BUILDING A WORLD OF DIFFERENCE

11 June 2013

DEVELOPING SUSTAINABLE ENERGY SOLUTIONS IN THE WATER INDUSTRY

RALPH T. EBERTS

EXECUTIVE VICE PRESIDENT
BLACK & VEATCH

NFS EWN Workshop June 2013

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TODAY'S GLOBAL WATER INDUSTRY DRIVERS

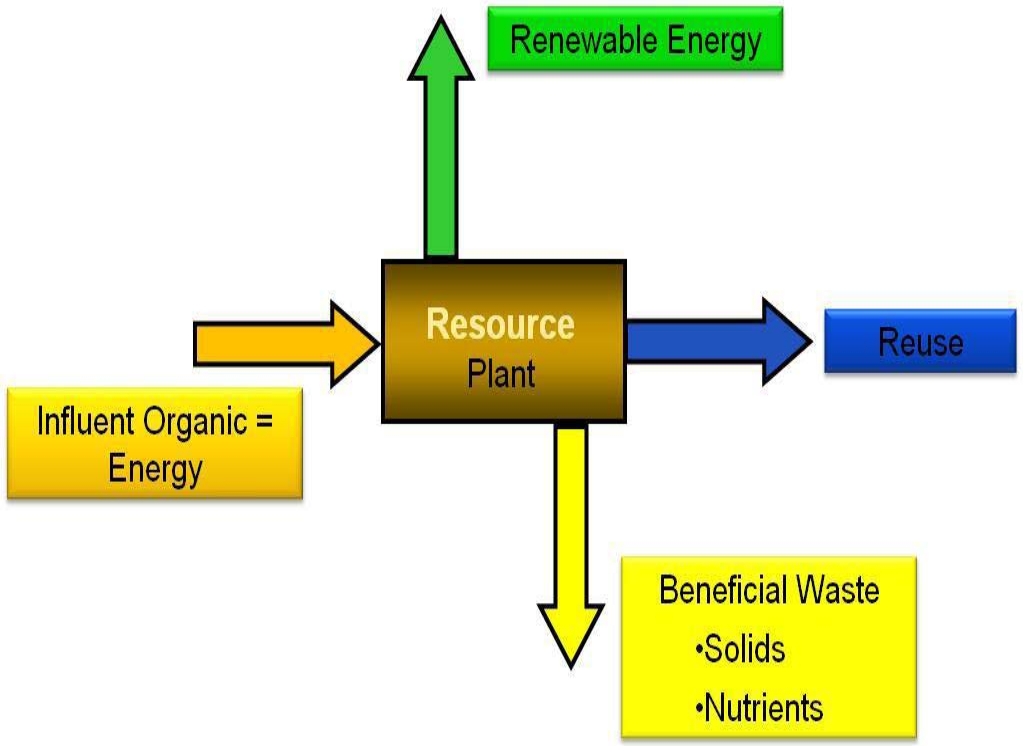
- Population Growth
- Urbanization
- Aging Infrastructure
- Water Scarcity
- Climate Change
- Lack of Funding

