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# Waste not, Want not!

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**Coventry, United Kingdom**

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# Water Reuse and Recycling

## Challenges;

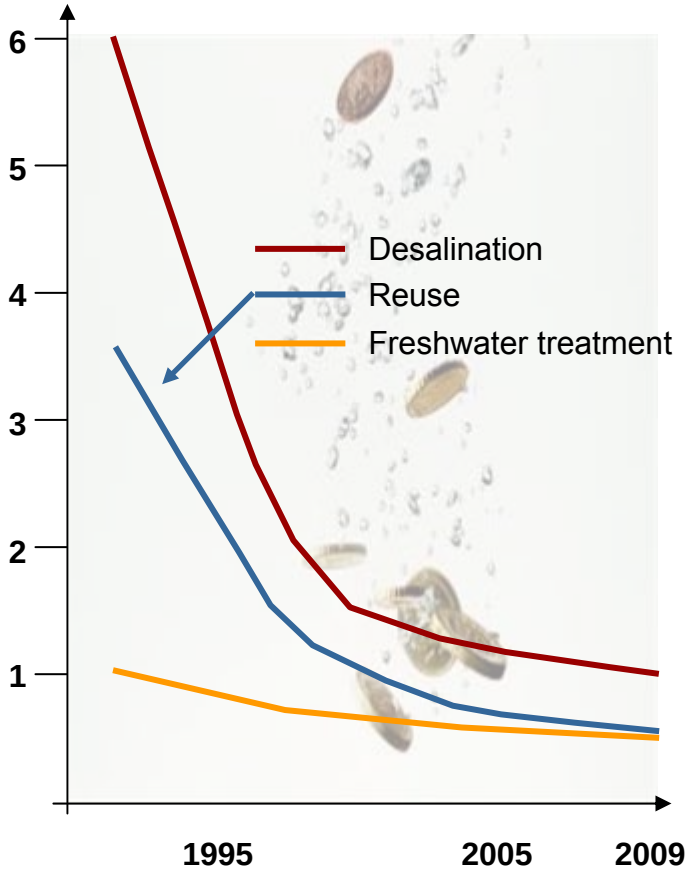
- Water is a strategic issue for industry
- Robust technology is needed
- Reuse has to drive shareholder value

# Global Trends: Wastewater Reuse Assessment

| Water reuse for irrigation | Industrial process reuse/recycling | Indirect potable reuse | Direct potable reuse |
|---|---|---|---|
| ■ Most common type of water reuse projects<br>■ Typically easiest way of water re-use | ■ Industrial process water reuse with zero liquid discharge target<br>■ Water reused for same process or boiler feed, cooling etc. | ■ Water reuse to sustain water levels in aquifers<br>■ No additional infrastructure necessary | ■ Limited cultural acceptance<br>■ Technically feasible<br>■ Additional infrastructure necessary |

# Water reuse is, in most situations, more economical than desalination

## Water price trends in the desalination market ($/m³)




### Benefits

- Sustainable and reliable resource
- Almost closed cycle
- Complementary to existing infrastructure

### Drawbacks

- Sometimes separate infrastructure required

# Energy Consumption by Treatment Process (typical)

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Extracted from GWI:

"Global Water Market 2008 - Opportunities in Scarcity and Environmental Regulation" study

| Type and source of water | Range in energy consumption (kWh/m3) |
|---|---|
| Drinking water supply (transportation to main storage tanks included) | |
| Surface water | 0.0002 -1.74 |
| Groundwater | 0.37 -1.32 |
| Desalination | 4.94 -5.41 |
| Biological wastewater treatment | |
| Activated sludge | 0.43 -1.09 |
| Extended aeration | 0.49 -1.01 |
| Waste stabilization ponds | 0.05 |
| Reclamation treatment for pathogen removal | |
| Direct filtration (pulsed bed filters) plus UV disinfection | 0.18 |
| Direction filtration plus UV disinfection | 0.50 -1.21 |
| Title -22 with UV disinfection | 0.20 -0.63 |

# Recycling and Reusing Treated Industrial Wastewater to Reduce Energy and $CO_2$ Emissions

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## Water Currently Discharged

Additional technologies are generally required to reuse the treated wastewater in most applications

## Water Currently reused for Irrigation

To reuse wastewater for boiler feed water, technologies likely include activated carbon and reverse osmosis

**Cost of Desalinated Water Using Seawater RO - $1.25 / M3 (Evaporation is 20% more)**

**Cost of RO quality water from Reuse: $0.40 - $0.50/M3**

# Alternative External Sources

Direct reuse of secondary treated effluent for high purity water in power generation

Packaged wastewater plants for direct Sewer Mining for Irrigation

New alternative sources of water for industrial use

Wastewater purification for irrigation and aquifer recharge (protect supply)

