Decentralised Wastewater Management and Re-use.

Saudi Water & Power Forum, Jeddah, October 12th – 14th 2009

There was discussion yesterday about the links between water and energy.

I think a Decentralised approach to wastewater management and water re-use can help address both energy consumption and water scarcity issues.

Dr. Adil Bushnak estimates that a decentralised wastewater system incorporating greater water reuse could lead to dramatic savings in investment costs in Saudi Arabia. According to Saudi government figures, around $27.5 billion will need to be spent over the next 20 years on extending the Kingdom's wastewater networks.

However, building regional systems could reduce this figure to as little as $8 billion as it would avoid the need to build big trunk mains in city centres (Dr. Adil Bushnak, Chairman – Bushnak Water Group – Saudi Arabia, "Water Reuse in Saudi Arabia", March 2005).

I will outline some reasons why this is the case. And then talk briefly about some enabling technologies which are available to make this happen.

But first let's begin with defining by what is meant by Centralised and Decentralised.

Most of us have grown up with the idea of a centralized model for providing water and energy is the natural way to go. Bigger is better, more economical, more efficient.

That paradigm evolved over the past 150 years from a world of less than 2 Billion people who were mostly rural at the time and lacking in modern technology.

The idea of the big pipe evolved out of a desire to take wastes out of cities. The word sewer comes from the old English word 'seaward' as the goal was to get wastes out of cities in and into the River Thames.

The need for treatment at the end of these pipe arrived later on.

As Cities grow we find ourselves in a never ending cycle of expanding networks and treatment facilities.

In the Kingdom it is estimated that there will be a 40% increase in population, over the next 15 years. (+10M, 25 to 35M)

Similarly Domestic water demand is set to increase from 2,665 million m^3 per year in 2010 to 3,650 million m^3 per year by 2025, representing a 37% increase over a 15 year period.

I believe that Saudi Arabia is planning 7 new cities to meet the needs of its growing population. These cities will need water and wastewater infrastructure.

In providing that infrastructure there is a real opportunity there at this stage to look at doing things differently, smarter and more efficiently.

Adopting a decentralized approach could save in the region of $20Bn in terms of the costs of wastewater infrastructure.

It could also reduce the energy costs associated with meeting demand for water and reduce the desalination capacity required, thereby saving on capital on that side of the equation.

As an early technology adopter, you can help companies cross the so called valley of death. There is an opportunity to grow a home based water technology industry where you develop the solutions to meet your own needs and then export those technologies to the world.

1. Provide for more than one type of water.
2. Implement source separation of different types of wastewater.
3. Implement water re-use on a local, distributed scale and groundwater aquifer replenishment.

1. Enables 'just in time' capacity building

The smaller unit size of the decentralised system allows closer matching of capacity to actual growth in demand. Decentralised capacity can be built cluster-by-cluster, in a "just in time" fashion. This provides a number of important benefits:

It defers capital costs of future capacity to the future. This typically reduces the net present value (NPV) of a decentralised approach and reduces the cost of financing debt. Each individual decentralised system is a smaller project which can be planned and implemented on much shorter lead times than can expansions of regional systems.

The management needs of each area can be considered independently, and the costs of systems for a particular area can be more readily assigned to the activity generating the demand.

Further, a decentralised or 'distributed system' is expanded by adding more treatment centres, rather than by routing ever increasing flows to the centralised plant, and therefore upgrading lines to increase capacity is never required.

2. Keeps Water within catchments and enables groundwater replenishment.

Enables groundwater replenishment close to the area of use.

Important in areas with non-renewable groundwater.

Saudi Arabia meets 84 % of its water needs from groundwater. However agriculture represents 85% of total water use and consumes most of this groundwater.

3. Facilitates water conservation and water re-use

In the Kingdom Domestic water use accounts for just 10% of total water use, but it accounts for approximately 95% of all desalinated water consumption. (Approximately 50% of the domestic water demand is met by desalination).

Addressing that 10% of water use, through water re-use, could have a very significant impact on the need for desalination capacity.

Water re-use in parallel with water conservation measures could enable Saudi Arabia to meet in the region of 50% of its municipal urban water demand from treated wastewater.

The cost of doing this is going to be less expensive than providing that water by desalination.

A Decentralised approach facilitates water re-use as the Treated Sewage Effluent (TSE) is close to the point of re-use which reduces the need for water re-use distribution networks.

When assessing the cost of water re-use, you should really look at the marginal costs of going from treated wastewater, to re-use quality wastewater. If you are going to have to collect and treat the wastewater, then it becomes a question of how much extra would it cost to treat that wastewater to a higher standard for non-potable water re-use and/or aquifer replenishment.

