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Rethinking Urban Water Management

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Regional Director of IWA

IWA ASPIRE CONFERENCE, HONG KONG, 2 NOV. 2019

inspiring change

PRESENT

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2.1 B

Without access to safe drinking water

4.5 B

Without access to wastewater & sanitation service

2050: FUTURE

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9 B Population

60 % food demand increase

40 % energy demand increase

50 % water shortage

Status quo is NOT an option.
We need to find new efficiencies by doing more and using MUCH less

GLOBAL PRESSURES WILL MAKE WATER MANAGEMENT DIFFICULT

- Climate Change
- Overexploitation on water due to the escalating demands from agriculture and energy
- Aging infrastructure has been the bottleneck of efficiency on delivering water & wastewater service
- Securing water supply might trigger the pressure on energy supply (e.g. Seawater desalination, long distance water delivery, etc.)

INDEXES FOR WATER SUSTAINABLE CITIES

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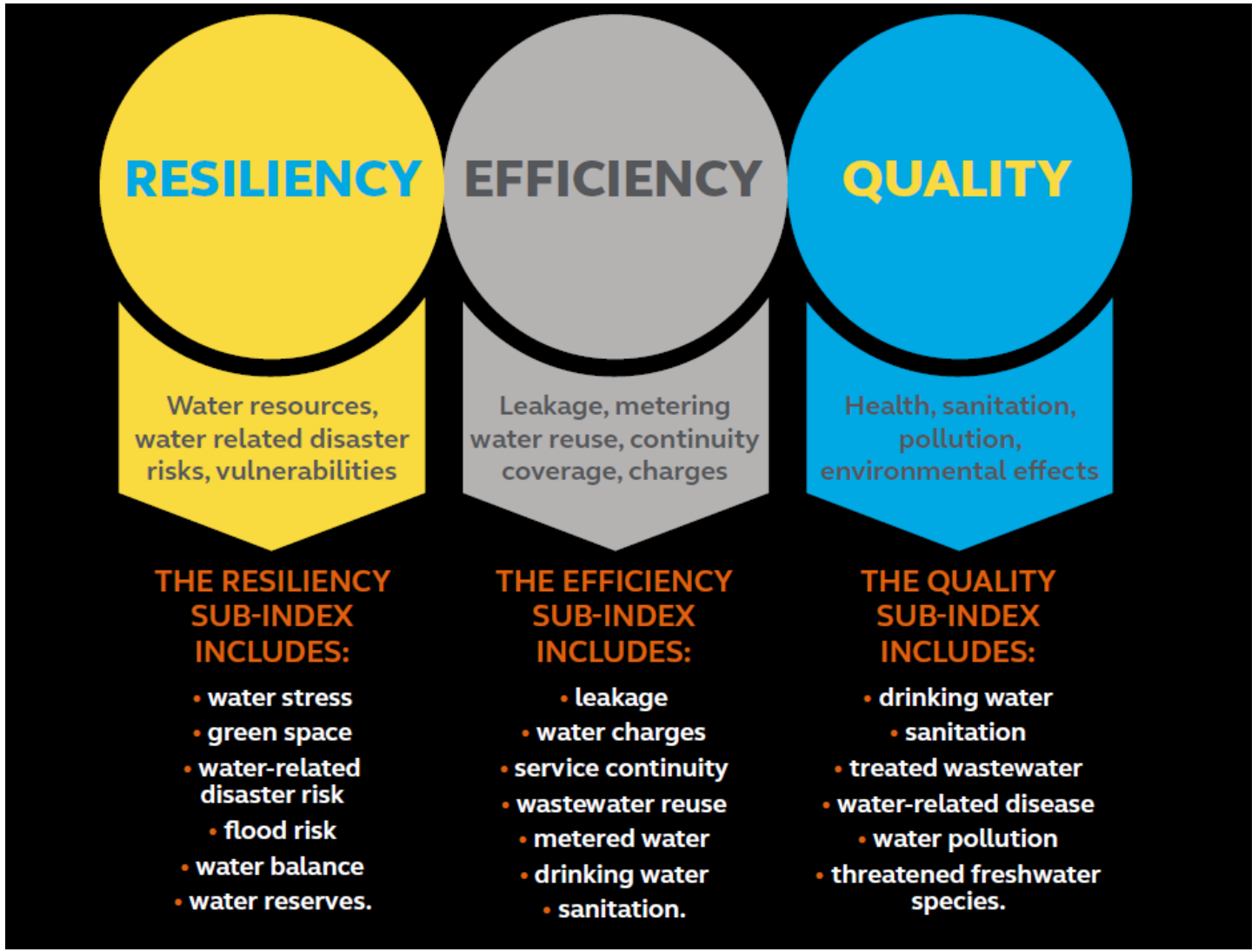
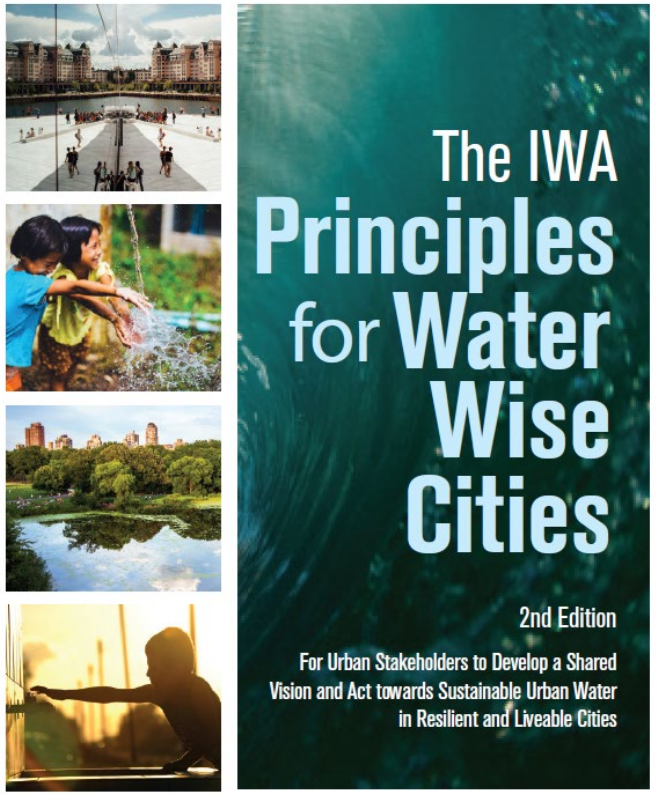


www.arcadis.com/waterindex

IWA PRINCIPLES FOR WATER-WISE CITIES



1 Regenerative Water Services

- Replenish Waterbodies and their Ecosystems
- Reduce the Amount of Water and Energy Used
- Reuse, Recover, Recycle
- Use a Systemic Approach Integrated with Other Services
- Increase the Modularity of Systems and Ensure Multiple Options

2 Water Sensitive Urban Design

- Enable Regenerative Water Services
- Design Urban Spaces to Reduce Flood Risks
- Enhance Liveability with Visible Water
- Modify and Adapt Urban Materials to Minimise Environmental Impact

3 Basin Connected Cities

- Plan to Secure Water Resources and Mitigate Drought
- Protect the Ecological Health of Water Resources
- Prepare for Extreme Events

