi-billion dollar market, including equipment, services and chemicals to meet the specialised water quality and water treatment needs of various sectors. Due to the highly differentiated nature of technologies and strong pricing, industrial water treatment sits close to the top of the water value chain. Water use is extensive across sectors and we see significant opportunities vis-à-vis sectors with heavy volumes and environmental constraints (utilities, oil & gas, mining), strict water constraints (FOB, cosmetics), and variable effluents (petrochemicals, energy, breweries), as well as in emerging areas like ship ballast water treatment.

Table 32: Demand for wastewater treatment by sector

Sector	Issue	Market potential
Agriculture	Surface run-off carrying large amounts of fertiliser and livestock slurry are contaminating waterways	Water quality regulations and protection of biodiversity will drive this industry
Chemicals	Wastewater from chemical industries often requires a combination of treatment methods to remove contaminant before discharge	Installed capacity is already at a reasonably high level
Electronics	Semiconductors require regular washing with ultra-pure water during manufacture	
Marine Transport	IMO ballast water regulations are expected to be ratified, enforcing stricter quality standards	More than 57,000 maritime vessels will require BWT equipment from 2009 to 2020. Potential to generate $34.1bn in revenues
Mining	Toxic waste and mine effluents can be mobilised by water contaminating local sources	Currently estimated expenditure: $818.1m
Oil & Gas	Produced water contains residual oil as well as other contaminants. Injection water can block reservoir pores if contaminated with solids and bacteria	More stringent regulations for discharge require exploration wells to closely consider more effective treatment systems.
Pharmaceuticals	Growing concern about the persistence of some pharmaceutical products and their impact on water resources	
Textiles	Almost all dyes, speciality chemicals and finishing products are applied to textiles in water baths	Majority of manufacturers have established treatment systems in place

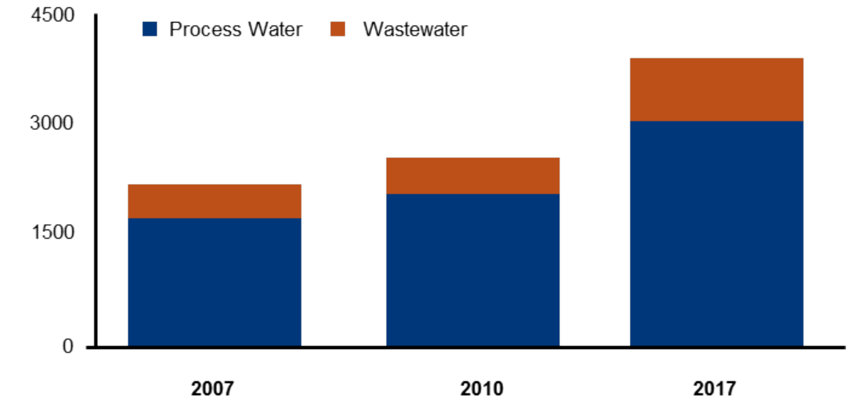
Source: BofA Merrill Lynch Global Research

Every day, on average, water-cooled thermoelectric power plants in the US withdrew 60 to 170bn gallons of freshwater, and consumed 2.8 to 5.9bn gallons of that water (Source: Union of Concerned Scientists)

Power plants, US$4bn market by 2017

The IEA forecasts that the world economy will demand at least 40% more energy by 2030. This will require the installation of larger and more efficient power generation plants across the world. This means massive water use – and increasing pressure to act on water stress and treat process water and process wastewater. By 2017, water treatment for utilities could grow to become a US$4bn market (Source: Frost & Sullivan).

Chart 61: Power generation water and wastewater market revenue forecast, CAGR 5.6% 2010-17

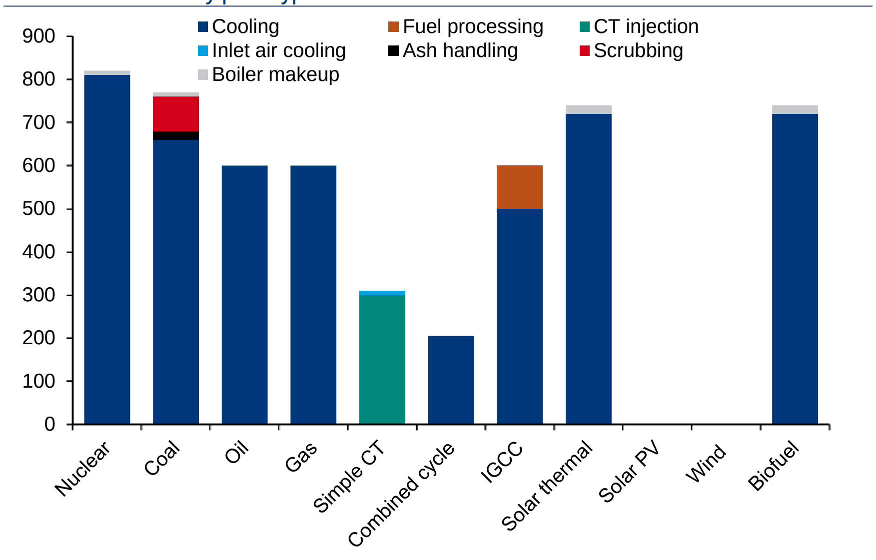


Source: Frost & Sullivan, BofA Merrill Lynch Global Research

Water-hungry power plants

The largest single use of water by industrials is for cooling in power generation. Other uses include producing steam, condensing and processing waste, removing impurities, and transporting fuel through pipelines. Gas-fired plants consume the least amount of water per unit of energy produced; coal and oil-fired plants consume up to twice as much as gas-fired, and nuclear consumes up to three times as much. The future is unclear, with IGCC (integrated gasification combined cycle) able to reduce a coal plant's water consumption by half, but CCS (carbon capture and sequestration) potentially increasing a coal plant's water consumption by 30-100%.

Chart 62: Water use by plant type



Source: EPRI, BofA Merrill Lynch Global Research

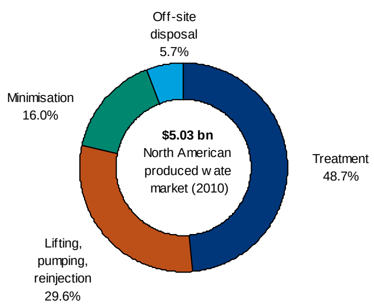
Water stress becoming increasingly important

Where this water comes from is becoming an increasingly important risk factor – especially for utilities that do not rely on surface water – given that growing numbers of groundwater aquifers globally are suffering from overdraft. While some of the water used by plants can be recycled or discharged back to source, water stress and scarcity mean that utilities will be facing increasing competition for water from agriculture and residential/municipal use. This poses a particular risk for China and India, which are planning over US$700bn of investments in "cheap" coal-fired power plants in the coming two decades, but face growing pressure on food, water and energy security.

Oil & gas, growing focus on produced water market

The oil industry is an indirect water industry, producing water as a by-product ("produced water"). The water to oil ratio (WOR) for the industry as a whole is around 2.5x, with some segments, such as North American onshore oil, producing 8x more water than oil. By 2025, the sector could be producing 5x more water than oil, with onshore crude oil having a ratio of up to 12x, largely on the back of ageing wells and increased unconventional O&G such as EOR, shale gas and oil sands – all of which have thirsty water needs. This produced water is often highly saline and contaminated by hydrocarbons: it is a hazardous waste which requires treatment, disposal, and – with advances in desalination – potentially on- or off-site recycling (Source: GWI).

Chart 63: N Am produced water market 2010

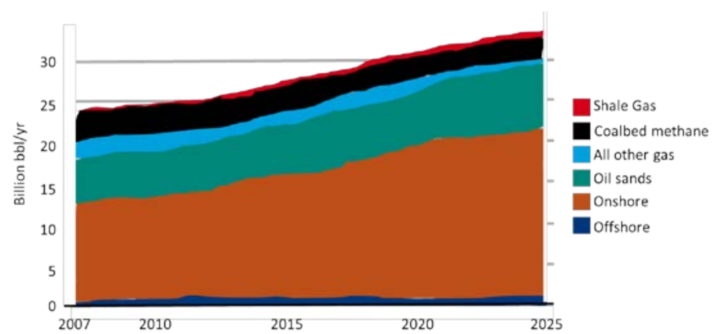


Source: GWI, BofA Merrill Lynch Global Research

Produced water market to grow by 5% CAGR over 20Y

The increased WOR and growing environmental concerns and regulation will, we estimate, see the market for water treatment technologies, such as membrane and thermal desalination technologies, filtration systems and biological treatment systems, grow at close to 5% pa over the next 20 years. Enhanced oil recovery (which needs water with a precise salinity) and highly water-intensive oil sands and shale gas will create the largest opportunities, in our view.

Chart 64: Produced water forecast to 2025

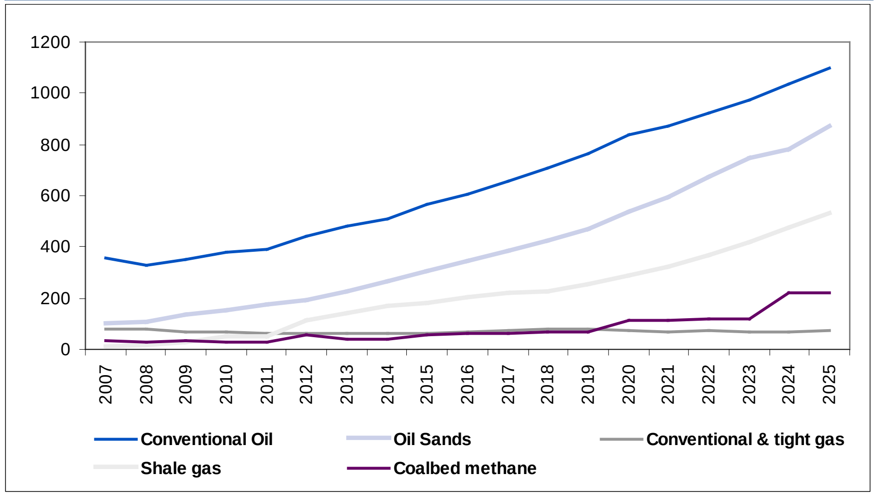


Source: GWI

Disposing of produced water off-site can cost as much as US$10 per barrel ($63/m3) (GWI)

Water treatment in the North American oil sector alone (of produced water) could grow from an estimated US$5bn in 2010 to US$10bn by 2025, a CAGR of 4.7%. Within the sector, the US-produced water treatment equipment market is set to grow from US$693mn in 2010 to US$2.9bn during that time, an annual growth rate of 10.1%. The desalination technologies market, currently worth US$59mn, should enjoy the fastest growth rate, averaging 20.4% per year (Source: GWI).

Chart 65: North American produced water equipment market 2007-25 (US$m)

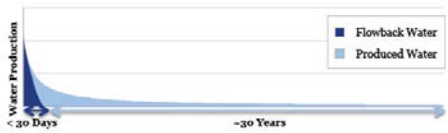


Source: GWI, BofA Merrill Lynch Global Research

Shale gas under growing water pressure

Shale gas remains controversial in many circles because the industry's process of fracking uses large volumes of water withdrawals from ground and surface water, which some believe could impair drinking water resources, as well as posing a contamination risk because of the chemicals used. An average of 6.3mn gallons of water are used per well in the US (Source Heckmann), and with companies drilling up to 16 wells per well pad, this means sizeable water treatment needs. Chemical and toxin-laced flowback water, which returns to the surface after the well is completed (over c.30 days), accounts for 20% of water. Produced water or water which flows over the lifecycle of a well after it has been drilled (over c.30 years) accounts for 80%.

Chart 66: Water use in shale wells



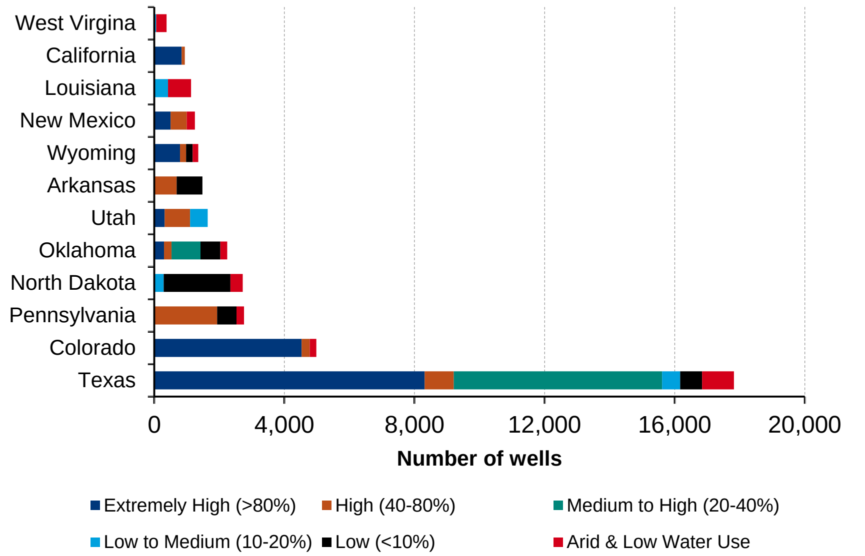
Source: Heckmann, BofA Merrill Lynch Global Research

50% of recent wells in water stressed areas

A 2014 report by CERES – a US-based not-for-profit – notes that close to half the oil and gas wells recently fracked in the U.S. "are in regions with high or extremely high water stress" and more than 55% are in areas experiencing drought. In Colorado and California, 97% and 96% of wells respectively, are in regions with high or extremely high water stress. Between Jan 2011 and May 2013, 97bn gallons of water has been used for fracking, with an average use of 2.5mn gallons per well.

Texas is high on the list for water sourcing risk due to its intense shale energy production in Eagle Ford, Permian, Barnett and Haynesville, and a projected doubling of hydraulic fracturing water use over the next decade. Total hydraulic fracturing water usage in 2012 was 25bn gallons – half the total in US for that year. This number is expected to rise to approximately 40 billion gallons by 2020s. This coincides with drought conditions in two thirds of Texas, stressed fresh water aquifers, and anticipated population growth.

Chart 67: States with most reported hydraulic fracturing activity by water stress category



Source: Ceres, BofA Merrill Lynch Global Research

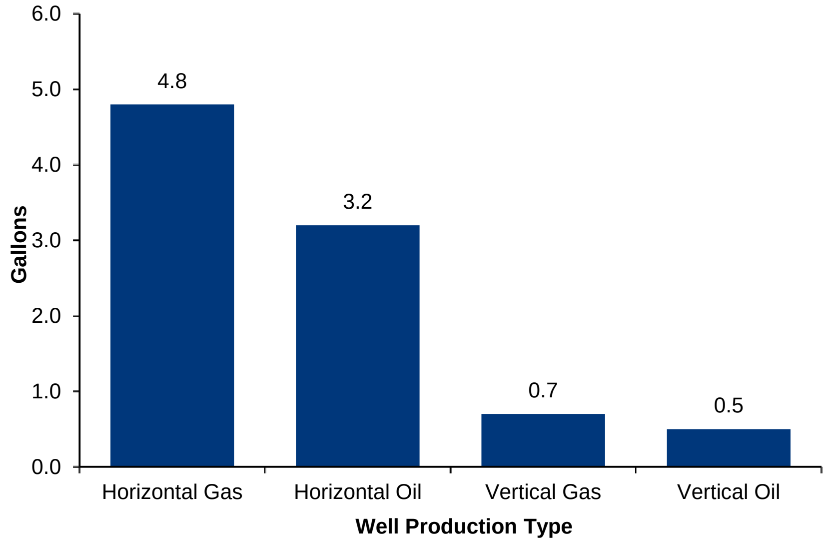
Groundwater depletion is especially a concern given they are less regulated and there is little visibility on how much is withdrawn. Groundwater is also by nature interconnected with one another and with surface water resources. Overuse not only creates local stress of groundwater but also leads to reductions to surface water flows. While groundwater supplies are naturally replenished by rainfall, this process may take decades or even centuries.

Fracking dominated by a few oil & gas companies

Oil and gas exploration and production (E&P) companies that are involved in hydraulic fracturing are ultimately liable for its environmental impacts and are most exposed to fracking-related water issues. In the US, the top 10 E&P companies account for 56% of fracking water. Oil servicers that help conduct field operations for E&P companies are even more concentrated. The top three servicers handle 55% of all hydraulic fracturing nationally (Source: Ceres).

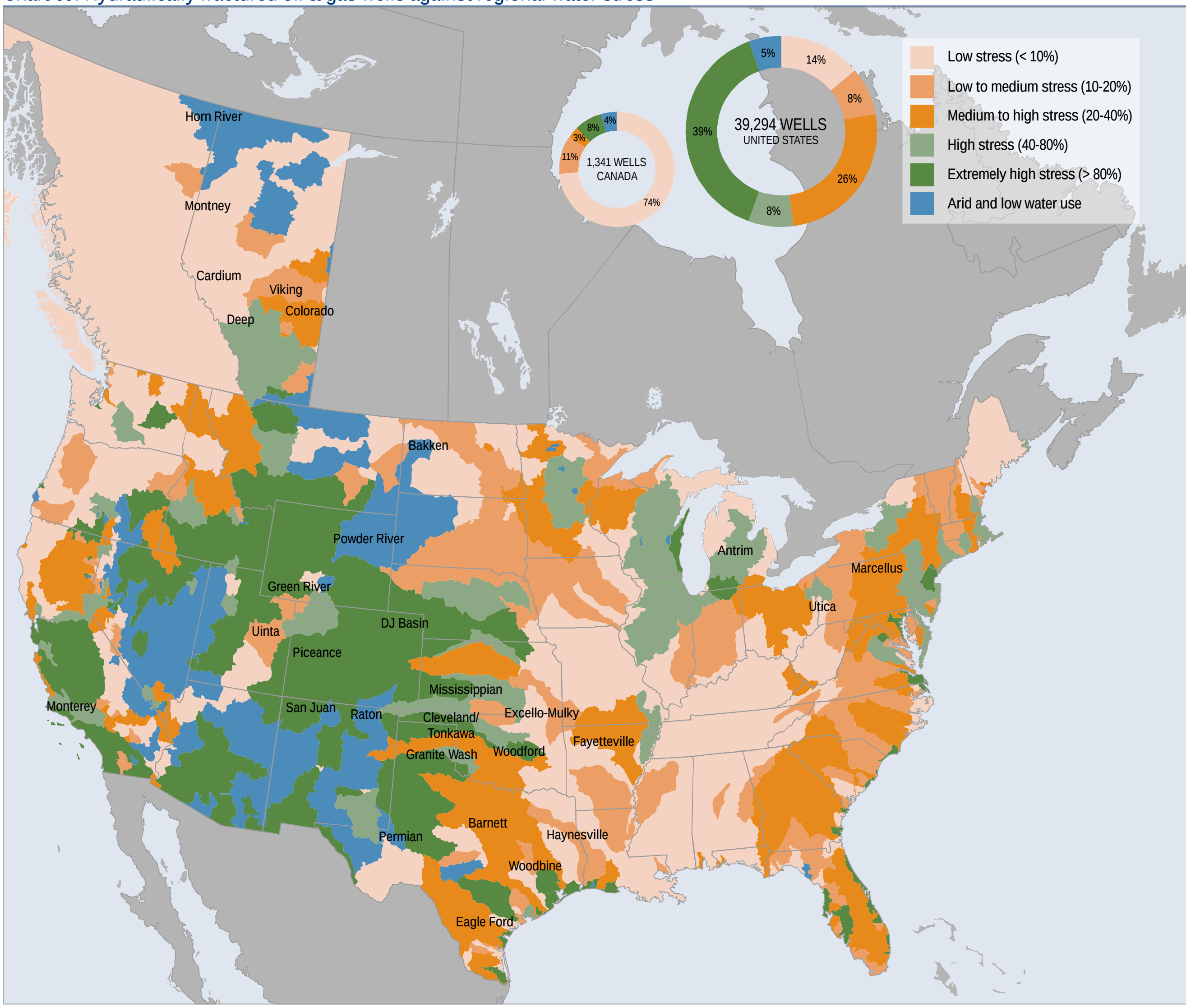
While studies have shown that power production from using hydraulically fractured natural gas consumes less water in aggregate than burning coal, much can be done to use recycled water or utilize alternative inputs such was brackish water and waste water. Many oil servicers are helping to develop technologies to recycle frack water themselves. Currently about one-fifth of total frack water usage comes from recycled or brackish water (Source: University of Texas). With more stringent regulation and increasing water scarcity, energy companies would be compelled to be more efficient with their water management for long-term sustainability.

Chart 68: Average water use per well by type of production (in mm)



Source: Ceres (based on PacWest FracDB from FracFocus data from wells drilled January 2011-May 2013)

Chart 69: Hydraulically fractured oil & gas wells against regional water stress



Source: Ceres, BofA Merrill Lynch Global research

The water needing to be treated poses challenges including salinity, hydrocarbons, chemicals and heavy metals

US$9bn market by 2020

The large amount of water needing to be treated is creating a frack water treatment industry, which is expected to exhibit a 28% CAGR to become a US$9bn market by 2020 (Source: Lux Research). The US EPA's likely move on water treatment should provide a fillip over the next two years. Technologies used by players in this field include bag filters, chemical precipitation, electric coagulation, distillation, membrane filtration or a combination (e.g., adding ozone, ultrasound, electricity and pressure).

Unlike many industrials, mining operations are reliant on the location of ores, with limited ability to mitigate local or regional water scarcity or stress

Mining, a US$14bn market by 2014

Water scarcity and broader environmental risks will continue to push up development and operating costs in the global mining industry as these trends become more pronounced (Source: Moody's). The mining industry is particularly dependent on water as a key input to the processing system, when the ore is crushed into finely ground tailings and mixed with various chemicals. With more and more miners operating in water-scarce regions, there will be significant investment to ensure the security of supply. Moreover, water pollution from waste rock and tailings has prompted national regulators to address the current water quality legislation. One of the problems – in terms of water – is the mechanisation of the industry, which has enabled mining companies to handle more rock and, importantly, lower-grade ore, which generates large volumes of waste. Mining companies will spend around $12 billion globally on water infrastructure in 2013. This is a 56% increase on the $7.7 billion the industry spent in 2011, and a 275% increase on the $3.2 billion spent in 2009. This compares to a net increase in global mining output for the major commodities of between 20% and 52% during the same period (Source: Moody's).

Table 33: Main effects of mining on water

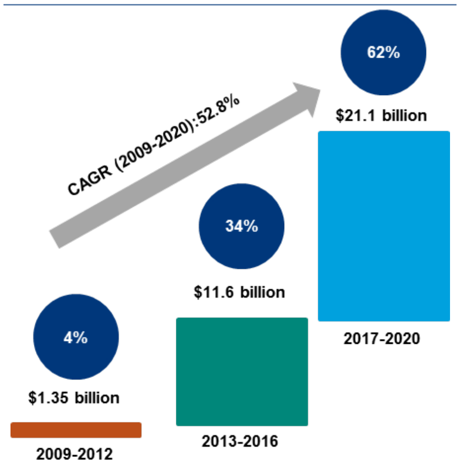
Mining impact	Overview
Acid mine drainage	A natural process whereby sulphuric acid is produced when sulphides in rocks are exposed to air and water. Acid mine drainage is, therefore, the same process magnified
Heavy metal contamination & leaching	Caused when such metals as arsenic, cobalt, copper, lead and zinc contained in excavated rock or exposed in an underground mine come into contact with water
Processing chemicals pollution	Occurs when chemical agents (such as cyanide or sulphuric acid) used to separate the mineral from ore spill, leak or leach form the mine site into nearby water bodies.
Erosion & sedimentation	In the absence of adequate prevention and control strategies, erosion of the exposed earth may carry substantial amounts of sediment into streams, rivers and lakes.

Source: BofA Merrill Lynch Global research

Miners increasingly investing to treat water

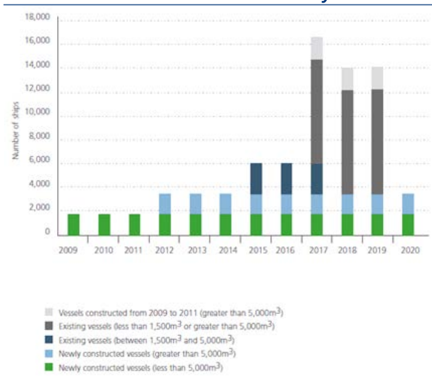
Mining companies are investing in treating water and wastewater used in operations and implementing best practices on water stewardship to adapt to the new water stress operating realities. Depending on mining wastewater quality, >90% can be reused via treatment (i.e., reverse osmosis, microfiltration). Together with best practice water management, daily freshwater intake can be reduced by up to 40% (Source: Frost & Sullivan). By 2014, it is estimated that the mining industry could spend US$13.6bn (vs. US$7.7bn today) on water-related infrastructure with c.US$820m spent on chemical treatment filtration and desalination systems (Source: Global Water Intelligence). For the companies involved, this presents a fast-growing market for water treatment. Specialist providers may even be able to derive additional revenue from metal recovery in mining effluents.

Chart 70: Ballast water treatment market



Source: Frost & Sullivan, BofA Merrill Lynch Global Research

Chart 71: Estimated number of vessels required to install ballast water treatment systems.



Source: IMO MEPC 61/2/17

Ship ballast water treatment, US$3bn market by 2023e

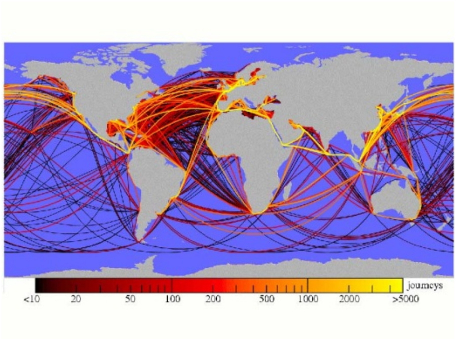
Close to 90% of worldwide trade is made possible by shipping, which also poses significant water risks. Ballast water is the seawater pumped into a ship to maintain operating conditions during a voyage and to stabilise a ship's hull when in port. While the ballast water enables safe and efficient shipping operations, it poses serious environmental problems due to the range of invasive marine species transferred from one ecosystem to another. This is estimated to cost the US alone US$120bn in environmental damage every year (Source: Blassius et al., Royal Society Interface). The emerging market for ballast water treatment is estimated to grow to US$3bn by 2023 (Source: Frost & Sullivan).

International convention close to coming into force

After more than 14 years of complex negotiations between International Maritime Organisation member states, the International Convention for the Control and Management of Ships' Ballast Water and Sediments (BWM) may finally be ratified soon. This Convention aims to address the issue of so-called 'invasive marine species' by enforcing mandatory treatment of ballast water. The BWM Convention will come into force 12 months after ratification by 30 States, representing 35% of the world merchant shipping tonnage. As of February 2014, 38 countries had ratified the Convention; however, a further 5% of world merchant shipping tonnage is needed to fulfil the other entry into force criteria (Source: IMO).

