

We began work on this publication '**Water Technology Markets – Key Opportunities and Emerging Trends**'. By asking a few key questions.

1. What were the pressure points for the water industry
2. What was driving change in the water industry.
3. What were the general trends which were emerging.

Our Current Water System

1. Our current water system is inefficient and wasteful
2. Due to mounting global pressures we can no longer afford an inefficient and wasteful system
3. This is driving radical change and creating opportunities for technology development.

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And from this the picture which is emerging could be summarized in three key points:

Our current water system is very inefficient and wasteful.

Due to mounting global pressures we can no longer afford an inefficient and wasteful system

This is driving real changes in how we manage water and creating opportunities for technology development.



**In 2008 \$8.4Bn was invested in
Clean Tech**

***How much was invested in
Water Technologies?***



Now in 2008 out of a total of \$8.4Bn invested in Clean Tech.

How much of this do you think was invested in Water Technologies?

Less than 2%.

Now the feedback that I get talking to VC's is not that they are ***not interested*** in water, but that they are just not quite sure where the game changing opportunities are. And there is a general feeling that the water sector is quite conservative and slow to change.

The Need for Change

- Increasing Population
- Climate Change
- Groundwater depletion
- Water scarcity
- Rising energy costs and GHG emissions.
- Urbanisation – > 50% now live in cities
- Ageing infrastructure in the developed world and a requirement for new infrastructure in the developing world.
- Resource depletion

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However I think a combination of different pressures are coming together which are bringing us closer to a tipping point and forcing us to re-think how we manage water.

Well so far things haven't changed because they haven't had to.

There are mounting pressures which are pushing for alternative ways of dealing with water.

The reasons why a change is underway are

Increasing Population

Climate Change

Depletion of groundwater resources

Water scarcity

Rising energy costs and a drive to reduce GHG emissions.

Urbanisation – Over 50% of the planet now lives in Cities.

Resource depletion – more and more people competing for less and less resources.

Ageing infrastructure in the developed world and a requirement for new infrastructure in the developing world.



The BlueTech Investment Opportunity

- There is a new vision of a sustainable water system emerging.
- Creating of the technologies to make this alternative system a reality are where the opportunities lie in the water sector.



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Elements of a Smart, Sustainable Water System

1. Energy generation from wastewater
2. Nutrient Recovery and recycling
3. Water Re-use

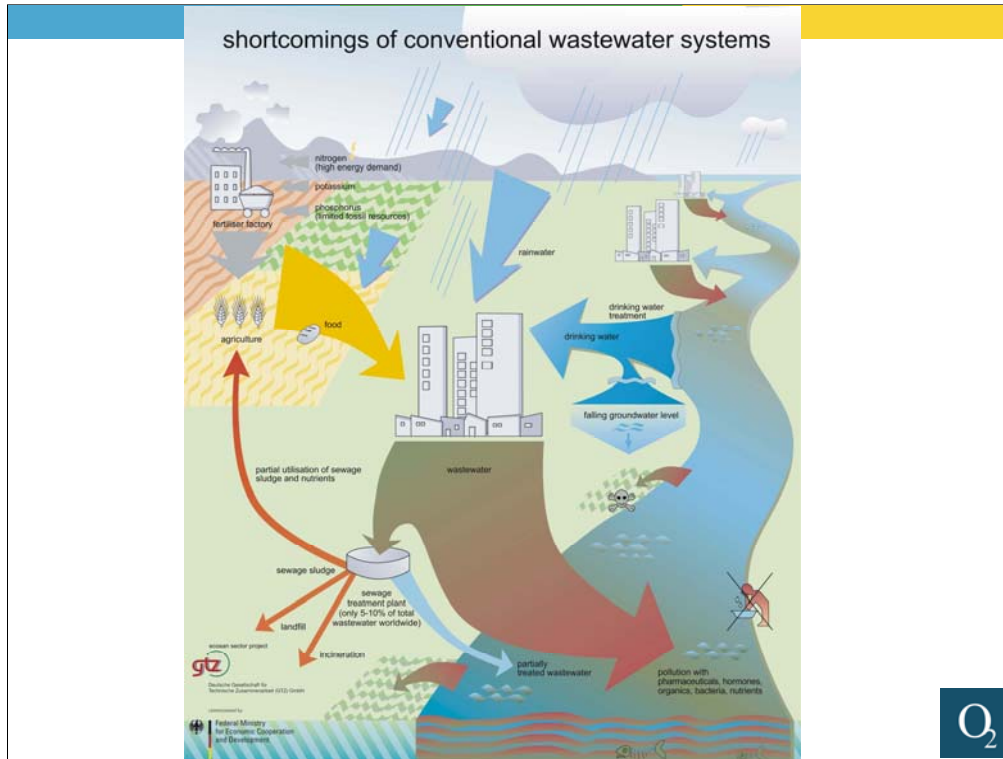


I would like to look at three elements which could form part of this new Smart Water system and the first is Energy Generation from Wastewater.