4 Water-Wise Communities

- Empowered Citizens
- Professionals Aware of Water Co-benefits
- Transdisciplinary Planning Teams
- Policy Makers Enabling Water-Wise Action
- Leaders that Engage and Engender Trust

http://www.iwa-network.org/projects/water-wise-cities/

WATER SENSITIVE URBAN DESIGN

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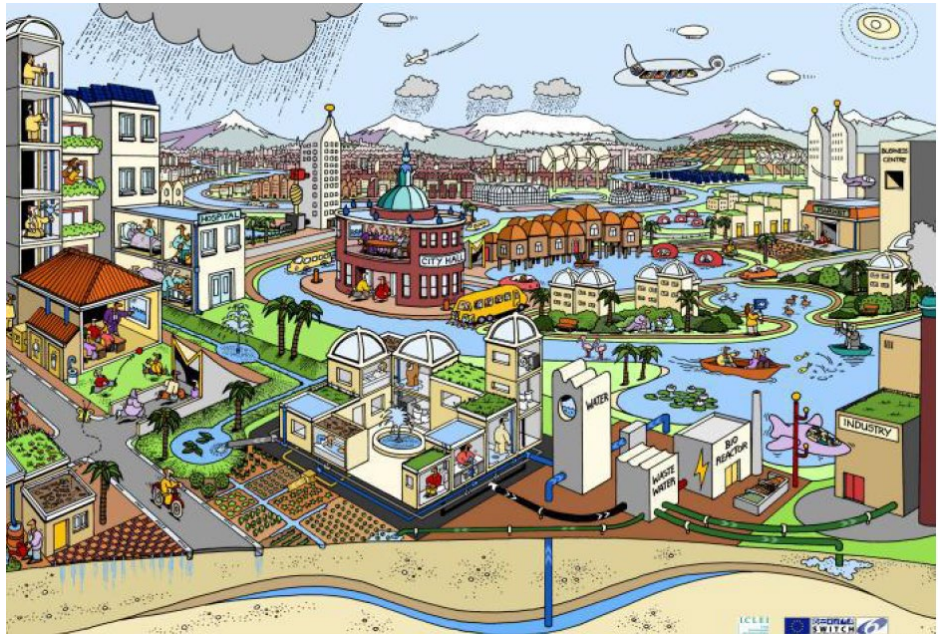
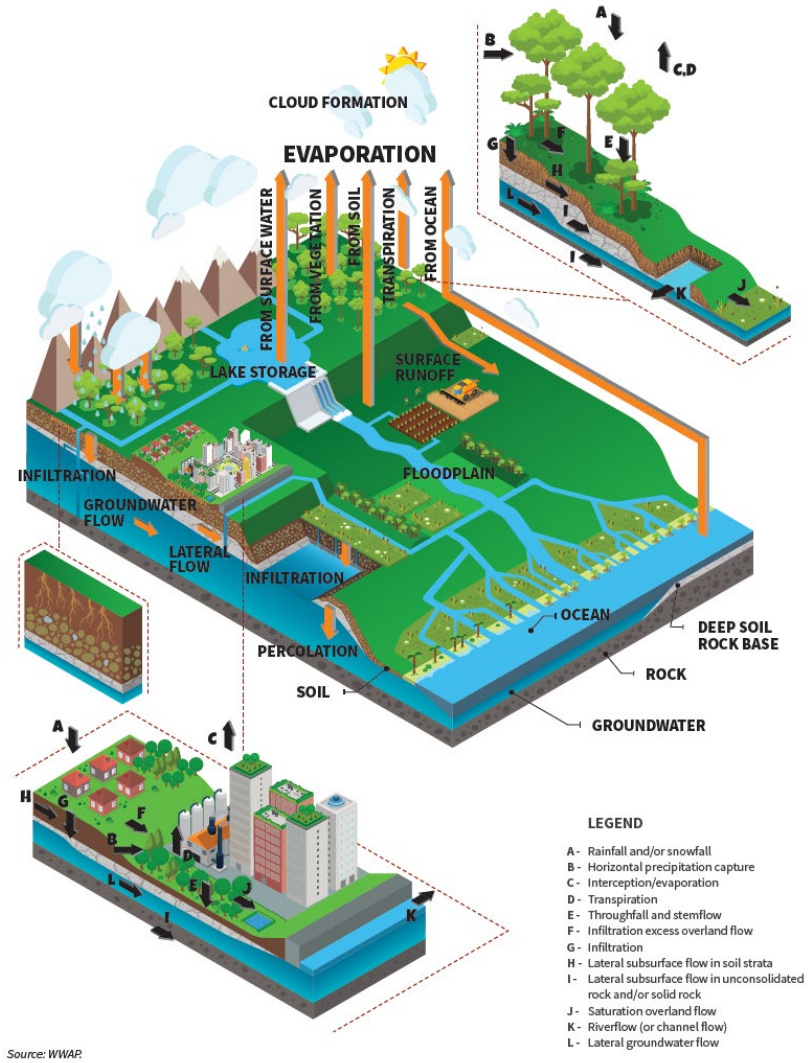


IWA new journal
"**Blue - Green Systems**"

- Water Sensitive Urban Design - Australia
- Low Impact Development – US
- Sponge City - China

NATURE BASED SOLUTIONS



Source: WWAP

- Secure water quantity and quality
- Decrease the impacts by extreme events
- Strenghten water safety

https://unesdoc.unesco.org/ark:/48223/pf0000261424

NATURE-BASED INFRASTRUCTURE IS CORE IN URBAN WATER SYSTEM

- Green roof for rainwater harvesting
- Constructing wetlands to improve water quality
- Bioretention tank and permeable pavement
- Reconnect rivers and floodplains

UN Water Development Report 2018

REGENERATIVE WATER SERVICES - 3Rs CONCEPT

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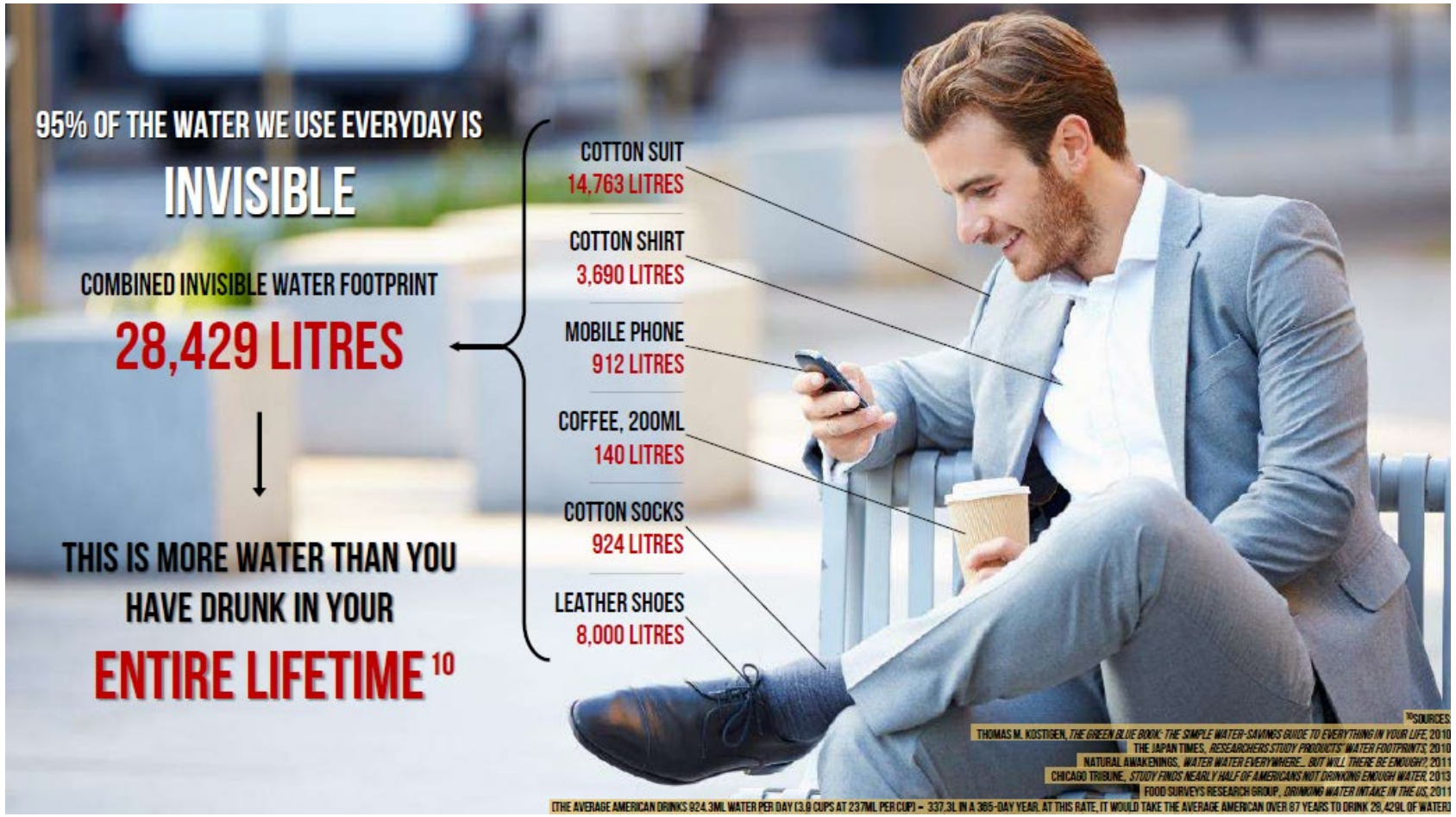
REDUCE WATER CONSUMPTION