Based on the fact that the Ballast Water Management Convention has not yet entered into force, and that the price for ballast water treatment systems has run into several million US dollars per ship, industry uptake has been slow. However, the effective result of the ratification threshold being reached in the near future will mean that several thousand ships will need to have such systems installed within a very short time span. Further delays in ratification are expected to exacerbate the situation.

Chart 72: Global shipping routes (20tn t miles)



Source: Royal Society Interface

Bottling companies typically use 75-85% of the water supplied to their treatment room for bottled water and soft drinks. The rest is discharged as a waste stream (Source: GE)

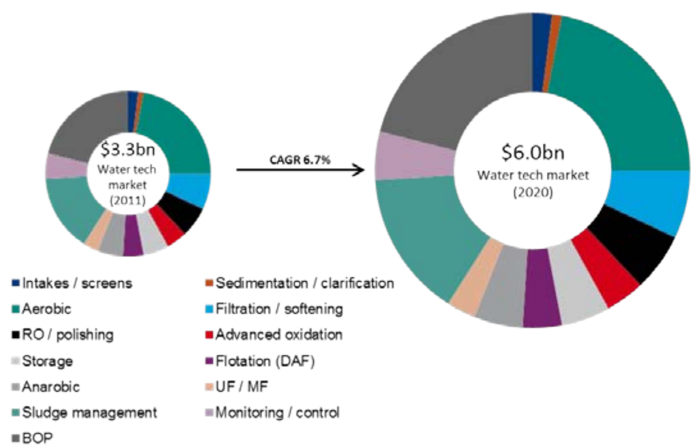
21% market CAGR 2013-2023

The Convention and other standards (e.g., US Coast Guard) present a considerable opportunity for IMO-certified systems manufacturers, as 60,000 maritime vessels will require a retrofit. The market is expected to grow at a CAGR of 21% and to generate revenues of US$ 3bn by 2023 (Source: Frost & Sullivan). Currently, reballasting at sea provides the best available means of reducing the risk of transfer of harmful aquatic species, but is subject to stringent ship safety limits. Up to 40 systems are at or close to commercialisation including solid-liquid separation and disinfection via chemical disinfection and dechlorination, physical disinfection, micro-agitation or advanced oxidation. Key players in the space include industrial groups (Hitachi, Siemens), water and wastewater industry suppliers (Severn Trent, Veolia), ship owners and ship builders (Cosco, Hyundai, CSIC, and Mitsubishi), marine industry suppliers, and BWT-dedicated start-ups

Food & beverage, US$5bn market by 2020

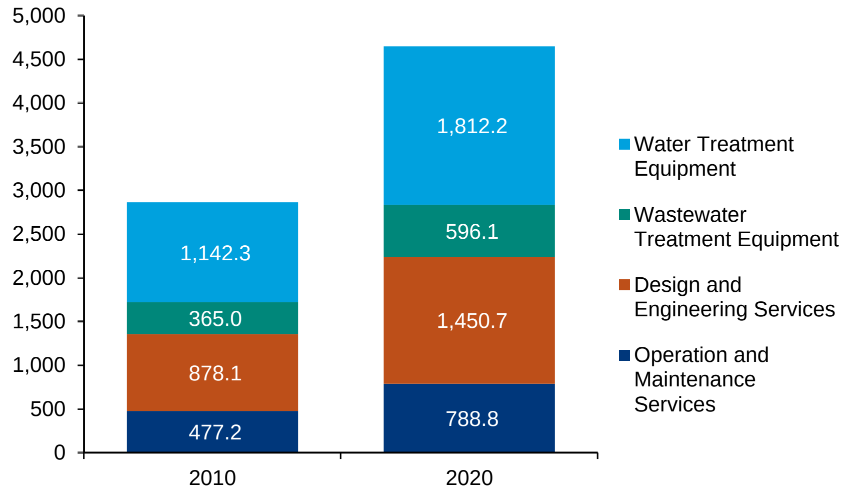
FOB companies are facing growing pressure from stakeholders, regulation and the realities of operating in water-scarce environments. This means an increasing focus on reducing water use and measures such as on-site anaerobic treatment and energy recovery. Recent studies have shown that water treatment technology can help beverage companies to safely treat and reuse water to achieve 99% or higher recovery at their plants (Source: GE). The global water technology market for the sector is expected to grow to US$4.6bn by 2020 (Source: Frost & Sullivan). In terms of technologies, GWI expects anaerobic systems (including biogas collection); ultrafiltration and microfiltration including membrane bioreactors; reverse osmosis and other process water polishing technologies (such as nanofiltration, ion exchange and electrodeionisation); and nutrient removal/recovery to have double digit growth rates.

Chart 73: Global Food and beverage water technology



Source: GWI

Chart 74: Global FOB water and wastewater market revenue forecast, 2010 and 2020 ($mn)



Source: Frost & Sullivan, BofA Merrill Lynch Global Research

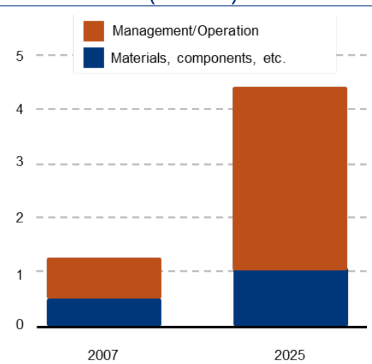
Further information on desalination can be found in BofAML analyst Takahiro Mori & Akiko Kuwahara's work on drought

Industrials & Insurance, 28 September 2012

Desalination, US$42bn industry by 2025

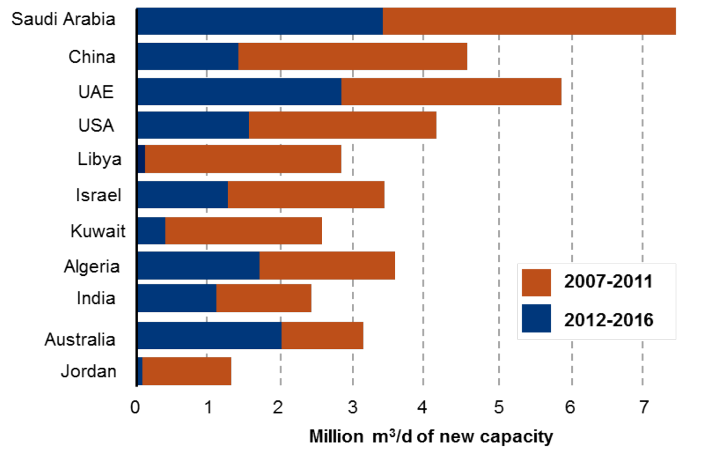
Among the direct methods of increasing water reserves are desalination of sea water, which essentially transforms "unusable" into "usable" water. In recent years, there has been a rapid increase in the installation of new seawater desalination plants, with growth accelerating since 2000, particularly in the Middle East as economic growth there has taken off. Desalination is now practised in 150 countries. Contracted desalination capacity has been growing at a compounded annual growth rate of 16.8% since 1997 (Source: Ministry for Water & Electricity, Saudi Arabia). In 2013, new installed capacity totalled around 6mn m^3/day, bringing global total installed capacity to 80.9mn m^3/day (Source: IDA/GWI). Moreover, 3800 old plants have been taken offline or decommissioned, which means 6.4mn m^3/d of old capacities are ready to be replaced by a much higher capacities. The Japanese Ministry of Economy, Trade and Industry estimates the global market for desalination will reach 4.4 trillion yen ($42.1 billion) by 2025, nearly four times the 1.2 trillion yen it was worth in 2007.

Chart 75: Forecasted growth in global desalination market (¥ trillion)



Source: Trade ministry of Japan

Chart 76: Top 10 desalination markets



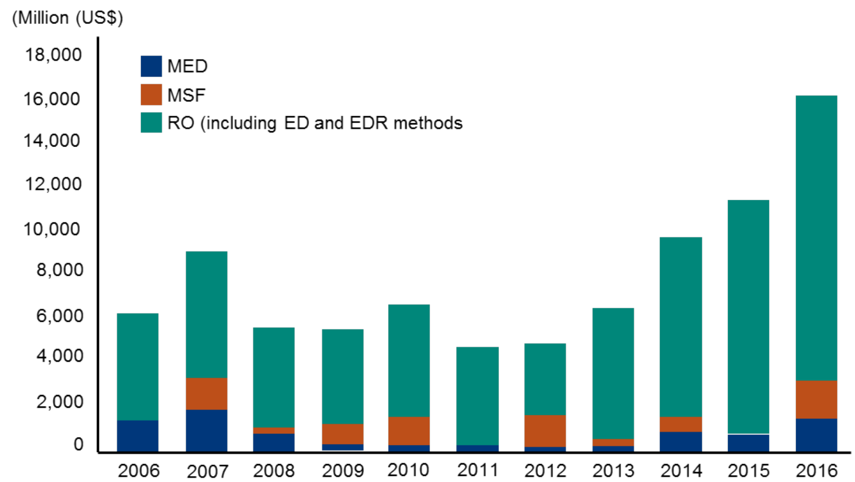
Source: GWI

Table 34: Desalination capacity

Country	Commissioned seawater desalination capacity m3/d
Saudi Arabia	9,170,391
UAE	8,381,299
Spain	3,781,314
Kuwait	2,586,761
Algeria	2,364,055
Australia	1,823,154
Qatar	1,780,708
Israel	1,532,723
China	1,494,198
Libya	1,048,424

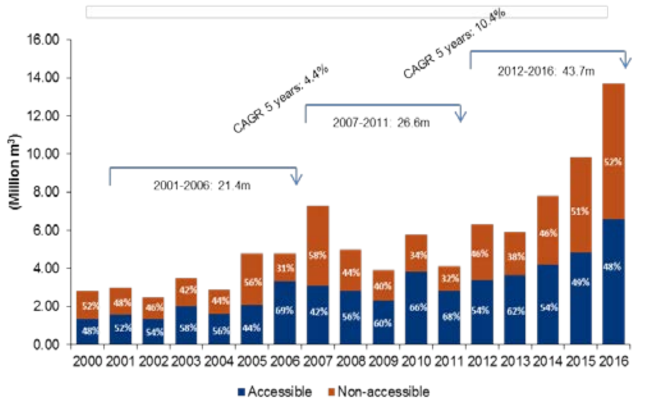
Source: International Desalination Association

Chart 77: Demand Forecast by Desalination Technology



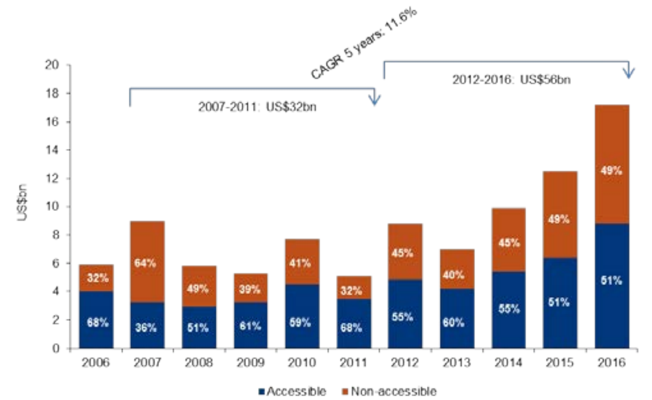
Source: GWI Desal Data

Chart 78: Global annual capacity



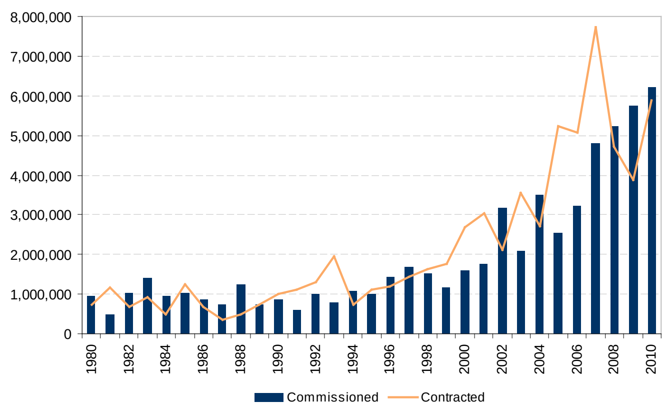
Source: GWI, IDE technologies

Chart 79: Global annual market value



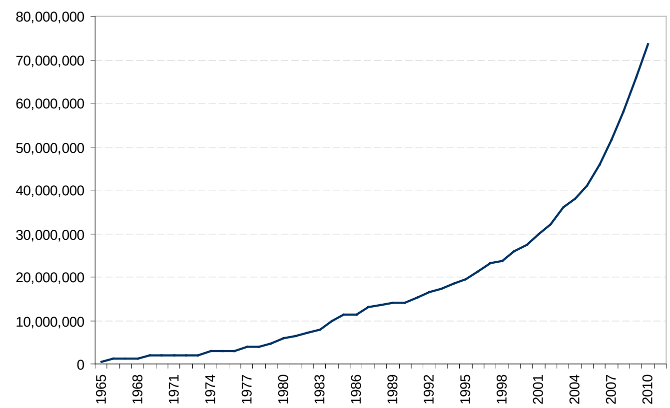
Source: GWI, IDE technologies

Chart 80: Global desalination plants' capacity (m3/d) - new seawater desalination plants



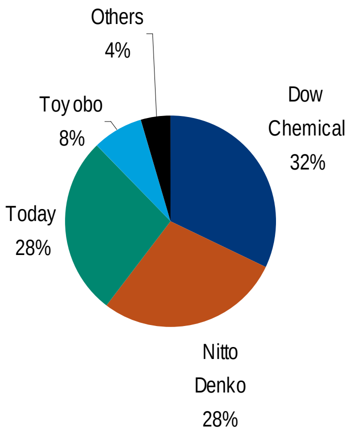
Source: Torishima Pump Mfg.

Chart 81: Global desalination plants' capacity (m3/d) - global installed desalination capacity



Source: Torishima Pump Mfg.

Chart 82: RO Membrane: share by company (2011)

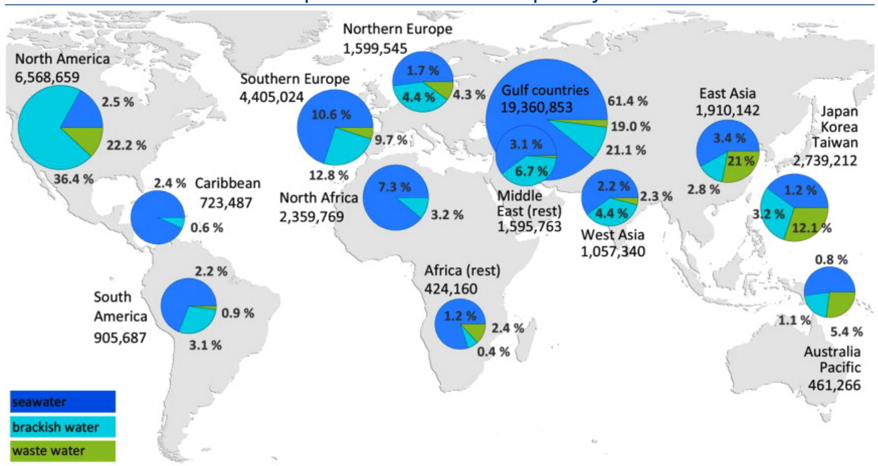


Source: Nikkei, BofA Merrill Lynch Global Research

Increasingly popular in certain regions

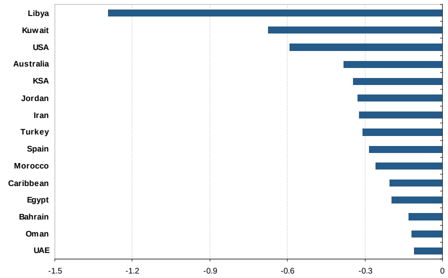
Approximately 1% of the world's population is currently dependent on desalinated water to meet their daily needs (Source: GWI). Desalination is becoming an increasingly popular solution to plug the gap caused by the depletion of freshwater reserves. By region, we expect the Gulf States, Australia, Central Asia and the US, and the Mediterranean rim to be the most naturally pre-disposed to developing desalination as a viable alternative given the importance of water shortages and stress, and their brackish and less saline feedwater. The current largest markets are Saudi Arabia, China, UAE, Israel, Spain, India, the Caribbean and Qatar.

Chart 83: Global desalination capacities in cubic meters per day



Source: Sustainability Science and Engineering, Volume 2, 2010, BofA Merrill Lynch Global Resaerch

Chart 84: Projected desalination capacity cuts 2011-12

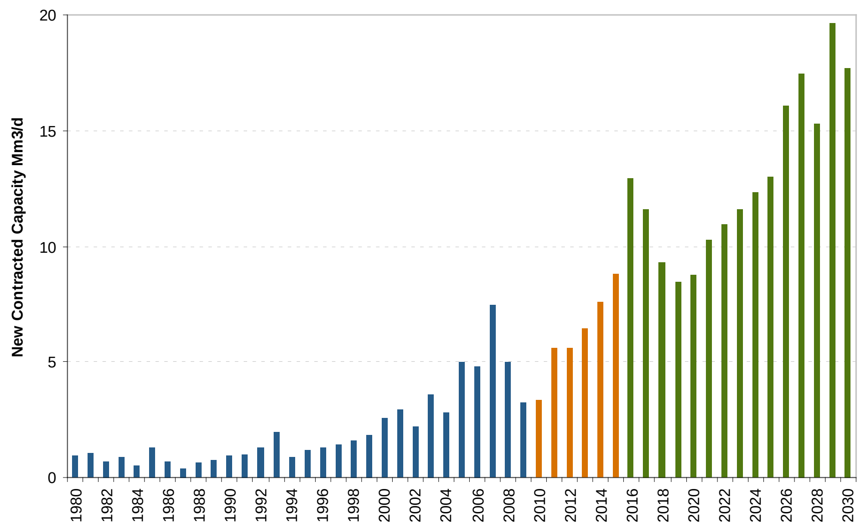


Source: GWI, Hyflux, BoFA Merrill Lynch Global Research

Short-term outlook is weak

The short-term outlook for desalination is weak with projected capacity cuts mainly in MENA. This is partly attributable to the large-scale build-out in recent years and financing challenges given the economic downturn.

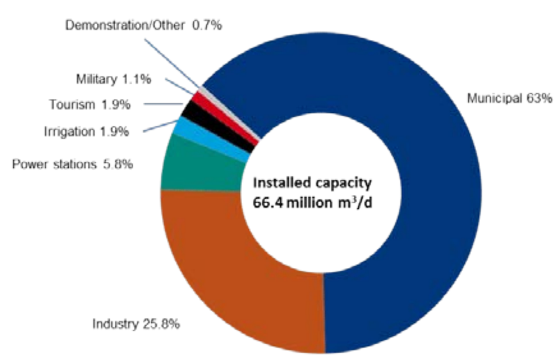
Chart 85: Global desalination market forecast (new contracted capacity)



Source: GWI, Hyflux, BoFA Merrill Lynch Global Research

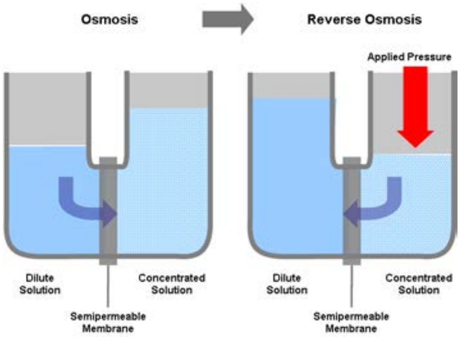
Since the financial crisis of 2008 the growth in demand for desalinated water to supplement municipal water supply has slowed dramatically. While the municipal sector still accounts for the greatest use of desalinated water the industry sector has a greater number of desalination facilities.

Chart 86: Total world installed capacity



Source: Desaldata

Chart 87: Reverse osmosis



Source: National Academy of Sciences

Reverse osmosis in the lead

The global reverse osmosis (RO) membranes and system components market is expected to reach $4.9 billion in 2013. BCC Research forecasts the market to reach $8.1 billion by 2018, and register a five-year compound annual growth rate (CAGR) of 10.7% for the period 2013 to 2018. (Source: BCC Research)

The two major desalination methods are reverse osmosis (RO) and multi-stage flash distillation (MSF). RO used to be at a disadvantage to MSF owing to its higher cost and declining purification effectiveness due to membrane pollution. However, advances in technology have brought costs down to the extent that as of 2001 it had become the cheaper technology. RO involves passing feedwater through a semi-permeable membrane (semi-permeable barrier sheets) at pressure so that the salt remains on one side and allows pure water to pass to the other.

RO is now becoming the mainstream technology for desalination plants as it offers the following advantages over MSF: (1) smaller energy input; (2) lower construction costs due to the use of simpler construction materials; (3) greater scalability due to the use of modular units. Advances have also been made in membrane antifouling treatment, enabling a higher rate of removal of boron, which had previously been a problem in seawater desalination.

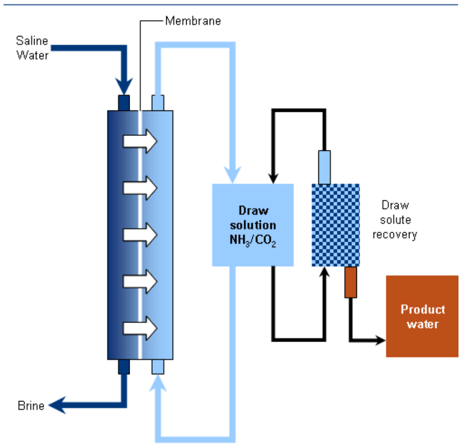
The construction of RO plants is handled by engineering companies such as Mitsubishi Heavy Industries. The largest maker of RO membranes is Dow Water & Process Solutions, though Japanese companies, including Toray, Nitto Denko and Toyobo, have an around 64% share of global supply. In 2011, the global market in RO membranes was worth around US$660mn, and we believe it is growing at around 9% yoy.

Newer technologies becoming commercial

Although RO has gained rapid acceptance, it is only 20% thermodynamically efficient (i.e., 8-20KWh of energy to produce 1,000g of desalinated water). As such, there has been significant R&D activity aimed at addressing concerns about the required energy input. For instance, forward osmosis is being commercially implemented. In the FO process, a draw solution is used to create a driving force for freshwater to pass through the membrane. The technology, according to Modern Water, can reduce energy use and costs by up to 30% and overcomes the fouling limitation inherent in pressure-driven membrane separations. Another option, Vacuum Multi Effect Membrane Distillation, uses processes that combine thermal and membrane technologies in a vacuum to boil the feedwater at lower temperatures (50°C to 80°C).

We find it unlikely that membrane distillation will replace RO in the next five years given the price advantage of the incumbent technology. Investment costs for a RO plant are between $800 to $2,500 per m^3 of daily production capacity. Ultimately, the selection of a desalination process depends on site-specific conditions, economics, the quality of water to be desalinated, the purpose for which the water is to be used and local engineering experience and skills.

Chart 88: Forward osmosis



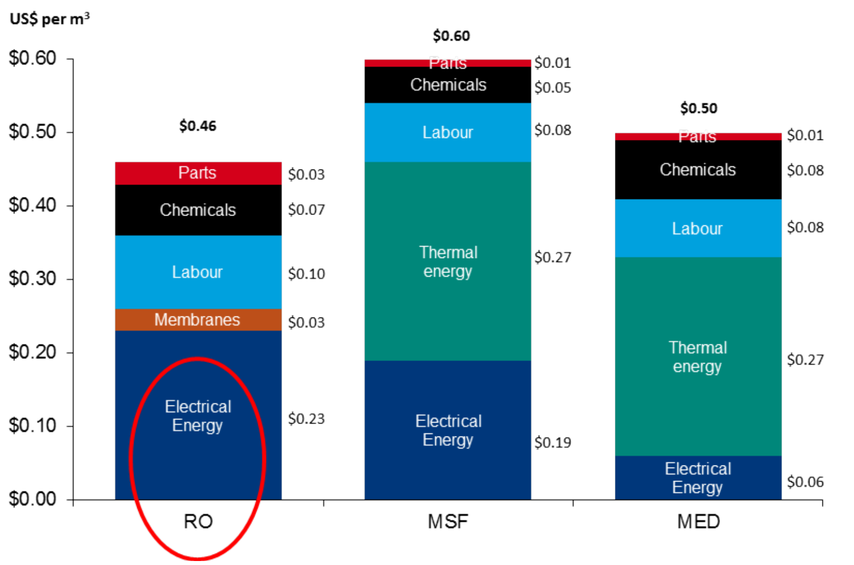
Source: Modern Water

Table 35: Energy requirements for desalination

Process	Total Energy (kW-h/m³)	Capital Cost ($/m³/d)	Unit Water (S/m³)
MSF (without waste heat)	55-57	-	-
MSF (with waste heat)	10-16	1,200-2,500	0.8-1.5*
MED (without waste heat)	40-43	-	-
MED (with waste heat)	6-9	900-1,200	0.6-0.8
SWRO	3-6	900-2,500	0.5-1.2
BWRO	0.5-2.5	800-1,200	0.2-0.4
Innovative Technologies/Hybridisation	<2.0	<800	<0.5

Source: IDA

Chart 89: Desalination plant operational cost components



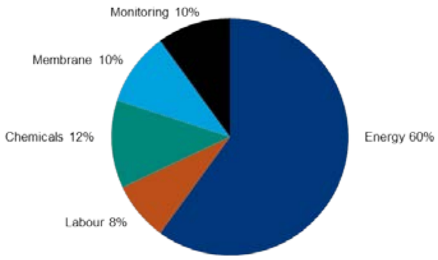
Source: IDA

Table 36: Overview of desalination technologies

Process	Basic Mechanism	Status	Strengths	Weakness	Future
Phase Change	*Salt-Free phase produce*				
Thermal	Steam is salt-free, condenses to form pure water. Energy reused	Major Application	Well established	Energy demand	Strong in 'hybrid' systems
Freeze-thaw	Ice is salt-free, thaws to pure water	Not used	Limited	Energy demand	Unlikely
Voltage Driven	*Salt ion transport*				
Electrodialysis	Ions move through ion selective membranes	Significant for low salt feeds	Well established	Possibly high salts Primary power	Strong but unlikely for seawater
Electro deionization	ED combined with ion exchange resin	Possibly growing	Enhanced ED	As above	As above
Capacitive deionization	Ions absorb and desorb on electrode due to DC voltage	Developmental	Removes minor ions	Possibly high salts Energy recovery	Possible
Pressure Driven	*Water Transport through membrane*				
Reverse Osmosis	Pressure > osmotic pressure, water through polymer film, salts retained	Major application	Established Low energy demand relative to thermal process	Energetic efficiency is low	Strong, with advanced membranes
Forward Osmosis	Water passes to draw solute of high OP. Draw solute regenerated to give water	Operational	Lower energy Ambient pressure	Membrane type	Potentially strong
Thermal-Membrane	Water Vapour Transport				
Membrane Distillation	Heated feed evaporates through hydrophobic microporous membrane	Demonstration	Ambient pressure Low grade heat	Availability of low grade heat	Potentially strong
Bio-enabled	*Cellular Ion Transport*				
Biometric Membranes	Cell wall transports/sorbs ions	Research	Biological process	Development of industrial analogue to biological process	Possible

Source: BofA Merrill Lynch Global Research

Chart 90: O&M costs for desalination



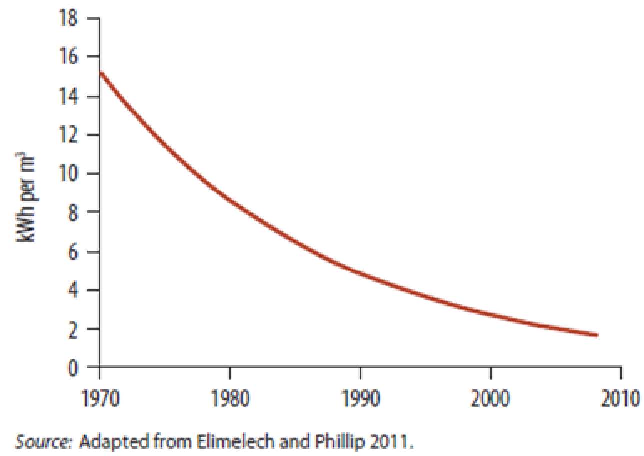
Source: Sembcorp Industries

Significant environmental implications & costs

Despite massive improvements over the past 50 years, desalination is a highly energy-intensive process, with energy constituting 60% of the operating and maintenance costs of desalinated water. Currently, the global production of 65.2 million m^3 of desalinated water requires at least 75.2 TWh per year, or 0.4% of the global electricity consumption (Source: International Renewable Energy Agency).

