

WELCOME

Unlocking the Potential of Wastewater

22 September 2020

SGT 1600hrs - 1730hrs

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- ✓ Please share your questions in the chat where we will try to provide answers where possible in the Q & A Segment.
- ✓ Do identify yourself so we can respond to any unanswered questions
- ✓ We will be recording this session and reserve the rights to the video
- ✓ Please complete a post event survey which upon return, we will forward the recording and presentation deck to the respondents.

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PROGRAMME

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| Time (SGT) | Agenda | Presented by |
|---------------|---|---|
| 4.00 – 4.05pm | Opening & Welcome Address | Singapore Water Association |
| 4.05 – 4.15pm | Introduction to the new environmental collaboration agreement between Singapore and Denmark by The Royal Danish Embassy | H.E. Sandra Jensen Landi Ambassador of Denmark to Singapore |
| 4.15 – 4.25pm | Introduction to Singapore's wastewater sector and future wastewater trends & developments by PUB | Dr Pang Chee Meng PUB, Singapore's National Water Agency Chief Engineering & Technology Officer |
| 4.25 – 4.35pm | Integrated Innovative BioSensor for Heavy Metals Monitoring in Used Water Network by EnvironSens | Dr Shailesh Kharkwal CEO & Co-Founder, EnvironSens |
| 4.35 – 4.50pm | Introduction to Denmark's wastewater sector and future wastewater trends & developments by State of Green | Ms Tanya Jacobsen Deputy Director, State of Green |
| 4.50 – 5.05pm | Unlocking the potential of wastewater – Danish perspectives and best practices | Mr Thomas Jensen Head of Department, Niras |
| 5.05 – 5.20pm | Landia's wastewater technologies and adaptability towards local demands in Singapore | Mr Thorkild Maagaard Export Sales Director, Landia |
| 5.20 – 5.28pm | Q & A | Moderator: Mark Edward Perry |
| 5.28 – 5.30pm | Closing | Singapore Water Association |

WELCOME ADDRESS

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Unlocking the Potential of Wastewater

22 September 2020

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Mr Dinesh Sharma
VP (Administration), SWA
CEO, DNR Process Solutions Pte Ltd

SWA Initiatives

Since April 2020

SWAssist



SWatch !



SG United Updates



SWA Marketplace Assist Platform (SWA-MAP)

INTRODUCTION

Unlocking the Potential of Wastewater

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H.E. Sandra Jensen Landi
Ambassador of Denmark to Singapore

Unlocking the Potential of Wastewater

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Dr Pang Chee Meng
PUB, Singapore's National Water Agency
Chief Engineering & Technology Officer

Q & A

Unlocking the Potential of Wastewater

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UPCOMING

Technical Briefing

PUB BIM e-Checker Initiative

PUB has launched BIM self-checking system
for Building Plan Consultation

Click [REGISTER](#) to reserve your seat for this technical briefing



6th October 2020

1000hrs - 1100hrs

(Cisco Webex)

| | | |
|-----------------|--|---|
| 1000 - 1005hrs | Opening & Housekeeping | Singapore Water Association |
| 1005 - 1015 hrs | Welcome Address | Singapore Water Association |
| 1015 - 1045hrs | Overview of PUB BIM e-Checker Initiative | Mr Low Yang You PUB, Centralised Services Department (Building Plan Unit) |
| 1045 - 1055hrs | Q & A | SWA/PUB |
| 1055 - 1100hrs | Closing | Singapore Water Association |

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enquiry@swa.org.sg

T : +65 6515 0812

THANK YOU

Unlocking the Potential of Wastewater

22 September 2020

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For further queries on the webinar, please contact :



Royal Danish Embassy
Mark Edward Perry
T: (65) 65150812
E: markpe@um.dk



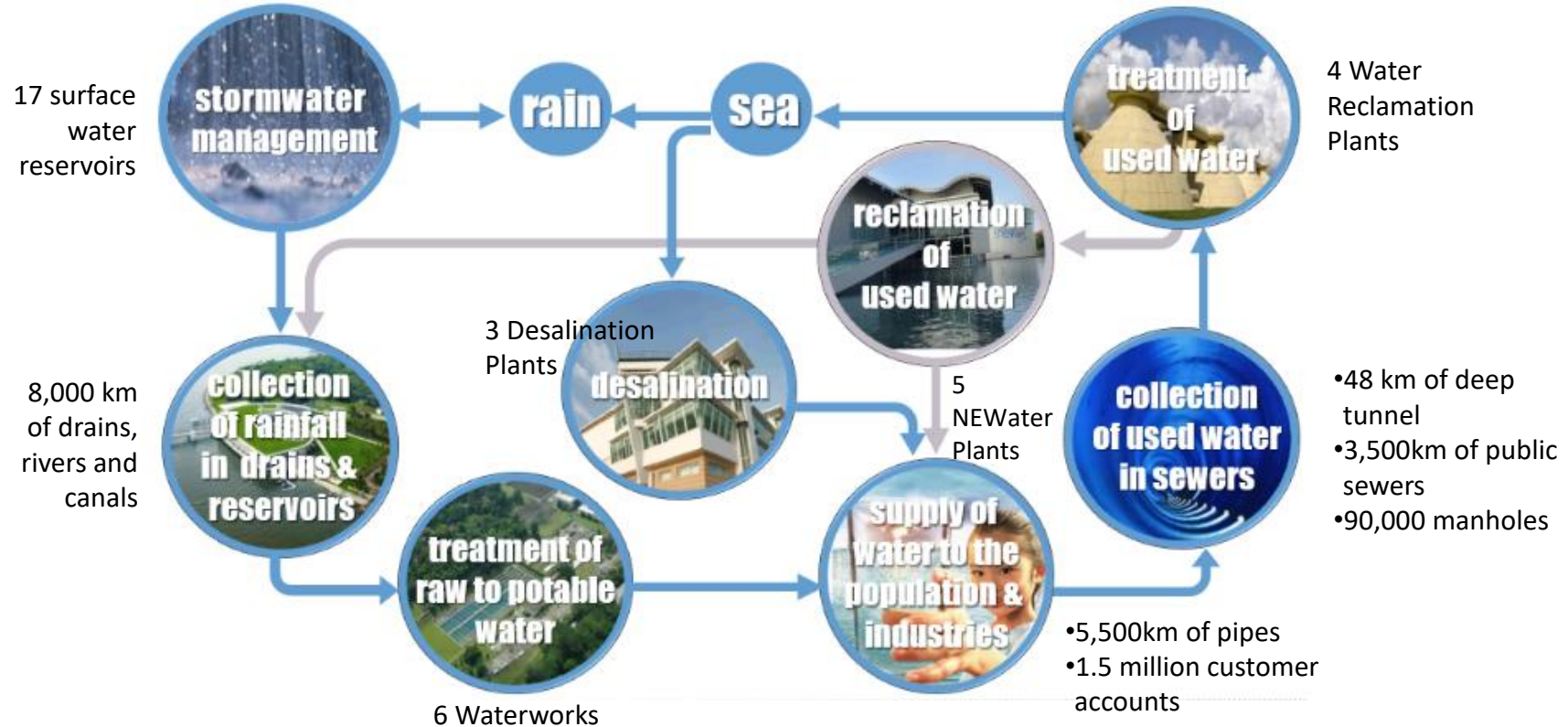
Singapore Water Association
T: (65) 65150812
E: enquiry@swa.org.sg
www.swa.org.sg