- We need to understand “Virtual water” (Water footprint)



www.thirsty4water.org

REDUCE WATER CONSUMPTION

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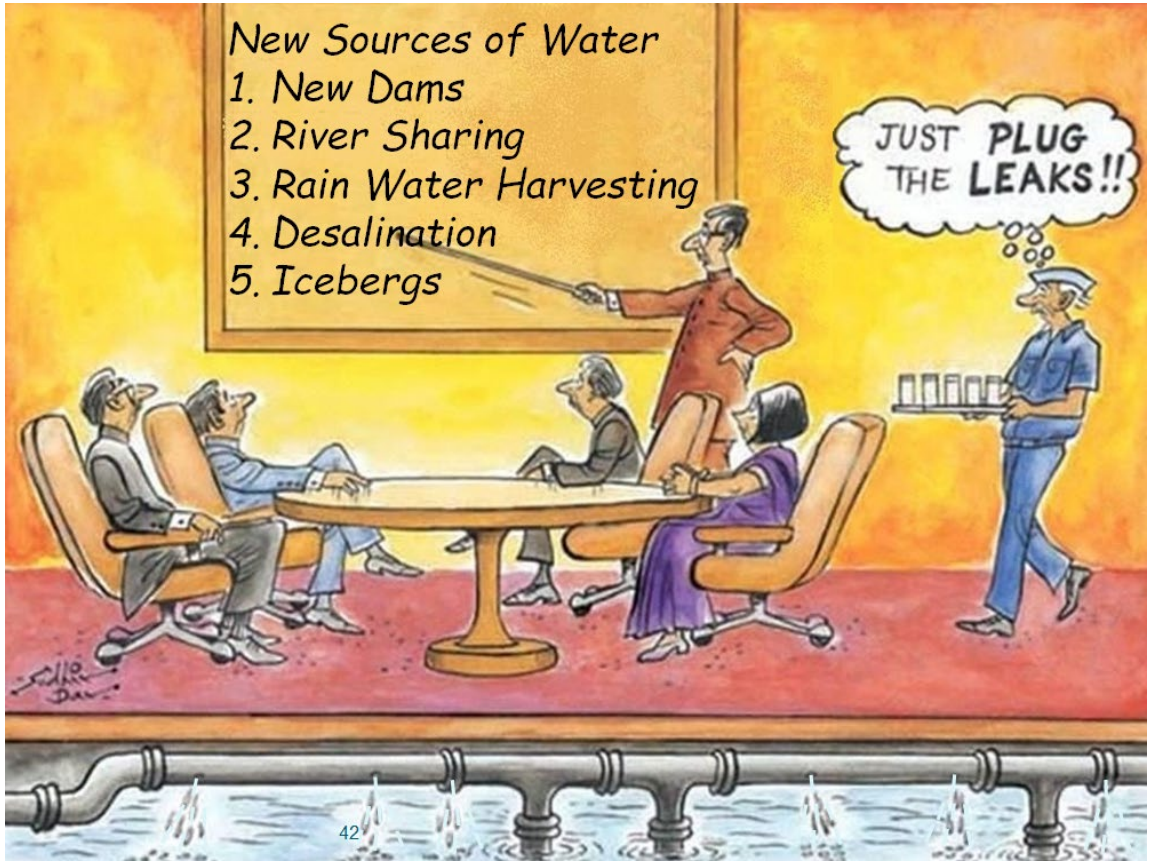
Per unit water consumption for food

Foodstuff	Quantity	Water consumption, liters 耗水量（升）	Foodstuff	Quantity	Water consumption, liters 耗水量（升）
Chocolate 巧克力	1 kg	17,196	Pizza 披萨	1 unit	1,239
Beef 牛肉	1 kg	15,415	Apple 苹果	1 kg	822
Sheep Meat 羊肉	1 kg	10,412	Banana 香蕉	1 kg	790
Pork 猪肉	1 kg	5,988	Potatoes 土豆	1 kg	287
Butter 黄油	1 kg	5,553	Milk 牛奶	250ml glass	255
Chicken meat 鸡肉	1 kg	4,325	Cabbage 白菜	1 kg	237
Cheese 芝士	1 kg	3,178	Tomato 西红柿	1 kg	214
Olives 橄榄	1 kg	3,025	Egg 鸡蛋	1	196
Rice 大米	1 kg	2,497	Wine 红酒	250ml glass	109
Pasta (dry) 通心粉	1 kg	1,849	Beer 啤酒	250ml glass	74
Bread 面包	1 kg	1,608	Tea 茶	250 ml cup	27

Meat and milk production may double by 2050, What does it mean for water and pollution?