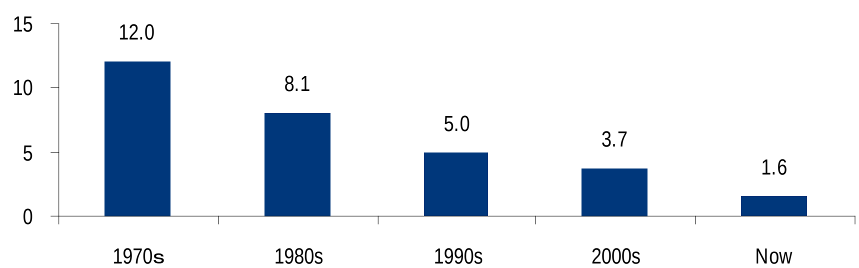
Since the 1970s, RO energy consumption has decreased almost 10-fold. Since 1996, continuous RO innovation in pretreatment, filter design, and energy recovery has reduced the energy consumption per unit of water by a factor of four. The cost of desalination has been decreased to US$0.5/$m^3$, while market prices for desalinated water are typically between US$1/$m^3$ and US$2/$m^3$.

Chart 91: Reduction in RO Power Consumption, 1970-2010



Source: World Bank adapted from Elimelech and Phillip 2011

Chart 92: Electricity consumption for desalination (kWh/m3)



Source: Toray, BofA Merrill Lynch Global research

Besides freshwater impacts, a desalination plant emits GHGs and highly concentrated brine. This latter potent liquid can have a highly detrimental impact on coastal water and marine wildlife if left untreated.

Table 37: Energy use of various water supply alternatives

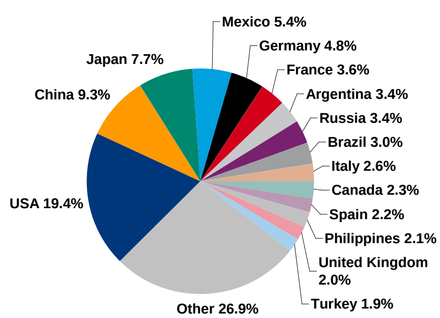
Water Supply Alternative	Energy use – kWh/m3
Conventional treatment of surface water	0.2-0.4
Raw water imported by state water project in California (w/o treatment)	2.4-2.8
Water reclamation	0.5-1.1
Indirect potable reuse	1.3-2.0
Brackish water desalination	0.8-1.3
Desalination of Pacific Ocean Water	2.6 – 3.7

Source: Water Globe Consulting, BofA Merrill Lynch Global Research

Bottled water, US$101bn market & 5% growth

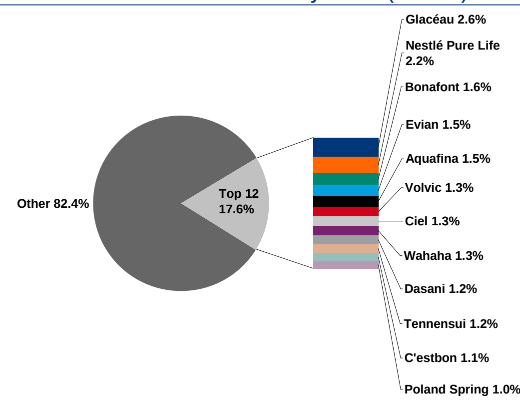
Bottled water is a topic of controversy for a number of stakeholders, but it can also be regarded as a potential water treatment solution or alternative. It has enjoyed a five-year volume CAGR of +4% and a 10-year CAGR of +7.7%, which puts it among the fastest-growing segments of the global liquid refreshment beverage (LRB) category. Bottled water is now a US$101bn market and equal in size to the carbonated soft drinks (CSD) market by volume. Our volume growth estimate for bottled water for 2010-15 is +4.6%.

Chart 93: Bottled water retail sales: by country ($101bn)



Source: BofA Merrill Lynch Global Research estimates, Euromonitor

Chart 94: Bottled water retail sales: by brand ($101bn)



Source: BofA Merrill Lynch Global Research estimates, Euromonitor

Danone & Nestlé the market leaders

Danone (no.2 in overall LRB) and Nestlé (no.3 LRB) maintain a large presence in bottled water and hold 9.8% and 9.6% shares of LRB, respectively. Newer entrants in bottled water include Coke, which maintains a leading share in LRB at 11.6%, and Pepsi at 4.2% (no.4 overall).

Successfully tapped into consumer trends

Bottled water has tapped into divergent consumer trends around the world:

- **Developed markets**: bottled water is a major commercial beverage by positioning itself as an attractive option for health-conscious consumers or vis-à-vis real or perceived health concerns surrounding the quality of tap water.
- **Emerging markets**: bottled water serves as a temporary solution to the problem of unsafe drinking water and/or is a beneficiary of rising disposable income in many countries. Both China and India have seen and should continue to see double-digit CAGRs in bottled water.

Table 38: Bottled water market share matrix (2012)

	Country	Market size (US$m)	PCC (US$ pa)	PCC (07-12)	Coca-Cola	Danone	Nestlé	PepsiCo	Suntory	Wahaha	China Resources	Ting Hsin	Yangshengtang	Acqua Minerale	Private Label	Other
1	USA	19,545	62.2	0%	19.5%	0.5%	20.4%	8.4%							23.4%	27.7%
2	China	9,434	7	13%	5.4%	10.4%	1.7%			13.6%	11.4%	10.3%	8.9%			38.4%
3	Japan	7,822	61.3	6%	17.0%	4.5%	1.7%		21.7%						1.8%	53.3%
4	Mexico	5,488	47.2	7%	23.2%	39.5%	5.5%	17.2%							0.2%	14.5%
5	Germany	4,797	58.6	1%	5.4%	7.7%	6.9%								13.5%	66.5%
6	France	3,603	56.8	-1%		27.3%	30.4%								12.2%	30.1%
7	Argentina	3,477	84.5	14%	5.9%	37.0%	5.9%	2.5%							0.7%	48.1%
8	Russia	3,421	23.9	1%	9.8%	0.3%	2.3%	12.1%								75.5%
9	Brazil	3,005	15.5	10%	3.8%	3.0%	2.7%	7.5%								83.1%
10	Italy	2,625	43.1	-2%	5.4%	0.1%	24.6%	0.1%						22.1%	4.3%	43.3%
11	Canada	2,287	65.6	1%	10.6%	4.0%	28.9%	8.4%							11.3%	36.8%
12	Spain	2,182	47.2	-4%	2.9%	16.1%	7.1%	1.4%						7.8%	23.4%	41.3%
13	Philippines	2,155	22.1	1%	5.6%		0.2%	0.4%								93.9%
14	UK	2,027	32.2	92%	1.0%	35.8%	6.9%	0.2%							28.3%	27.7%
15	Turkey	1,953	26.1	0%	3.0%	4.3%	14.1%	2.6%								76.1%
16	Indonesia	1,876	7.7	6%		46.7%									1.2%	52.1%
17	India	1,646	1.3	18%	13.1%			15.7%								71.2%
18	Dom. R.	976	95.8	2%												100.0%
19	Poland	973	25.5	3%	0.8%	27.0%	10.0%	1.8%						1.5%	10.9%	47.9%
20	South Korea	933	18.7	8%	16.4%	1.3%	8.8%									73.6%
	Total	100,960			11,661	9,850		4,224	1,840	1,286	1,074	969	838	825	8,113	50,554
	% share	100.0%			11.6%	9.8%		4.2%	1.8%	1.8%	1.1%	1.0%	0.8%	0.8%	8.0%	50.1%

Source: BofA Merrill Lynch Global Research, Euromonitor

A glass half full or empty, the stakeholder debate

Bottled water is the subject of much debate with many stakeholders raising doubts as to its social and environmental utility. The industry faces many challenges including:

- **Embedded water**: Estimates suggest that the embedded water (i.e., the water used in the production of a good) in a 500ml plastic bottle is anywhere between 1-2l.
- **Aquifer depletion and the contamination of water sources** pose a severe problem for many players, especially in regulated markets such as the EU where bottled waters must comply with the European Parliament Directives 80/777/EEC & 96/70/EC (i.e., spring water and "mineral water" must come from a specific underground source and be bottled there). Companies offering bottled table water (i.e., tap water that has been treated in some way), where water utilities act as the main suppliers, are not as vulnerable [to regulatory interventions].
- **Packaging:** The primary roles of packaging are to contain, protect and preserve bottled water as well as aid its handling and presentation. The Essential Requirements regulation in the European Directive on Packaging and Packaging Waste specify that these functions must be met by use of the minimum packaging necessary. Since the bottled water industry's green credentials have been challenged, large players have overhauled the composition of their packaging in order to reduce the weight of their bottles and incorporate 100%-recycled/100%-recyclable PET bottle alternatives into their production process.
- **Carbon footprint:** While the carbon footprint of bottled water may be the same as tap water at the time the bottle is filled, if we include packaging and transportation, its carbon footprint becomes substantially larger.

US$14bn POU market provides an alternative

Point-of-use (POU) water treatment technologies offer a cost-effective potential alternative to bottled water where the water has already been treated. Water mains-fed attached point-of-use drinking water purifying and dispensing systems are designed for environments such as offices, factories, other workplaces, hospitals, hotels, schools and restaurants. The POU business consumer sector in the US and Europe was valued at US$2bn in 2009 (Source: WaterLogic). The size of the global residential POU/Point-Of-Entry ("POE") market in 2009 was estimated at US$5.5bn (not counting replacement filter cartridges) (Source: Piper Jaffray) with the total size of the POU/POE market estimated at US$14bn. Pall Corp and WaterLogic offer exposure to this burgeoning industry.

Strong market drivers

There is an increasing move away from Bottled Water Coolers ("BWC"), which currently account for 80% of the water dispenser market in the EU and US (Source: WaterLogic). Drivers of this shift include cost, convenience, health benefits and environmental considerations.

Life sciences, tools for water security

This section is based on BofAML analyst Derik de Bruin & team's work on "Global Drought"

Industrials & Insurance, 28 September 2012

The life science tools (LST) market consists of a diverse set of companies that supply equipment, analytical instruments, consumables, services, and software to research and commercial laboratories. These companies participate in a US$80-85bn market that we estimate is growing organically at a rate of 3-5% a year. However, the phrase "life science tools" is somewhat of a misnomer. While the key customers for most LST companies reside within the drug development industry and academic biomedical research community, LST companies also supply products and services to labs serving industrial and applied market customers.

Food-water-energy security

Life science tool companies sell many products used to monitor food and environmental (e.g., water, air, and soil) quality

Within the applied markets, LST companies sell a broad range of test and measurement tools used for applications in food and beverage safety and environmental monitoring (e.g., water, air, and soil quality). In addition, the analytical instruments sold by many LST vendors are enablers of energy R&D. As such, with their unique position as gatekeepers of human and environmental health, LST companies are likely beneficiaries of the challenges to food, water and energy security. The Table below shows LST companies covered by BofA Merrill Lynch that have exposure to this theme, from relatively lower exposure (+) to relatively higher (+++). Overall, Thermo Fisher Scientific has the broadest exposure to food, water and energy security

Table 39: BofAML covered LST companies exposed to food, water and energy security

Company	Ticker	Food safety	Environmental monitoring (water, air & soil analysis)	Energy
Agilent Technology	A	***	**	**
Bruker Corp	BRKR	*	**	***
Life Technologies Co.	LIFE	**	*	*
Mettler Toledo Int'l	MTD	**	*	*
Plal Corp	PLL	**	***	**
PerkinElmer Inc.	PKI	**	***	**
Sigma-Aldrich	SIAL	*	*	**
Thermo Fisher Scientific	TMO	***	***	***
Waters Corp	WAT	***	**	*

Source: BofA Merrill Lynch Global Research

Tools for environmental & water security

The market for life science tools used for environmental testing applications is estimated at approximately US$4.0bn, growing 4-6% annually. Environmental testing encompasses the analysis of water for chemical and biological contaminants; air monitoring for particulates, pollutants, and greenhouse gases; as well as soil, sediment and solid waste analysis for agricultural and industrial purposes. As this report focuses on the global water crisis, here we briefly look at how the LST sector serves the global water market. That said, we would also expect to see demand for air and soil testing to increase in tandem with the growing demand for clean water and energy.

Water quality

According to Dionex (part of Thermo Fisher Scientific) less than 1% of the planet's water is available for human consumption. Ground and surface water are the largest sources of fresh water, and these sources need to be rigorously analysed for a broad range of primary and secondary contaminants. Not only is it important to look for toxic compounds such as chemicals left over from the manufacturing, heavy metals, pesticides, and other pollutants, it is also necessary to test water for disinfection by-products used during the treatment process to remove harmful microorganisms.

Because water samples, especially wastewater samples, are typically complex in nature, that is, they may contain compounds that interfere with the detection of a specific pollutant, a significant amount of sample preparation may be required as part of the analysis. As such, separation methods based on liquid chromatography (LC), especially ion chromatography (IC), are typically used as part of the sample prep process. Waters and Agilent are the leading players in the LC market, while Thermo Fisher Scientific (via its Dionex unit) is the dominant player in IC with an estimated 69% market share.

Filtration is also a key part of the water treatment process. Through its municipal water business, Pall offers microfiltration, ultrafiltration, and reverse osmosis membrane systems for municipal water treatment. The Pall Aria line of water treatment systems uses hollow-fiber membrane technology to produce pure water from almost any water source, removing bacteria, viruses, trace elements, and other contaminants from the water supply. The system can also be used to desalinate sea and brackish water, and to clean up waste water.

Water management solutions

Table 40: BofAML Global Water - Stocks in our coverage universe with exposure to Management

Company	Water Exposure*
Itron	High
Melrose plc	Medium
Monsanto	Medium
Syngenta	Medium
Syngenta AG - ADR	Medium
Wolseley	Medium
BASF	Low
Deere & Co	Low
Dow Chemical	Low
DuPont	Low
Duratex S.A.	Low
Hexagon AB	Low

Source: BofA Merrill Lynch Global Research
* Water exposure = BofAML estimates of current sales derived from water management-related products, services, technologies and solutions

In our view, a number of companies are well placed to benefit from the theme of water management, vis-à-vis their involvement in areas such as "more crop per drop", irrigation, drought resistant seeds and crops, precision agriculture, "big data", smart metering and household water efficiency.

Water management has assumed greater importance in recent years as a strategy to improve efficiency and the sustainable use of resources. Water usage is growing faster than population growth – with US usage alone increasing 207% from 1950 to 2000 and per capita usage growing by 20% during the same period (Source: EPA). In a situation of growing water scarcity, fragmented water management (and conflicting interests of stakeholders) is no longer cost effective or sustainable in the long term. There is growing recognition that the current water crisis is as much a consequence of weak policies and poor management as natural scarcity. Effective water management enables users to cut their demand, mitigate the risks associated with its shortage and reduce the need for capex-intensive solutions.

Given that agriculture accounts for 70% of global water use –and up to 60% of this water is wasted, the "more crop per drop" theme will grow in importance in a climate change and extreme weather constrained world.

There is significant potential for the US$5.6bn irrigation market given that gravity flow/furrow irrigation accounts for 91% of irrigation globally, and low energy precision application still has extremely low global penetration. More efficient techniques such as mechanised irrigation offer hope and have captured close to 50% market share in some developed markets.

Farmers and stakeholders are becoming increasingly open to drought tolerant/resistant seeds and crops, which are more resistant to adverse extreme weather and environmental conditions like drought and water stress.

Precision agriculture and big data solutions are set to grow in importance in increasing agricultural production and profits with technology helping to optimise the use of farming practices and inputs including water, fertilisers, pesticides and seeds. The global market could be worth US$3.7bn by 2018, representing 13% CAGR growth (Source: MarketsandMarkets).

Leakage and non-revenue water costs utilities upward of US$20bn pa in lost revenues, which should create substantial downstream basic and smart meter demand from water utilities. We forecast a CAGR of 19% in water meter spending to 2016.

Water efficiency will become as important as energy efficiency as 70% of the global population becomes urban by 2050. This will mean that household water management will become increasingly important. The potential is huge – if all US households installed water-saving features, the dollar-volume savings would be US$11.3mn per day or more than US$4bn pa (Source: American Water Works Association).

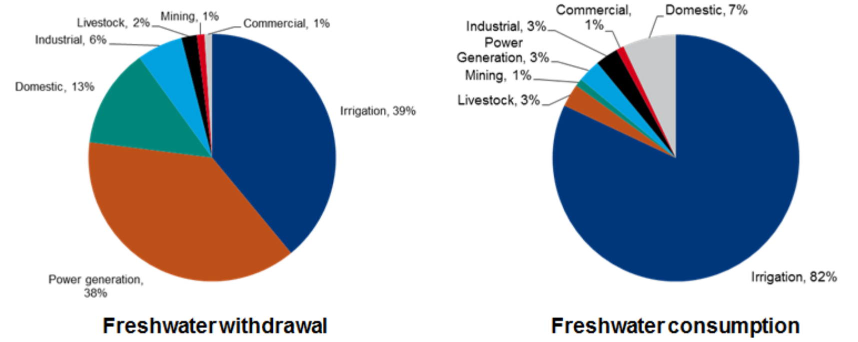
Water use in agriculture is often highly inefficient with only a fraction of the water diverted for agriculture effectively used for plant growth

Globally, roughly 15-35% of irrigation withdrawals are estimated to be unsustainable (Source: WBCSD)

Agriculture & irrigation – more crop per drop

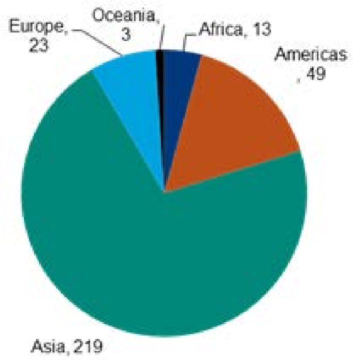
Agriculture accounts for approximately 70% of global water withdrawals and has significant long-term challenges in the form of water scarcity and rising food needs. In the light of extreme weather – drought becoming part of the "new normal" – there is a pressing need to implement better water management practices with the appropriate infrastructure to develop solutions that produce crops with greater water efficiency. Solutions include improving soil structure; increases surface water storage; weed control using herbicides (lowers the need for tillage, which removes topsoil, and maintains roots, which improves water absorption; and: more efficient irrigation systems (deliver water to roots, reducing waste).

Chart 95: Freshwater withdrawal and consumption



Source: EPRI , BofA Merrill Lynch Global Research

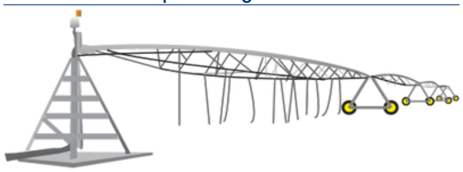
Chart 96: Area equipped for irrigation (mn hectares)



Source: FAO Aquastat

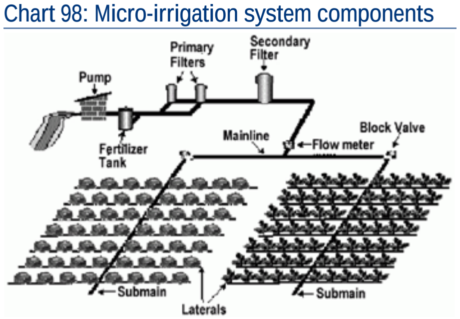
Globally, irrigated crop yields are about 2.7 times those of rainfed farming, hence irrigation will continue to play an important role in food production. The area equipped for irrigation increased from 170 million ha in 1970 to 304 million ha in 2008. (FAO 2011)

Chart 97: Centre pivot irrigation



Source: University of Maryland, BofA Merrill Lynch Global Research

Chart 98: Micro-irrigation system components



Source: International Commission on Irrigation and Drainage

US$5.6bn global irrigation market

The irrigation market is estimated to be worth US$5.6bn, equally split between agriculture and lawn and garden. The agricultural market in particular looks to us to be poised for strong growth on the back of drivers, such as global population growth, water use efficiency, food requirements, biofuels, and environmental considerations. There is huge room for improved efficiency with gravity flow/furrow irrigation accounting for 91% of irrigation globally, followed by sprinklers (8%) and low-volume methods (1%). More efficient techniques such as mechanised irrigation (e.g., low elevation spray elevation (LESA)) offer hope and have captured a 46% market share in the US (Source: Lindsay, Aquastat). For the agricultural irrigation segment, Valmont and Lindsay dominate with some 73% of global market share (Source: Lindsay).

More efficient irrigation

Irrigation provides approximately 40% of the world's food including most of its horticultural output from an estimated 20% of agricultural land (Source: FAO). Given the strong pressure to produce more with less, and a growing awareness of the environmental impact of agriculture, we are seeing a rethink of current strategies for intensifying agriculture in favour of more efficient irrigation.

Centre pivots through to micro-irrigation

We see significant opportunities in the development of more efficient forms of irrigation. Centre pivots rotate around a centre point and so their coverage areas are circular and provide considerable advantages over older methods -- such as furrow and gravity-fed irrigation -- as they conserve water, energy, and labour while increasing or stabilising crop production. Other lower-cost beneficiaries include micro-irrigation, trickle irrigation, daily flow irrigation, drop irrigation, SIP (sub-irrigated planter) irrigation and diurnal irrigation – all of which fall into the more crop per drop category. The choice of irrigation technology will depend on the level of local economic development, the hydrological situation, political and social institutions, management skills, financial resources and popular attitudes to water.

Table 41: Overview of main types of irrigation

Type	Overview
Surface irrigation	Based on the principle of moving water on land by simple gravity in order to wet it, either partially or completely, before infiltrating. Often this type of irrigation leads to the run-off of chemicals and fertilisers.
Sprinkler Irrigation	Consists of a pipe network, through which water moves under pressure before being delivered to the crop via sprinkler nozzles.
Localised Irrigation	A system whereby the water is distributed under low pressure through a piped network, in a pre-determined pattern, and applies water as a small discharge to each plan. There are three main categories: Drip irrigators: drip emitters are used to apply water slowly to the soil surface Spray or micro-sprinkler irrigation: applies water slowly to the roots of plants through a network of valves, pipes, tubing and emitters Bubbler irrigation: a small stream is applied to flood small basins or the soil adjacent to individual trees
Spate Irrigation	Random irrigation using the floodwater of a normally dry water course or riverbed.

Source: Aquastat, BofA Merrill Lynch Global Research

Micro-irrigation has huge EM potential

Micro-irrigation increases land productivity, improves soil conditions and brings about savings in water, energy and fertilisers. Moreover, it has great potential in markets like India where only 8% of feasible irrigated land uses micro-irrigation. Globally, only 14% of irrigated land uses micro-irrigation.

Precision agriculture, "big data" solutions, a US$3.7bn opportunity

Precision agriculture is the technology optimizing the use of resources, such as water, fertilizer, pesticides, seeds, to increase production and profits. Developments in machine-to-machine (M2M) technologies and information automation has made has made precision agriculture a viable method. The global market could be worth US$3.7bn by 2018, representing 13% CAGR growth (Source: MarketsandMarkets). M2M solutions comprise sensors that collect event data from machines, and communicate it over a wireless network for processing by a software application, which is typically centralized. The software can then prescribe actions and affect behaviour that are specific to the environment of interest, in the most advantageous manner.