Leveraging R&D for Used Water Treatment

Dr Pang Chee Meng
Chief Engineering & Technology Officer
PUB, Singapore's National Water Agency



What PUB Does



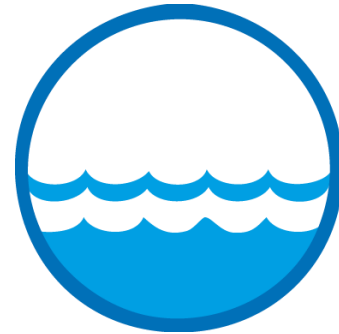
3 Principles in Managing Water Supply



**Capture
every drop
of rain**



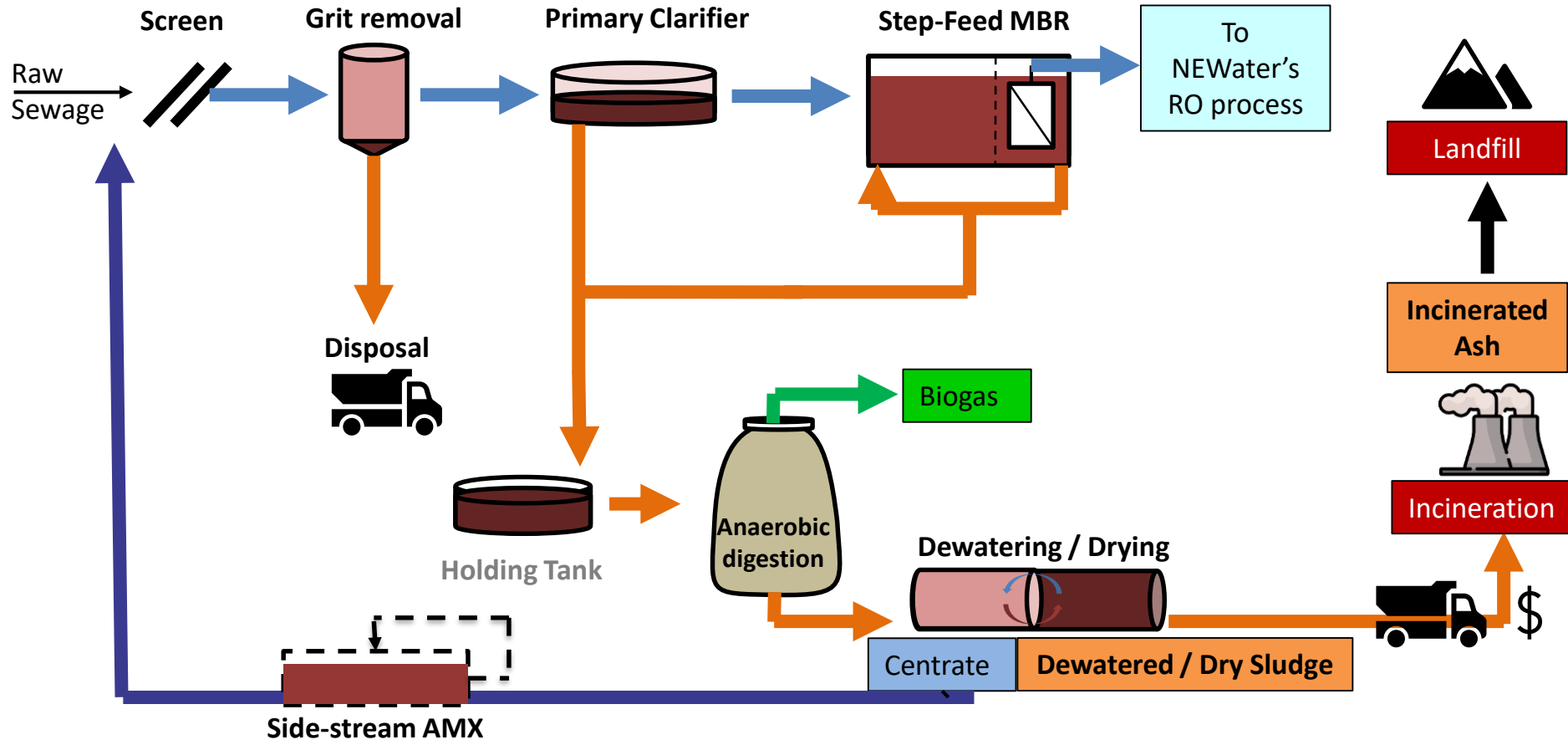
**Reuse
water
endlessly**



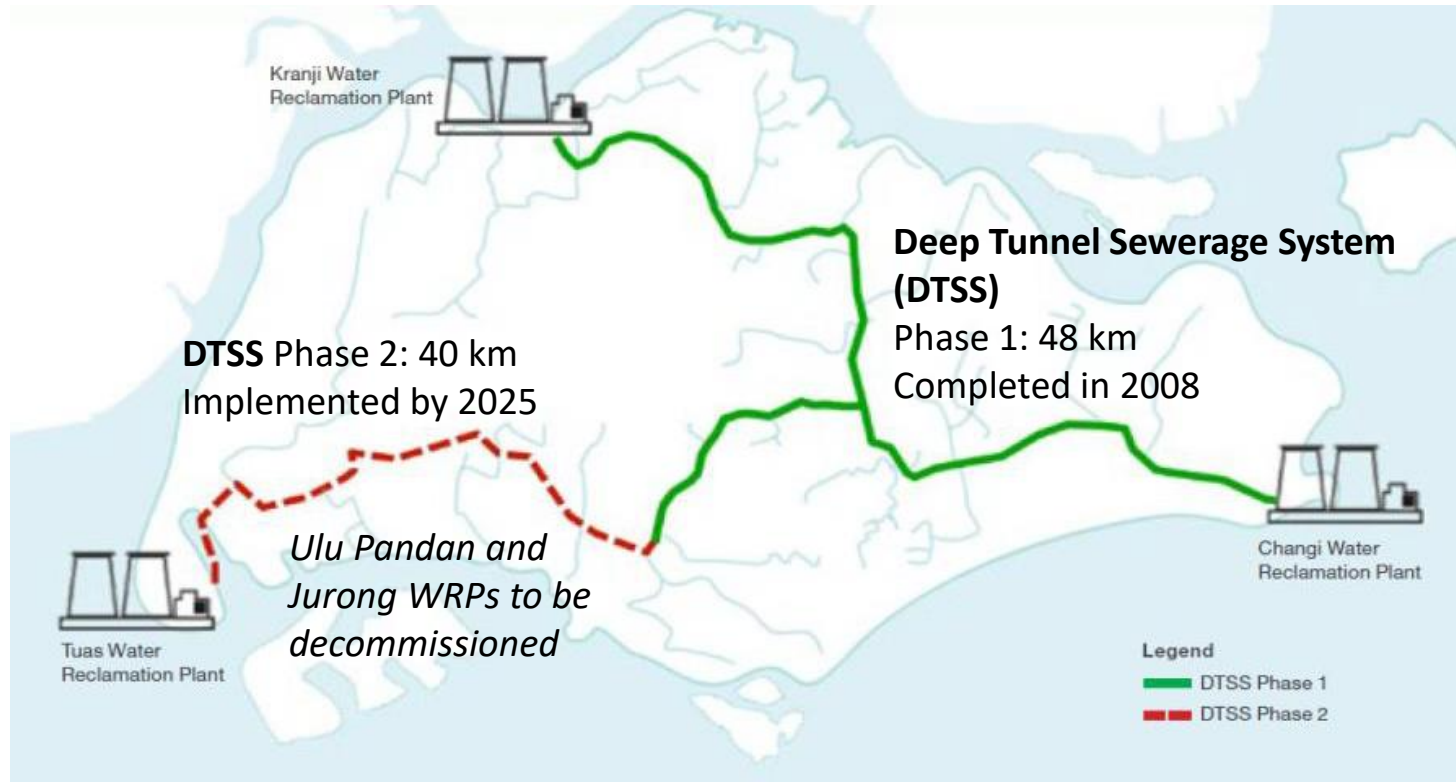
**Desalinate
more
seawater**

Used Water Treatment is an
integral part of Singapore's
water sustainability

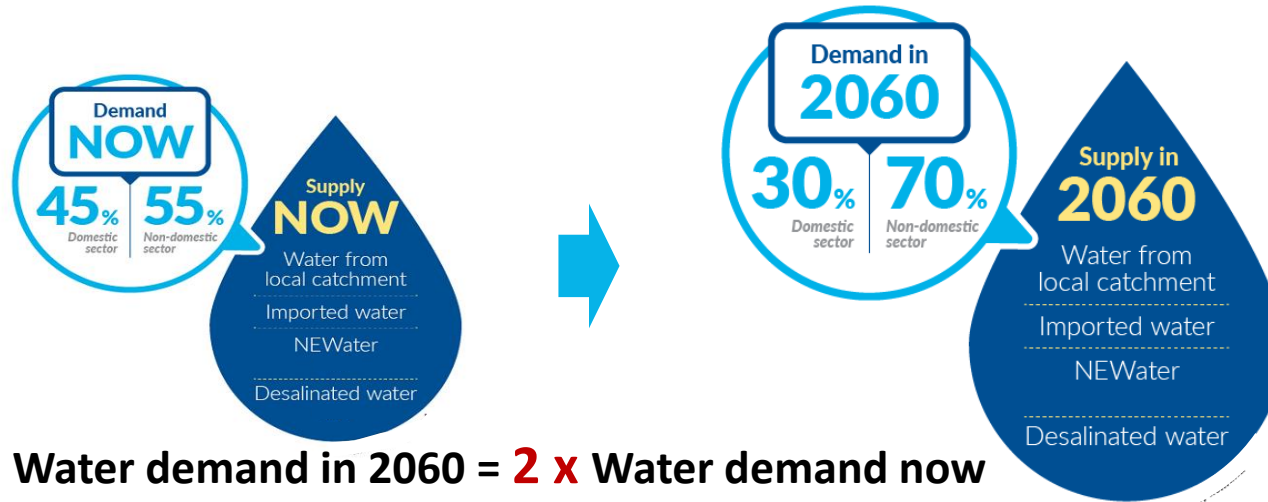
Singapore's Used Water and Sludge Treatment Processes



Singapore's Used Water System



Increasing Water Demand and its Implications



To deliver water using existing technologies will mean:

4 x
Energy

2 x
Sludge

More
Challenging
Water Quality

Increased
Land Use

1. Reducing Energy and Sludge

Energy Neutral Used Water Treatment



Current:

25% energy sufficient

Based on full-scale
operational plant data from
UPWRP

Short-Term:

85% energy sufficient

IVP Pilot/Demo Plant + Sludge