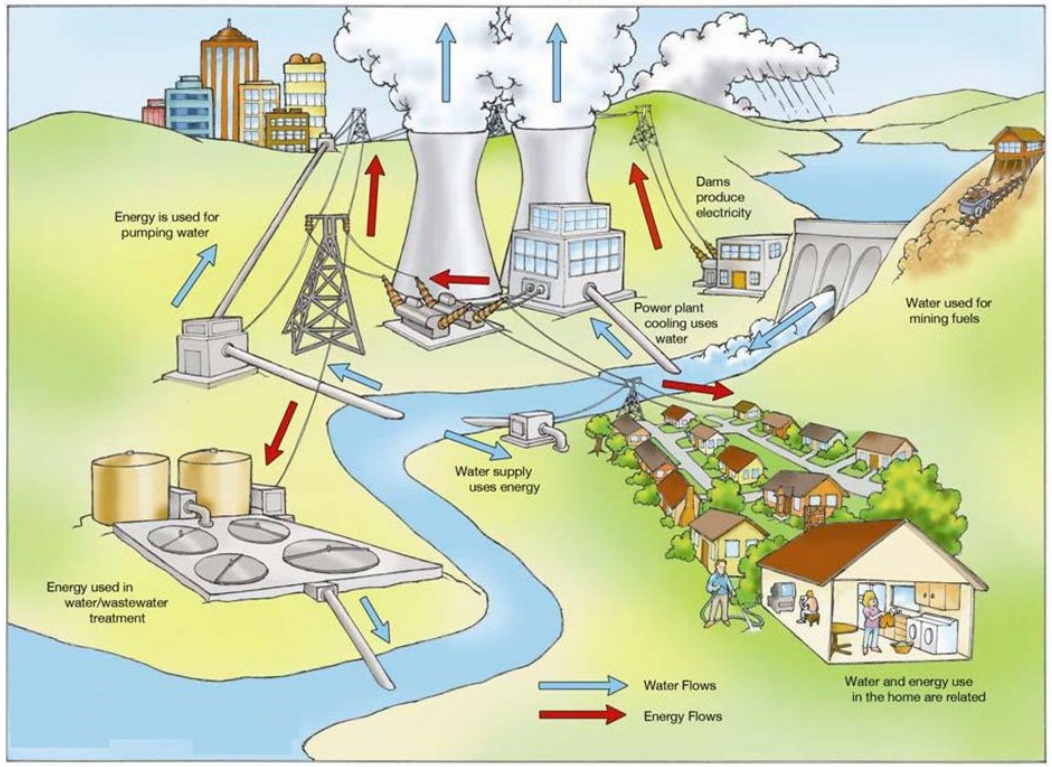
REDUCE WATER LEAKAGE

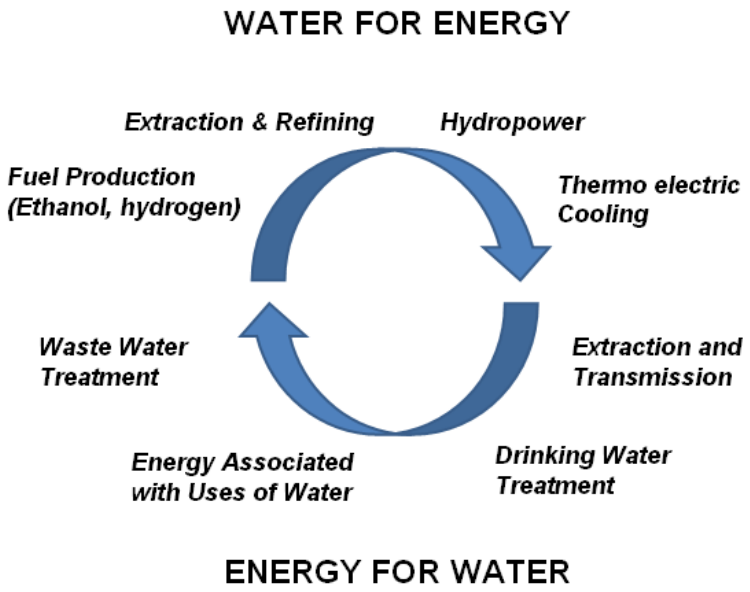


Reduce water leakage MUST be one of the priorities of water suppliers.
50% WL decrease will benefit 90 M people

Courtesy of Malcom Farley

WATER AND ENERGY NEXUS





Water and energy are both key elements for urban sustainability

Source: US Department of Energy 2006

REDUCE WATER IN ENERGY SECTOR

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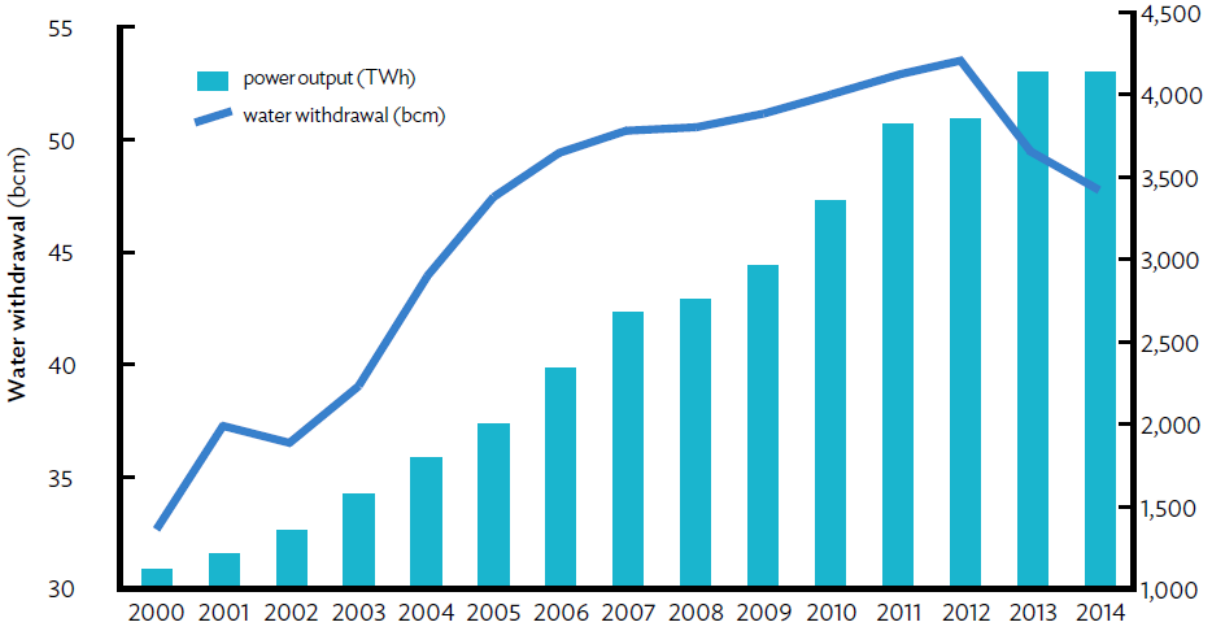
Trends in power generation and associated water withdraw in China 2000-2014



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
power output (TWh)	1,108	1,204	1,352	1,579	1,810	2,018	2,374	2,721	2,803	3,012	3,417	3,900	3,926	4,222	4,227
water withdrawal (bcm)	32.65	37.1	36.42	38.92	43.74	47.33	49.43	50.39	50.55	51.13	51.87	52.88	53.55	49.52	47.8

bcm= billion cubic meter, TWh = terawatt-hour.
Sources: Ministry of Water Resources. 2001–2015; China Electricity Council. 2001–2015; and World Resources Institute estimates.

- Power plant is the largest industrial consumer in China , around 8% total water usage
- Saving energy is saving water

Water Energy Nexus in The PRC and Emerging Issues, ADB 2017

REDUCE ENERGY IN WATER SECTOR

- Water sector has been one of the largest energy consumers
- 4-5% (US), 3% (UK), 10% (Israel), 20% (California)
- 35 % cost in water utilities is associated with energy
- Saving water is saving energy

ENERGY CONSUMPTION IN WATER

Total water use cycle energy intensity: 0.53-5.3 KWh/m^3

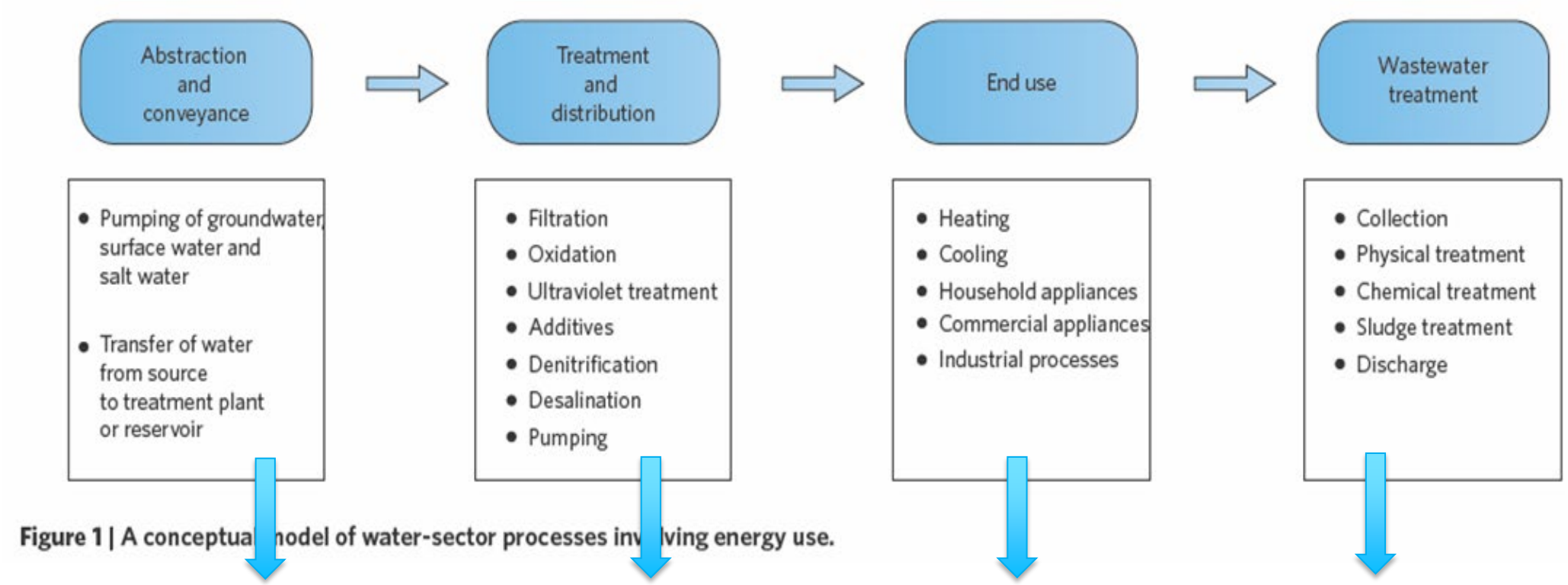


Figure 1 | A conceptual model of water-sector processes involving energy use.