Table 42: Examples of Energy Efficiency improvements at the farm level

Direct intervention	Indirect intervention
Adoption and maintenance of fuel efficient engines	Improved water allocation and management of water demand
Precise water application	Improved surface water delivery to reduce the need for pumping
Precision farming for fertilisers	Provision of water services for multiple water use
Adoption of no-till practices	Reduced water losses
Energy efficient buildings	Crop varieties and animal breeds that demand less input (including multi-purpose crops and perennials)
Heat management of greenhouses	Reduced soil erosion
Propeller design of fishing vessels	Use of bio-fertiliser
Use of high efficiency pumps (high cost)	Efficient machinery manufacture
	Identification of stock locations and markets by information and communications technology

Source: Adapted from FAO (2011b)

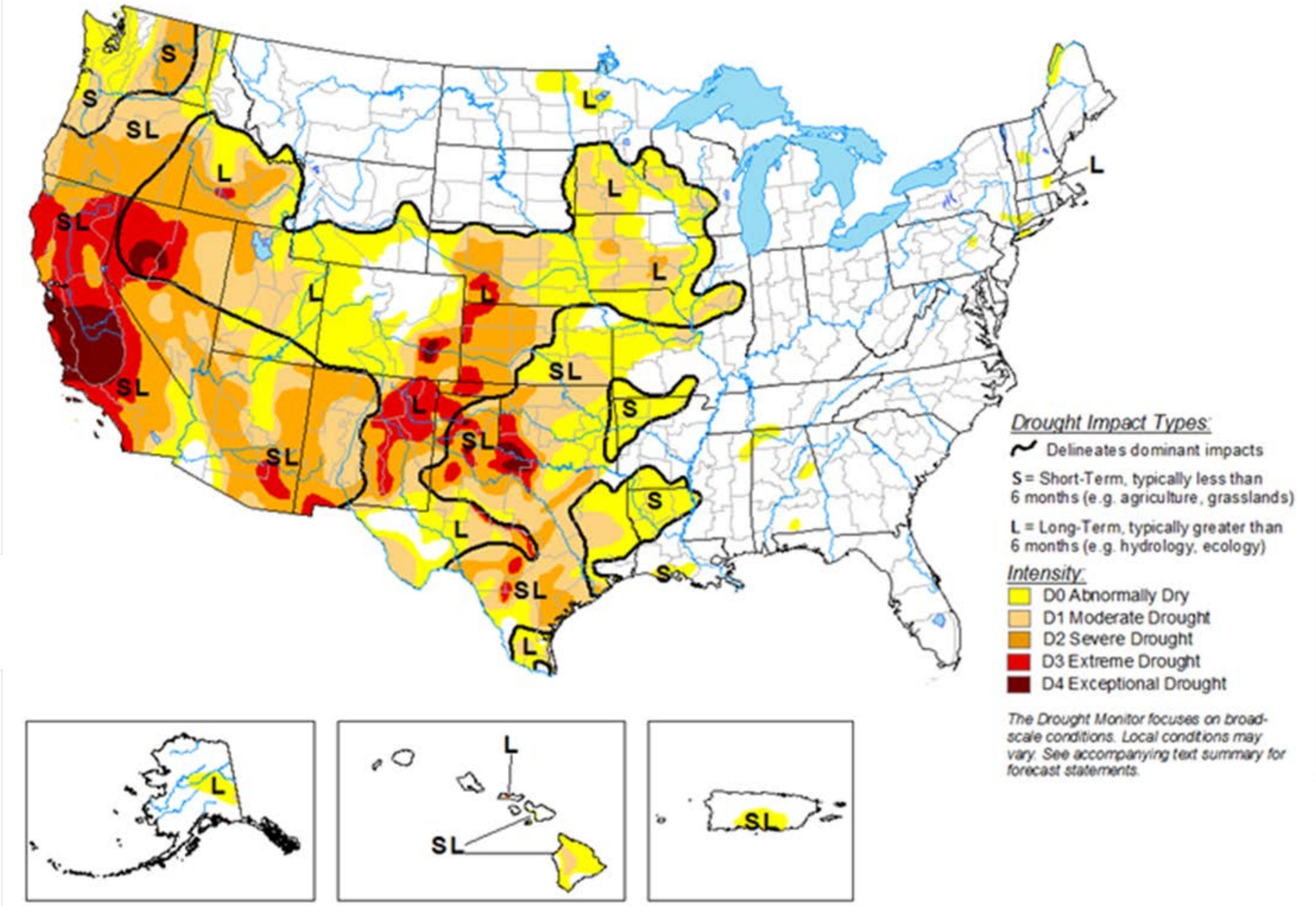
Precision Ag in practice

Precision agriculture typically utilize technologies such as GPS, yield monitoring and mapping, soil sampling and variable rate (VRT) application, remote sensing, crop scouting, and geographic information systems. At the front-end sensing stage, tractors, combines, trucks are outfitted with sensors and GPS tracking devices. This allows for site-specific crop management and VRT application of seeds, fertilizers water, herbicides and pesticides, so farmers apply resources only where it is needed. Sensors and cameras are also distributed around the field and in the soil itself, which monitors environmental factors such as wind speed, temperature, sun light, precipitation, humidity, soil moisture, and air pressure. Variable rate irrigation management would be possible and allow farmers to conserve water usage. For example, the centralized analytics can turn irrigation sprinklers on or off, in variable degrees, and focused on precise areas of the field, based on weather, soil moisture, and state of the crop canopy.

Drought resistant seeds

More than half of the United States is now suffering from drought conditions (Source: US Drought Monitor). Genetic modification (GM) can create seeds and plants that are tolerant or resistant to drought. While they are controversial in some stakeholder circles – especially in the EU and Japan – crops can be designed to endure the most severe droughts. Since biotech crops were first introduced in the 1990s, the technology has proved to be increasingly efficient. For 2013, companies stepping up their efforts in this space include Monsanto (DroughtGard Hybrids), DuPont Pioneer (Optimum Aquamax), Syngenta – Agrisure Artesian) and Dow (genetically screened corn hybrids with drought tolerant traits).

Chart 99: More than half of United States is experiencing severe drought



Source: U.S. Department of Agriculture, BofA Merrill Lynch Global Research

GM drought-tolerant characteristics are achieved in three ways (Source: Barnabas, Jager, and Feher)

- Plant reproduction before onset of severe water stress by shortening crop duration.
- Maintaining high tissue water during stress levels by reducing leaf area, closure of stomata, and senescence of older leaves.
- Physiological and cellular adjustments to tolerate tissue water desiccation.

22% yield improvement in corn

Crops gaining attention for GM include: corn, which can be found in up to 75% of grocery products; alfalfa because hay is key for feeding livestock; wheat; and resurrection plants, which can be deprived of water for weeks but spring back to life when watered, with the goal of isolating genes that allow those plants to recover quickly from drought and transfer those traits to crops such as corn. A Study done in 2012 by North Dakota State University has shown that drought resistant GM corn could potentially improve yields by 8-22%. Similar ideas are in use to breed drought tolerance into livestock herds, such as cattle being bred with genes from African and Indian varieties accustomed to hot climates and poorer forage.

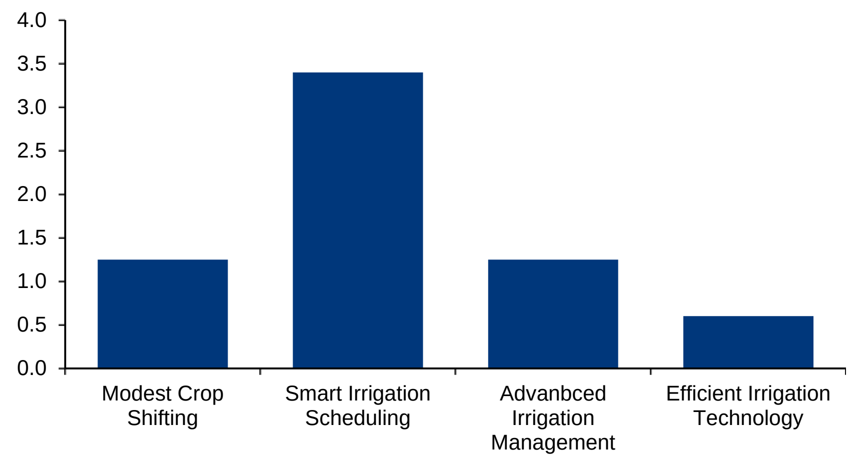
Smart Irrigation/Precision Ag effectiveness

Analysis by the Pacific Institute evaluates scenarios for improving agricultural water-use efficiency, with a focus on the Sacramento-San Joaquin Delta in California. Four scenarios for improving the water-use efficiency of the agricultural sector were evaluated:

- Modest Crop Shifting – shifting a small percentage of lower-value, water-intensive crops to higher-value, water-efficient crops
- Smart Irrigation Scheduling – using irrigation scheduling information that helps farmers more precisely irrigate to meet crop water needs and boost production
- Advanced Irrigation Management – applying advanced management methods that save water, such as regulated deficit irrigation
- Efficient Irrigation Technology – shifting a fraction of the crops irrigated using flood irrigation to sprinkler and drip systems

The highest water savings were seen to occur from smart irrigation.

Chart 100: Water Savings by Scenario



Source: Pacific Institute

Conservative tillage

No-till farming is a crop system where at least 30% of the soil is covered with crop residue after planting. These residues protect the soil from erosion, wind and water. Seeds are drilled directly in to the ground, which reduces erosion and retains water. The following benefits accrue:

- Green water - effective in reducing evaporation from soil, to increase the water holding capacity and soil moisture and increase water infiltration
- Blue water - effective to reduce runoff, water erosion, improved recharge rate of the water table and allow more constant flow in the river stream
- Grey water - water quality may be improved in no-tillage if fertiliser and pesticide use is minimised, clean water is drained and pollution, sedimentation and erosion are reduced due to lower water infiltration. (Source: FAO, Sustainable Agriculture Initiative)

Shift to water efficient crops – from rice to wheat

Growing crops according to the amount of water available has the potential to change agricultural patterns. The water-optimization of crops could result in a shift in water intensive crops like rice and maize to more efficient cereals like wheat (Source: FAO).

Table 43: International micro-irrigation potential

Region	# countries	Available irrigated area	Sprinkler irrigated area	Drip irrigated area	Total micro-irrigated area	Proportion of available irrigated area
Americas	35	41.9	13.3	1.9	15.2	36%
Europe	35	25.2	10.1	1.8	11.9	47%
Asia	46	194.0	6.8	1.8	8.6	4%
Africa	53	12.5	1.9	0.4	2.3	18%
Oceania	5	2.6	0.9	0.2	1.1	42%
GLOBAL	174	276.2	33.0	6.1	39.1	14%

Source: Jain Irrigation

Household water – 35-70% savings potential

If all US households installed water-saving features, water use would decrease by 30%, saving an estimated 5.4bn gallons per day. This would result in dollar-volume savings of US$11.3mn per day or more than US$4bn per year (Source: American Water Works Association)

Household water management is a rapidly growing sector, comprising companies that provide the technology and services to improve end-use efficiency for residential customers. Companies providing high-efficiency equipment including showers, faucets, toilets and other residential and commercial appliances may benefit as water prices rise, limits to economic supply are reached, new regulations are adopted and awareness of efficiency potential increases. Companies in this area include Geberit and Toto. The potential is huge – if all US households installed water-saving features, water use would decrease by 30%, saving an estimated 5.4bn gallons per day. This would result in dollar-volume savings of US$11.3mn per day or more than US$4bn per year.

Three types of household water

The average family of four can use up to 400 gallons of water every day, and, on average, approximately 70% of that water is used indoors

Household water consists of three main components (grey water, yellow water and brown water) each with diverse properties. While faeces-contaminated brown water contains most of the organic substances, urine-contaminated yellow water contains nearly all the soluble nutrients, such as nitrogen, phosphorus, potassium etc. Grey water is domestic wastewater generated from dishwashing, laundry and bathing. Different uses can be derived from each type of waste water. Grey water has received the most attention as it can be channelled back into the household water cycle or be allowed to drain back into the soil for groundwater recharge.

Efficiency measures could reduce demand by 70%

By installing more efficient water fixtures and regularly checking for leaks, households can reduce daily indoor per-capita water use by 35-70% (Source: American Water Works Association, US EPA).

Table 44: Household water use statistics – daily US average vs. efficient water use average

Use	Daily average g per capita	% daily use	Daily efficient* g per capita	% daily use
Showers	11.6	16.8%	8.8	19.5%
Clothes washers	15.0	21.7%	10.0	22.1%
Dishwashers	1.1	1.4%	8.2	1.5%
Toilets	18.5	26.7%	0.7	18.0%
Baths	1.2	1.7%	1.2	2.7%
Leaks	9.5	13.7%	4.0	8.8%
Faucets	10.9	15.7%	10.8	23.9%
Other domestic	1.6	2.2%	1.6	3.4%
Total Use	69.3 gallons		45.2 gallons	

Source: American Water Works Association, BofA Merrill Lynch Global Research. * By installing more efficient water fixtures and regularly checking for leaks.

Best practice is good, but incentives will be key

One of the principal policy levers of water conservation available to governments and water utilities is to impose a volumetric water charge on households. This requires that (1) households have water meters (ideally smart meters) and (2) that household water bills depend on the amount of water consumed. Water-efficiency best-practice voluntary standards, legislation and subsidies will be critical for the growth of this industry. Some examples include:

WaterSense has enabled the saving of a cumulative 287bn gallons of water and US$4.7bn in water and energy bills

- **WaterSense** in the US helps people save water with a product label and tips on saving water around the home. To date, WaterSense estimates that it has enabled the saving of a cumulative 287bn gallons of water and US$4.7bn in water and energy bills. By the end of 2011, reductions of 38.4bn kWh of electricity and 13m metric tons of carbon dioxide were achieved through the use of WaterSense labelled products.

- **The US Green Building Council and LEED** is an internationally recognised green building certification system known as the Leadership in Energy and Environmental Design certificate. The LEED promotes a whole building approach to sustainability by recognising performance in key areas including water efficiency.

- **UK Water Supply (Water Fitting) Regulations** 1999 are national requirements for the design, installation, composition and maintenance of water fixtures and fittings. These regulations are intended to protect customers and the environment from poor water quality and the misuse of water supplies.

- **Australia's commitment to household water conservation**: In addition to mandatory water restrictions in many parts of the country, a significant number of Australians have been voluntarily conserving water by adopting water-saving practices and installing water-saving devices such as dual-flush toilets. The A$250mn National Rainwater and Greywater initiative aims to help people use water wisely in their everyday lives and includes a rebate of up to A$500 for a household that installs rainwater tanks or Greywater systems.

Many barriers remain

Nevertheless, significant barriers remain – notably the low price of water and the lack of funding to carry out water-saving projects. Domestic solar initiatives may provide a useful guide, whereby a residence can be rewarded for water efficiency.

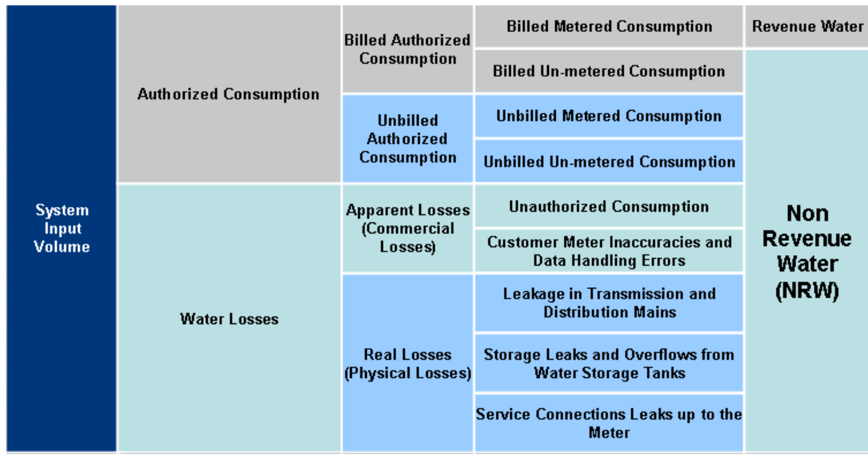
Water meters – tapped for 19% CAGR

In the water market, growing demand and greater awareness propelled by this year's US drought should drive basic and smart downstream meter installations in order to combat leakage and lost revenue.

Metering – "what gets measured gets managed"

In addition to tackling the huge issue of non-revenue water (NRW), there is an increasing realisation that companies can conserve water and reduce costs with more data – which is fuelling the growing application of demand-side management. However, existing mechanical water meters (90-95% of the global market) provide limited information on the real-time status of water availability and quality. Moreover, little information is shared, which leads to water stress for downstream users.

Chart 101: Non-revenue water (NRW)



Source: Smart water Networks Forum, BofA Merrill Lynch Global Research

Smart water meters are data-logging devices that enable commercial and residential customers to enhance efficiency and analyse water flow to detect abnormal water usage or leakage. On average, a meter can save up to 20l of water per day as customers are more aware of the water they use

Smart water meters are part of the solution

‘Smart’ water meters – advanced sensor networks and automation systems – are a solution to water wastage. Smart water meters are data-logging devices that enable commercial and residential customers to enhance efficiency and analyse water flow in order to detect abnormal water usage or leakage. Smart water metering systems differ from their traditional counterparts in that it allows for continuous real-time monitoring of water consumption as opposed to manual readings that are updated on a monthly or even quarterly or half-yearly basis.

- **Advanced meter infrastructure (AMI)** consists of water meters capable of two-way communication over a fixed network with other smart devices and stakeholders active in water systems. Stakeholders include utilities and utility customers.
- **Basic meters do not feature communication capability** but water utilities will continue to demand basic meters, in our opinion.
- **Distribution automation (DA) hardware and software allows utilities to influence water flows and usage** between the distribution substation and end user.
- **Technologies** include advanced and smart water meters and communication modules; advanced systems including handheld, mobile, and fixed network collection technologies; meter data management software; knowledge application solutions.

Table 45: Smart water management at three levels

Environment	Utilities	Companies
Water resource mapping and availability	Water quality and usage	Water usage tracking
Water quality monitoring and management (surface and subsurface)	Discharge, combined sewer overflow	Water quality control (into and within plants, discharges)
Land use analysis	Asset management	Supply-chain optimisation
Extraction monitoring (surface and subsurface)	“Smart levees” and levee monitoring systems	Energy management
Flood control	Weather event assimilation	Business process improvements
	Energy management	Metrics and management

Source: IBM, BofA Merrill Lynch Global Research

Cheap gas and water conservation are driving smart adoption in their respective segments

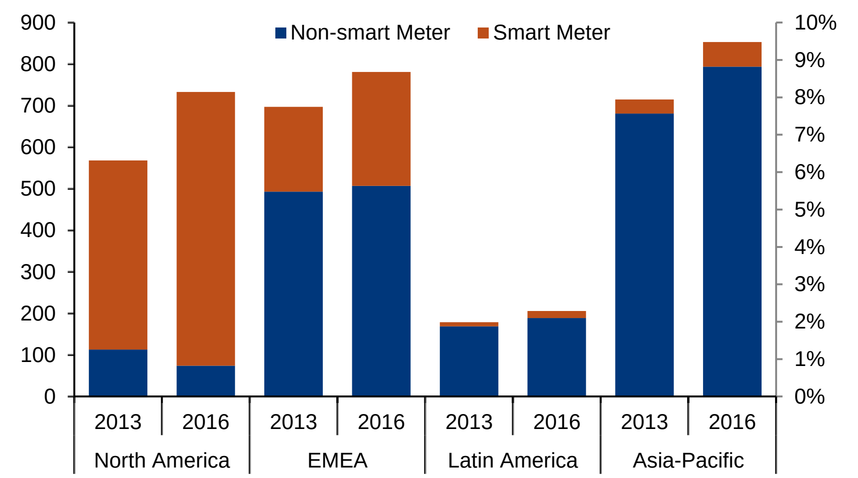
Water meters tapped for growth

At less than 20% of annual smart meter shipments combined through 2016, the market for smart water meters appears small on an absolute basis. However, the nature of demand drivers in each segment suggests installation growth rates that exceed those of the smart electricity segment. We forecast an 18.8% CAGR for water meters compared with just 10.8% for electricity. The water segment will be driven by a 25% increase in demand for water worldwide when access and leakage concerns are at an all-time high, on our forecasts.

Growth in basic and smart meters

The global smart meters market is estimated to reach $15.3bn in 2016 from $4.4bn in 2010, at a CAGR of 20.8% from 2011 to 2016 (Source: MarketsandMarkets). In 2012, global shipments of smart meters reached 100mn units rising by 31.6% over 2011 and a market size of USD 7 bn in 2012 (Source: Huidian Research).

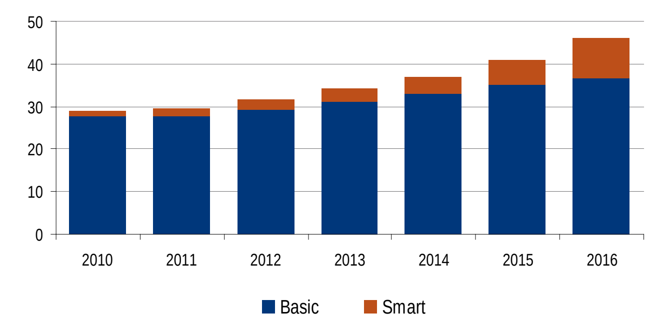
Chart 102: Global meter market in GBP mn



Source: Elster 2013

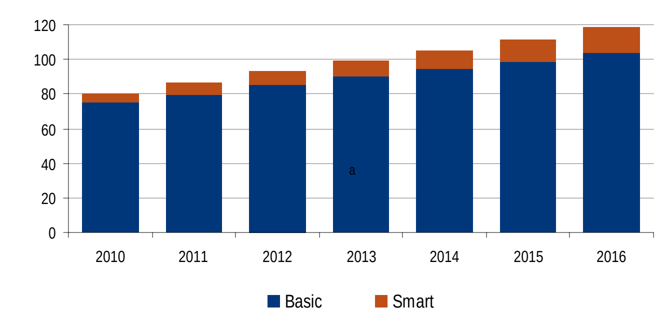
A feature of the water market that sets it apart from the electricity segment is that we forecast growth in both smart and basic meters. This is particularly true in the water segment which is significantly under-metered globally anyway. As a result, we forecast a 5.4% CAGR in basic water meters in 2011-16E.

Chart 103: Annual gas meter installations globally (millions of meters)



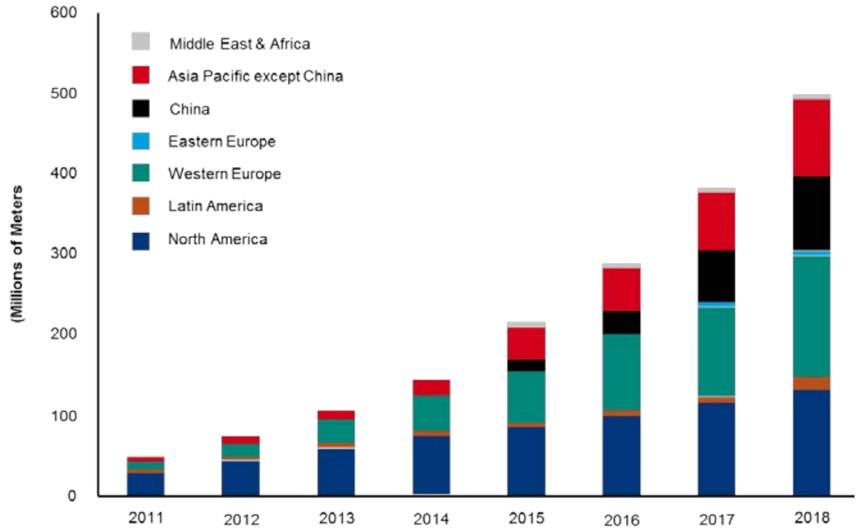
Source: Industry sources, BofA Merrill Lynch Global Research estimates

Chart 104: Annual water meter installations globally (millions of meters)



Source: Industry sources, BofA Merrill Lynch Global Research estimates

Chart 105: Smart meters with an MDM by Region, World Markets: 2010-2018



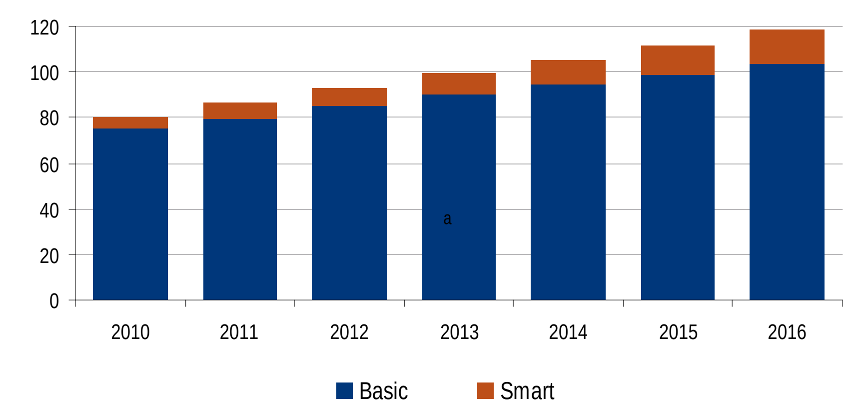
Source: Pike Research

Growing interest from water utilities

Illegal, unregulated & unmetered water abstraction is rife in EMs and beyond. In Spain, up to 45% of all groundwater pumped to irrigate crops, golf courses and urban developments is thought to be taken illegally

Smart water meters account for only 10% of the installed base. We are beginning to see greater interest among water utilities. However, of the 8.8mn smart meters for which global utilities have awarded tenders in H2 2012, 64% were exclusively for smart water meters, including a 4.6mn meter tender by Sydney Water awarded to Itron in late June 2012.

Chart 106: Annual water meter installations globally (millions of meters)



Source: Industry sources, BofA Merrill Lynch Global Research estimates

Water, water (leaking) everywhere

As many water utilities are government entities, smart meters present cash-strapped national and local governments with a significant revenue opportunity

We expect the global market for smart water meters to reach US$1.2bn by 2016 as utilities seek substantial cost savings and lost revenue opportunities from leakage and unmetered usage. In the US alone, the EPA reports that 6bn gallons of water are lost from leaks every year. Globally, the World Bank estimates that costs from unmetered water total US$14bn annually. On the revenue side, Itron estimates that water utilities globally lose around US$500mn per day in non-revenue water.

Growth opportunities in Asia

Sydney Water's 4.6m smart meter project is indicative of Asian market strength

Globally, there are over 1 billion water meters installed, out of which less than 10% are automated. We think the greatest share gain will occur in Asia, which we forecast will account for 14% of smart water meter installations by 2016E up from 5% in 2011. We note Sydney Water's recent tender for 4.6mn smart water meters awarded to Itron as evidence of smart water progress in Asia, and highlight this project as a significant driver of the 46.7% CAGR for the region.

Table 46: Meter ASPs by segment based on estimated 2011 prices

	Basic	Smart	
		One - way	Two -way
Electricity	$33	$50	$130
Gas	$61	$117	
Water	$30	$64	

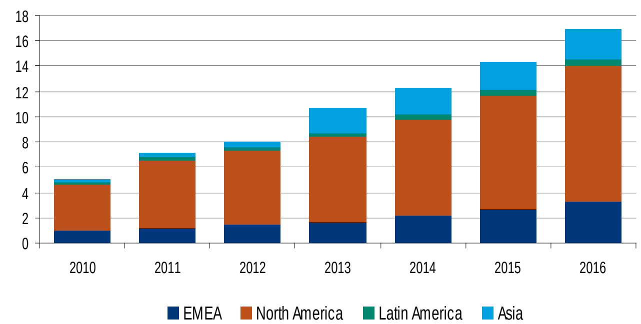
Source: Industry sources, BofA Merrill Lynch Global Research estimates

Basic water meters also set to grow

Basic meters will remain particularly relevant in the water market

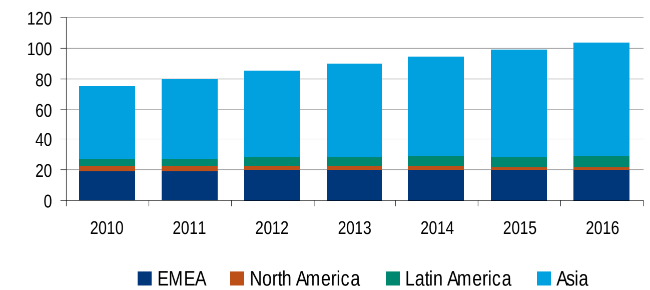
We forecast significant growth in basic water meters as well, from 80m installed globally in 2011 to 104m in 2016. The water segment is significantly under-metered and water utilities are often cash-strapped public entities. We view the cost-saving and revenue-generating opportunities from basic meters as substantial enough for utilities to forego smarter and more expensive options. Our model shows the greatest growth in basic water meters in Latin America and Asia – the Australian project notwithstanding.