Preconditioning

Liquids:

- Enhanced Pretreatment
- Early capture of organics
- Improve aeration efficiency
- Side stream Anammox

Solids and Biogas

- Thermal Hydrolysis
- Recuperative Thickening & Co-digestion

Long-Term:

100% energy sufficient

Biosorption/Anaerobic MBR +
Mainstream Anammox

Liquids:

- Anaerobic MBR
- Mainstream Anammox
- Co-location of Facilities
- Advanced online sensors & controls

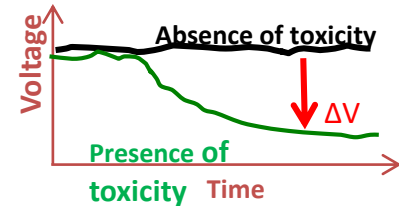
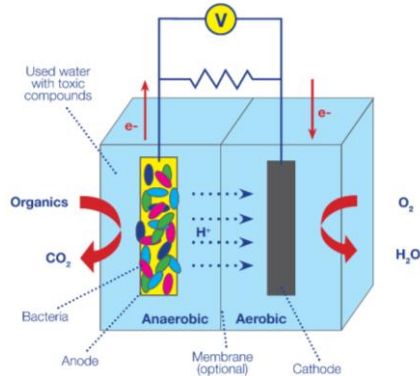
Solids and Biogas:

- Advances in CHP/DFE/Fuel Cells for
high electricity conversion

2. Addressing Used Water Quality

Real-Time Detection of Illegal Discharges

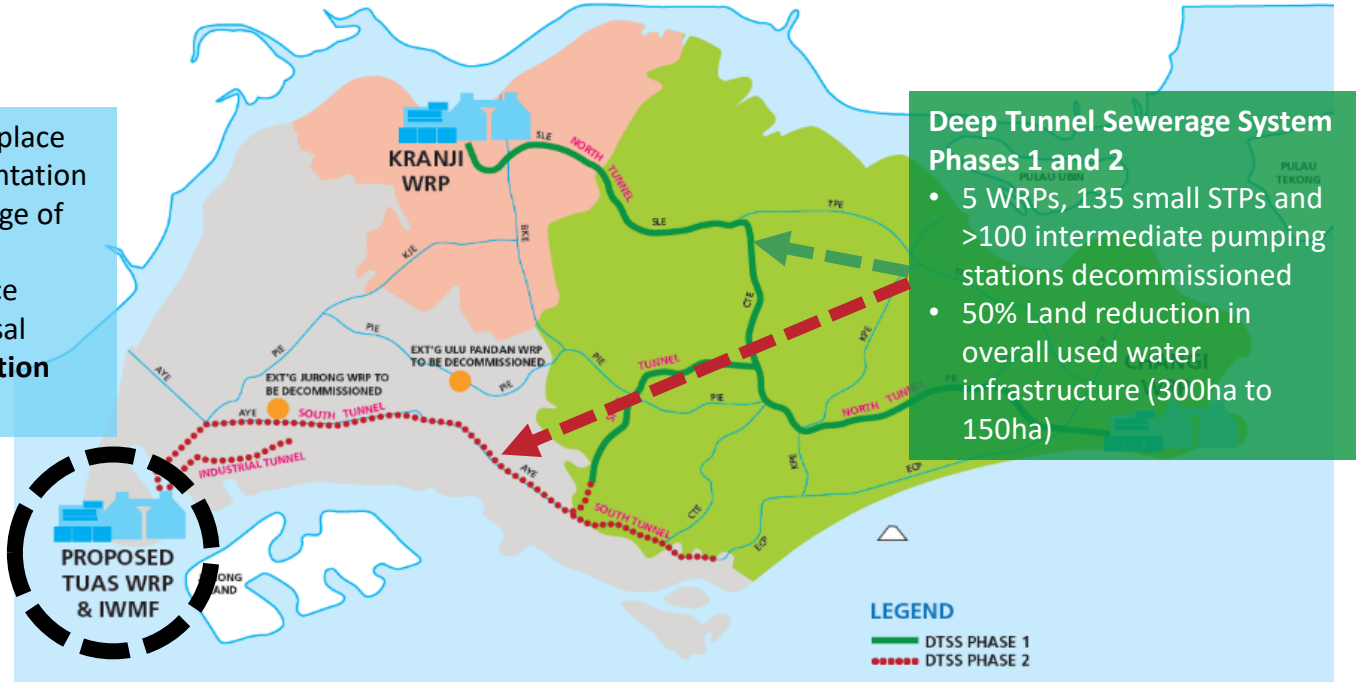
- Microbial Electrochemical Sensor for heavy metal detection.
- 8-year development from proof-of-concept at NUS lab to validation and field trial at PUB.
- Mass deployment of 100 units at industrial premises carried out by EnvironSens Pte Ltd, a spin-off company from NUS.
- 12 cases of illegal discharges successfully detected.