0-1.06 KWh/m^3 | **0.026-4.5 KWh/m^3** | **13.6 KWh/m^3** | **0.25-1.22 KWh/m^3**

Old approaches: add energy for trading water quality

Sabrina G. S., et. al., Nature Climate Change, 26 June 2011

NEW PARADIGM: ENERGY NEUTRALITY WWTP

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Energy Saving 10-20% (fine bubble aeration, energy efficient motors and pumps)	**Renewable Energy 5-10%** (wind, solar, thermal)
Energy from sewage flows 2-10% (hydro-turbines, heat pumps)	**Sludge 40-100%** (anaerobic digestion)

Valentina Lazarova, Water Energy Interaction of Water Reuse, 2012, IWA Publishing

ENERGY NEUTRALITY WWTP CASE STUDY - STRASS IN AUSTRIA

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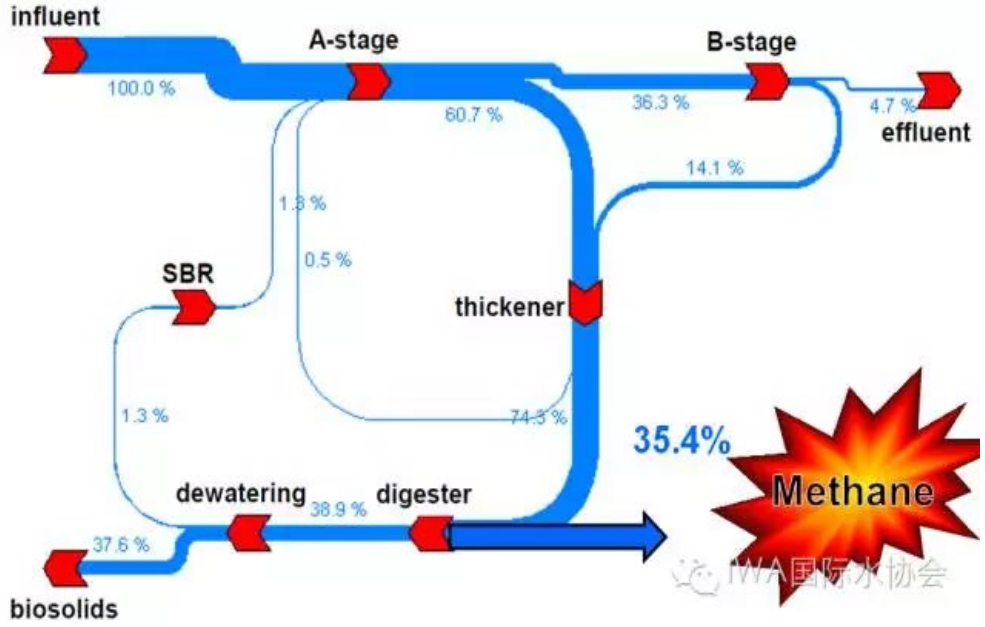
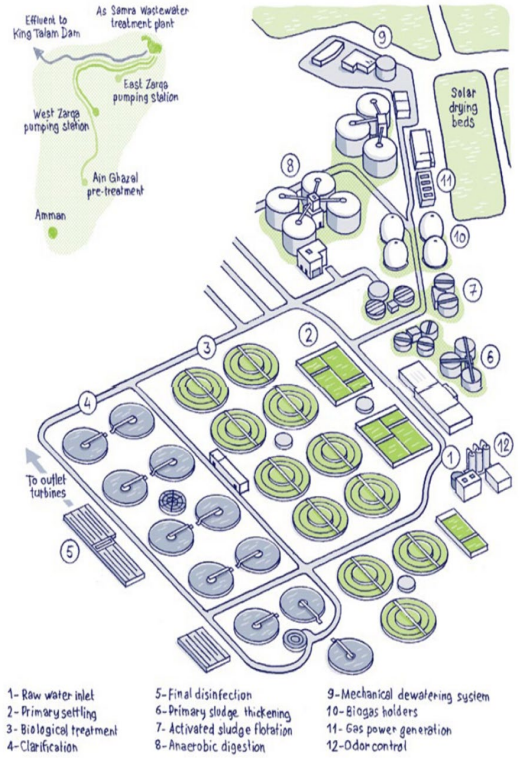


- Side stream Anammox has been implemented since 2006, and achieved 108% energy recovery
- 200% energy recovery has been achieved with food waste co-digestion since 2016

ENERGY NEUTRALITY WWTP CASE STUDY - AS SAMRA IN JORDAN



- 70% Wastewater in Jordan
- 90% energy recovery
- 10% agriculture water supply
- 230,000 Kwh/d

REDUCE FRESH WATER INTAKE
- ALTERNATIVE WATER RESOURCES (AWR)