Energy generation from wastewater

Recovery and recycling of Nutrients.

Water Re-use Technologies.



The first thing to note about our current water system is that it is inefficient and wasteful.

We have a **'use once'** approach to water, currently, which would be the exact opposite of a cradle to cradle approach.

Current Model:

We take fresh water, filter it, chlorinate it, distribute it, lose anywhere from 30%-60% in that process due to leaking pipes. We use it once, we add faeces, urine, food waste, pharmaceutical and personal care products, transport it all to a centralized treatment plant where we try and take everything out again; take out the nutrients, take out the organics, produce a treated water which we don't re-use but discharge into the environment and it turns out this is very costly in terms of capital and operational costs.

About half of the energy bill of any Municipality is associated with providing water services. Half of that is associated with moving water from one place to another, distribution, and the other half is taken up with water and wastewater treatment. In fact, energy represents the single largest controllable cost of providing water services.

Now this system wasn't designed with efficiency in mind. In fact, it wasn't really designed at all. It just happened over time. Sewers were constructed in the 1850's to take wastes 'seaward' that's where the word sewer comes from.

Then we started to build large treatment plants at the end of these large pipes, and that's how we got to where we are today. With an inefficient, that is very heavy on energy. And in an energy starved world, we can't afford a system like this.

There is Energy in Wastewater

- The energy in the wastewater produced by one person each day could power a 100 watt light bulb for 5 hours

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ENERGY RECOVERY

I would like to talk now about an area where there is huge opportunity for change and this is energy generation from wastewater.

Now the current prevailing technology for secondary wastewater treatment is the activated sludge process. And its been with us just about 100 years.

There are two problems with the activated sludge process.

It consumes large quantities of energy and

It produces a waste sludge is problematic and costly to dispose of.

I would like to introduce a key point here.

Wastewater represents a significant untapped source of energy.

There is energy present in wastewater.

If you were take the wastewater produced by one person and convert the chemical energy into electricity, you could power a 100 watt light bulb for 5 hours.

So if there is energy present in wastewater, why do we spend energy to treat it?

There is something fundamentally wrong with that picture.

{ Our current WWT process is essentially an exercise in growing bacteria. We provide them with food & nutrition, in the form of wastewater, give them air and oxygen, which consumes energy, and then end up with a waste sludge which we have to dispose of. We are in essence giving bacteria a free lunch, paying them to eat it. }

They say that if you are in Ireland and you stop and ask an Irishman for directions, he will look at you and say, 'well if I were you I wouldn't start from here'. If you were setting out to design an efficient system, you wouldn't start with this.

Energy from Wastewater

- **Anaerobic Membrane Bioreactors**
 - Proposed demonstration plant at the Masdar Ecocity in Abu Dhabi.
- **Microbial Fuel Cells**
 - The Israeli company EMEFCY is marketing the MEGAWATTER process which does just this.
- **Advanced Primary Treatment**
 - Micromedia Filtration have a demonstration plant operating in Woodsville, New Hampshire

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There are three main technologies that I see emerging as viable alternatives to the Activated Sludge process.

Anaerobic Membrane Bioreactors

Produce very little sludge, require very little energy, produce re-use quality water and generate methane gas, so there is a potential for net energy production. Back & Veatch did trial work on this which won an award from the Royal Society they are now collaborating with a number of large industry players including Siemens, Memcor, Noritt and Zenon and there are proposals to construct a 5,000m³/day demonstration facility and I have seen some proposals that this will be used at the new Masdar EcoCity in AbusDhabi.

Microbial Fuel Cells

This is a very clever system where you use of special group of bacteria, known as exoelectrogens, which release electrons as they treat wastewater. The electrons are collected on Anodes used to generate electricity. The Israeli company EMEFCY is marketing the MEGAWATTER process which does just this. So this could turn a wastewater treatment plant into a power generating facility.

Advanced Primary Treatment

Micromedia Filtration is an example of a very small company trying to do something game changing. They have a demonstration plant operating in Woodsville, New Hampshire in the US. This facility treats 60,000 gpd.

Now these three technologies are not simply incremental improvements on an existing process. There are completely alternative, game changing strategies which could eliminate the energy consumption and GHG emissions associated with WWT and potentially turn a WWTP into a net energy producer.



Elements of a Smart, Sustainable Water System

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NUTRIENT RECOVERY

The next alternative approach offer the opportunity to Reduce Energy and Chemical Use, Recovery and Recycle nutrients and generate a source of revenue.

Current Nutrient Removal

- Consumes energy
- Consumes chemicals
- Produces a waste product

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Wastewater contains Nitrogen and Phosphorus.

And increasingly wastewater treatment plants are required to remove these from the wastewater prior to discharge to meet discharge limits. In fact this is Regulatory hurdles facing WWTP's.