FUTURE STATE OF WATER INDUSTRY

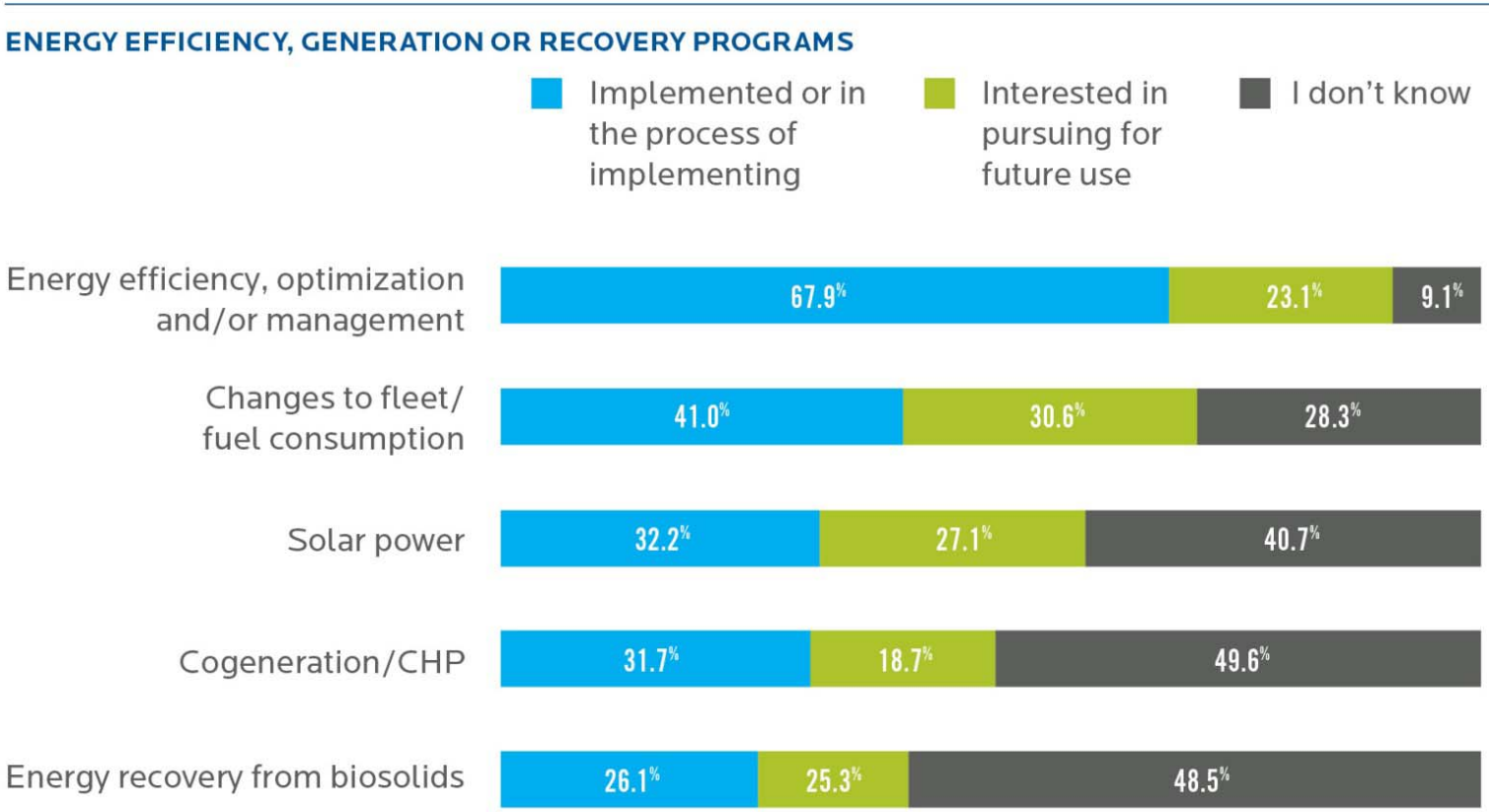
- Embedded into Urban Planning
- Sustainable solutions
- Diversification of supplies
- Resilient infrastructure
- Integrated into Liveable Cities

CREATE RESOURCE RECOVERY PLANTS

- Paradigm shift from waste to recovery
- Business case to balances resource supply and demand
- Recovery of energy, water, solids, and nutrients



NEXUS OF WATER AND ENERGY



Significant opportunities exist to not just reduce energy consumption, but to recover energy