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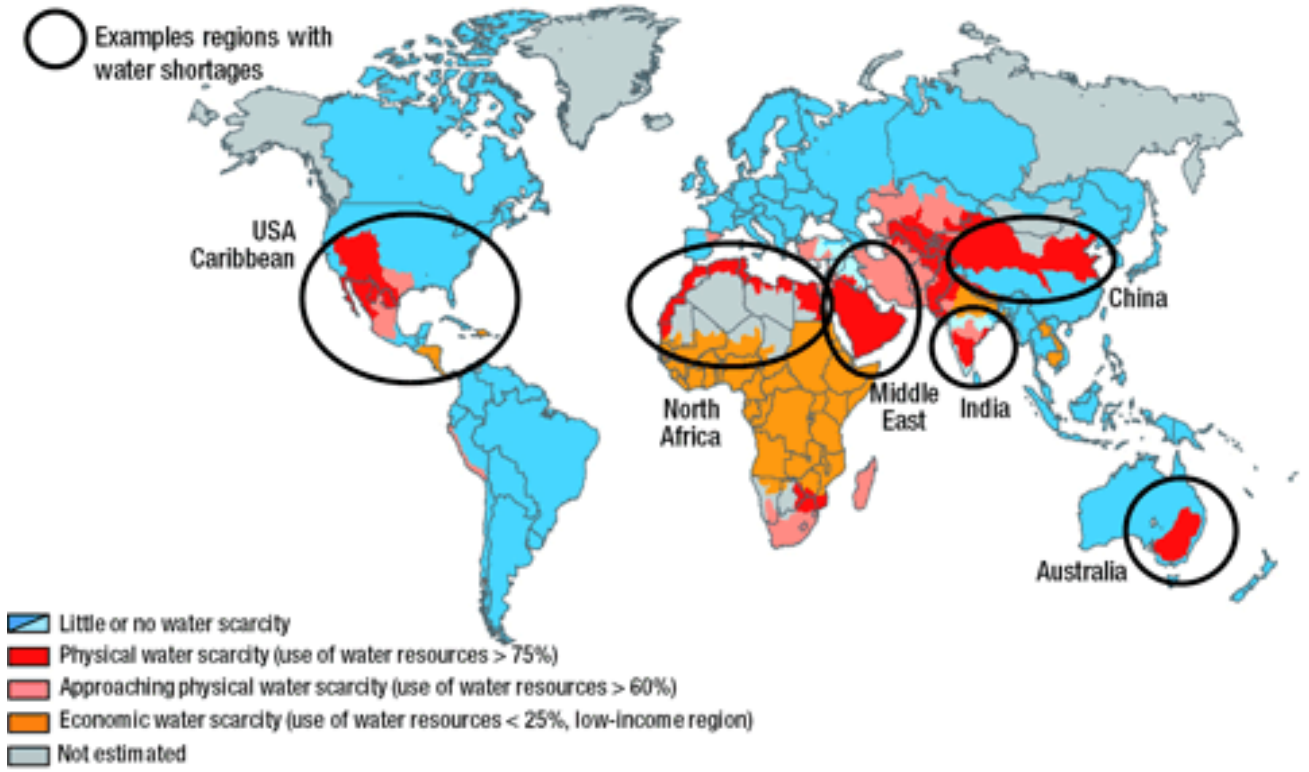
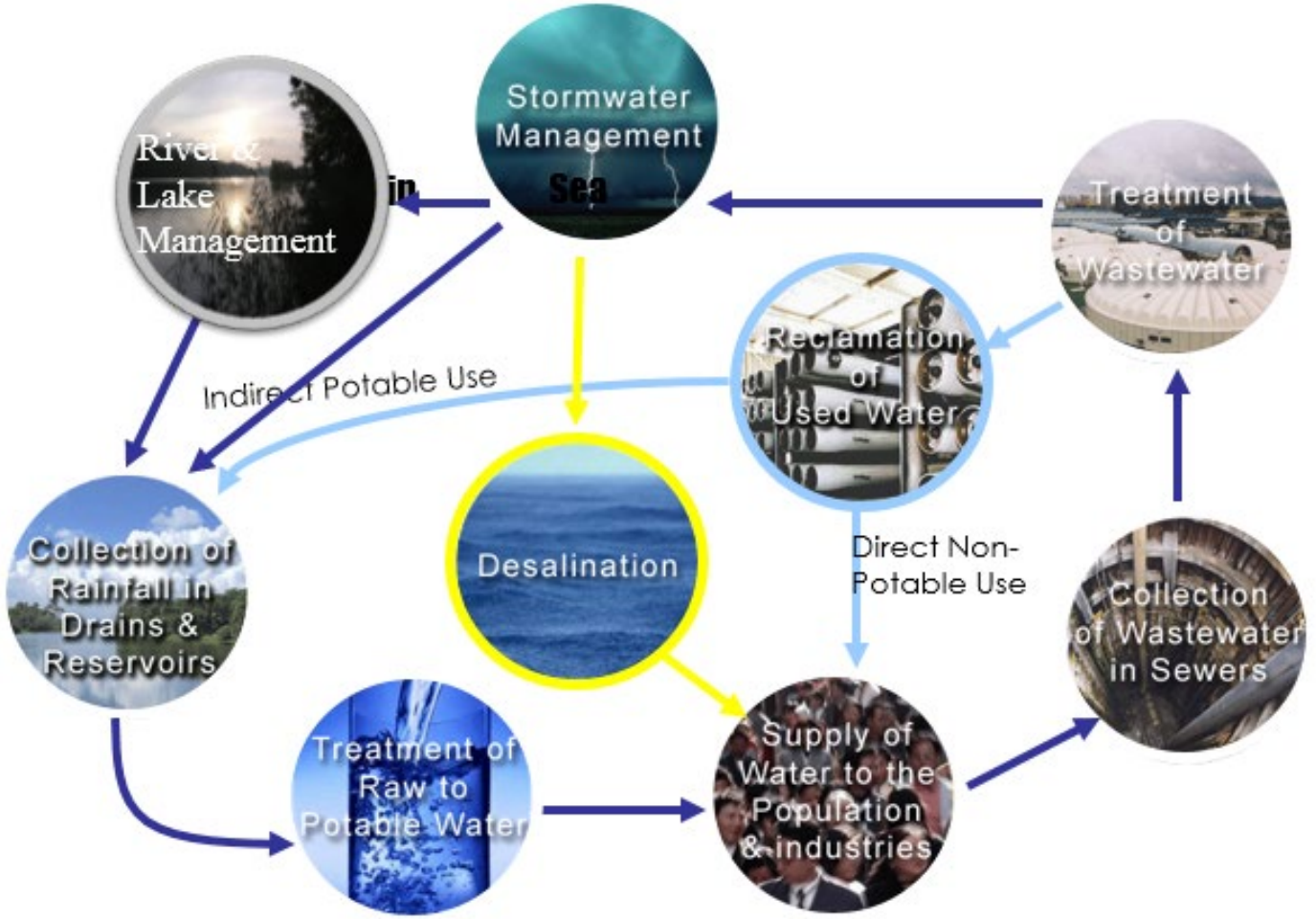
- Rainwater
- Used Water
- Brackish Water/ Sea Water