# Designing to Fit the Need

- **Reuse water is often treated for a specified purpose**
  - Not all of it is produced to the highest standards of purity
  - Some non-potable uses may require a certain amount of additional treatment
- **Examples:**
  - Crop irrigation and lawn watering may require rich nutrients to be left in the reuse water because of its role as a fertilizer
  - Reuse water for dust suppression in a coal yard or as an ingredient in cement will need very little treatment beyond secondary clarification
  - Wastewater, reused in boiler feed applications, will require advanced treatment which is higher than potable standards

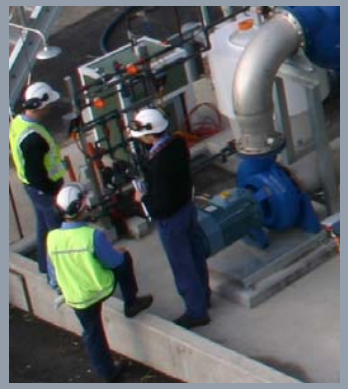
**Groundwater replenishment facility for re-charging the aquifer from treated secondary waste water.**

**Capacity of**

**~ 340 MLD (90 MGD)**

# Water Reuse Portfolio

**Biological**



**Membranes**

**Filtration**

**Disinfection**

**…for total water management**

# Water Technology Provider's Reuse Portfolios Reflect the 'Most Promising' Opportunity Areas

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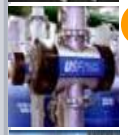
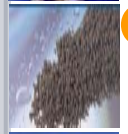
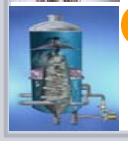
## Water Megatrends

- Lower quality of raw water
- Higher awareness of water quality
- Higher demand for drinking water (quality and quantity)
- Shifting demand to regions with already scarce resources
- Higher standards in wastewater treatment
- Rising energy expenses for water treatment

## Opportunity Areas

- Major basic technologies are membranes, UV and advanced biological treatment
- Energy efficiency esp. in desalination, reuse and waste-to-energy
- Combination of different technologies to treat complex water and wastewater
- Higher need for online analysis and control

## Technology Platforms

| Technology Platform | Objectives | Key Industries |
|---|---|---|
|  1 **Hollow Fibre Membranes** | ▪ Next Gen Membrane Fibers<br>▪ Water Filtration<br>▪ Membrane Distillation | ▪ Municipal<br>▪ Food & Beverage<br>▪ Oil / Gas<br>▪ Power |
|  2 **Electro-chemical Processes** | ▪ ED/EDI for Desalination<br>▪ Hardness Tolerant Systems<br>▪ Acid/Caustic Recovery<br>▪ Ballast Water Treatment | ▪ Municipal<br>▪ Power<br>▪ Chem / Pharma<br>▪ Microelectronics |
|  3 **Advanced BioProcesses** | ▪ Green WW Treatment<br>▪ Anaerobic processes with minimum CO2<br>▪ Membrane Bioreactor | ▪ Municipal<br>▪ Food & Beverage<br>▪ Pulp & Paper<br>▪ Chem / Pharma |
|  4 **Enhanced Oxidation & analytics** | ▪ UV treatment<br>▪ Mixed Oxidants<br>▪ Advanced Oxidation<br>▪ Online analytics | ▪ Municipal<br>▪ Microelectronics<br>▪ Food & Beverage<br>▪ Power |
|  5 **Media Process Solutions** | ▪ New nano-modified media<br>▪ Advanced IX media<br>▪ Delivery Systems & Process<br>▪ New regeneration methods | ▪ Municipal<br>▪ Power<br>▪ Microelectronics<br>▪ Metals / Mining |
|  6 **High Rate Separation** | ▪ Oil/Water Separations for sec./tert. clarification<br>▪ High Rate Clarification (contact, magnetic) | ▪ Municipal<br>▪ Oil / Gas<br>▪ Pulp & Paper<br>▪ Metals / Mining |

# Municipal Water Reuse: Sustainability and Water Supply Management in the Face Of Decreasing Resources

## Project Facts

- **Project:** Reuse plant for industrial, agricultural & indirect potable use
- **Capacity:** 75 MGD [284 MLD] – when started in 2007, one of the largest such systems globally

## So California, USA

**Orange County**

**Southern California USA**

## Advantages

- Reuse requires a fraction of the energy needed for seawater desalination
- Membrane treatment provides 5x the capacity of conventional clarification at same footprint

## Technology

- Memcor submerged membrane system
  - Secondary treated wastewater was formerly discharged into the ocean
  - Via membrane filtration, solids, bacteria and contaminants are removed
  - Water pumped into recharge basins and blended with groundwater