COMBINE RENEWABLES AND WATER TREATMENT SYSTEMS

- Pressure to Innovate
- Desire to be Green
- Drive to Energy Neutrality

Thames Beckton Water Treatment Plant

LOS ANGELES DIGESTER GAS UTILIZATION PROJECT

- Renewable energy source produced through treatment of wastewater
- Third party solutions driven by innovation
- Effectively closes water and energy cycles

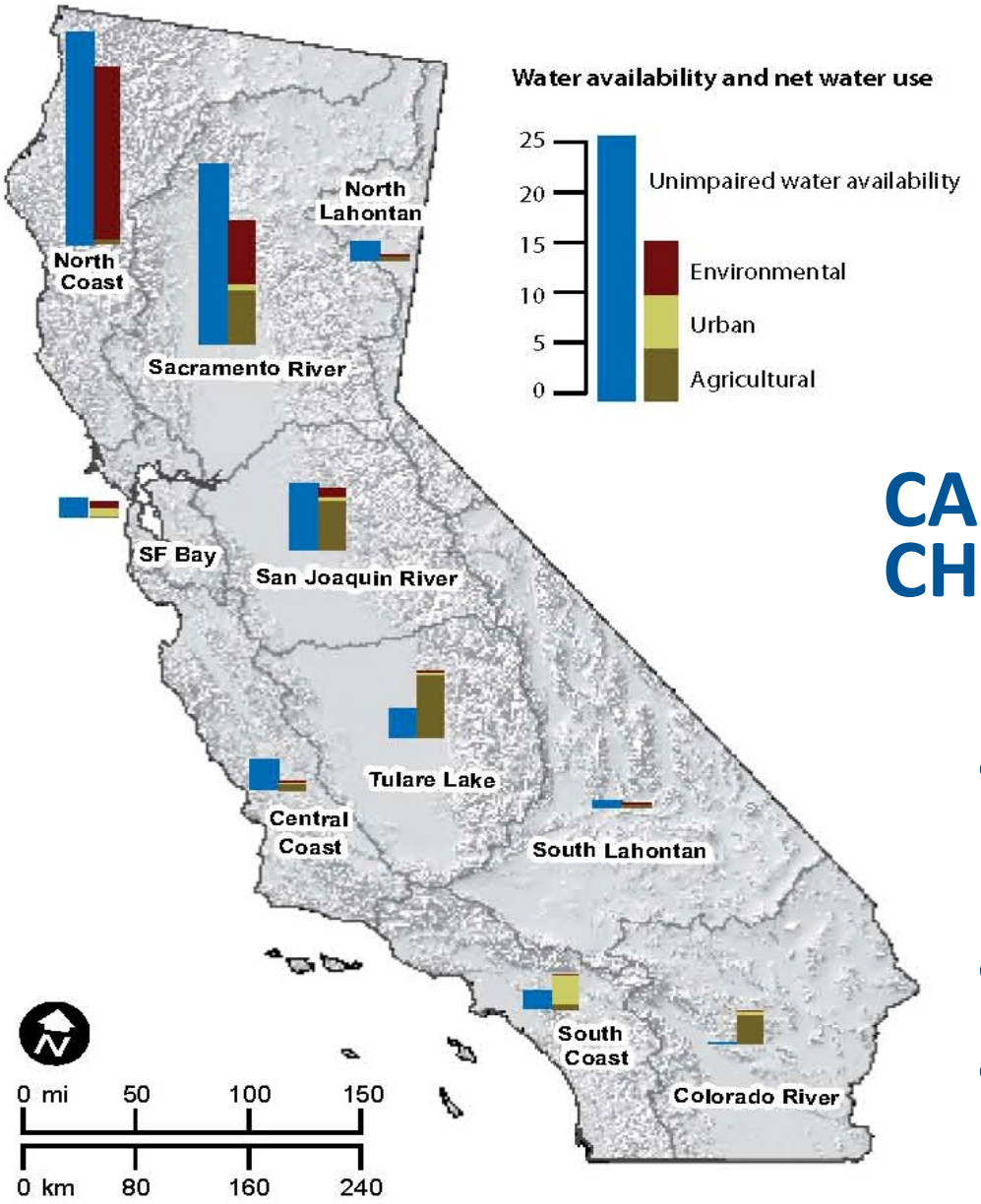
Digester facility at Hyperion Treatment Plant