AWR: SINGAPORE CASE



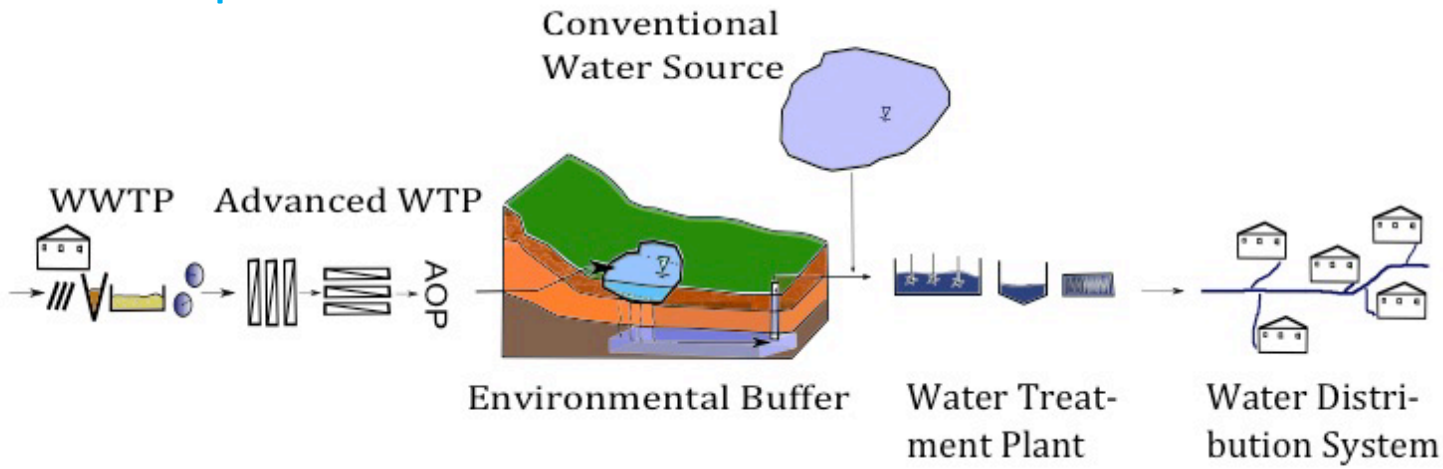
PUB

WASTEWATER REUSE- NOT POTABLE

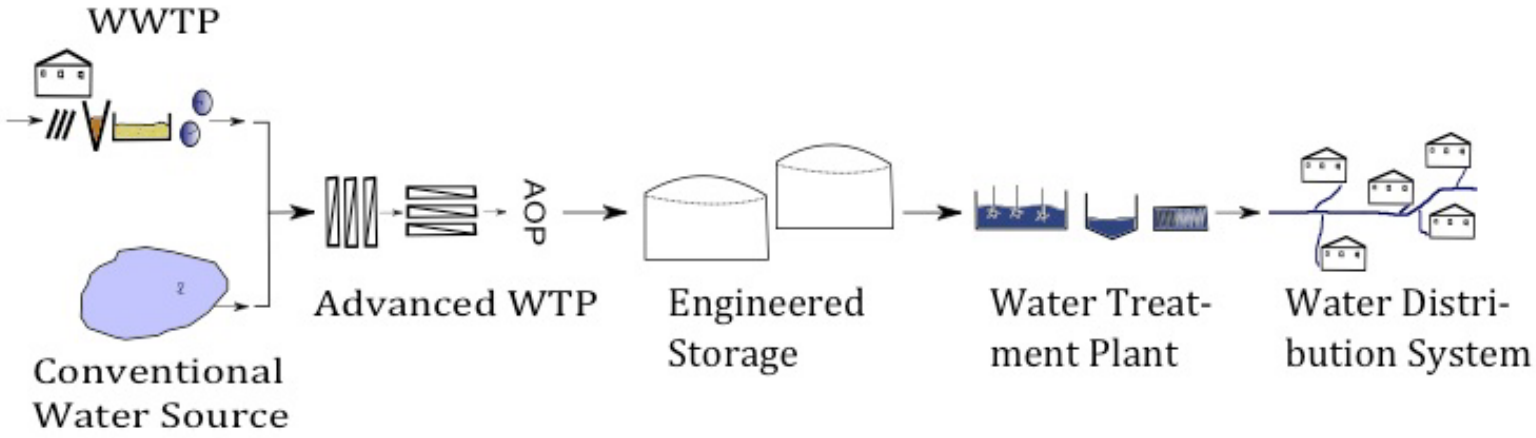
- The conventional WWTPs haven’t been designed without reusing purpose
- Used water has been widely reviewed as 2nd water resources in many cities
- Mainly reused for Irrigation, industry, toilet ect.
- More adaptable in newly developed area.
- Fit for Purpose reuse

WASTEWATER REUSE- POTABLE

- Indirect potable water reuse

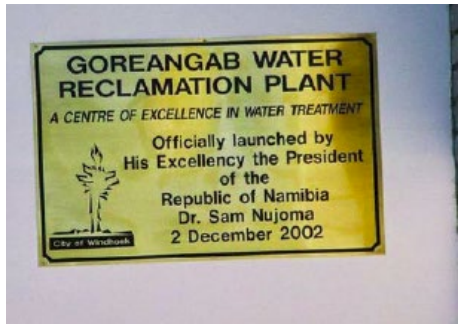


- Direct potable water reuse



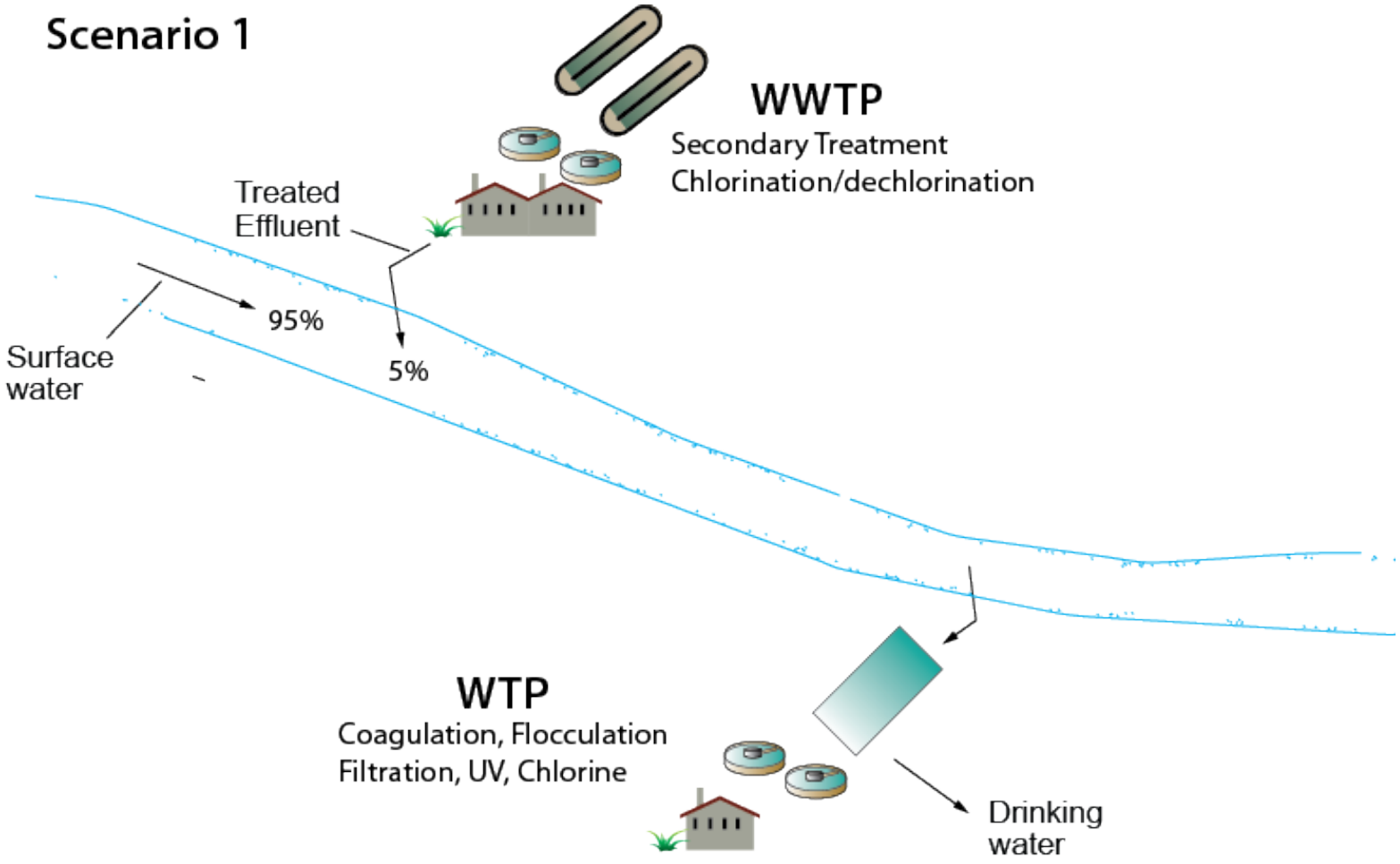
HISTORY OF POTABLE REUSE

- 1962 - **Montebello Forebay Spreading Grounds**, Los Angeles County Sanitation Districts, California, USA
- 1968 - (Old) **Goreangab Water Reclamation Plant**, Windhoek
- 1976 - **Water Factory 21**, OCWD, California, USA
- 1978 - **Upper Occoquan Service Authority**, Virginia, USA
- 1985 - Hueco Bolson Recharge Project, El Paso, Texas, USA
- 1985 - Clayton County, Georgia, USA
- 1993 - West Basin Water Recycling Plant, California, USA
- 1999 - Gwinnett County, California, USA
- 1999 - Scottsdale Water Campus, Arizona, USA
- 2002 - New Goreangab Water Reclamation Plant, Windhoek, Namibia
- 2002 - **Toreele Reuse Plant**, Belgium
- 2003 - **NeWater Bedok**, Kranji Singapore
- 2005 - Alimitos Barrier, California, USA
- 2007 - Chino Basin Recharge Project, California, USA
- 2008 - **Groundwater Replenishment Project**, California, USA
- 2008 - Loudon County, Virginia, USA
- 2008 - Western Corridor, Queensland, Australia
- 2009 - Arapahoe/Cottonwood, Colorado, USA
- 2010 - NeWater, Changi, Singapore
- 2010 - **Prairie Waters Project**, Colorado, USA
- 2010 - **Groundwater Replenishment Trial**, Perth, Australia
- 2012 - Dominguez Gap Barrier, California, USA
- 2012 - **Beaufort West**, South Africa
- 2013 - **Big Spring**, Texas, USA
- 2014 - Groundwater Replenishment Project, California (Expansion), USA
- 2015 - Wichita Falls, Texas, USA