# Industrial Waste-to-Energy: Energy Savings with Anaerobic Technology

## Project Facts

- **Project:** Waste Water Treatment Plant Capacity: 5320 m³/d [1.5 MGD]
- **Customer/End User:** Khon Khaen Brewery, Thailand
- **Project Value:** ~ USD 2'600
- **Operative:** March 2007

## S E Asia, Thailand

**Khon Khaen**

**Major City in Northeastern Thailand**

## Scope

**Total Solution including:**

- Pre-Treatment
- Anaerobic / Aerobic Treatment
- Sludge Dewatering
- Chemical Dosing
- Installation and Commissioning

## Technology

- Membrane type diffused aerators
- High performance clarifiers
- Anaerobic reactors

**Benefits:**

- Low energy biological process
- Methane gas “won” can be used as fuel

# Quality Water at the Lowest Cost: Managing Water, Energy, Chemicals, Environment, Operations

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**Real Time Automation and Monitoring - Operational Excellence**

**Integrated solution**

**Chemical Minimization**

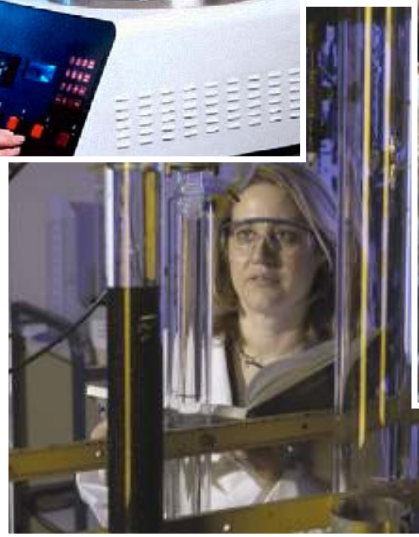
**High Efficiency Mechanical Treatment**

**Integration of all treatment components to influence:**

- Cost effectiveness
- Process quality
- Energy consumption
- Carbon footprint
- Environmental topics
- Regulations

# Industrial Wastewater Treatment
# Key Design Factors

## Treatability and Pilot Studies Capabilities



# MBR Water Reuse Plants are Growing in Size

## Sydney Harbor, AU North Head Plant

- 0.5 MGD [ 2.0 MLD ]
- Installation at local WWTP
- Utility water


## Martin Way Olympia Washington, USA

- 2MGD [ 7.5 MLD ]
- Satellite reclaim installation
- Groundwater recharge


## Bei Xiao He, China: Olympic Park Village

- 17 MGD [ 64.0 MLD ]
- Largest MBR reuse plant in the world
- Irrigation & utility

# Meeting the Needs of Refineries and Communities

## Challenge

Lime-softening and sand filtration of secondary effluent at the **West Basin** Water Recycling Facility in **El Segundo, CA** had proven to be too costly and not effective in preventing RO membrane fouling.

## Solution

From 1997 through 2002, UF membranes filtration systems were installed in phases to supply high-quality water for local refineries as the conventional treatment system was phased out. In 2004, a UF filtration system of 113 MLD [ ~ 30 MGD ] was installed to expand the capacity of the plant further.

## Benefits

For 10-years, the technical and economic advantages of membrane filtration have proven to be invaluable. By reclaiming wastewater, a sustainable water supply for industries and communities has been established.