3. Overcoming Land Constraint

Re-thinking water infrastructure design for greater land efficiency

- **Membrane bioreactor** to replace aeration tanks, final sedimentation tanks and microfiltration stage of NEWater process
- **Thermal hydrolysis** to reduce sludge production for disposal
- **Lamella primary sedimentation tanks**



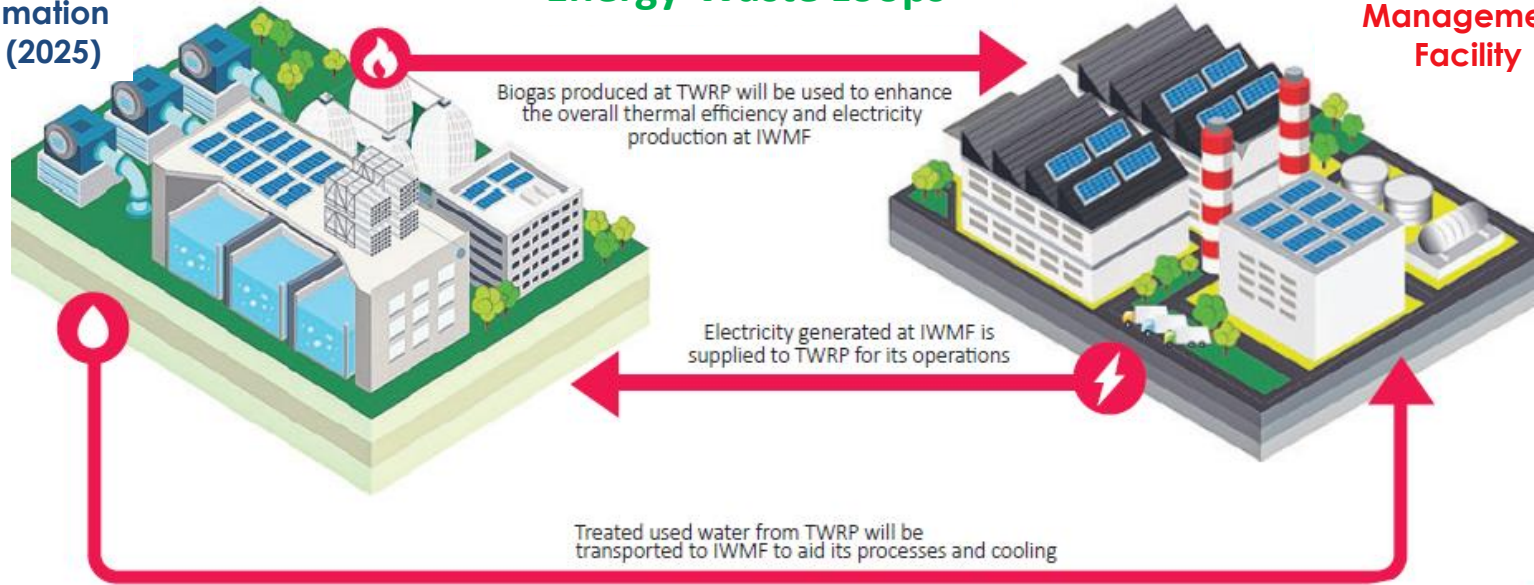
New Opportunities: Water-Energy-Waste Loop

Tuas Nexus – Synergies through Co-Location

Tuas Water
Reclamation
Plant (2025)

Closing the Water- Energy-Waste Loops

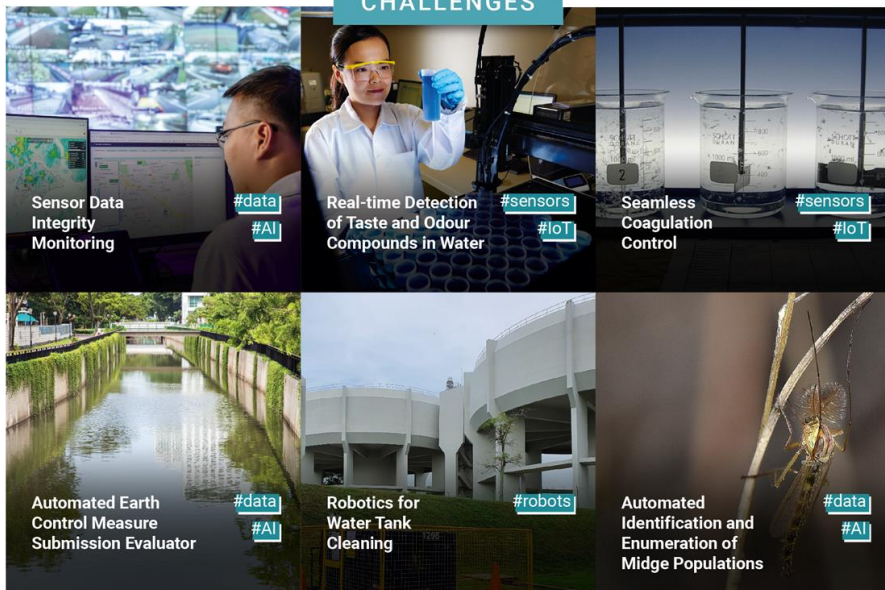
Integrated Waste
Management
Facility



PUB Global Innovation Challenge

Seeks to accelerate PUB's discovery and adoption of digital solutions and smart technologies to improve operational excellence and meet future water needs

CHALLENGES



Timeline



Application

September



Evaluation

Early November



Interview

Mid November



Pilot

2021 - 2022

Ecosystem Partners

Booky
Oren

Global Water Technologies

emerald
Technology Ventures



IMAGINE H₂O // ASIA



padang
&co



TRUE NORTH
VENTURE PARTNERS

Nurturing Innovation: Singapore Water Exchange

The Singapore Water Exchange is a dedicated space to further the growth of a vibrant water industry in Singapore. It houses a dynamic ecosystem of water-related companies to leverage mutual strengths and potential synergies to push the frontiers of water innovation and business growth



Commercialisation Ecosystem



Our Water Companies



Singapore International Water Week 2021



SINGAPORE INTERNATIONAL WATER WEEK 2021



20 – 24 June 2021



Sands Expo & Convention Centre
Marina Bay Sands, Singapore



500
Water
Leaders



110
Regions/
Countries



> 24K
Participants



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Statistics are based on the Singapore International Water Week (SIWW) 2018



Thank You!