Jorg Drewes (2015), Recent Developments in Potable Reuse. Springer

De Facto Potable Reuse is Common



Jorg Drewes (2015), Recent Developments in Potable Reuse. Springer

CALIFORNIA - GROUND WATER REPLENISH SYSTEM-GWRS

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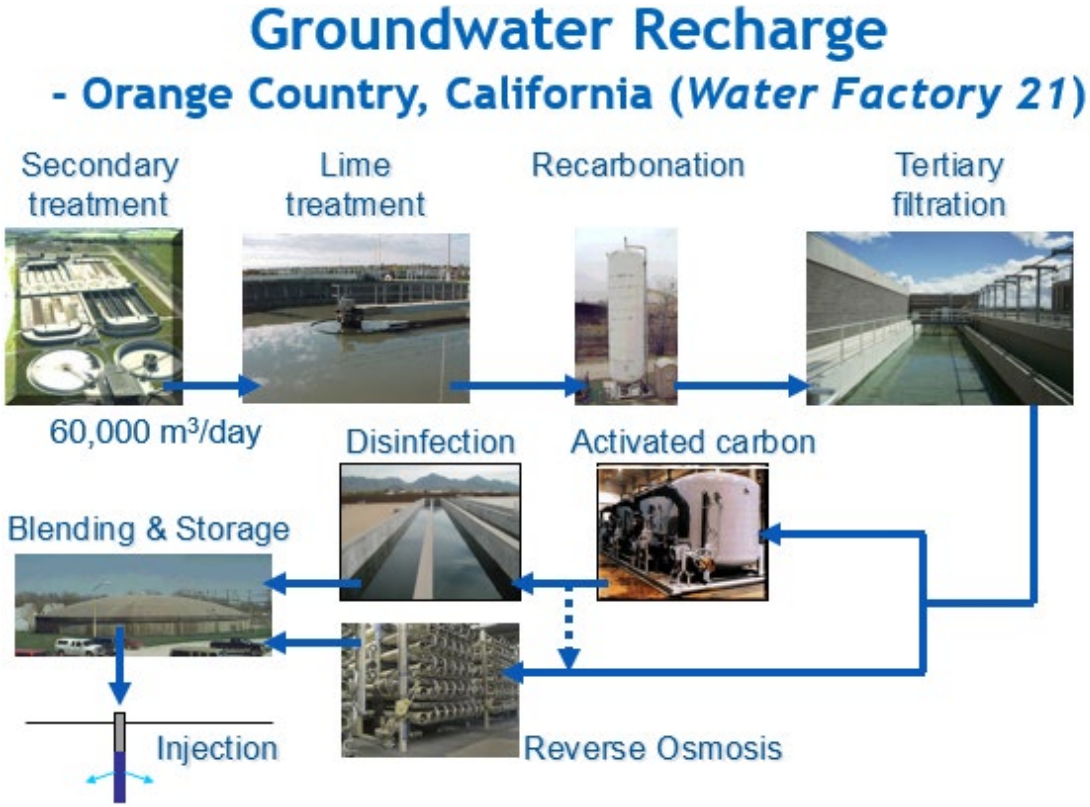

- 1st plant o use RO technology (1976)
- 379,000 m3/d, the largest groundwater recharge project in the world

RESOURCES RECOVERY
- PHOSPHORUS RECOVERY IN CHICAGO

- Stickney WWTP has invested 31 M US$ to build the largest recovery facility in the world
- 10,000 Tons struvite is expected to be produced annually

WASTEWATER TREATMENT PLANT - RESOURCE RECOVERY FACILITIES

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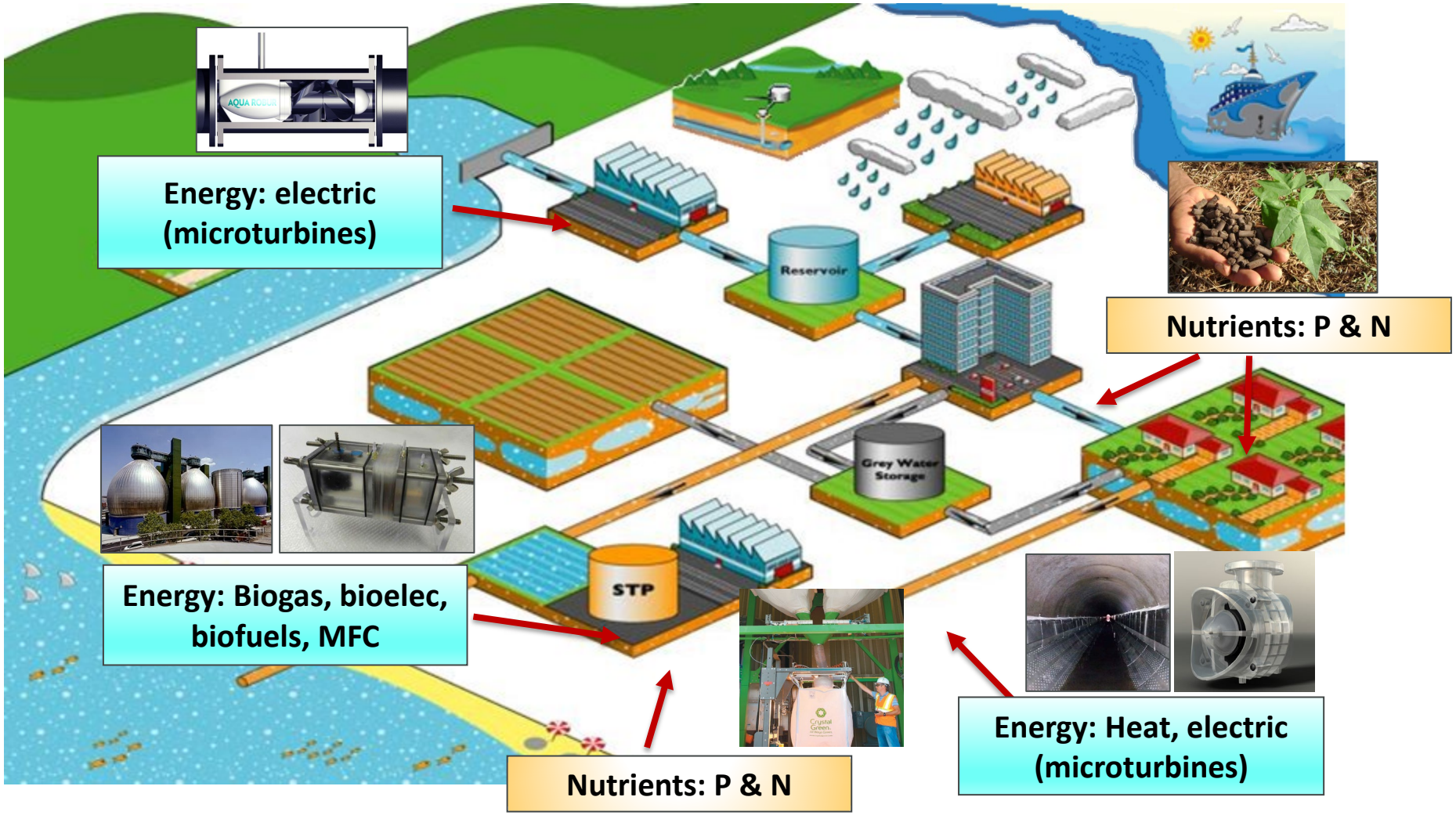

CONCLUSIONS:

- Changing our perspective creates opportunity to do things differently
- Circular economy model will be widely adopted in water sector