SINGAPORE
70 MGD TUAS DESAL DBOO
CLIENT: PUBLIC UTILITIES BOARD (PUB), SINGAPORE

- 70 MGD (318 MLD) seawater desalination plant in Singapore
- Design-Build-Own-Operate (DBOO) Project Delivery
- Facility adjacent to SingSpring Desalination Plant

SINGAPORE
70 MGD TUAS DESAL DBOO
CLIENT: PUBLIC UTILITIES BOARD (PUB), SINGAPORE

- Hyflux Ltd identified as Preferred Bidder
- First Year Tariff = S$0.45/$m^3$
- Solution included power plant adjacent to desal plant
- Water Purchase Agreement signed 6 April 2011
- Opening ceremony scheduled for September 2013



SOURCE: California Department of Water Resources, *California Water Plan: Update 2009*, Bulletin 160-09.

NOTE: The map shows annual average values for 1998–2005 in millions of acre-feet.

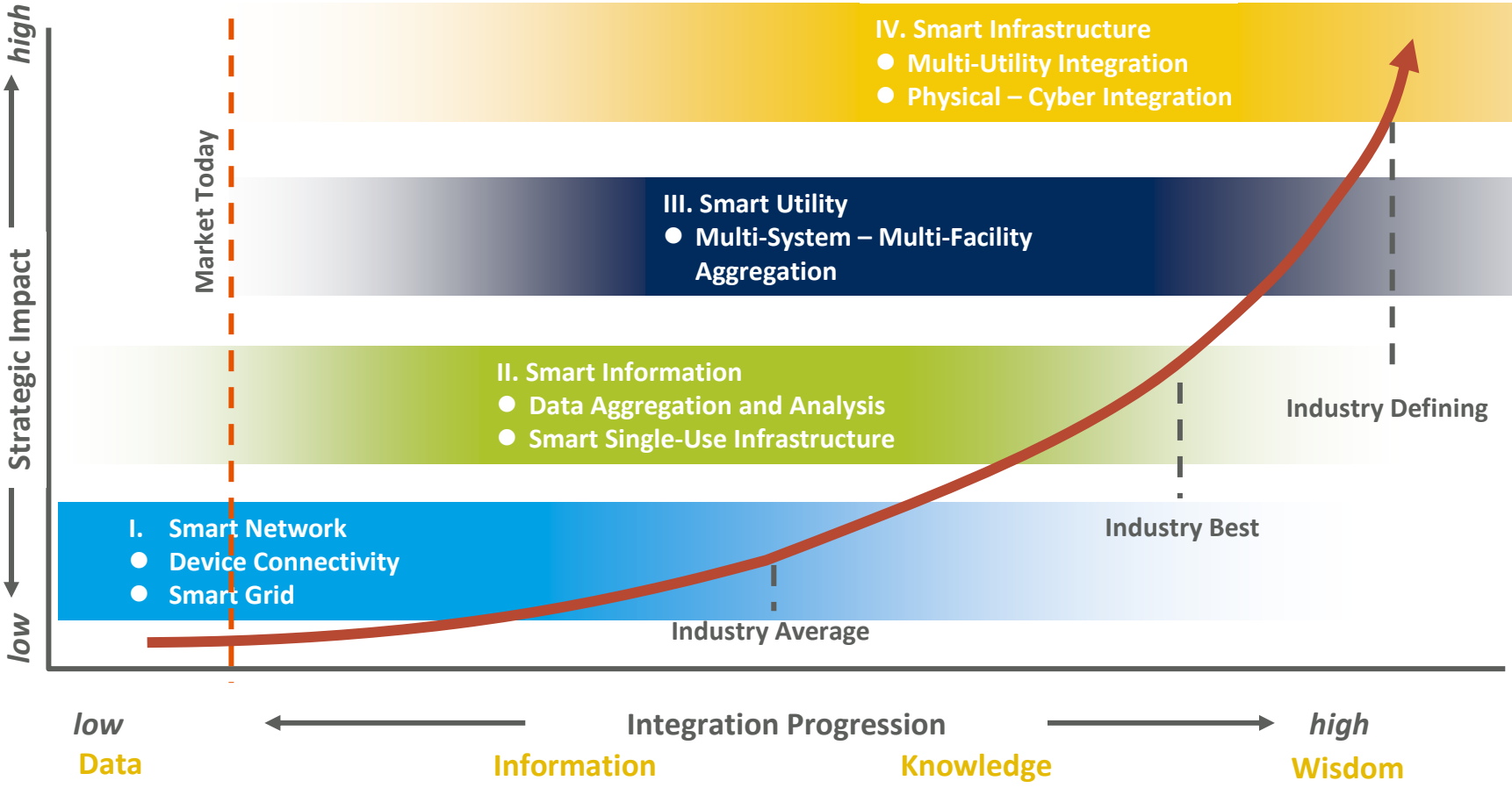
CALIFORNIA'S WATER CHALLENGE

- Supply vs. Demand
- Seismic activity
- Cost to convey

SINGAPORE - SIEMENS ED-CEDI DESALINATION TECHNOLOGY

- Low-energy seawater desalination project involving a combination of electrodialysis (ED) and continuous electrodeionization (CEDI).
- Commenced R&D efforts in Singapore on 1 October 2008
- Target energy consumption of 1.5 kWh/m^3
- Composite average power consumption from January-April 2011 was recorded as 1.8 kWh/m^3

SMART UTILITY IS A JOURNEY



NEW TREATMENT TECHNOLOGIES

- Membrane based
  - RO membrane based processes
    - Nano materials
    - Forward osmosis
    - Biomimetic membranes
  - Ceramic Membranes
- Electrodialysis & Electodeionization based processes
  - Electrical potential driven
  - Salinity gradient driven