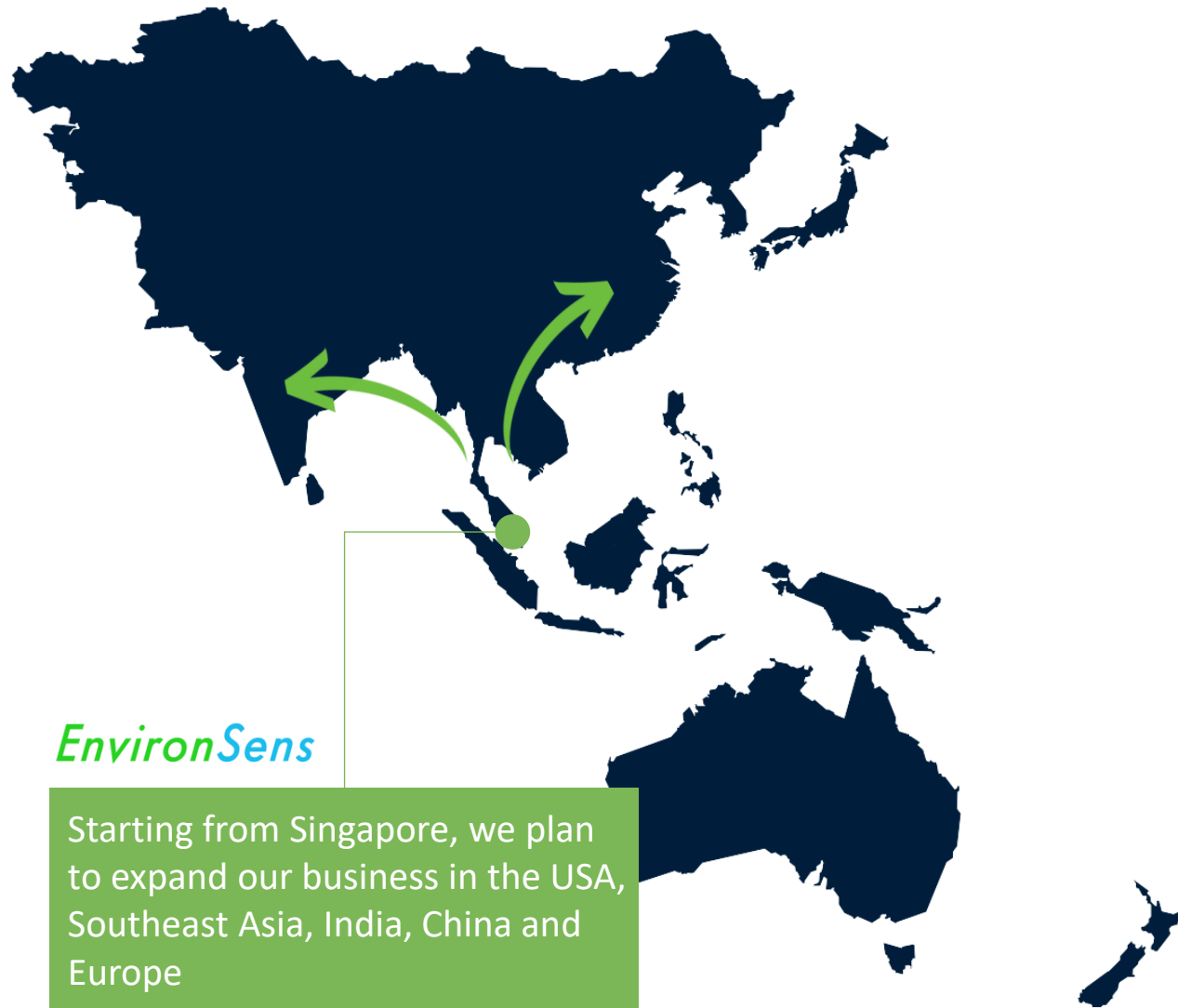


The background is a dark blue field filled with intricate, glowing light blue and green patterns. These patterns include concentric circles, dashed lines, and complex circuit-like structures with nodes and connecting lines, suggesting a high-tech or biological network. A large, semi-transparent gear is visible in the upper left, and a network of lines and nodes extends across the right side.

EnvironSens

Intelligent and Integrated Bio-Sensor for Toxicity Monitoring in Sewer Network

Introduction



EnvironSens

Starting from Singapore, we plan to expand our business in the USA, Southeast Asia, India, China and Europe



Key Business Domain and Capability

We design, manufacture and provide water quality monitoring product (I2BioS) and service. I2BioS monitors toxicity (heavy metals) in used water networks in real-time and on 24x7 basis; hence, protects downstream biological treatment at Water Reclamation Plants and Water Resources.



Our Origin

EnvironSens is a spin-off from National University of Singapore in 2018 and the team has worked closely with PUB, Singapore's National Water Agency over the last 8 years for I2BioS development and are supported by Enterprise Singapore.

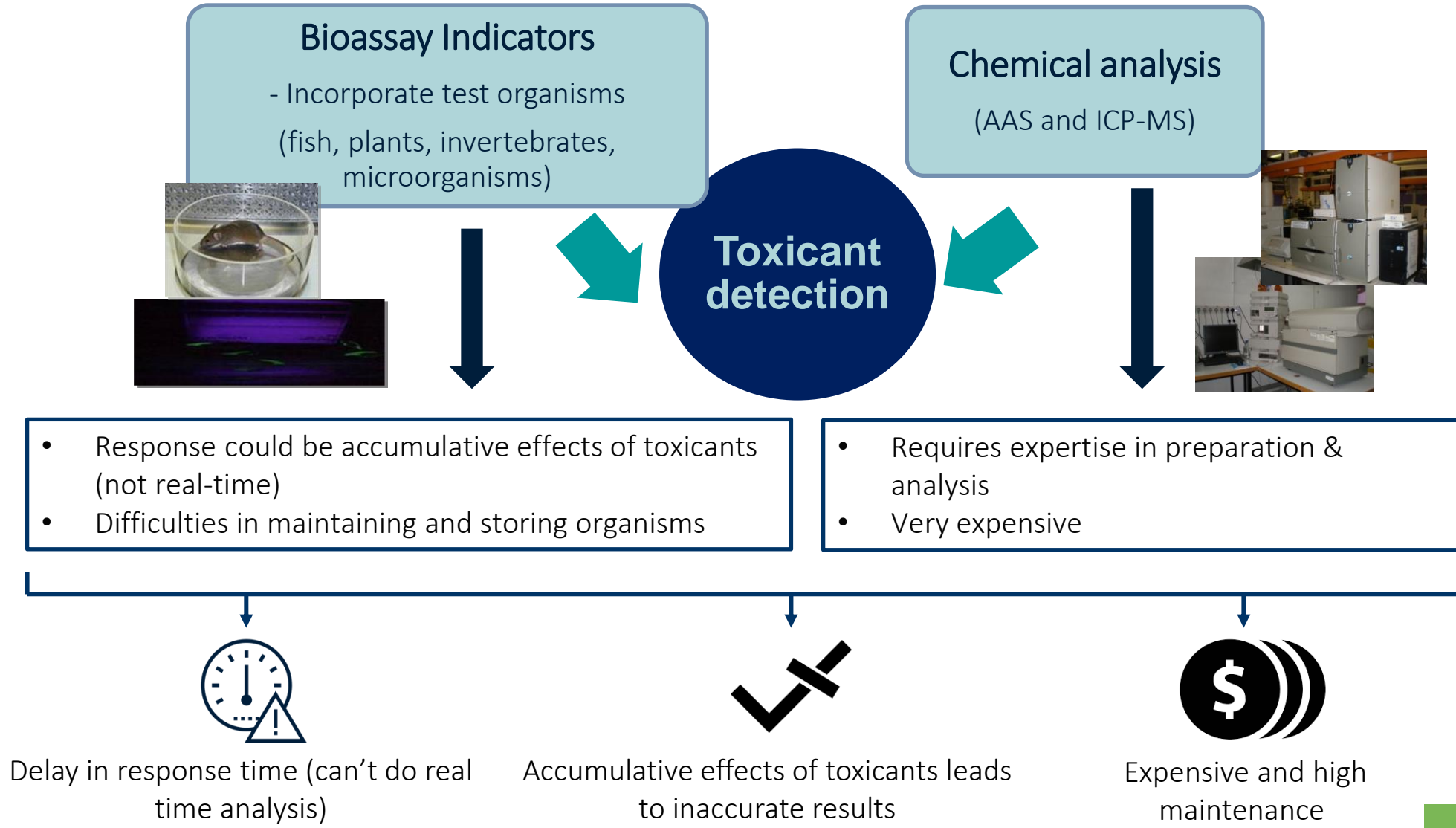
Requirement: An early warning system for used water source control