Chart 107: Smart water meter installations by region (millions of meters) 2010-16E



Source: Industry sources, BofA Merrill Lynch Global Research estimates

Chart 108: Basic water meter installations by region (millions of meters) 2010-16E



Source: Industry sources, BofA Merrill Lynch Global Research estimates

Many challenges remain

There are still a number of challenges to the mass adoption of smart water meters. Most notable is the lack of an adequate IT and telecommunications infrastructure outside urban environments. Without sufficient bandwidth, the information promised by such technology cannot be transferred effectively and will be a barrier to growth.

Cost of smart meter adoption

While AMI addresses many issues in water management, the cost of implementation has been a hindrance to faster adoption. The deployment of a smart water metering system entails upfront costs such as communications infrastructure, data management applications, and analytic software. The per unit cost of AMI will vary greatly depending on scale and existing infrastructure. Within US, this cost is around $300 per smart meter with distribution automation costing an additional $65 per unit (Source: SGCC, SGIG). The payback periods in studies done in US and Australia have been in the range of 3-10 years.

Pre-payment meters face legal hurdles over social impact

Pre-payment meters face a growing legal obstacle as some jurisdictions declare them illegal on the basis of depriving the poor of water. Cases have already been filed in the UK and South Africa, where judges found that the underlying basis for the introduction of pre-payment meters seemed to be credit control rather than water efficiency. Moreover, the provision of 25 litres a day for free was deemed to be insufficient to meet the basic needs of inhabitants.

Water meters and volumetric tariffs can reduce water consumption

A study by the University of Australia in 2009 concluded that volumetric water charges increase the probability of engaging in water-saving activities, such as turning off the tap while brushing teeth, watering the garden at the coolest part of the day, and collecting/recycling rainwater and wastewater. In the same survey, respondents listed seven factors that would reduce water consumption: 1) practical information on how to save water; 2) money savings; 3) environmental benefits; 4) availability of water-efficient products; 5) confidence in water-efficiency labels; 6) lower-cost water-efficiency equipment; and 7) mandatory water restriction.

Water infrastructure & supply solutions

Table 47: BofAML Global Water - Stocks in our coverage universe with exposure to Water Infrastructure

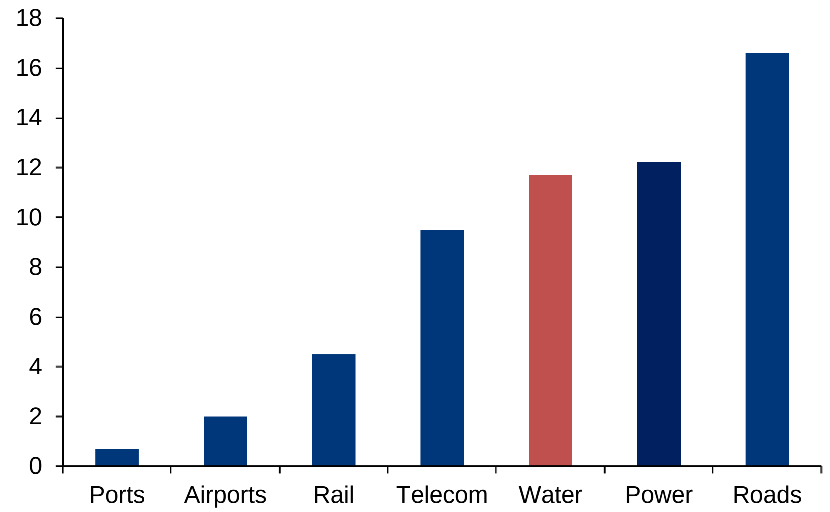
Company	Water Exposure*
Aguas Andinas	High
Aguas Metropolit	High
American Water Works	High
Beijing Enterprises	High
COPASA	High
Guangdong Invest	High
Manila Water	High
Pentair Ltd	High
SABESP	High
Sabesp-ADR	High
Severn Trent	High
United Utilities	High
EBARA	Medium
Kubota	Medium
Metro Pacific	Medium
Pennon	Medium
Rexnord	Medium
Suez Environnement	Medium
Veolia	Medium
Veolia ADR	Medium
AECOM Technology	Low
Chiyoda Corp	Low
Downer EDI	Low
Empresas ICA	Low
Flowserve	Low
HK&China Gas	Low
Keppel Corp	Low
Kinden	Low
Leighton Holdings	Low
Rotork	Low
Samsung Engineering	Low
Shanghai Indus	Low
UGL	Low
URS Corp.	Low
Voltas	Low
WorleyParsons	Low

Source: BofA Merrill Lynch Global Research
* Water exposure = BofAML estimates of current sales derived from water utilities related products, services, technologies and solutions

In our view, a number of companies are well placed to benefit from the theme of water infrastructure and supply solutions, vis-à-vis their involvement in areas such as engineering, procurement, construction and consulting, pipes, pumps and valves, and water, wastewater and sewage treatment utilities.

Water and sanitation infrastructure requires US$11.7tn in global investment to 2030 (Source: McKinsey, E&Y). Crumbling and incomplete infrastructure in developed markets are a primary cause of this – with the US alone estimated to need US$335bn in public water investments over the next 20 years simply to address shortcomings and another US$335bn to improve systems (Source: US EPA). For EMs, the challenge is building out basic water infrastructure with water infrastructure 3x more expensive to build and maintain than electricity infrastructure (Source: IBM). Overcoming the neglect and under-financing of earlier years could cost 0.35%-1.2% of GDP pa over the next 20 years (Source: OECD).

Chart 109: Global infrastructure demand by 2030

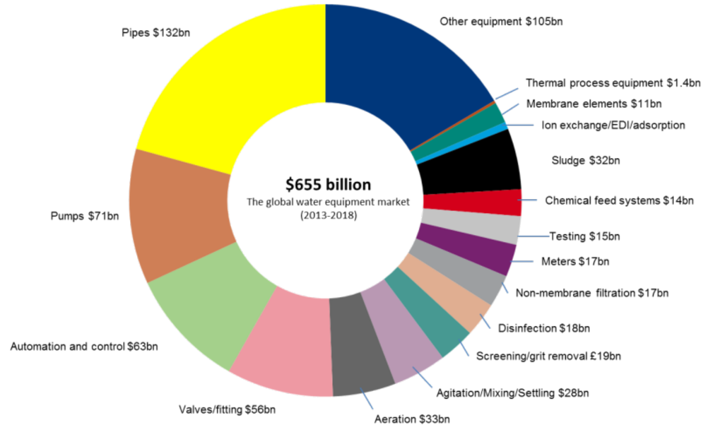


Source: McKinsey, E&Y

The private sector will play an increasingly important role in developing and running water infrastructure and is expected to account for 30% of water investments in the next 3-5Y (Source: Global Water Fund). Full cost pricing - and increasing tariffs, taxes and transfers - are being used as tools to address funding gaps and to strike a balance between infrastructure and financing needs, improving service provision levels for stakeholders, and profitable growth opportunities for corporates.

Global water equipment capex is expected to be a US$655bn market from 2013-2018 with pipes (US$132bn), pumps (US$71bn), automation and control (US$63bn), valves and fittings (US$56bn) and aeration (US$33bn) accounting for the largest segments. There will be a significant increase in spending as the late cycle business returns to previous trends, with industrial spend outpacing municipal spend (Source: GWI Global Water Market 2014).

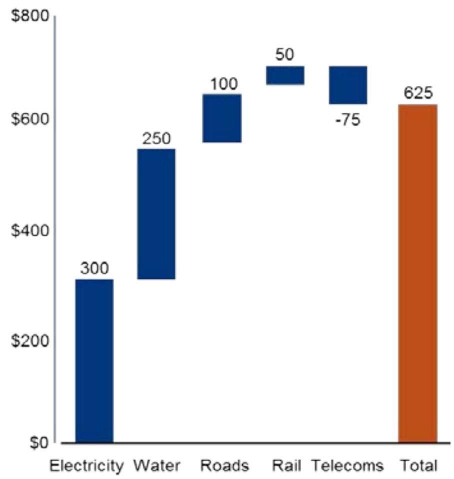
Chart 110: global water equipment capex – 2013-2018 forecast



Source: GWI

The global water utilities industry is expected to grow by 4.3% CAGR to reach US$891bn (vs. US$722bn in 2012) (Source: Reportlinker). Growth rates are low but stable for the highly fragmented sector where around only 10% of customers are served by investor-owned companies – and performance depends on regulatory factors as well as fundamental drivers of revenue and cost. But we see significant opportunities in Brazil and China – where water is increasingly a long-term secular growth story - as well as the U.S.

Chart 111: OECD estimated change in run-rate investment spending 2010-2020 (forecast)



Source: OECD, BofA Merrill Lynch Global Research

Water infrastructure – financing needs not met

Financing is critical for ongoing O&M in developed markets and new infrastructure in emerging markets – with annual water investment needs estimated to rise to more than US$770bn for the OECD and BRICs by 2015 (Source: Ashley and Cashman). Water services are more capital intensive than other utilities, requiring twice the capital of electricity utilities with the same annual operating expenses. With growing financial needs, along with a decline in public investments in water, and the lack of private investment being directed to this sector, new strategies need to be found to encourage much-needed investments. Full cost but stakeholder-friendly pricing is a key tool being considered to address funding gaps (Source: OECD).

Two-speed growth – fastest in Asia and LatAm

We expect two separate growth patterns for the water sector. Emerging markets will, in our view, present the highest growth opportunities as they attempt to tackle their burgeoning water needs and develop adequate infrastructure – often from scratch. We anticipate the highest growth for Asia and Latin America. For developed markets, the task is equally large, but will provide lower growth opportunities as, in many cases, they will be concentrating on finding a balance between budgetary constraints and upgrading and maintaining their antiquated water infrastructure.

Chart 112: Global water infrastructure needs

Source: Camradata based on BofA Merrill Lynch Global Research's WDWW (Who Does What Where) Geographic Risk Screening Model.

Water infrastructure is 3x more expensive to build and maintain than electricity infrastructure (Source: IBM)

The recession is biting – PPPs a 'must' but under the gun

Water infrastructure spending, unlike water itself, is affected by the macro economy. The investment needed for the global water infrastructure market far exceeds the capacity of public sources to fund it. The past decade has witnessed growth in partnership-based procurement around the world such as public/private ventures. This trend is likely to continue as national governments recognise the correlation between economic competitiveness and the quality of infrastructural provision, but are restricted by the austerity measures and budgetary pressures weighing on governments around the world.

However, we must be conscious of the reality that the financial crisis is having a profound impact on PPP markets. Illiquidity and the erosion in lending capacity within the banking sector globally have led to a marked increase in the cost of debt. This has been compounded by the contraction in risk appetite across the investment community.

Focus on reducing costs, the 3Ts (increasing tariffs, taxes and transfers), and mobilising repayable finance from the market or public sources

Closing the finance gap – the "3Ts"

Closing the financial gap will require countries to mobilise financing from multiple sources including reducing costs (i.e., efficiency gains or cheaper service options), increasing tariffs, taxes and transfers (commonly referred to as the "3Ts"), and mobilising repayable finance (from the market or public sources). This will require an ongoing reform push to implement such mechanisms:

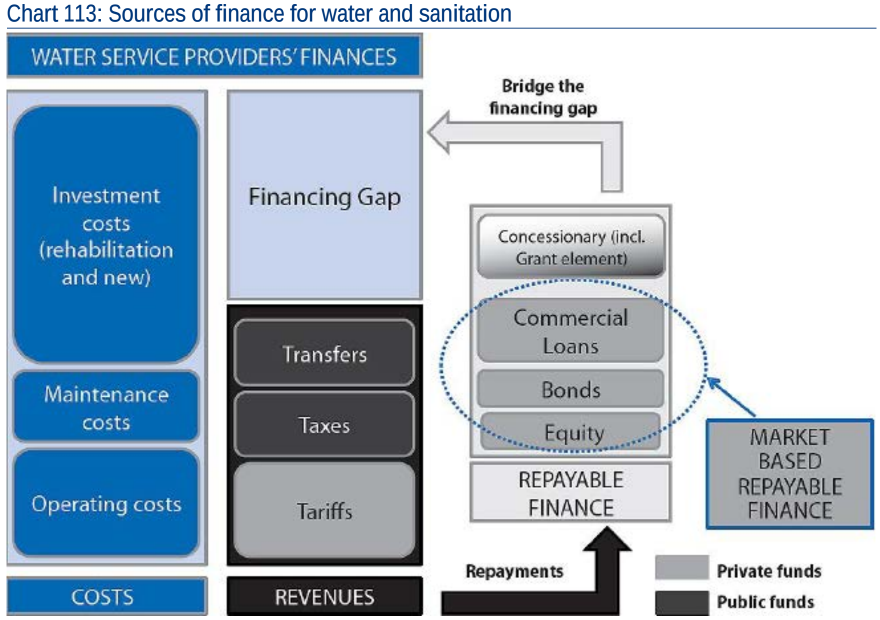
- **Developed markets**: The regulatory regime in place can critically influence the selection of investment options, and the resulting investment cost.
- **Emerging markets**: It is necessary to examine the broad range of options along the service ladder in order to assess the tradeoffs between affordability and investment costs when delivering improved water and sanitation. (Source: OECD).

In particular, the 3Ts can be used to leverage and eventually repay or compensate other funding sources, such as loans, bonds and equity. Most countries have used public transfers to fund the development of water and sanitation, particularly for capex. As countries develop water and sanitation, there tends to be a shift towards greater use of commercial finance, reimbursed by growing cash flows from user charges (*i.e.,* tariffs). While revenues from the 3Ts can close the financing gap for water and sanitation services, repayable finance can be used to bridge the financing gap (Source: OECD).

Key role for the private sector

The private sector has a key role in developing water infrastructure. Formal and informal water and sanitation operators, PFIs and private companies are all able to help improve overall sector efficiency (thereby reducing costs and financial needs), as well as the sector's creditworthiness and ability to attract financing. The private sector can also help to finance investment costs (particularly when the public sector's ability to borrow is limited) and manage and enable the capital programmes of public authorities (Source: OECD).

Chart 113: Sources of finance for water and sanitation



Source: OECD

Among the G8, the US is the leader in the water utilities industry, with market revenues of US$177.6bn in 2012, which is expected to grow to US$235.3bn in 2017 (Source: MarketLine)

Global water utilities – US$891bn by 2017

The global water utilities industry had total revenues of US$722.5bn in 2012, growing by 4.2% CAGR from 2008-2012. Market consumption volumes reached 2,907.6 m^3, growing by 1% CAGR over the same period. The water utilities industry is expected to grow at 4.3% to 2017 to reach an estimated US$891bn (Source: Reportlinker).

- **Value and volume growth**: By 2017, the industry is estimated to grow 4.3% to a volume of 3,045.8bn m^3 and by 23% to a value of US$891bn. Domestic is the largest segment for the industry, accounting for 47.7% of the total volume (Source: MarketLine).
- **Americas & G8 markets are key**: The Americas accounted for 41% of the industry's value in 2012, while Europe accounts for a further 33.9% of the global industry. The G8 countries accounted for US$412.9bn of value in 2012, with this group expected to record a 3.7% CAGR in 2012-17 (Source: MarketLine).
- **EMs are catching up**: The top-five EMs contributed US$120.9bn to the global water utilities industry in 2012, with a CAGR of 6.4% between 2007 and 2011. By 2017, the top five should account for US$168.5bn (2011-17E CAGR of 6.5%) (Source: MarketLine).
- **China is the key EM**: China is the leader of the top-five EMs, with market revenues of US$56.6bn in 2012, which are expected to grow to US$71.1bn by 2017 (Source: MarketLine).

Growing role for the private sector

With public funding increasingly under financial pressure, it is difficult to imagine that public water utilities will be able to meet the needs for infrastructure investment via government capex. Private companies or private companies operating public water and wastewater treatment facilities currently serve close to 300m people worldwide – and this will only grow in the coming years (Source: Deloitte). Among the key areas for private sector involvement will be:

- **Heavy capex municipal**: privatisation, building / revamping infrastructure;
- **Light capex municipal**: O&M optimisation, energy optimisation, customer service, smart networks, technologies and networks.

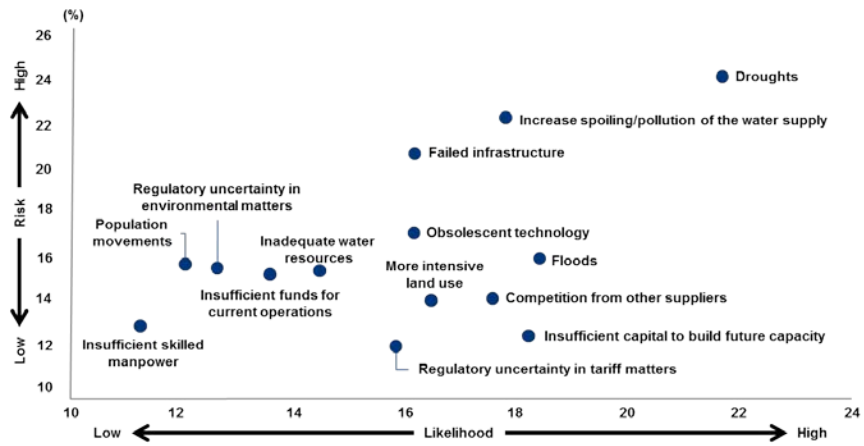
Supply challenges mean increased investments

Consistent with the key message of our report – and the long-term water supply vs. demand picture – water utilities are increasingly looking to drive a change in the way water is used. The 2012 report by the Economist Intelligence Unit and Oracle Utilities surveying executives from 244 water utilities in the UK, North America, Spain, France, Australia, Brazil, Russia, India and China found that:

- **93% of utilities think it moderately or highly likely that consumer demand for water will outstrip supply** in their countries over the next two decades;
- **Most water utilities are increasing investments to meet supply challenges**, with 22% boosting spending by 15% or more in the next three years.
- **Wasteful consumer behaviour was identified as the biggest barrier to ensuring enough supply**, with 45% of respondents highlighting inefficient water use as a major challenge.

- **The biggest risks facing utilities are drought and increased water pollution**, according to the study, which said half of those surveyed found government support lacking to address water scarcity (Source: EIU-Oracle Utilities).

Chart 114: Water company executives' top concerns in terms of their severity and risk



Source: EIU and Oracle Utilities, BofA Merrill Lynch Global Research

Growing climate change risks

Climate change presents increasing challenges to drinking water and wastewater utilities, including increased frequency and duration of droughts, floods associated with intense precipitation events and coastal storms, degraded water quality, wildfires and coastal erosion, and subsequent changes in demand for services (Source: US EPA).

Table 48: Climate change challenges facing water utilities

Challenge	Overview of challenge	Drinking Water	Waste-water
Drought	Reduced groundwater recharge	☑	
	Lower lake and reservoir levels	☑	
	Changes in seasonal runoff & loss of snow-pack	☑	
Water quality & degradation	Low flow conditions & altered water quality	☑	☑
	Saltwater intrusion into aquifers	☑	
	Altered surface water quality	☑	☑
Floods	High flow events & flooding	☑	☑
	Flooding from coastal storm surges	☑	☑
Ecosystem changes	Loss of coastal landforms / wetlands	☑	☑
	Increased fire risk & altered vegetation	☑	☑
Service demand & use	Volume & temperature challenges	☑	
	Changes in agricultural water demand	☑	
	Changes in energy sector needs	☑	☑

Source: US EPA, BofA Merrill Lynch Global Research

Table 49: Strong regional regulations driving water investment

Europe	U.S.	Asia
Dangerous Substances Directive	Clean Water Act	China - Prevention and Control of Water Pollution
(1976): cadium, mercury, DDT etc.	(1976): pollutant discharge legislation, BOD/COD, temperature, turbidity, nitrogen, phosphorous, heavy metals such as mercury and cadium, and synthetic organic checmicals such as dioxin and PCBs	(1984 - revised 1996)
Urban Wastewater Treatment Directive	Safe Drinking Water Act	China - The Water Law of PRC
(1991): sewage discharge (covers BOD/COD, phosphorous, nitrates etc.)	(1984): 200 potential contaminants including microbial contaminants (e.g. cryptosporidium); byproducts of drinking water disinfection; ration; arsenic	(1998 - revised 2002)
Directive on Nitrates Pollution from Agricultural Sources	Arsenic Rule	China - Law of PRC on Water and Soil Conservation
(1991): nitrogen fertiliser and manure leachate	(2001): reduces arsenic levels from 50 ppb to 10 ppb; drives activated alumina and other technologies	(1991)
Directive on Integrated Pollution Prevention and Control	Enhance Surface Water Treatment Rule (LT2)	China - 11th Five-Year Plan: RMB
(1996): pollution from factories and other facilities	(2005) Pathogen Control: enhance monitoring, membrane filtration and UV treatment	RMB330 billion investment in Wastewater [as well as RMB320 billion for the "South North Water Transposition" project]
EU Water Framework Directive	Stage 2 Disinfection Byproduct Rule	Japan - Water Pollution Control Law
(2000): combines many of the above measures to cover industrial effluent, pesticides, nitrates, biocides etc.	(2005): controls chlorine byproducts; drives UV treatment	(1997)
	Combined Sewer Overflow (CSO)	Japan - Sewage Law
	Some rules completed; more pending	(1970)
	ARRA	Japan - Water Works Law
	(2009): $6 billion in funding for municpal water ($2 billion) and sewer($4 billion) projects under the State Revolving Funds program	(last revision in 2001): controls water quality criteria
		China - 12th Five-Year Plan: Water and Waste
		RMB450 billion - specific provisions approved for enhanced water quality

Source: Pax World

For further information on Brazilian water, see the ongoing work of BofAML analyst Diego Moreno & team

LatAm Water Utilities, 09 October 2013

Emerging markets – exciting opportunities

Brazil – many areas lacking coverage

The Brazilian sanitation sector requires substantial investment. Approximately 81% of Brazil's residents get potable water from a water supply system, 46% have sewage collection services, and 38% sewage treatment, according to a report by the Global Water Partnership (GWP) in 2013. Brazil still has almost 8 million people defecating daily in the open (Source: OHCHR). In addition, the loss levels of the water utilities in Brazil are very high versus the world average (37.4% in Brazil versus 13% on average for the world).

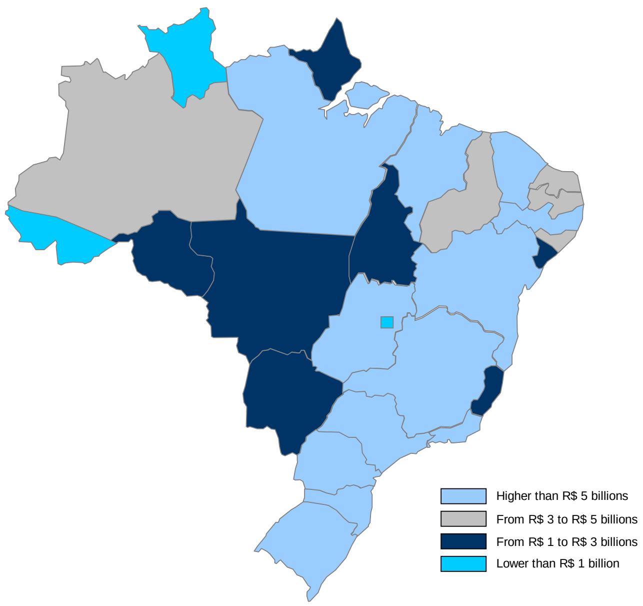
70% of Brazils fresh water availability is in the amazon basin where only 7% of the population lives. The remaining 93% of the population depends on just 30% of the water available. The 'per capita' availability varies from 1460 m^3/ person/year in the semi-arid Northeast to 634 887m^3/ person/year in the Amazon region (Source: GWP).

Bullish on the US$219bn opportunity

In December 2013, Brazil published a 508bn-real (US$219bn) national sanitation plan (Plansab) to be implemented over the next 20 years. Besides addressing solid waste and storm water management issues, Plansab is aimed at reaching universal potable water supply in urban areas over the next 10 years, while sewage collection and treatment service is expected to reach 93% coverage in urban areas in 20 years. Under the plan, the federal government should be investing 298bn reais over the next 20 years, while the rest will come from other sources. It has scheduled investments of 10bn-20bn reais per year until 2030, with short, medium and long-term goals for 2018, 2023 and 2033.

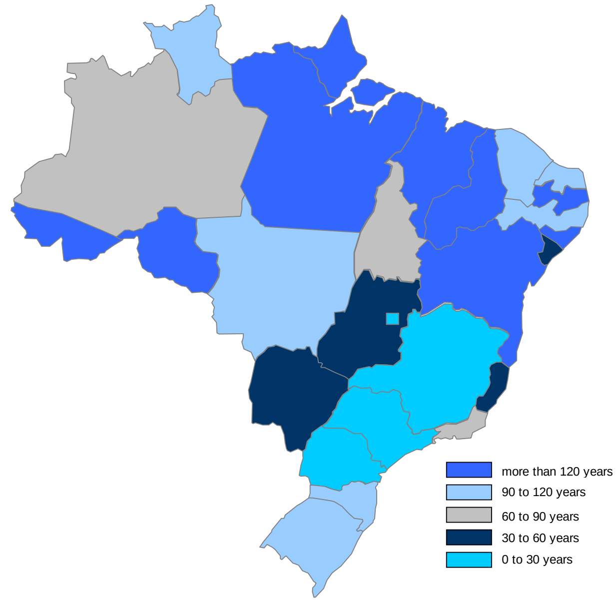
With greater regulatory visibility, we believe the Brazilian water sector is entering a new era as (1) capex will start to be remunerated, strengthening state-owned companies' balance sheets and bringing a growth component to the investment cases, and (2) the solid and consistent regulations will attract private players to the sector.

Chart 115: Annual investment needs to achieve universal coverage



Source: BofA Merrill Lynch Global Research, Instituto Trata Brasil

Chart 116: Estimated time to achieve universal coverage



Source: BofA Merrill Lynch Global Research, Instituto Trata Brasil

The new sanitation law approved in 2007 requires all sanitation companies in Brazil to have a tariff regime established and regulated by a regulatory agency (state or municipal) by the end of 2014, which may be postponed to 2016. Currently, the tariff structure does not take into consideration the amount of capex undertaken by companies; so from the perspective of a minority investor, it would be better if companies paid a lot of dividends instead of allocating funds to increase service coverage. The new regulatory framework will align minority, political and company interests as the proposed tariff methodology would be ROA-based, whereby regulators will establish a regulatory asset base (RAB) that will be remunerated by a regulatory WACC, similar to Brazilian electricity distribution regulation. Thus, EBITDA will start to grow cycle by cycle as capex will be incorporated into the RAB. Given its magnitude it will offset the probable WACC reduction over cycles.