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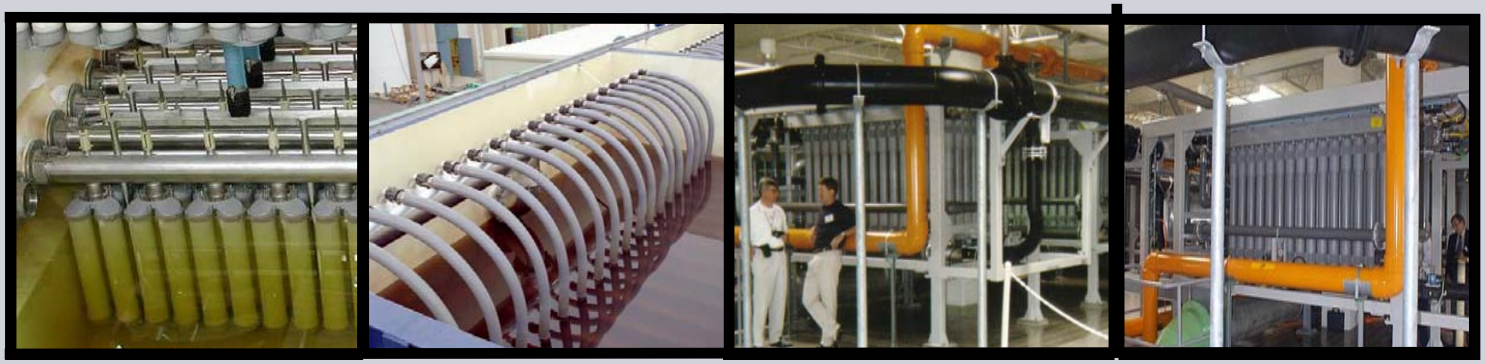
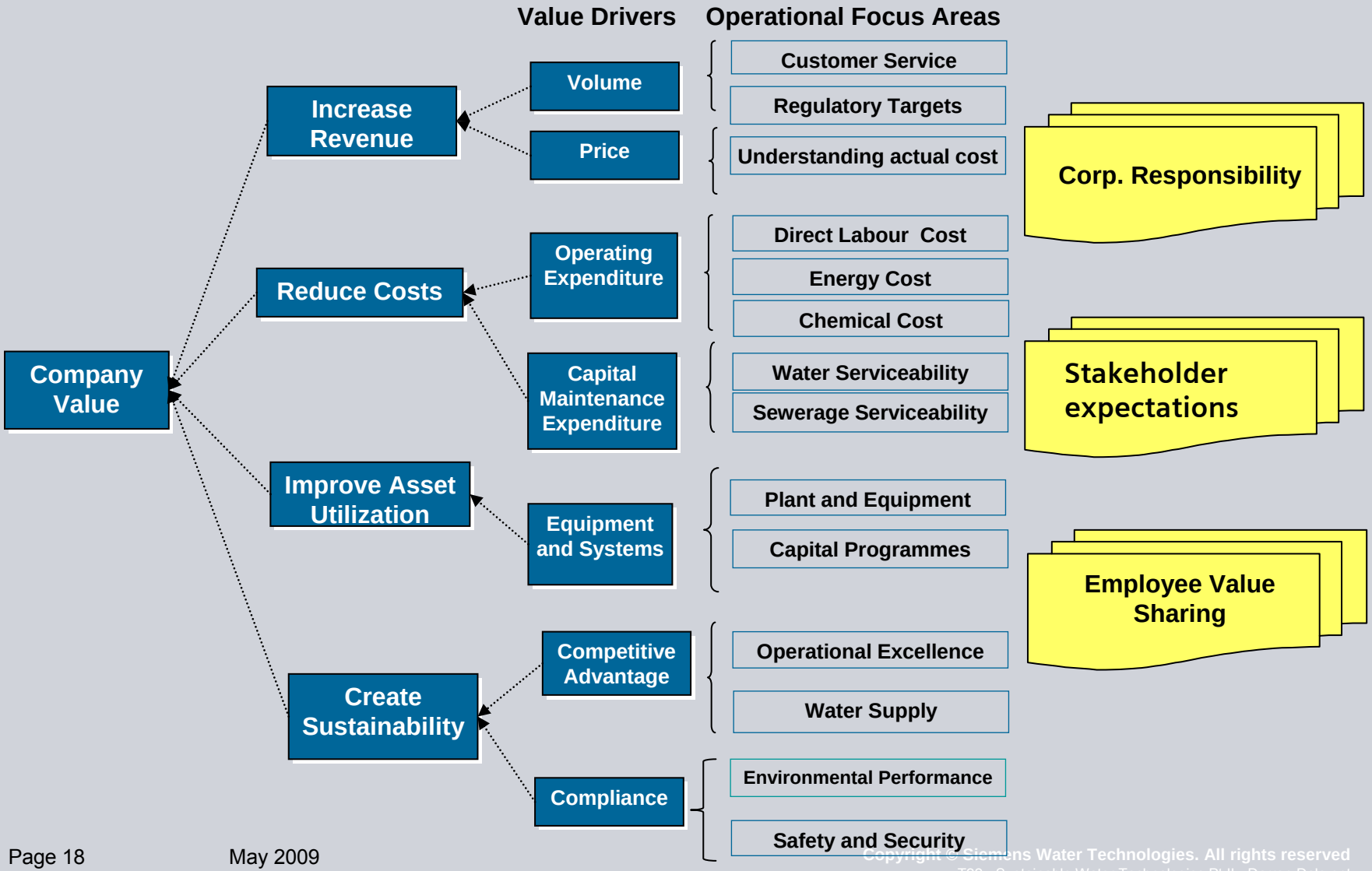
## Where else are people really doing this?

**Use of UF low pressure membranes is key to successful use of municipal waste water for boiler feed water**

- Eraring Power (Australia): Power plant
- Kranji (Singapore): Semiconductor manufacturing
- Honouliuli (Hawaii): Chemical plants
- West Basin (El Segundo, CA): Refineries
- European Framework Directive placing limits on abstraction
- China regulations requiring power plants to use seawater or reclaimed wastewater
- Singapore “New Water” direct reuse with “blending”



# Value Framework for the Water Footprint –



# Waste not, Want not!

Reusing wastewater in Industry provides a direct economic benefit, a secured “raw material” resource and reduces the global carbon footprint.  Industry should get the *credit* too!

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