DEMONSTRATION PLANT AT CCK WTW, SINGAPORE

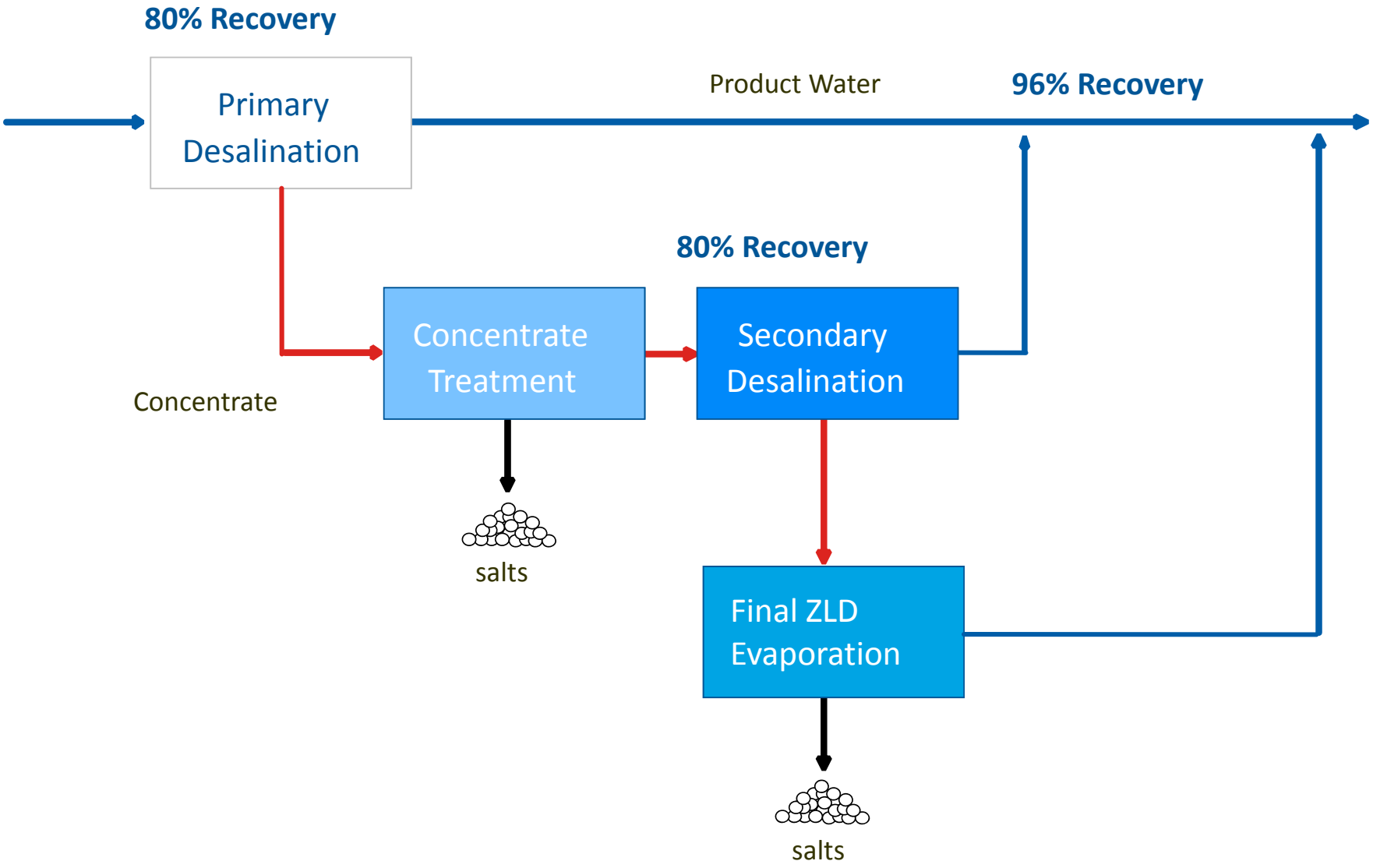
Source: R&D Team, PWN Technologies

- **PWN Technologies, Netherlands & PUB Singapore**
- **3 MLD capacity**
- **Key Objectives**
  - Evaluate Flux (maximize to reduce capital costs)
  - Evaluate chemical cleaning frequencies (optimize to minimize recurrent costs)
  - Influence of ozone on membrane performance

CONCENTRATE MANAGEMENT OPTIONS

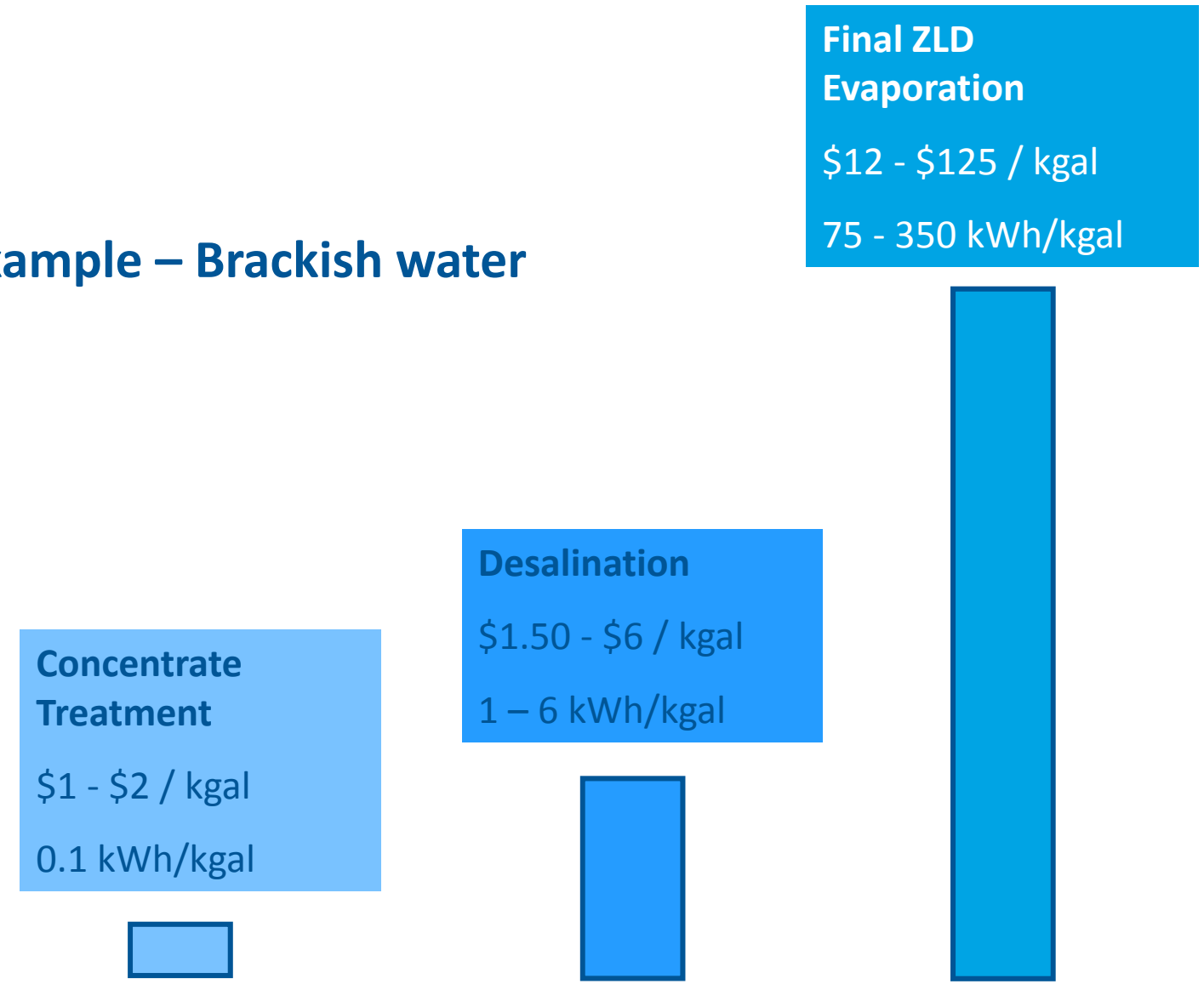
- Direct discharge to surface water
- Discharge to POTW
- Underground injection
- Zero Liquid Discharge.