Regulation likely to drive multiple re-rating

A regulatory framework that adequately remunerates investments should provide the key missing element to attract private investment. The upcoming implementation of a regulatory framework should drive a re-rating of valuation multiples from the current 2013E 7-8x P/E to 11-12x, which is the level of Brazilian electric utilities. The two major Brazilian water utilities, Sabesp and Copasa, used to trade at distressed valuations (6-7x P/E) and already have done part of the re-rating (8x 2014E P/E) due to better visibility about the implementation of the new regulatory framework, but they are still trading at a 30% discount to Brazilian electric distributors.

China – deregulation presents investment opportunities

With the largest population and one of the fastest-growing economies in the world, China's demand for water is intense. With per-capita water resource at one-quarter of the world's average, water resources in China are scarce and water pollution is worsening. To cope with this, the Chinese government has launched a number of initiatives to reform the severely under-resourced water sector. Companies that stand to benefit from this deregulation present an interesting investment opportunity, in our view.

RMB4tn water project investment over the next 10 years

In its 12th Five-Year Plan which began in 2011, China stated that it will shift its environmental focus to water. In the State Document no.1, which usually reflects government priorities each year, the Chinese government announced measures to improve the country's relatively backward water conservancy situation. According to the document, the PRC government plans to spend an average RMB400bn per year in 2011-20 on water projects, up from RMB200bn in 2010. China aims to improve the quality of its water by 30-50% through investments in waste water treatment, recycling, and membrane technology (Source: Bloomberg).

We believe this will help expand the scale of water exploitation, improve the efficiency of water usage, and curb water pollution, which should benefit companies with China water exposure. Currently, only 50% of urban sewage is treated. By 2015, the government intends to add 42mn tons of daily sewage treatment capacity to increase its urban waste water treatment rate to 85% (Forbes).

China's water crisis

54% of households in China are not connected to water pipelines

With a per-capita water resource at one-quarter of the world's average, water resources in China are very scarce to start with. Serious water pollution, low water tariffs that discourage water conservation and investment in the sector, and wastewater treatment bottlenecks are all worsening the situation. The World Bank puts the cost of China's water problems at 2.3% of GDP.

- 400 cities are facing water shortages, including 110 which face serious water scarcity (Source: Ministry of Water Resources)
- China is over-exploiting its groundwater by 22bn m^3 per year (Source: World Bank)
- 55% of the 50,000 rivers that existed in the 1990s are estimated to have disappeared (Source: Ministry of Water Resources)
- Only 47.4% of the surface water in China's lakes, rivers and reservoirs can meet water quality standards that make it usable under its functional zoning (Source: Ministry of Water Resources)
- 24mn tons of chemical oxygen demand (COD), a measure of organic matter in water, and 2.45mn tons of ammonia nitrogen are emitted into water each year (Source: Bloomberg)

Unequal water distribution between north and south of the country

Water availability differs dramatically between the north and south of country. Northern China has 65% of China's cultivated land, produces around half of the country's grain, accounts for more than 45% of GDP, but has only 20% of the nation's water supply. To alleviate this, the government is constructing the US$60bn South-North Water Transfer, the world's largest hydroelectric project, which will divert 6tn gallons of water from south to the Yellow and Hai rivers in northern China. However, many are concerned of the ecological effects this may have on local species, and whether this would be a long-term solution to the water scarcity problem.

According to China Ministry of Water Resources Only half of China's water is being used effectively, which is 20% less than in developed countries. Around 4.05mn hectares of land are irrigated with polluted water, which has a negative effect on crop yield and food quality.

Economic advancement as part of the problem

With the rapid development of industry, many chemical plants had been built along the Yangtze River, which may have posed threats to water safety. In 2011, up to 40% of China's rivers were seriously polluted after 75bn tons of sewage and water had been discharged into them (Source: Ministry of Water Resources). A 2013 report stated that 90% of the country's ground water is polluted (Source: Geological Survey of China), and water from 25% of major rivers is so polluted that it be unsuitable for industry or agriculture. In March 2014, Premier Li Keqiang set out to crack down on businesses that illegally discharge wastewater and local officials who fail to provide oversight (Source: Bloomberg BNA). With expanding industry and increasing urbanization, the problem of water scarcity will only worsen as people increase consumption of water-intensive goods such as meat, alcohol, washing machines, etc.

Around 70% of China's electricity comes from coal-fired generators, which are significantly more water intensive than natural gas combined cycle plants or renewable energy. As of July 2012, the Chinese government planned an additional 363 plants, which amounts to an almost 75% increase in coal-fired generating capacity (Source: WRI).

China's water sector deregulation

The Chinese government is fully aware of the severity of the water shortage and pollution in China, and has set in motion a multi-year reform objective to deregulate the water sector that would:

- Open up the water sector for non-state investment
- Invest and build up the water supply infrastructure and wastewater treatment facilities
- Implement measures to increase investment and participation in the sector
- Increase water resources fees, water tariffs and wastewater treatment charges
- Expand water rights trading that had been piloted in Ningxia-Hui and Inner Mongolia Autonomous regions

Chart 117: Relative performance of ML China Water Index and S&P Global Water Index

Source: BofA Merrill Lynch, Bloomberg

Potential water tariff hike to benefit waste water sector

According to the recent 3rd Plenary Session Decision in 2013, the PRC government will likely conduct utility pricing reform, eliminate government intervention on resources pricing and promote pricing mechanism. PRC average water price has doubled over the past 10 years, but is still significantly lower than other countries and world average. The pricing reform will mainly focus on waste water treatment tariff as well as water resource fee. If water tariff from end users is lifted, local governments will have more funds to invest in water, waste and environmental related projects. The government has also targeted recycling water usage rate of 20% by end of 2015 from a previous target of 15%. Waste water treatment operators will benefit the most from this.

To ensure sound implementation of water reform, NDRC demands water tariff adjustments to be transparent and take into consideration water supply, wastewater treatment industry development needs and the impact on low-income families, all of which will contribute to steady adjustment in the water price.

More tariff hikes have been recently granted for projects in Anhui, Zhejiang, Guangdong, Jiangsu and Hainan. The tariff increases in some cities have been as high as 60%-105%. This shows the government's ongoing support to raise water tariffs and the rate of return to attract investment in the sector.

Table 50: Water tariff hikes in China

Process	City	Effective date	After (RMB/ton)	Before (RMB/ton)	Change (%)	Note
Effective	Maanshan, Anhui	01/09/2010	1.90	1.60	*18.8*	Residential end user price
			2.40	2.10	*14.3*	Residential end user (<17m^3)
			3.35	2.10	*59.5*	Residential end user (18m^3-30m^3)
Effective	Wenzhou, Zhejiang	01/09/2010	4.30	2.10	*104.8*	Residential end user (>31m^3)
			4.10	3.55	*15.5*	Non operating business
			4.20	3.70	*13.5*	Operating business (industrial & commercial)
			7.10	6.10	*16.4*	Special business
			2.31	2.15	*7.4*	Residential end user (<12m^3)
			2.77	2.15	*28.8*	Residential end user (12m^3-20m^3)
			3.79	2.15	*76.3*	Residential end user (>20m^3)
Effective	Hefei, Anhui	01/10/2010	2.60	2.40	*8.3*	Non operating business
			2.65	2.35	*12.8*	Industrial user
			3.03	3.25	*(6.8)*	Commercial user
			9.00	7.00	*28.6*	Special business
		01/12/2010	1.25	1.00	*25.0*	Option 1 (comprehensive water supply fee)
		01/12/2010	1.17	1.00	*17.0*	Option 2 (comprehensive water supply fee)
Public hearing held	Dongguan, Guangdong	2011	1.25	1.17	*6.8*	
		01/12/2010	1.17	1.00	*17.0*	Option 3 (comprehensive water supply fee)
		2012	1.28	1.17	*9.4*	
		4Q10	1.61	1.47	*9.5*	Option 1 (comprehensive water supply fee)
Public hearing held	Zhongshan, Guangdong	4Q10	1.51	1.47	*2.7*	Option 2 (comprehensive water supply fee)
		01/07/2011	1.60	1.51	*6.0*	
		01/07/2012	1.61	1.60	*0.6*	
Public hearing proposed	Nanjing, Jiangsu	4Q10	3.10	2.80	*10.7*	Residential end user
Public hearing proposed	Haikou, Hainan	4Q10	NA	NA	*NA*	

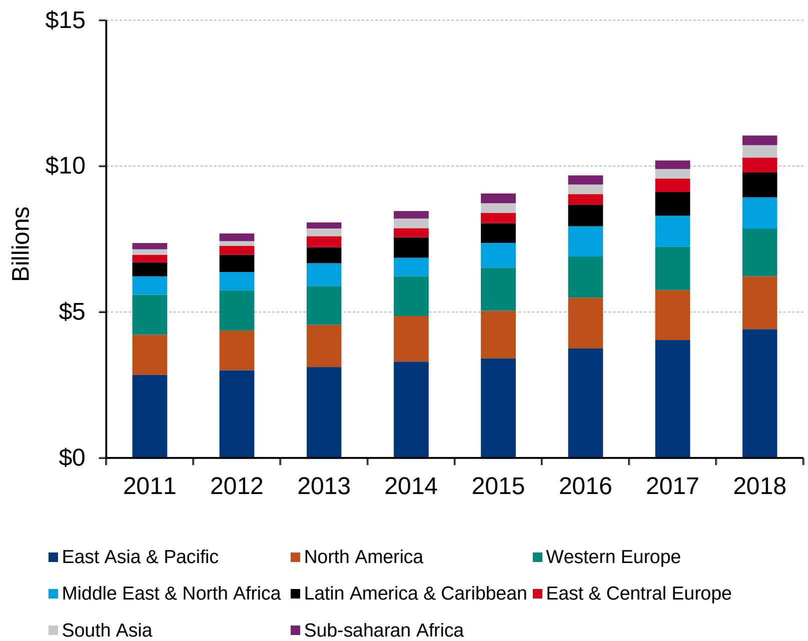
Source: BofA Merrill Lynch Global Research

China's water sector investment opportunities

We believe that companies in the water sector (supply, treatment process, engineering and technology) that are well positioned to benefit from China's water sector deregulation present an interesting investment opportunity. Those that would have an advantage in competing within the sector would be:

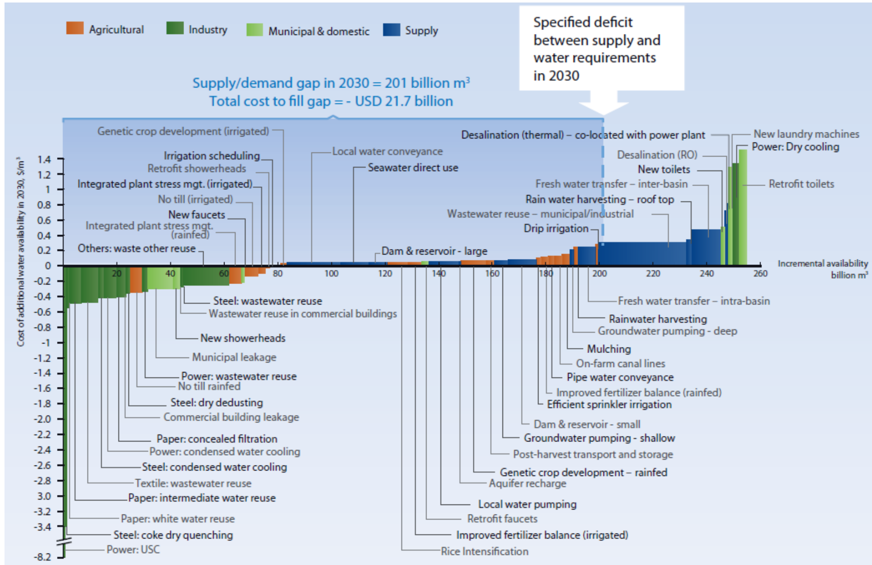
- Companies that own water supply networks and collect water fees directly from end users, which would thus benefit from any tariff hike
- Companies that operate in relatively affluent regions with relatively high fixed returns
- Companies that specialise in water conservation and purification and have marketable technologies/products
- Designers and manufacturers of water-conservation and water-treatment products/projects that could benefit from rapid expansion in water facilities

Chart 118: Fastest capex growth for water valves, actuators & fittings coming from Asia



Source: GWI

Chart 119: Costs of supplying water in China



Source: UNEP

India – waking up to the need for investment

In its 11th Five-Year Plan (2007–12), India planned for investment of 127,025 core (US$28.3bn) in urban water supply and sanitation, including urban (stormwater) drainage and solid waste management. The Indian government is increasingly acknowledging the importance of water infrastructure, given the population pressure and need for greater economic development.

Ministry of Water Resources estimates shows utilisable water of 1,123 billion cubic metres (BCM) against current water demand of 710 BCM, Ministry of Water Resources estimates total water demand rising to 1,093 BCM in 2025. The 2030 Water Resources Group (2009)2 estimates that if the current pattern of demand continues, about half of the demand for water will be unmet by 2030.

The 12th Five Year Plan proposes the setting up of a National Irrigation Management Fund (NIMF) to catalyse and support demand for irrigation management and institutional reform.

Problems in management and equitable supply

Data suggests that most cities spend anywhere between 30% and 50% of their water supply accounts for electricity to pump water. We have no official accounts for the excreta we generate or the excreta we treat or do not treat. Currently, we measure sewage in the most rudimentary of ways: we assume that 80% of the water officially supplied by municipalities is returned as sewage. Surveys of groundwater are finding higher and higher levels of microbiological contamination—a sign of sewage contamination. As per the NSS 65th round, only 47% urban households have individual water connections. Census 2011 shows that only 32.7% urban Indians are connected to a piped sewer system and 12.6% — roughly 50mn urban Indians — still defecate in the open.

Table 51: Sanitation Facilities in Urban India

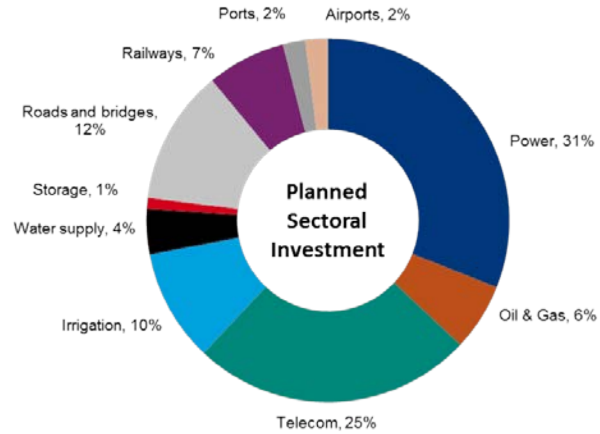
No.	Facility	%
1	Flush/pour toilet latrine of which connect to:	72.6
A	Piped sewer system	32.7
B	Septic system	38.2
C	Other system	1.7
2	Pit latrine of which:	8.3
A	With slab/ventilated improved pit	6.4
B	Without slab/open pit	0.7
C	Night soil disposed into open drain	1.2
3	Service latrine of which:	0.5
A	Night soil removed by human	0.3
B	Night soil serviced by animals	0.2
4	No latrine within premises of which:	18.6
A	Public latrine	6.0
B	Open	12.6
	Total	100.0

Source: Census of India 2011, House, Household Amenities and Assets: Latrine Facility, Office of the Registrar General and Census Commissioner, India

The 12th Plan included a proposal to set up a National Water Commission (NWC) to monitor compliance with conditionalities of investment and environment clearances given to irrigation projects. It generated a draft for 'Model Bill for State Water Regulatory System'. This proposes two separate authorities – a State Water Regulatory and Development Council (SC) which is expected to provide the 'normative' or 'political' framework for the techno-economic regulatory decisions, and the State Independent Water Expert Authority which is accountable to technical experts through the mechanism of regular peer reviews.

The plan also proposes a new Model Bill for the Protection, Conservation, Management and Regulation of Groundwater. Projected spending on water and sanitation in the 12th five year plan is more than double that of the previous level. It amounts to Rs 2,542bn (c. US$ 40bn) (Source: Indian Planning Commission).

Chart 120: Sectorial investment planned in 12th five year plan



Source: Ernst & Young 2012

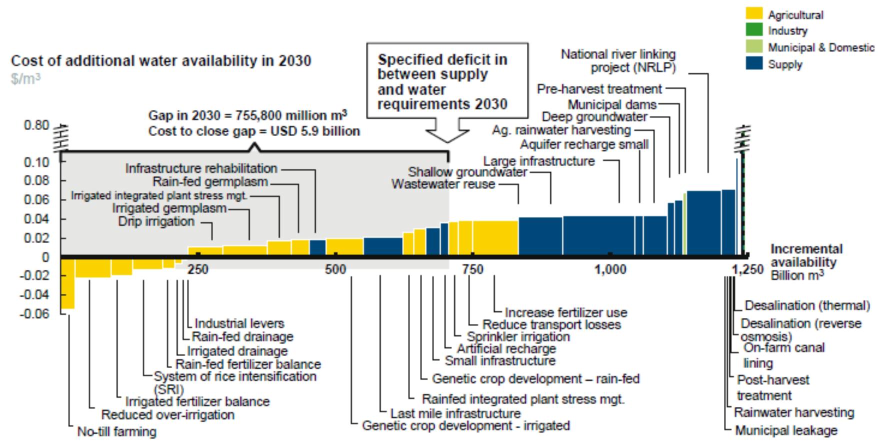
Greater private investment but lowest global tariff base

There has also been a shift away from the earlier state-dominated investments whereby the central government played a major role. Now, private investments have a place in the development of the water sector. There are also positive signs that utilities are attempting to reduce their historical reliance on state subsidies and move a step closer to cost recovery. But there is still huge room for progress given that the combined water tariff for 17 cities with data was only US$0.15/m^3 in 2013(+3.9% yoy) – far below China at US$0.51 and the global average of US$2.11 (Source: GWI).

Huge need for large-scale storage & supply

Despite the large investments in inventory infrastructure, India lags behind other countries in water storage. India can still store only relatively small amounts of its seasonal rainfall, so there is a requirement for large-scale storage and supply projects. High-cost solutions like desalination are increasingly finding a foothold in India. The sector is poised to grow in double digits per annum in the coming 3-5 years and is likely to lead to significant job creation in the private sector. State utilities have also started attaching importance to water efficiency projects and agriculture is seen as a major development area.

Chart 121: India – water availability cost curve



Source: Water 2030

Russia – poorly accounted and managed

In Russia, water resources are generally poorly accounted and managed. The existing water supply system uses obsolete Soviet-era technology in which key assets are close to exhaustion. According to the Federal Agency for Construction, Housing & Utilities, the current level of wear and tear on wastewater infrastructure ranges from 50% to 70%. An estimated RUB15tn (US$459bn) is needed to complete necessary upgrades, refurbishment and new construction for water and sanitation infrastructure by 2020.

Expert estimates suggest that Russia holds 20% of the world's total freshwater resources. Within its territory there are over 120,000 rivers with an overall length of 2.3 billion kilometres, and there are around three billion lakes. The majority of the country's rivers and lakes are covered with ice during winter. Russia's biggest rivers are in Siberia, including the Lena (4,500km), the Amur (4,400km), the Yenisei, the Irtysh and – in the European part of Russia – rivers such as the Volga (3,500km) and the Don. Russia also possesses significant underground water resources (both fresh and mineral water). A lot of its water is contained within glaciers, the biggest of which are found on Arctic Ocean islands. The mountain glaciers of the Caucasus and other Russian mountains are of great economic importance as they feed the country's rivers.

The total access to water supply and sanitation in Russia in 2004 was between 76% and 90%, while the total water supply coverage was between 91% and 100%. The Russian municipal water supply system includes water inlets, pumping stations, water preparation and purification stations, water supply networks and water sanitation stations. There are approximately 50,000 water supply stations and 20,000 water sanitation stations. In addition, there are 4,876 local water supply networks with a total length of 463,000 km. Approximately 70% of drinking water supply comes from surface water and 30% from groundwater. In 2004, water supply systems had a total capacity of 90 million cubic metres a day. The average residential water use was 248 litres per capita per day. (Source: IWA – International water association)

South Africa – US$40bn water funding gap

In South Africa, up to half of freshwater is wasted in some areas on the back of inefficient irrigation (farming accounts for 60% of water use) and ageing infrastructure (Source: Department of Water Affairs). Worryingly, of the government's 2020 infrastructure project targets, water represents only 2% of planned spend. Its water infrastructure requires investment of ZAR670bn (US$76bn) over the next decade, which is almost double the available funding, leaving a gap of ZAR338bn (US$40bn). This will pose increasing challenges for South Africa's water-intensive mining sector as well as Eskom, with many corporates admitting that water stress is already a real risk and that costs could double in the next five years.

South Africa needs 700 billion rand ($71 billion) to meet the country's growing demand for water. The country raised the estimate for spending on water provision over the next 10 years from 570 billion rand after including sanitation, refurbishment of existing infrastructure and irrigation. The country has budgeted for about 45 percent of the 700 billion rand needed, leaving a gap of 385 billion rand. South Africa's water demand will outstrip its supply between 2025 and 2030, according to projections in the National Treasury's 2012 Budget Review. South Africa loses about 1.58 million cubic meters of water each year, or about a third of its urban supply, to leaks and theft, according to the second edition of the National Water Resource Strategy (Source: Department of Water Affairs, Bloomberg).

Developed markets – downturn delays growth

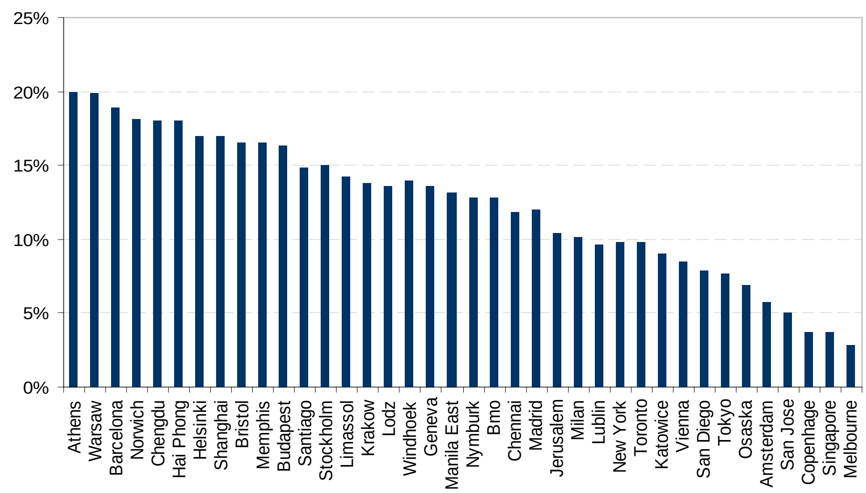
Developed market water networks are often in great need of modernisation. For instance, the US EPA estimates that US$636bn will be required over the next two decades to keep the American water systems in safe working order. Despite this, the chronic budget deficits of many developed countries – and ongoing downturn – could act as a barrier to activity in this segment of the water industry for some time. Indeed, political considerations have often overridden decisions to address infrastructure needs, due to the disruptive nature of network improvements and the lack of public interest that water has generated in the past.

Focus on maintenance, water loss & NRW

More than 45m m^3 per day are lost through leakages. The total cost to water utilities worldwide is estimated at more than US$14bn per year

Water loss or non-revenue water (NRW) is a considerable problem around the world, especially in emerging markets. But even in developed markets, water losses from creaking supply systems and inefficient irrigation can exceed 50%. The American Society of Civil Engineers estimates that 26.5m m^3 of safe drinking water (or 15% of the total) is lost every day in the US as a result of antiquated distribution systems.

Chart 122: NRW is an issue in many developed market cities



Source: Smart water Networks Forum, BofA Merrill Lynch Global Research

NRW comprises three components: physical losses including leakage and overflow; commercial (or apparent) losses caused by customer meter under-registration, data-handling errors, and theft of the utility for operation purposes and water used for free by certain consumer groups; and unbilled authorised consumption. All are considerable issues for every water utility because they are a straight hit to the top line.

Given that the majority of water distributors rely on municipal contracts and funds to conduct their investments, there are growing opportunities for affordable management practices rather than expensive replacement projects. Water utilities primarily compare their estimated current level of leakage with a notional economic level of leakage – the point at which the cost of reducing leakage is equal to the benefit gained from further leakage reduction.

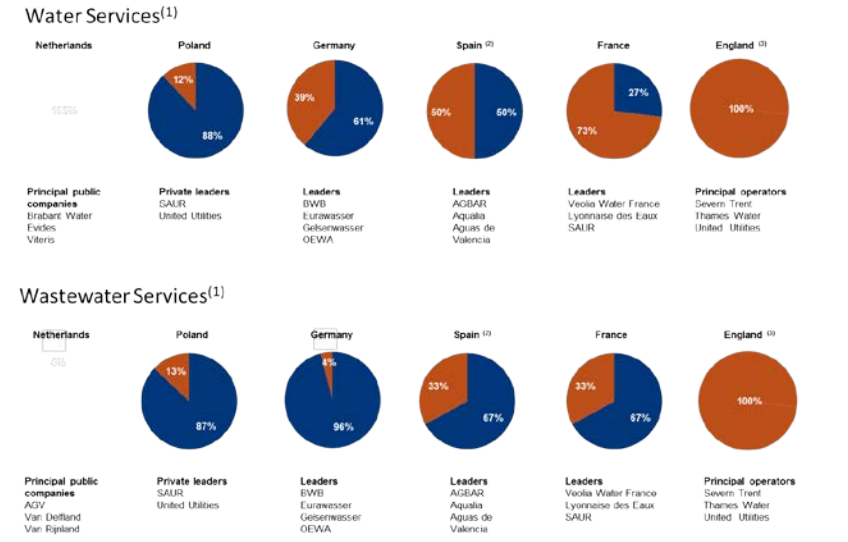
Utilities usually estimate when pipes need replacing from a number of variables – age, soil type, etc., but this is time consuming and inefficient. There are a number of small private companies involved in providing IT-orientated infrastructure management solutions. The technology ranges from stethoscope-like devices that are pressed against the asphalt to detect leakage to miniature sensors that are inserted into the sewer mains. We see this as an exciting segment of supply-side water management.