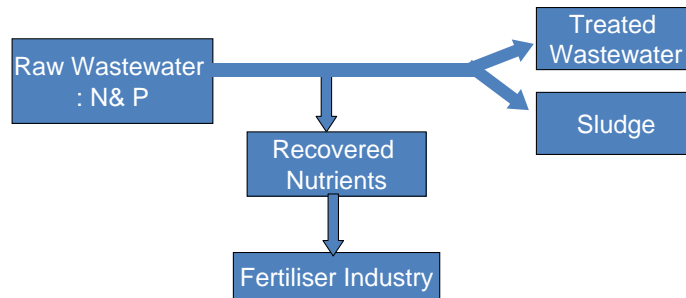
And currently the prevailing method of doing this

Consumes energy,

Consumes chemicals

Produces a waste which has to be disposed of at a cost.

Nutrient Recovery & Re-use



- Recovers Nutrients for re-use
- Produces a Fertiliser product which has a value
- Revenues helps to off-set treatment costs

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The alternative approach which is emerging is to recover these nutrients and re-usable fertilizers, sell these fertilizers as a product and use the revenues to off-set treatment costs.

So again more of a cradle to cradle approach.



Peak Phosphorus

– there is no man made alternative to phosphorus



One reason for the focus on nutrient recovery is that we are going to run out of Phosphorus.

You have heard of Peak Oil, You have probably heard of Peak Water, but you may not have heard of Peak Phosphorus, but it is very real.

Phosphorus is mined in a handful of locations worldwide and is used as a fertilizer. We rely very heavily on it to sustain agricultural output and food production.

Unlike Oil, which we can replace with renewable forms of energy, there is no man made alternative to Phosphorus.

This is already causing countries like Germany and Sweden to mandate P recovery from wastewater.

Nutrient Recovery Technologies

- Ostara
- DHV – Crystallactor
- Phosnix
- Pho-Strip
- REM-NUT
- P-RoC – Phosphorus Recovery
- Kemira- Kemicond & Krepro
- ThermoEnergy – Ammonia Recovery Process



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There are a number of technologies which are currently being commercialized to achieve this goal.

Ostara, DHV Crystallactor, Phosnix, Pho-Strip, REM-NUT etc

Of note would be the struvite crystallisation processes as they produce a slow release fertiliser.

Water Re-use

- Currently just 5% of the wastewater which is collected & treated is re-used.
- Aquifer Replenishment e.g. Organge County California
- Technologies:
 - Membranes & UV
 - Advanced Oxidation
 - AquaPure
 - HiPox



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Water Re-Use.

I have saved an area with perhaps some of the greatest potential for emerging technologies for last. Water Re-use.....

Now currently just 5% of the wastewater which is collected and treated is re-used.

Starting from 5%, you can see that there is a HUGE opportunity for increase in the rate of water re-use.

Now currently there are certain connotations associated with water re-use.

People don't like the thought that the water which comes out of their tap, may in the not too distant past have been in their toilet, or worse still, some one else's toilet.

However views are changing in relation this.

People are realizing that there is more than one type of water. At the moment we just think Potable Water and Wastewater, and never the twain shall meet.

However there is a growing awareness that there is potable water, but there are also other grades of water, like Title 22 Re-use quality water which we can use for other things like flushing our toilets or irrigating land.

And there are different types of wastewater, there is black water, grey water, and there's even a Yellow Water.

Now, one thing we are starting to see with water re-use is **Aquifer Replenishment.**

There is a project in Orange County California las year which won an award from the Stockholm Institute.

Where they are treating water to a very high level and then injecting it back into the ground to replenish their aquifer which, over time, they will then extract again to provide part of the potable supply.

And that is the thing and of the

When there is Big Change there is Big Opportunity

Can a System That Evolved*:

- For Global Population < 2 Billion
- Mostly Rural
- Lacking Modern Technology

Be the Solution When:

- Global Population ~ 10 Billion
- Mostly Urban
- Experiencing Greater Resource Constraints?

* - Source: Glen T. Daigger, CH2MHill, WEFTEC, Chicago 2009



SUMMARY

When there is Big Change, there is Big Opportunity.

And Big Change is what Venture Capital does well. Its really what it is designed for.

And this is the type of change that the VC world is really effective at helping to make happen. Its not about a incremental improvements of grabbing a portion of the existing market, its about doing something disruptive.

If you are wondering whether there will be a technology revolution in the water industry that would embody some the elements I have outlined, with the types of changes that will create real opportunities for the Venture Capital world, consider the following question posed by Glen T. Daigger, of CH2MHill at WEFTEC 2009,

'Can a system which was designed for a population of less than 2 Billion, mostly Rural dwelling and lacking in technology, provide an adequate system for 6 billion, 8 billion, ultimately 10 billion people, most Urban and experiencing greater resource constraints'.

If you believe the answer is no, then this is going to create opportunities for BlueTech investing in new technologies for this new, smarter, more efficient system, as we are seeing happening in the energy sector.

And this is where the BlueTech opportunity lies.



The BlueTech Investment Opportunity

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Water Technology Markets

Key opportunities and emerging trends

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Microbial Fuel Cell