4. Reduces Dependency on Large Assets.

It used to be that centralized facilities were higher tech, higher spec, and more reliable. Not anymore. The advent of the use of membranes in wastewater changed all of that. Membrane Bioreactors are ideally suited to decentralized treatment. There are also a number of other new and emerging technologies that I will speak about in a moment which present opportunities for water re-use.

5. Reduces costs and issues associated with conveyance to a centralised facility

For the Kingdom as a whole, there are 1.1M potable water connections but only 628,000 wastewater connections. A significant expansion of the wastewater network and an expansion and upgrade of the Kingdom's WwTPs will be required to increase water reuse levels.

Smaller systems lose the advantages of economies of scale that are achievable in centralised wastewater treatment in relation to capital costs and operational and maintenance costs.

However, smaller systems also avoid diseconomies of scale that are inherent in sewer systems. Given that collection system costs can be 80 percent or more of total systems costs, collection diseconomies of scale can overwhelm treatment economies of scale, resulting in decentralised systems being the more economical choice.

Dr. Adil Bushnak has estimated that it could reduce the cost of providing water services from $27.5Bn to as little as $8Bn by avoiding the need to build big trunk mains in city centres.

Typically, decentralised systems minimise the number of lift stations and eliminate large trunk mains. The collection infrastructure that remains is typically composed of smaller pipes running at shallower depths which also leads to less disruption to the public during construction. There is a social cost benefit inherent in this reduced disruption during construction.

The Enabling Technologies

There are a variety of new enabling technologies being developed to provide for efficient water treatment and re-use. I will highlight just three of these.

1. Anaerobic Membrane Bioreactors
    a. Less energy
    b. Less sludge
    c. Re-use quality wastewater
2. Deepshaft wastewater treatment -
    a. drills 100m in the ground and carries out WWT in an underground treatment system. and you have the opportunity to also drill groundwater infiltration wells at the same time.
    b. In other parts of the world people are not familiar with drilling technology, but in the Kingdom, this would be a natural fit. The expertise is there.
3. Technologies which use waste heat
    a. Oasys Forward Osmosis
    b. Pasteurisation Technology Group – waste heat for disinfection.

Conclusion

The models and methods of providing water services are changing.
The Kingdom is well placed to use tomorrows approaches and technologies to meet the requirement for water services in doing so, help reduce energy use and
Finally, as an early technology adopter, there is an opportunity to develop Saudi solutions and become a technology exporter.

Questions

1. *What are the opportunities for Decentralised wastewater technologies?*

For the Kingdom as a whole, there are 1,184,793 potable water connections but only 627,654 wastewater connections. A significant expansion of the wastewater network and an expansion and upgrade of the Kingdom's WwTPs will be required to increase water reuse levels.

Bushnak estimates that a decentralised wastewater system incorporating greater water reuse could lead to dramatic savings in investment costs in Saudi Arabia. According to Saudi government figures, around $27.5 billion will need to be spent over the next 20 years on extending the Kingdom's wastewater networks.

However, building regional systems could reduce this figure to as little as $8 billion as it would avoid the need to build big trunk mains in city centres (Dr. Adil Bushnak, Chairman – Bushnak Water Group – Saudi Arabia, "Water Reuse in Saudi Arabia", March 2005).

One of the advantages of wastewater treatment in the Kingdom is that you don't have the added variable of Stormwater to deal with. The rate of flow will be extremely predictable both in terms of quantity and quality, which makes treatment and re-use much easier.

Also, the water is quite warm. This makes processes like Anaerobic Membrane Bioreactors feasible. An Anaerobic Membrane Bioreactor consumes very little energy, produces very little waste sludge and produces a re-use quality wastewater. Saudi Arabia would be an ideal location to implement a technology like that.

2. **What Strategies could be applied to improve power and water supply to rural areas?**

   Rural areas are a challenge for centralized treatment models and are ideally suited to distributed, decentralized models.

   At the level of individual homes and houses, on-site treatment and re-use could be implemented.

   In Districts, wastewater presents an available resource in the community.

   To date we have hunted for water. This will change to a 'cultivation' of water.
   Once you have water in your community, you can potentially keep using that water, over and over again. This greatly reduces the amount of 'new water' from desalination, groundwater or surface water that you can need to extract, treat and supply.

3. **How can decentralized production help the Kingdom improve efficiency? What lessons can be learnt from overseas experience?**

The provision of water services on an international basis accounts for in the region of 5% of total energy use in developed nations.

For a given municipality or city, the energy used to provide water services can represent 50% of the total energy bill of the city.

One lesson that is being learnt overseas is that the current way we manage water is inefficient and wasteful. We have a use once approach to water.