Table 52: Companies involved in water management software

Company	Ownership	Description
Innovyze	Private	Leading provider of wet infrastructure modelling and simulation software
Pure Technologies	Private	Technology driven solutions for infrastructure asset management
Syrinix	Private	Leading developer of smart pipeline technology
Fuji Tecom Inc.	Private	Manufacturer of leak detection and measurement instruments
TaKaDu	Private	Provider of IT software that searches for patterns in data to detect problems within the water supply system
Hydropoint	Private	Provider of monitoring and metering for landscape irrigation
Echologics	Private (Mueller Water Products	Provider of leak detection and assessment services using acoustic expertise

Source: BofA Merrill Lynch Global Research

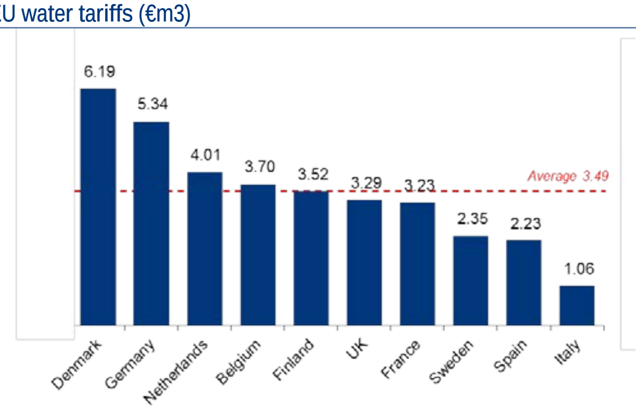
Chart 123: Water Europe – Public-Private market shares in Europe



Source: BIPE – Envrioscope 2010

(1) In terms of number of people served (2) Group estimation (3) Excludes Scotland, Wales and Northern Ireland

Chart 124: EU water tariffs (€m3)



Source: Suez based on NLS Consulting

France – a long history of private sector participation

France has been a pioneer of PSP in the water sector. Since French water services belong to a specific category of public service called industrial or commercial public services, a local public authority can delegate the management of the water service to a private firm. In the case of private management, the relationship between the local municipality and the firm can take different forms: management contracts, "affermage" (lease contracts) where the municipality remains the owner of assets, and concessions where the private operator is responsible for financing all new investments over the period of delegation. Affermage is the most common form of contract, usually awarded for 12-15 years.

Increasing client pressure & declining volumes

Municipalities have managed to cut prices by 5-10% on average at each contract renewal

Over the past few years, pressure from municipal clients has increased gradually and significantly, hurting the profitability of private players when renewing water production/distribution contracts in France. Besides this, the legislation has changed, pushing for a reduction in the average duration of contracts and thus promoting competition.

Politicians looking to cut water prices

As the economic crisis has unfolded, local politicians are increasingly willing to prove to customers/voters that they are committed to obtaining significant cuts in water prices. By waiving the threat of remunicipalisation, municipalities have managed to cut prices by an average 5-10% at each renewal (versus only a slight decrease or even no decrease in the past). Thus, a company like Veolia has reported c. €300mn of EBITDA decline over 2008-13 on its French water business. One contracts will have been rebased (by the end of 2015) profitability is then supposed to improve on efficiency gains and by adding new services.

UK – muddying the successful waters

Historically stable

For further information, see BofAML analyst Pinaki Das & team's "Muddying the Waters" report

UK Water Utilities, 31 October 2012

The UK water sector is generally perceived as a major success story and as functioning well. It is regarded as one of the most stable and well regulated sectors among European utilities and arguably even globally. This stability has facilitated solid access to the credit markets, helped lower the cost of capital, deliver efficiencies, keep bills affordable and deliver over £100bn of investments in the past 20 years. Returns are linked to inflation, attractive to many investors – especially to infrastructure and pension funds with a longer time horizon and a focus on dividends.

These attractions have also meant that the sector's M&A appeal has remained strong, with many UK water assets sold at large premiums to the regulated asset value (RAV) in recent years. Of the 21 water companies (of which 10 are large), the majority are now owned by infrastructure/pension fund consortia and only three remain listed (United Utilities, Severn Trent and Pennon). The most recent approach, in May 2013, for Severn Trent was rejected by the company but there is clearly some hope that the suitors will return once the current regulatory review is complete – this has been one of the factors behind recent share price strength, along with demand for high-quality defensives and lacklustre growth elsewhere.

Price control review is a key driver

The sector is going through a regulatory review during 2014 that will set revenues (and determine profitability) for the 2015-20 period. The regulators' posture has been generally tough, lowering allowed returns and encouraging the companies to think carefully about costs and the impact on consumers' bills. The affordability debate remains acute in the UK at present, given the political backdrop in a pre-election year.

At the time of writing, Pennon's water subsidiary (South West Water) had been granted "enhanced" (fast-track) status – this provides a superior level of clarity, and our initial read of the numbers imply the company should be able to outperform the allowed return on equity by c1.4% on average. Much of Pennon's success in the review is attributable to its focus on lowering customer bills, which is more aggressive that SVT or UU.

The process for the other companies will be largely complete during Summer 2014, and reach an official conclusion by the end of the year. This should bring an end to uncertainty and clarify the extent to which the companies can maintain dividends (not in doubt for PNN). We believe there are still risks in the review for SVT and UU, and they could still end up with less revenues/cost allowances than requested in their business plans.

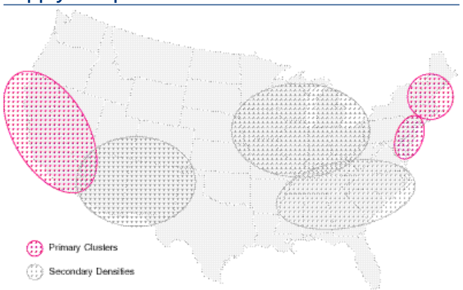
Resilience will be key in the future

Since privatisation, investment in the UK water industry has focused principally on developing the supply network, improving quality and meeting environmental compliance with the higher standards set by Europe. Over the next 20 years, much of the investment is to be maintenance but with a focus on resilience given the challenges from climate change (for example, more frequent and severe droughts/floods). The EU Framework Directive will require specific investments to ensure compliance, although these vary by region. Manufacturers of maintenance equipment required by the utilities are likely to be positively affected by such a strategy.

US – fragmented market yet exciting opportunities

The US water supply industry is highly fragmented. There are more than 53,000 drinking water companies across the country regulated by the EPA (85% municipal, 15% private). The majority of which serve very small populations – less than 1% of these serve more than 100,000 people.

Chart 125: Distribution of regulated water supply companies



Source: BofA Merrill Lynch Global Research

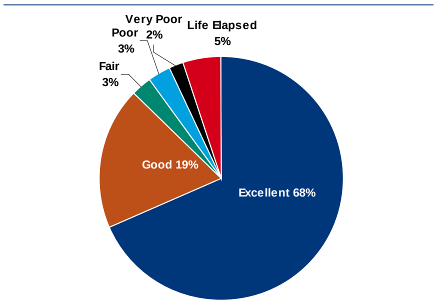
Niche industry with consolidation potential

Water supply is a niche industry with only 10 listed companies with a market cap of US$16bn. There are significant barriers to entry to the near-monopoly business with start-ups having little success (Source: Aqua Resources). We expect further consolidation as a consequence of more stringent regulations and greater capital requirements for investment. As the chart on the left illustrates, the US private sector water suppliers – which supplied some 73m people in 2011 (Source: National Association of Water Companies) – are concentrated in the populous coastal states where efficiencies are more readily achievable, though resources more constrained.

US$2.6bn of treated water lost every year

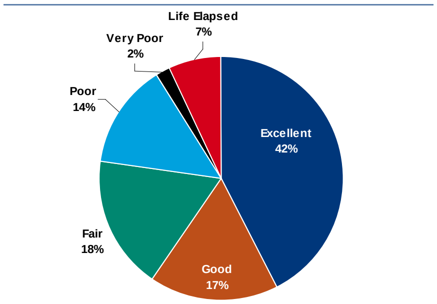
The U.S. has c1mn miles (1.6mn km) of water pipelines – with a major water main breaking every two minutes, with 2tn gallons of treated water lost every year at a cost of US$2.6bn. With regard to the U.S.' 800k (1.28mn km) miles of sewer mains, 900bn gallons of untreated sewage are discharged every year. Without renewal or replacement of existing systems, 44% of pipes will be classified as poor, very poor or life elapsed by 2020 (Source: American Water).

Chart 126: Percentage of water pipes in the US by classification (1980)



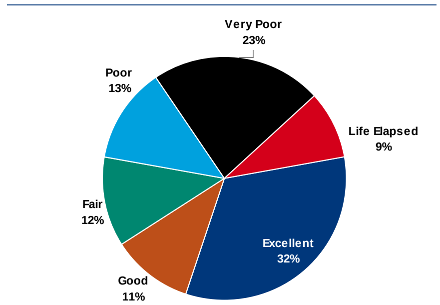
Source: American Water Works based on US EPA, BofA Merrill Lynch Global Research

Chart 127: Percentage of water pipes in the US by classification (2000)



Source: American Water Works based on US EPA, BofA Merrill Lynch Global Research

Chart 128: Percentage of water pipes in the US by classification (2020)



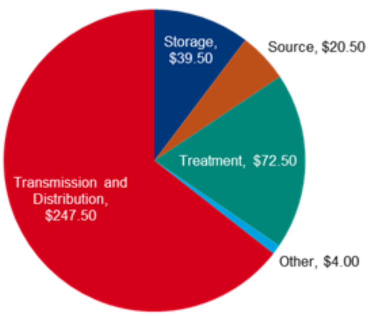
Source: American Water Works based on US EPA, BofA Merrill Lynch Global Research

The US's ageing drinking-water systems have been under-funded for many years and require huge investment in the coming decades. A major water main breaks every two minutes in the US

Urgent need for up to US$1tn in investment

US water and wastewater requires urgent investment of as much as U$S1tn over the next 25 years (Source: American Water Works Association). The US EPA, for instance, estimates that US$384bn would be required to 2030 simply to address infrastructure shortcomings – and an additional US$335bn to improve the systems. The American Society of Civil Engineers currently ranks both the nation's drinking water and wastewater infrastructure as D-. Huge investments are needed in drinking water treatment plants and distribution lines, sewer lines and storage facilities.

Chart 129: US water infrastructure investment needs

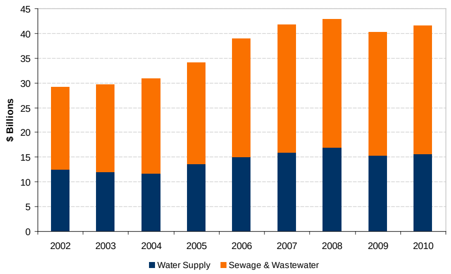


Source: US EPA

Cash-strapped municipalities starting to look to private sector

Positively, there are growing signs that large US public municipal water utilities are willing to contract with the private sector on the back of financial constraints and insufficient public funding, ageing infrastructure, increasing EPA regulations and less "emotional attachment" to water by municipalities. The private sector is already playing a greater role in areas such as advisory services, municipal players are increasingly open to partnerships, and the acquisition pipeline is looking more robust.

Chart 130: US water infrastructure spending, 2002-10



Source: US Census Bureau, BofA Merrill Lynch Global Research

Water-friendly energy solutions

Table 53: BofAML Global Water - Stocks in our coverage universe with exposure to Water-Friendly Energy solutions

Company	Water Exposure*
Acciona	High
China Longyuan	High
CPFL Energia S.A	High
Datang Renewable	High
EDP Renovaveis	High
Enel Green Power	High
ENPH	High
First Solar	High
Itron	High
NextEra Energy	High
NRG Energy	High
Pattern Energy	High
SCTY	High
Sun Edison	High
SunPower Corp.	High
Suzlon Energy	High
Trina Solar	High
Vestas	High
Yingli Green Energy	High

Source: BofA Merrill Lynch Global Research
* Water exposure = BofAML estimates of current sales derived from water-friendly energy-related products, services, technologies and solutions

"Support for the development of renewable energy will need to increase dramatically in comparison to support for fossil fuels in order to make a significant change in the global energy mix and, and by association, to water demand." – UN World Water Report 2014

In our view, a number of companies are well placed to benefit from the theme of water -friendly energy solutions, vis-à-vis their involvement in areas such as wind, solar and geothermal energy, co-production of energy and water, exploiting synergies (e.g. combined power and desalination plants, CHP plants using alternative water sources for thermal power plant cooling, and energy recovery from sewage water), energy efficiency in agriculture and across the agrifood chain, and smart irrigation and precision agriculture, among others.

Water and energy are interlinked and interdependent – with approximately 90% of global power generation water intensive. Moreover, today's power sector is largely designed for a water-rich world, which will become an increasingly unsustainable challenge in the coming years. Global water withdrawals for energy production – predominantly cooling water - amount to 583bn (c15% of the world's total withdrawals), of which 66bn m3 was consumed (Source: IEA). By 2035, water withdrawals could increase by 20% and consumption by 85% (manufacturing +400%, thermal electricity demand +140%), driven via a shift towards higher efficiency power plants with more advanced cooling systems (reduced water withdrawals but increased consumption) and increased production of biofuels (Source: IEA, UN).

With total energy water demand set to double by 2035, going forward, regulators and the energy sector will need to integrate water efficiency as a central component of policy frameworks, cooperation and integration among different sectors: This will be key given the increasing challenges posed by extreme weather and climate change, and growing competition for water from agriculture and industry.

From a water perspective, power generated from solar PV and wind is the most sustainable choice, having the lowest operational and lifecycle water consumption footprint (i.e. water use per unit of electricity generated). Issues remain regarding transmission constraints as well as regulatory, technical and operational factors – and their intermittent nature means that they will need to be supported by other water-intensive forms of energies to maintain load balance, until we see advances in energy storage.

The economics of cleantech are increasingly compelling with recent technological advancements in solar and wind along with rising cost of emissions and pollution controls closing the gap between renewable power generation and fossil fuels. As of 2013, wind, coal, and gas generation were in line with one another at around US$0.07-0.08/kWh, with PV solar at US$0.14/kWh (Source: BNEF).

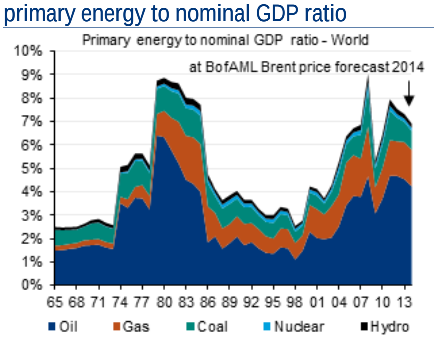
Other water-friendly energy solutions - Geothermal power also holds out potential in a number of regions, as does co-production of energy and water, exploiting synergies (e.g. combined power and desalination plants, combined heat and power plants using alternative water sources for thermal power plant cooling, and energy recovery from sewage water, among others). Finally, energy efficiency in agriculture and across the agrifood chain, as well as smart irrigation and precision agriculture can reduce energy-related water use (Source: UN).

Table 54: Energy trends produce water use trends

Energy trends produce water use trends	Resulting trend in Energy's water use
Shift from foreign oil to biofuels	Increases energy's water consumption if domestic agricultural irrigation water (and other inputs) is needed for fuel production
Shift to shale gas	Natural gas development using hydraulic fracturing may raise water quantity concerns if well development is geographically concentrated in areas with water constraints. However, natural gas from fracturing consumes less U.S. freshwater than domestic ethanol or onshore oil.
Growth in domestic electricity demand	Concentrating solar power technologies can use more water to produce electricity than coal or natural gas; these solar facilities are likely to be concentrated in water-constrained areas. Technologies are available to reduce this water use. Other renewable technologies, such as photovoltaic solar and wind, use little water.
Use of carbon mitigation measures	Carbon capture and sequestration may double water consumption for fossil fuel electric generation.

Source: CRS

Chart 131: Our preferred metric to determine whether energy is cheap or expensive is the primary energy to nominal GDP ratio

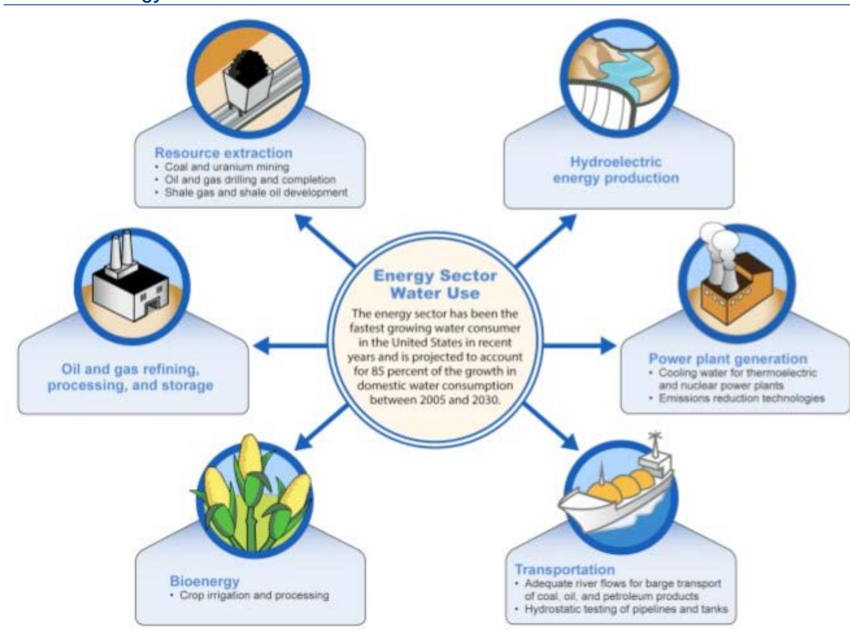


Source: IMF, IEA, BP, Bloomberg BofA Merrill Lynch Global Commodities Research

Global energy crisis & the water nexus

The world is facing a global energy crisis, with 7-9% of GDP being spent on energy in the last decade. Primary energy demand is expected to increase by up to 50% by 2030 (Source: IEA) with demand to grow for all energy sources including coal, oil, natural gas, nuclear, hydro and renewables Emerging markets will account for 90% of the projected growth in global energy demand, according to the IEA. Electricity demand is expected to grow by approximately 70% by 2035. As a result, energy-related CO_2 emissions are likely to increase by 20%, following a trajectory consistent with a long-term rise in the average global temperature of 2°-4°C – resulting in irreversible climate change, according to the IEA.

Exhibit 1: Energy sector water use



Source: Government Accountability Office (US),US DOE, Congressional Research Service

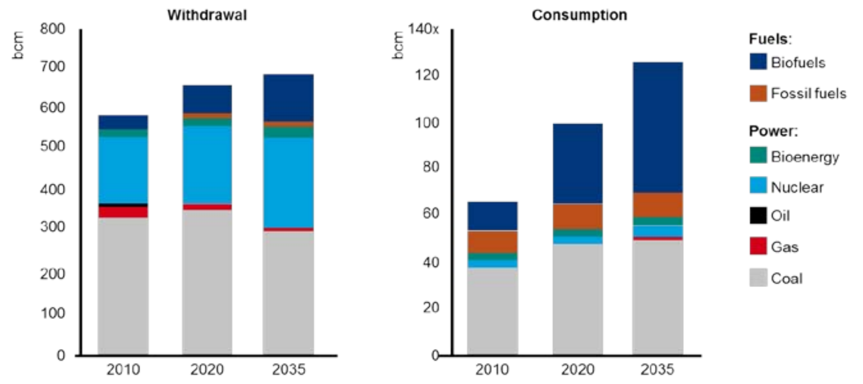
Water withdrawals for power are expected to increase by +20% and water consumed by +85% to 2035

In China, coal-fired electricity currently uses more than 114tn litres of water, c.20% of the country's total consumption, rising to 40% over the next decade if current trends continue

Impacts of rising energy demand on water

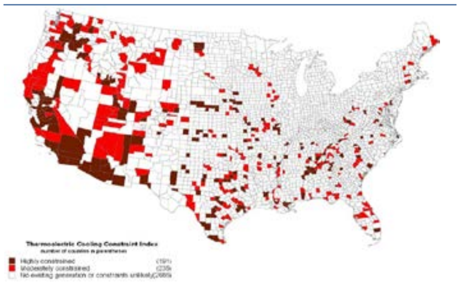
90% of global power generation is water intensive – and it accounts for 15% of the world's water withdrawals (583bn m^3), which are expected to increase by 20% over the next 20 years (Source: IEA). Increasing energy demand as well as the boom in water-intensive non-conventional energies such as shale oil and gas is partly responsible for this growth. Medium to long-term, we anticipate increasing vulnerability for the energy sector (especially in water-constrained regions) and growing domestic competition for water resources between the agricultural, industrial and residential/municipal users.

Chart 132: Global water use for energy production by fuel type



Source: IEA WEO 2012

Chart 133: Thermoelectric cooling constraint index

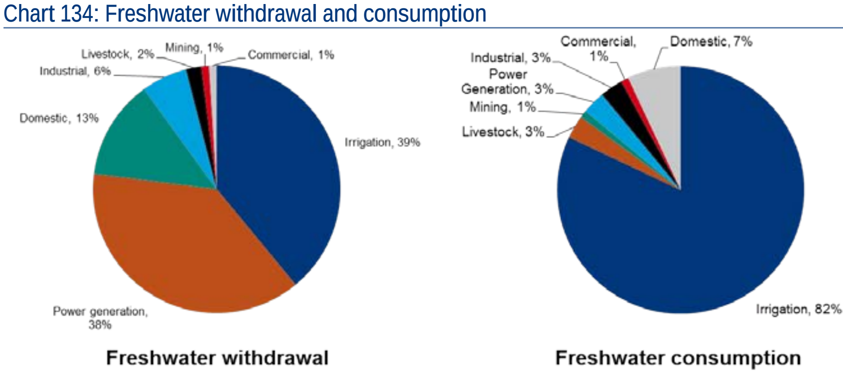


Source: CRS based on EPRI

- **Thermo-electric power plants are responsible for approximately 80% of global electricity** production, and power plant cooling is responsible for 42% of total freshwater withdrawals in the EU (50%+ in several countries), nearly 50% in the US, and >10% of the national water cap in China. Thermal power plants require cooling water to condense the steam turbine exhaust steam. Exhaust steam from the turbine enter a condenser, which is then condensed by running cold cooling water flowing through the condenser tubes. Cooling water increases the efficiency of the power plant. Most of the water is returned, but at a higher temperature and lower quality.

- **Coal-fired electricity alone accounts for 20% of non-agricultural water use in the US** and in China could account for 40% of all water use over the next decade.

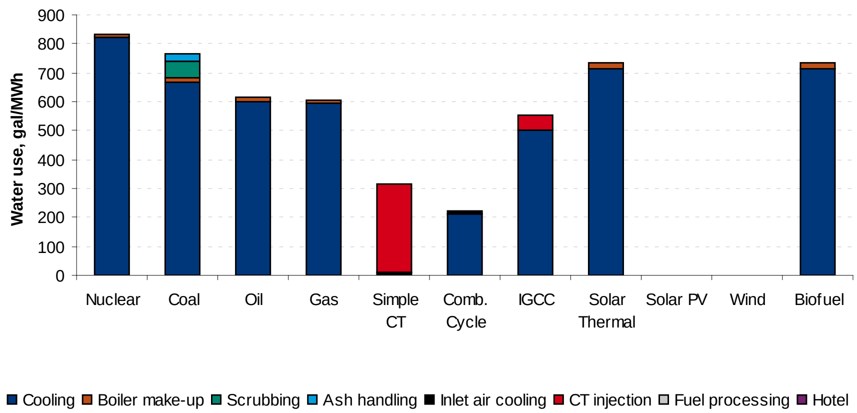
Chart 134: Freshwater withdrawal and consumption



Source: EPRI, BofA Merrill Lynch Global Research

- **The installation of larger and more efficient power generation plants still means massive water use**. Gas-fired plants consume the least amount of water per unit of energy produced; coal- and oil-fired plants consume up to twice as much as gas-fired, and nuclear consumes up to three times as much. The future is unclear, with IGCC (integrated gasification combined cycle) able to reduce a coal plant's water consumption by half, but CCS (carbon capture and storage) potentially increasing a coal plant's water consumption by 30-100%.

Chart 135: Water use by plant type



Source: EPRI, BofA Merrill Lynch Global Research

By 2025, the oil sector could be producing 5x more water than oil, with onshore crude oil having a ratio of up to 12x largely on the back of ageing wells and increased unconventional O&G such as EOR, shale gas and oil sands

- **Oil and gas extraction** yields high volumes of produced water, which comes out of the well along with oil and gas, with shale gas much more water intensive than conventional oil and gas (using an average of 5mn gallons of water per well). The oil industry currently produces 2.5x more water than oil and by 2025, the oil sector could be producing 5x more water than oil, with onshore crude oil having a ratio of up to 12x largely on the back of ageing wells and increased unconventional O&G such as EOR, shale gas and oil sands (Source: GWI). Produced water is usually very difficult and expensive to treat.

- **Production of biofuels** is among the most water intensive types of fuel production and the demand for water-intensive agricultural feedstocks for biofuels is the largest source of new demand for agricultural production in decades, and was a driving force behind the 2007-2008 spike in world commodity prices. As biofuels also require water for processing the water requirements of biofuels produced from irrigated crops can be much larger than for fossil fuels (Source: UN, IEA).

Table 55: Energy water demand outlook to 2035 (bn m3)

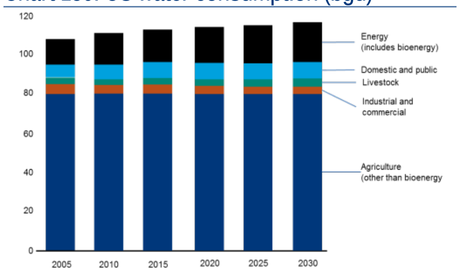
	Withdrawal		Consumption	
	2010	2035	2010	2035
Primary energy	38	127	23	64
Biofuels	25	110	12	49
Coal	2	2	1	2
Gas	2	3	2	3
Unconventional	0.3	1.1	0.3	1.1
Oil	10	12	8	10
Unconventional	0.7	2.1	0.7	2.1
Power generation	544	564	43	59
Coal	331	299	38	49

Table 55: Energy water demand outlook to 2035 (bn m3)

	Withdrawal		Consumption	
	2010	2035	2010	2035
Gas	35	13	2	2
Oil	2	1	0	0
Nuclear	167	222	3	5
Biomass	9	28	1	2
Other renewable	0	1	0	1
Total	583	691	66	122

Source: IEA

Chart 136: US water consumption (bgd)

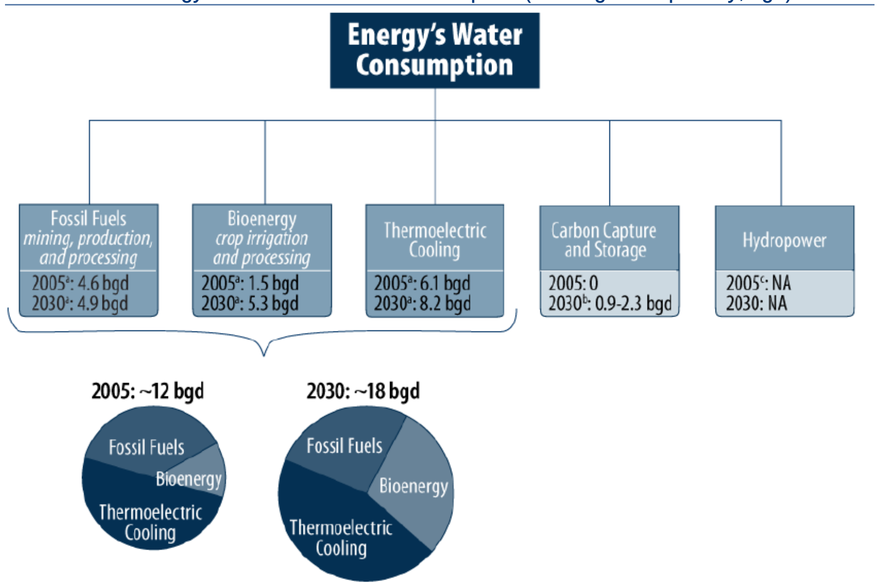


Source: CRS

Energy = 85% of US water consumption growth to 2030

The U.S. energy sector accounts for 44% of water withdrawals and 6% of water consumed in the US, mainly via cooling for thermo-electric plants (Source: CRS). Energy is the fastest growing water consumer and is expected to account for a projected 85% of domestic water consumption growth from 2005 to 2030 (Source: Congressional Research Service.