What do Utilities need?

- ✓ An **early warning system** to monitor illegal discharge at source using a **low cost** and **efficient** sensor
- Able to quickly identify **WHERE**, **WHEN** and **WHO** discharged so that WRP operators can have longer time to react

Problem: Limitations of existing heavy metals detection methods



Our Solution: I2BioS (Intelligent Integrated Bio Sensor)

A online and continuous monitoring system of heavy metal toxicity in water bodies and sewer network



EASY
OPERATION

Standalone I2BioS provides End-to-end solution to customer



ACCURATE
DETECTION

Embedded algorithm for accurate detection of toxic chemicals from 1-500 ppm
(i.e., copper, cadmium, chromium, nickel, zinc, Lead, Arsenic, cyanide, etc.)

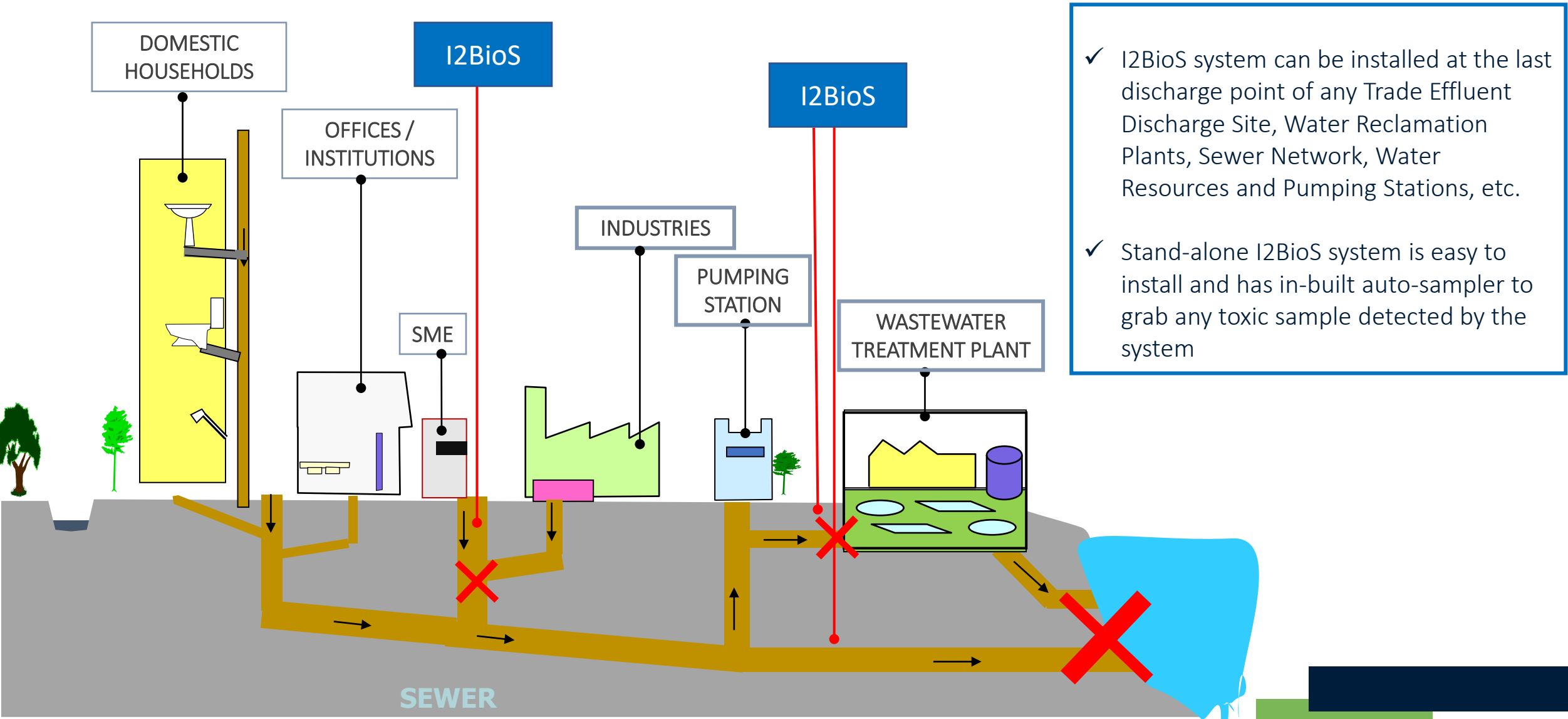


FAST
RESPONSE

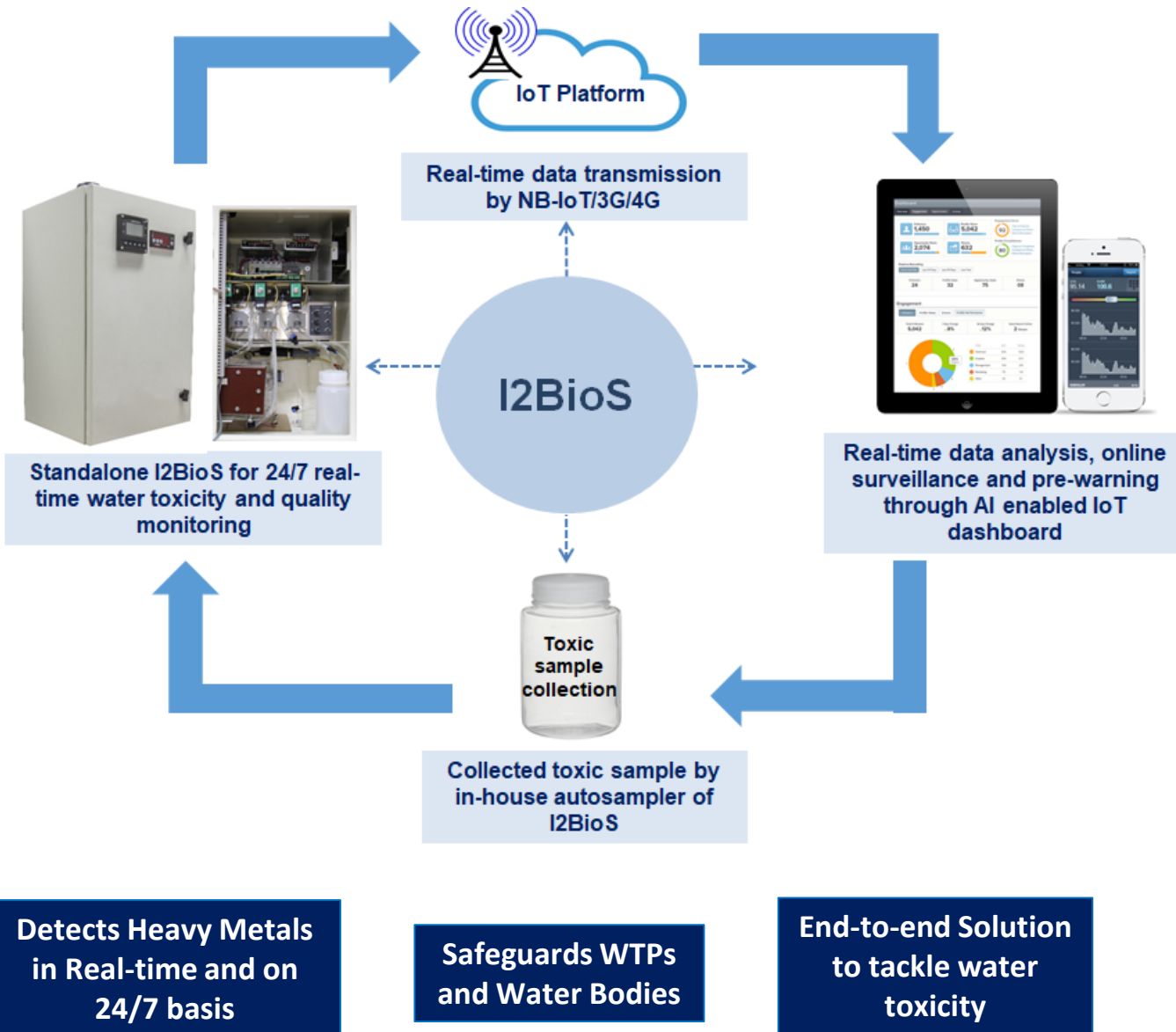
Online continuous monitoring system with 24/7 AI enabled Dashboard



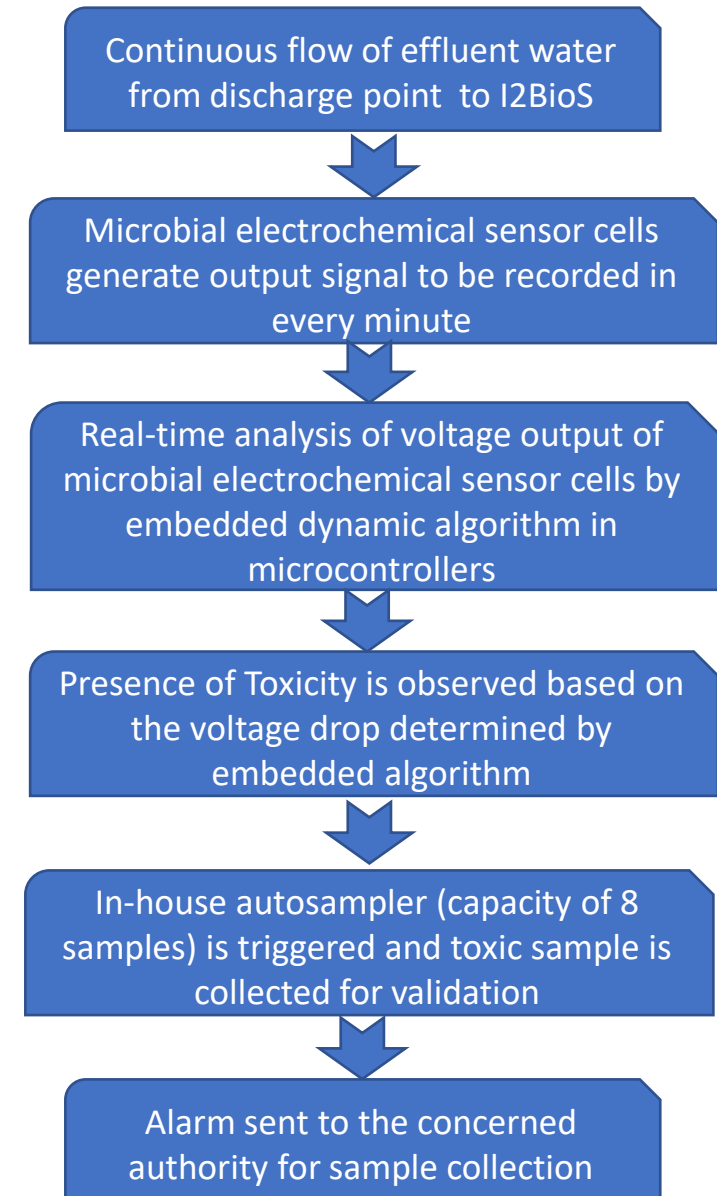
I2BioS for protecting sewer networks and water bodies



How I2BioS works



Process of real-time detection and analysis



A Journey from Lab to Market

Development of I2BioS in Different Phases



Lab-scale I2BioS developed at Centre for Water Research ,
National University of Singapore (2011)



Field Trial of Pilot-scale I2BioS at a Pumping Station in
Singapore (2013)



Standalone commercial I2BioS installed in a factory
located in Singapore (R) and in one event (L) (2018)



Compact I2BioS at the final discharge point of a factory
located in Singapore (2016)

Installation and Deployment

I2BioS

Where

Installation Location: last discharge point of factories, upstream of sewer network, before WRPs, before water resources, etc.

What

Installation Requirements: availability of power source, access of the last discharge point or point of interest

When

Maintenance Frequency: bi-monthly maintenance for topping up organic source, probe calibration and cleaning