CONCENTRATE MANAGEMENT

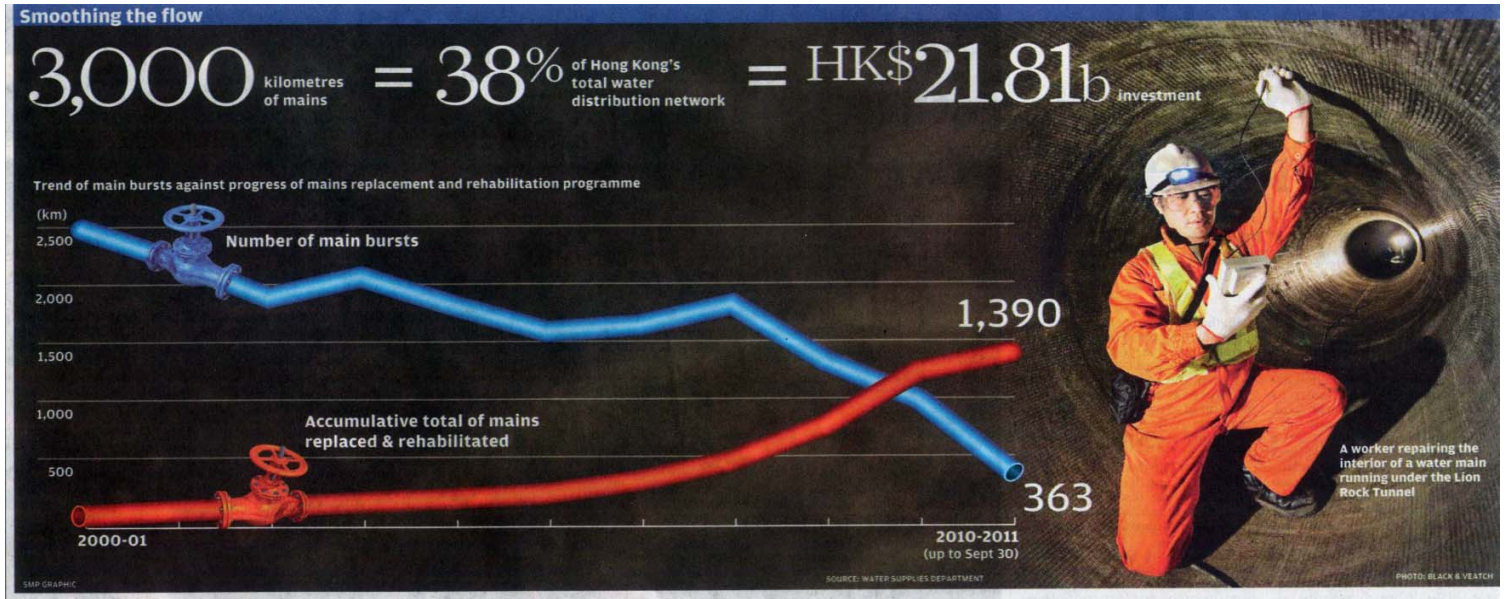


COSTS AND ENERGY INCREASE THROUGH THE PROCESS

Example – Brackish water



ASSET MANAGEMENT



Replacement programme is easing pressure on ageing water supply system

Turning the tide against burst pipes

Christopher Dewolf

A spate of water main bursts this year has left some wondering if Hong Kong is sitting on a ticking time bomb of ageing water pipes. The most recent burst, last week, left thousands in Taikoo Shing and other eastern Hong Kong Island estates without fresh water for 12 hours.

The bursts have been blamed on old water pipes that have reached the end of their service lives, making them vulnerable to leaks.

But a contractor who has replaced many old pipes says there is nothing to worry about because the government is investing HK$21.81 billion to replace more than a third of its water mains.

"The Hong Kong government has been approaching the issue systematically since 2000 and is well on the way to rehabilitating and replacing 3,000 kilometres of water mains by 2015," said Alan Man, managing director and vice-president at Black & Veatch, one of several contractors working for the government's water mains replacement and rehabilitation programme.

The 3,000 kilometres of mains that will be replaced make up 38 per cent of the city's total water distribution network. 1,390 kilometres of mains have already been replaced, with the rest scheduled to be replaced by 2015.

More than a quarter of Hong Kong's water mains are over 30 years old, which is the normal lifespan for many galvanised and cast iron pipes. Since Hong Kong's varied topography can create huge build-ups of pressure inside the pipes, water leakage is a constant problem, which can sometimes lead to burst pipes.

Recently, to fight leakage, the government has been installing pressure-reducing valves inside pipes, which has cut the percentage of water lost to leaks from 25 per cent in 1999 to 20 per cent today. The number of water main bursts has decreased even more substantially, from 2,479 in the 2000/01 financial year to 988 in 2009/10, according to the Water Supplies Department.