Chart 137: US energy sector's freshwater consumption (billion gallons per day, bgd)



Source: Congressional Research Service (CRS)

98% of South Africa's water resources have been allocated, leaving little resilience to respond to increasing energy demand, extreme weather & climate change

South Africa's water-energy crisis, a sign of things to come

Water and energy are inextricably linked and mutually dependent, with changes in water availability significantly impacting energy supply. The water-energy crisis in South Africa is a worrying sign of things to come with the country allocating c2% of water supply to coal mining and c2.5% to designated "strategic water user", the electrical utility Eskom. According to Greenpeace Africa, c98% of if South Africa's water resources have been allocated, leaving next to no resilience in the system to respond to increasing energy demand, let alone extreme weather and climate change.

Energy infrastructure highly susceptible to climate change

Energy infrastructure is highly susceptible to climate change impacts according to a January 2014 report by the U.S. Government Accountability Office (GAO). Snowpack, precipitation, and runoff are strongly related to climate and climate change researchers predict both water quantity and timing changes including more rain, less snow, changes to seasonal water availability, and more frequent extreme weather. These changes will present major challenges for thermo-electric and hydro energy (Source: CRS).

Minimising water use in energy going forward

There is no silver bullet solution to minimising energy-related water use. Efforts to minimise freshwater use will need to encompass adopting energy policies/mix that are less water intense and more sensitive to water constraints, promoting activities that reduce energy's water use (e.g. incentives for adopting less water intense energy generation technologies), market-based mechanisms for making water available to the energy sector (e.g., through allocations, permits, or water trading), and improving data and analysis on energy's water use to better inform decision-making (e.g., resource planning efforts and decision-support tools) and enhancing the availability and dissemination of water-efficient technological alternatives.

Table 56: Energy-water relationship

Energy element	Connection to water use / scarcity	Connection to water quality
Energy Extraction and Production		
Oil and Gas Exploration	Water for drilling, completion and fracturing	Impact on shallow groundwater quality
Oil and Gas Production	Surface water and groundwater for cooling and scrubbing	Produced water can impact surface and groundwater
Coal and Uranium Mining	Mining operation can generate large quantities of water	Tailings and drainage can impact surface water and groundwater
Electric Power Generation		
Thermal electric (fossil, biomass, nuclear)	Surface water and groundwater for cooling and scrubbing	Thermal and air emissions impact surface waters and ecology
Hydro-electric	Reservoirs lose large quantities to evaporation	Can impact water temperatures, quality and ecology
Solar PV and Wind	None during operation; minimal water use for panel and blade washing	
Refining and Processing		
Traditional Oil and Gas refining	Water needed to refined oil and gas	End use can impact water quality
Biofuels and Ethanol	Water for growing and refining	Refinery waste-water treatment
Synfuels and Hydrogen	Water for synthesis or steam reforming	Wastewater treatment
Energy Transportation and Storage		
Energy Pipelines	Water for hydrostatic testing	Wastewater requires treatment
Coal Slurry Pipelines	Water for slurry transport, water not returned	Final water is poor quality, requires treatment
Barge Transport of Energy		Spills or accidents impact water quality
Oil and Gas Storage Caverns	Slurry mining of caverns requires large quantities of water	Slurry disposal impacts water quality and ecology

Source: BofA Merrill Lynch Global Research

Table 57: Domestic Freshwater impacts from Electricity Sector Shifts

Shifts in Electricity Generation	Change in U.S. Freshwater Consumption	Impairment of Domestic Water Quality and/or Aquatic Ecosystems
Fuel Source Shift		
Nuclear displaces coal	Unclear with current data	Shift in pollutants generated during fuel extraction, processing and electricity generation
Concentrating solar power (with freshwater cooling) displaces coal	↑	↓
Domestic natural gas displaces coal	↓	Shift from nonpoint source to more point source pollution
Hydropower without new reservoirs displaces coal	↓	Shift from nonpoint source pollution to potential harm to aquatic ecosystem and species
Photovoltaics displace coal	↓	↓
Wind displaces coal	↓	↓
Ocean/tidal/hydrokinetic displace coal	↓	Potential for harm to aquatic ecosystem and species
Geothermal displaces coal	↓	↓
Electricity Sector Shifts		
CCS added to a power plant	↑	Unknown
Dry cooling replaces evaporative cooling	↓	↓
Electricity conservation decreases electricity consumption	↓	↓

Source: CRS

Table 58: Water consumption for electricity generation by fuel source

Generation Technology and Fuel	Water for Fuel Mining, Production, or Processing (gal/MWh)	Evaporative Cooling Water at Power Plant (gal/MWh)	Other Water Used for Power Plant Operations (gal/MWh)	Avg. Total Water Intensity (gal/MWh)	Data Sources
Biomass/Waste					
Non-irrigated biomass	0	300-480	30	420	DOE 2006
Non-irrigated biomass with CCS	0	Not available	30	-	DOE 2006
Irrigated biomass	Highly variable	300-800	30	-	DOE 2006
Municipal waste	Not available	300-480	30	420	DOE 2006
Coal					
Conventional/Subcritical coal	5-74	449	68	557	DOE 2006; NETL 2009
Convention/Subcritical coal with CCS	5-74	884	101	-	DOE 2006; NETL 2009
Supercritical coal	5-74	392	59	491	DOE 2006; NETL 2009
Supercritical coal with CCS	5-74	759	86	-	DOE 2006; NETL 2009
Ultra-supercritical coal	Not available	Not available	Not available	-	DOE 2006; NETL 2009
Ultra clean coal	Not available	Not available	Not available	-	DOE 2006; NETL 2009
Coal IGCC (slurry fed)	30-70	290	19	359	DOE 2006; NETL 2009
Coal IGCC (slurry fed) with CCS	30-70	355	97	502	DOE 2006; NETL 2009
Coal IGCC (dry fed)	5-74	243	53	336	DOE 2006; NETL 2009
Coal IGCC (dry fed) with CCS	5-74	355	120	515	DOE 2006; NETL 2009
Geothermal					
Enhanced geothermal	0	Dry cooling	290-720	585	Argonne 2010
Geothermal binary	0	Dry cooling	80-270	175	Argonne 2010
Geothermal flash	0	Dry cooling	5-10	8	Argonne 2010
Hydroelectric			Evaporation varies with site		
Natural Gas					
Natural gas combined-cycle	11	192	0	203	DOE 2006; NETL 2009
Natural gas combined-cycle with CCS	11	338	0	349	DOE 2006; NETL 2009

Source: CRS

Renewables are a big part of the solution

Renewable energy technologies that do not use thermoelectric processes have minimal water requirements for electricity generation. From a water perspective, power generated from solar PV and wind is the most sustainable choice, having the lowest operational and lifecycle water consumption footprint (i.e. water use per unit of electricity generated).

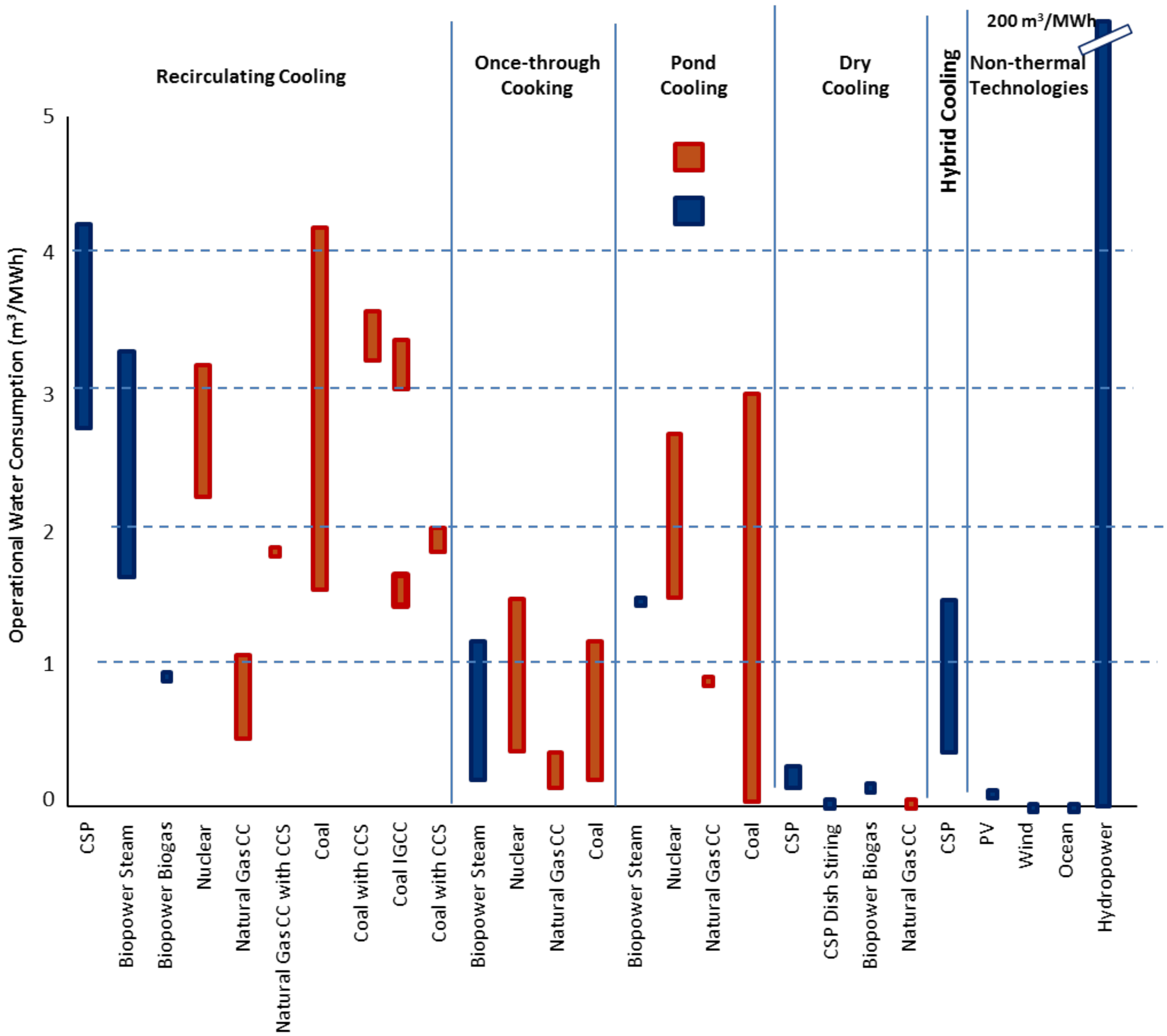
Not all power is created the same

However, there are huge differences in water requirements amongst different energy technologies. Nuclear, coal, oil, gas and biofuels are used by thermal power plants, all using 500 gallons of water or more per MWh (Source: EFRI). Most of the water is utilized as a cooling mechanism in the plant through either an open or closed-loop system. Open-loop systems withdraw water and return it at a higher temperature and lower quality. Closed-loop systems recirculate cooling water through a cooling tower, which means less water is withdrawn, but more water would be consumed due to evaporation. Nuclear power plants with closed-loop systems need as much as 700-1100 gallons per MWh. Closed-looped Coal-fired power require 500-600 gallons per MWh. Closed-loop systems for each would increase the amount of water used to 25,000-60,000 gallons per MWh and 20,000-50,000 gallons per MWh for nuclear and coal respectively.

Water use in renewables negligible

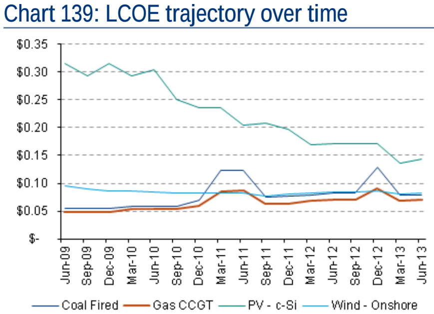
Solar and wind power generation require only 55-85 gallons per MWh, or about one-tenth for nuclear power and one-sixth of coal. In PV solar power, water is only utilized to periodically wash the panels. Water is not during wind power generation but it considered during the lifecycle of the project as the construction affects surrounding marine wildlife. Renewables have a significant advantage over fossil fuels in that they reduce the water scarcity and water treatment intensity challenges associated with fossil fuels – and lessen the burden on the water-energy nexus.

Chart 138: Operational water consumption for the production of various types of energy



Source: IPCC (2011) – Trends in the demand of water for energy

Chart 139: LCOE trajectory over time



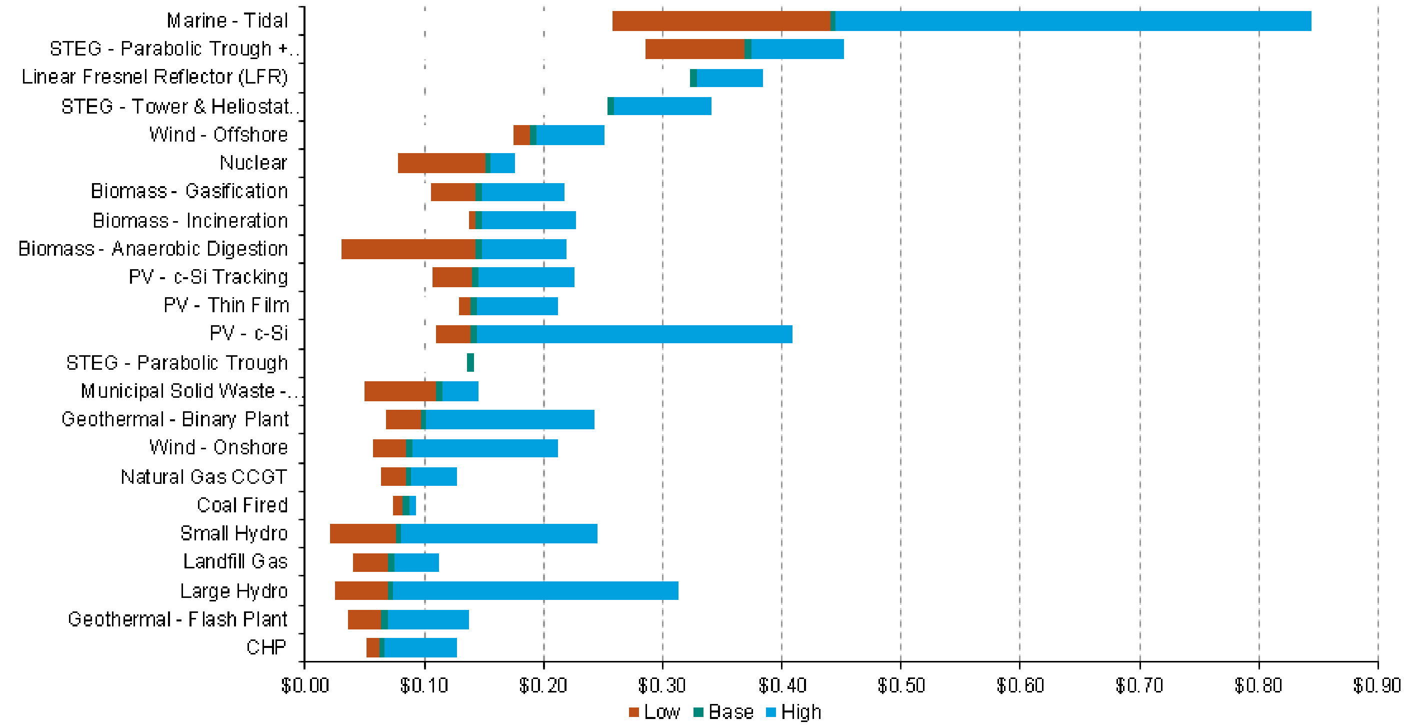
Source: BNEF, BofA Merrill Lynch Global Research

Economics of power generation

Recent technological advancements in solar and wind generation along with rising cost of pollution controls is closing the gap between renewable power generation and fossil fuels. The economic viability of clean energy alternatives is now more compelling versus retrofitting pre-existing coal plants. Increasing capacity factors and reductions in capital costs has resulted in a 55% drop in PV C-Si relative cost of electricity (LCOE) and 14% drop in onshore wind power since June 2009 (no subsidy assumptions). During the same period, coal-fired and gas CCGT power has risen 42% and 43% respectively. As of 2013, wind, coal, and gas generation were in line with one another at around US$0.07-0.08/kWh, with PV solar at US$0.14/kWh (Source: BNEF).

As power plants bring themselves in line with the EPA's Mercury and Air Toxics Standards (MATS), it becomes more economical and pragmatic to retire coal fired plants in favour of renewables. 60 GW of coal-fired capacity will be retired between 2012 and 2020 in order to meet the 2015 deadline for compliance with MATS, and other existing laws and regulations (Source: IEA). SNL Energy estimates that 11 GW of coal capacity will be converted into other fuels such as natural gas or biomass from mid-August 2013 through the end of 2022.

Chart 140: Current relative cost of electricity



Source: BNEF, BofA Merrill Lynch Global Research

Solar energy uptake

In 2013, solar power generation accounted for 144 billion kWh globally out of the 7,644 billion kWh of total power generation, or 1.9% penetration of the market. This number is expected to grow to around 2.4% in 2014 and to 3.6% in 2016. Average capacity factor – how much electricity a generator produces out of the maximum – has also been steadily rising, from 7.85% in 2009 to 9.8% in 2013 and to E10.6% in 2016. Pricing and power generation reliability will make renewable energy an increasingly competitive source of electricity.

$523bn in fossil fuel subsidies vs. $88bn for renewables

The IEA estimates that global fossil fuel consumption subsidies totalled US$523bn in 2011 vs. only US$88bn for renewable energy. Support for the development of renewables will need to increase dramatically in comparison to support for fossil fuels in order to make a significant change in the global energy mix and, and by association, to water demand (Source: IEA, UN).

Table 59: US water opportunities and challenges in meeting energy demand with renewables

Region	Opportunities	Challenges
Southwest	High quality solar and geo/thermal resources	Water constraints and drought vulnerability favour more expensive, water efficient use of these renewable resources
Northwest	Generates most of its electricity from hydropower	diversifying to include more wind in light of environmental protections, increasing off stream uses and climate change effects on hydropower
Great Plains	May reduce water competitions among the thermoelectric and agricultural sectors by exploiting wind power to produce electricity	Grid balancing and transmission of that electricity, especially to other regions, may pose constraints. Increases in irrigation to support bioenergy crops may tax stressed aquifers

Table 59: US water opportunities and challenges in meeting energy demand with renewables

Region	Opportunities	Challenges
Southeast	Could reduce its dependence on coal and nuclear fuel and decrease its vulnerability to electricity. Interruptions during drought by producing electricity from biomass and photovoltaics	
Midwest	Could reduce competition between the thermoelectric and agricultural sectors and reduce the regional energy sector's low flow, drought and flood vulnerability by exploiting its wind resources	Overcoming significant regulatory transmission issues participating in the production of bioenergy crops, in particularly corn for ethanol, raising water quality concerns, including that excess nutrients in agricultural runoff are feeding the growth of the "dead zone" in the Gulf of Mexico
Northeast		Is not experiencing a regional issue with energy's growing water consumption, however, fracturing in shale gas formations is raising quality concerns
Hawaii	Could transition to water efficient power generation technologies to protect limited freshwater resources consumed in thermoelectric generation, which is dominated by oil-fuelled power plants	
Coastal regions, including Alaska	Potential to develop offshore wind, tidal energy, waves or ocean thermal gradient to reduce energy's onshore water use and land requirements	Public opposition, transmission challenges, resource availability mismatched with demand and natural hazards.

Source: CRS

Case study in Saudi Arabia and water-energy security, a long-term opportunity for PV solar

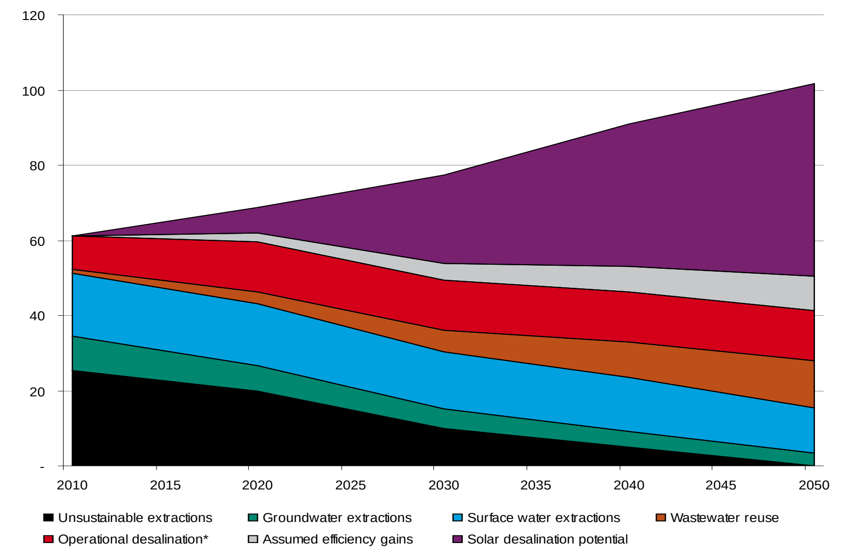
The intersection of water supply and energy availability challenges on the Arabian Peninsula represent a large opportunity for PV solar demand. As the figure below illustrates, the trajectory of Saudi water demand is decoupling from traditional supply sources, especially various forms of extraction and wastewater reuse. Existing desalination capacity is plugging the gap, but additional plants need to be added rapidly during the next 30 years to address likely demand growth. We estimate that 60% to 70% of Saudi Arabia's water demand by 2050 could be addressed by thermal and membrane-based desalination.

Saudi Arabia's solar powered desal initiative

Unsustainable extractions meet rising demand

Desalination is not a time-of-day dependent process. Unlike electricity, fresh water can be stored and delivered when needed, which makes desalination an ideal candidate for intermittent power sources. Smaller but more energy-intensive reverse osmosis plants are especially well suited to PV power. Meanwhile, there are good reasons to consider non-traditional sources of energy for desalination. Saudi Arabia currently burns 1.5 million barrels of oil per day - or about 13% of its daily production - to power 10.1 million cubic meters per day (Mm3/d) of desalination capacity in operation as of 2012. Cognizant of the Kingdom's outstanding solar resources and the opportunity cost of burning oil otherwise destined for export, the country's leadership has embarked on a three-phase initiative to grow its solar powered desal base by at least 300,000 m3/d by 2020. It's clear from our research, however, that the plans under consideration are not sufficient to address the Kingdom's long-term water needs.

Chart 141: Water supply sources for Saudi Arabia (Mm3/d)



* Based on plants in operation in 2010. Incremental capacity through 2020 based on plants under construction or planned

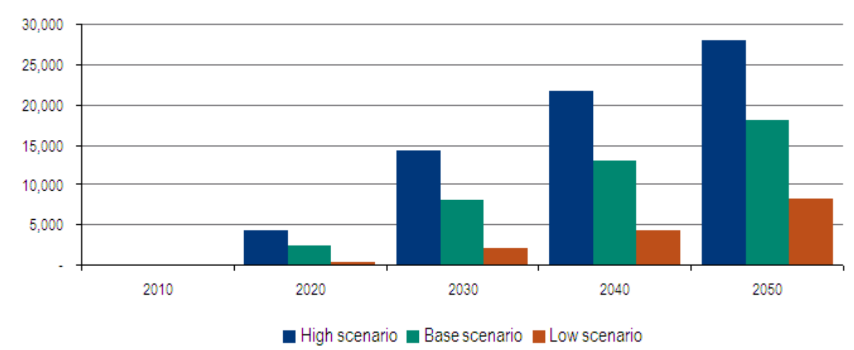
Source: BofA Merrill Lynch Global Research estimates, Fichtner 2011 (MENA Regional Water Outlook, prepared for World Bank)

Up to 68GW of solar PV

We expect more of the desal demand to be addressed with solar following 2020

We estimate that as much as 68GW of solar PV could be installed in Saudi Arabia by 2050 to power desalination plants necessary to offset increasing water scarcity. Over 90% of that total will most likely be installed between 2020 and 2050, as the near-term prospects for solar desalination are still subdued. Of the 3.3 Mm3/d of desalination capacity currently either under construction or planned for completion by 2020, only about 10% is slated to be solar powered as of October 2012. This includes the Al Khafji reverse osmosis plant currently under construction, which will be the largest solar powered desalination plant in the world when it is placed into service in 2013. We believe, however, that the economics of burning expensive oil to make cheap subsidized electricity, in a country with abundant solar resources, will become less appealing to the Saudis during the coming 5 years.

Chart 142: PV installation scenarios necessary to power desalination demand (MW)



Source: BofA Merrill Lynch Global Research estimates, Fichtner 2011

Table 60: Costs of Desalinated Seawater from Renewable Energy Alternatives

RE source	Solar Heat			PV			Wind RO	
Desalination technology	CSP-MED	MEH	Stills	EDR	RO	MVC	Small	Large
Production (m^3/day)	>5,000	1-100	<0.1	<100	<100	<100	50	1,000
Cost (Euro/m^3)	1.8-2.2	2-5	1-15	8-9	9-12	4-6	5-7	1.5-4.0

Source: After ProDes 2010

Renewables reduce GHG emission from desalination

By 2050, Middle East and North Africa's (MENA) incremental annual desalination requirements are projected to be approximately 90 km^3. If the water are to be made from a 50:50 oil-gas mix, which is what is done now, 270-360 million tons (MT) of CO2 would be emitted from the process each year. This number would be cut down to 3.4-3.8 MT per year if desalination were to be done using CSP technology (Source: The World Bank). Increasing renewable energy usage overall can cut MENA's CO2 emissions to 265 MT as opposed to 1,500 MT by 2050.

Solar powered desalination has also been found to create a more efficient process, creating fewer by-products. Increased share of CSP-RO and CSP thermal desalination would reduce MENA's annual brine production by nearly half, from 240 to 140 km^3.

Solar desalination in California

California is currently developing the first solar thermal desalination solutions in the US. A company called WaterFX is taking the contaminated irrigation runoff that is drained from farms, and putting it in solar-heated tanks that steams the water, separating the freshwater from the salt and minerals. The phase change technology currently in development would be much less energy intensive than reverse osmosis.

Link to Definitions

Industrials

Click here for definitions of commonly used terms.

Macro

Click here for definitions of commonly used terms.

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