> You do not have the luxury of opening up the road and laying a new pipe to replace the old
>
> **Alan Man, managing director and vice-president, Black & Veatch**

Replacing old pipes has not been easy. "Improving the buried infrastructure in a dense environment like Hong Kong is sometimes like threading the eye of a needle," said Man. "You do not have the luxury of simply opening up the road and laying a new pipe to replace the old."

As a result, new technologies have been developed to replace water mains without digging into the ground. In one case, workers actually entered the water main that runs underneath the Lion Rock Tunnel to reinforce its walls by hand. They used a fibreglass fabric that is normally used to patch cracks on boat hulls.

Underneath the Tolo Highway, a new polyethylene pipe was inserted into a 3 kilometre stretch of old pipe a technique known as swage lining. It was the first time in the world such a procedure had been completed on such a long water main.

Most of the new water mains being installed are made from polyethylene and ductile iron, which have an expected lifespan of at least 50 years. By the time the replacement programme ends in 2015, nearly two-thirds of Hong Kong's water pipes will be less than 10 years old.

BENEFITS OF ASSET MANAGEMENT

- Proven to reduce cost of ownership by as much as 30 percent.
- Enhance risk management programs
- Improve levels of service for customers
- Conservation of resources

THE GEARING OF WATER & ENERGY

- Inextricably linked at every stage of production
- VFDs for water pumps
- Energy recovery devices
- Microturbines
- Cogeneration
- Advanced Decision-making tools

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Together

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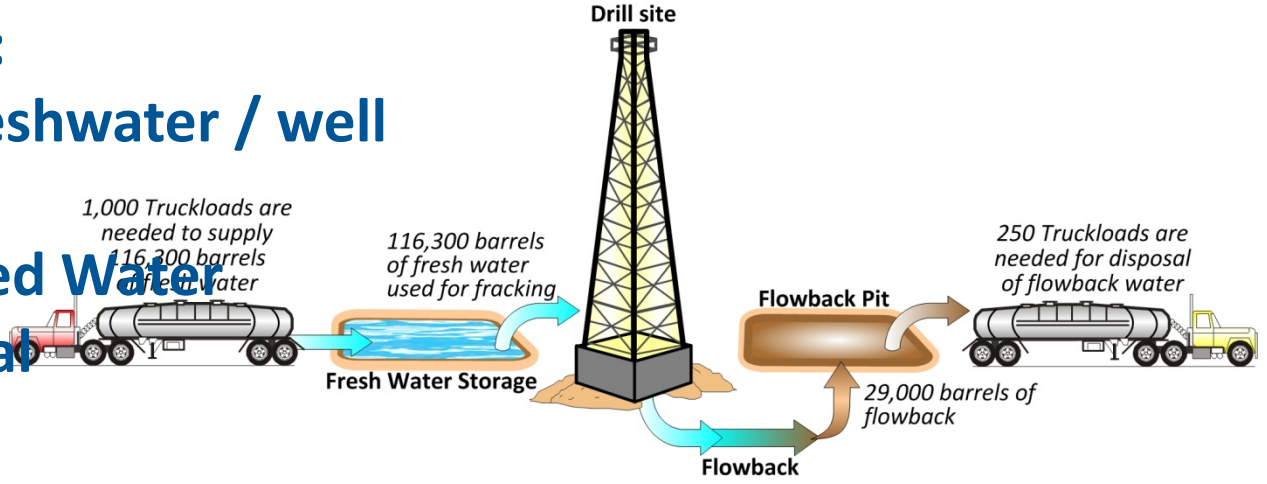
SHALE GAS – HOW CAN WE BETTER MANAGE THE WATER RESOURCES?

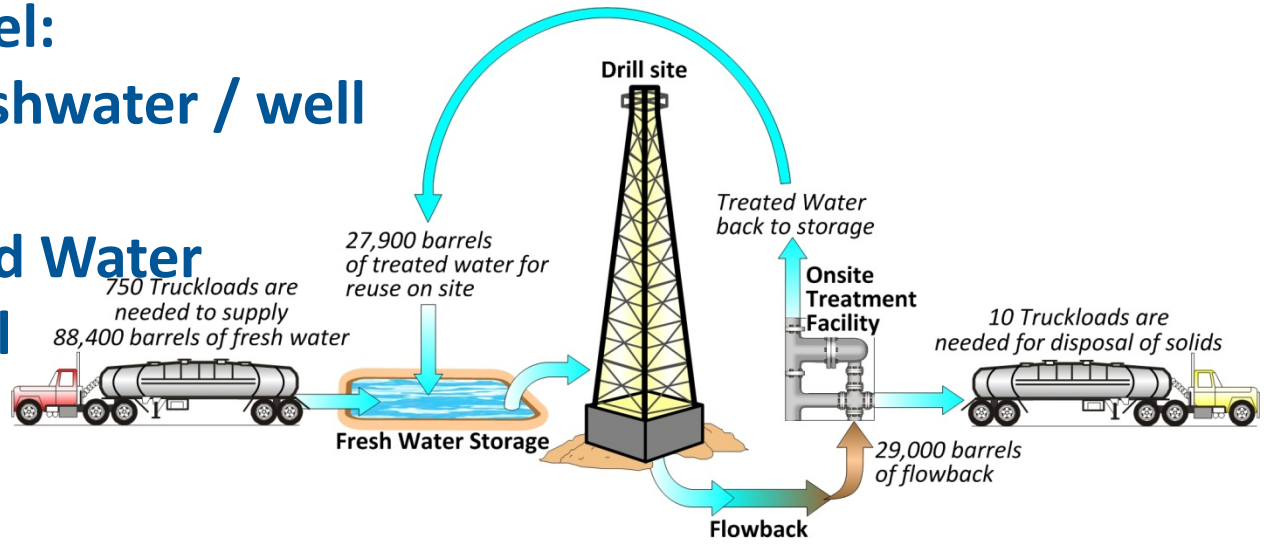
Current Approach:

- 5 MGallons of Freshwater / well
- 2 MGallons of Flowback/Produced Water Hauled for Disposal
- 1000s of Trucks



100% Recycle Model:

- 3 MGallons of Freshwater / well
- 0.2 MGallons of Flowback/Produced Water Hauled for Disposal
- 100s of Trucks



DEVELOPING SUSTAINABLE ENERGY SOLUTIONS IN THE WATER INDUSTRY

- **Macro-level – Tracking at global level – population growth, Urbanization, build out cities with precious little room for new infrastructure, Cities of the Future, Livable Cities,**
  - small footprint technologies
  - Provide community amenities as well as treatment systems
  - Drive to industrial application scale/commercial building scale/residential scale
- **Direct potable reuse**
- **Membranes that don't foul and have reduced energy requirements**
- **VFD water pumps**
- **Smart grid/smart water/smart gas**
- **Advanced meters**
- **Combined renewables and water treatment systems.**
- **Decision making tools for water resource management that address energy efficiencies. Most operations are now focused on pushing when needed where needed often just in time.**
- **Zero-liquid discharge**
- **Micro turbines to capture hydraulic grade differences**
- **Energy recovery devices in existing systems – GWRS expansion**
- **Creating standards for meters**
- **Making business case for adding sensors, collecting and integrating data, programming systems**

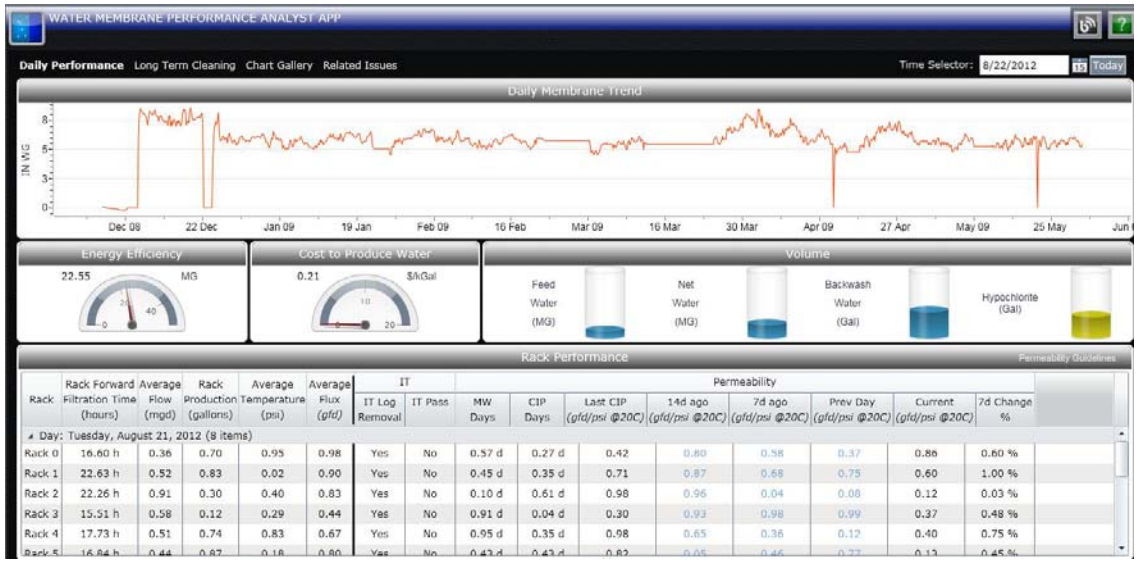
KEY INDUSTRY ISSUES DRIVING NEED FOR SMART ANALYTICS

- Data Overload
- Operational Complexity
- Skilled Workforce Shortage
- Aging Assets
- Tight Operating Margins
- Volatile Markets (Chemicals, Energy, Financial)
- Regulatory Compliance + Future Uncertainty
- Drive for Efficiency

Analytics can leverage utility-wide data

THE BEST ANALYTIC SOLUTIONS WILL COME FROM COLLABORATION

- **There is an opportunity to develop analytics that:**
  - Improve efficiency – energy, chemicals, etc.
  - Adapt -- to achieve long-term health of system
  - Involve manufacturers and engineers in remotely monitoring and diagnosing issues and performance



TECHNOLOGIES