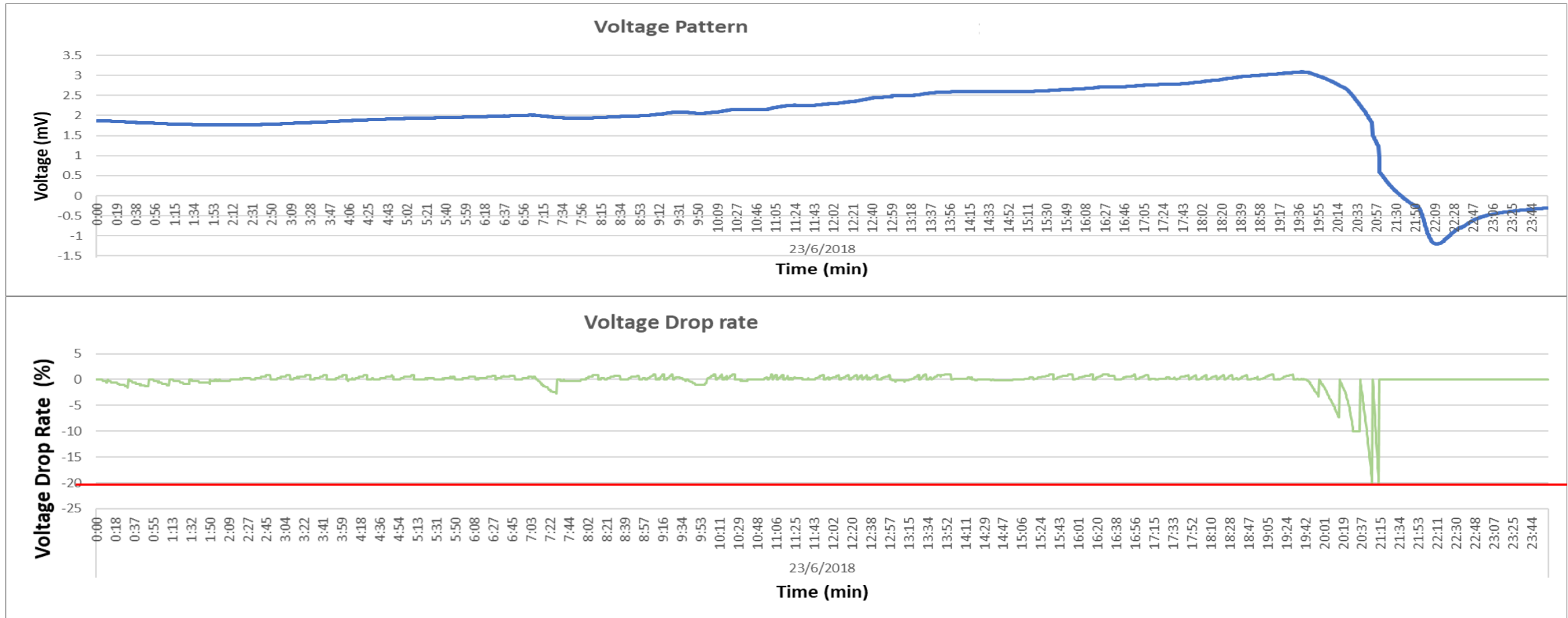
How

Footprints: Stand-alone system of size 1000 (h) (mm) X 500 (d) (mm) X 550 (w) (mm); weight is ~ 35 Kg

Power Consumption: Consumes power less than 350 W

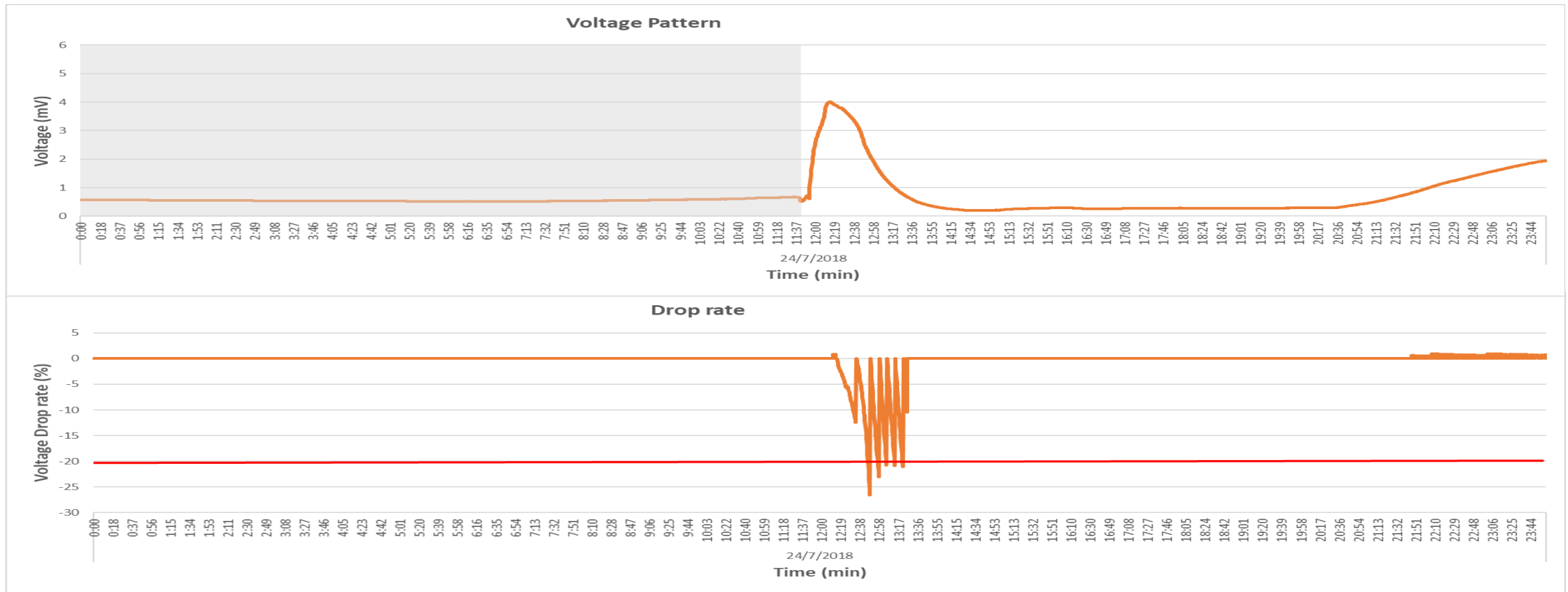


Case Study: Toxic events detected by I2BioS at different trade effluent locations



- I2BioS installed at last discharge point of one trade effluent site (Electroplating company) detected heavy metal toxicity and autosampler was triggered
- Captured sample was measured to have **10.5 ppm of Cu (II)**

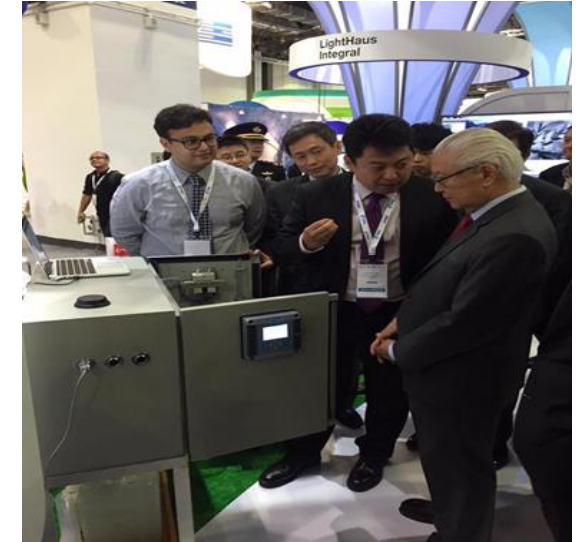
Case Study: Toxic events detected by I2BioS at different trade effluent locations



- Grey Colour area is “no discharged water situation in manhole”
- I2BioS installed at last discharge point of one trade effluent site (solid waste collector) detected heavy metal toxicity and autosampler was triggered
- Captured sample was measured to have **Cu (7.19 ppm)**, **Ni (25.39 ppm)** and **Zn (14.11 ppm)**

Success Story from Singapore

- More than 90 units of I2BioS have been in operation in Singapore and more installation shall be done in near future
- Have picked up >10 illegal/accidental discharge events
- Listed in APAC 25 for MES technology by the Cleantech Group
- Selected in Asia Cohort of Imagine H2O
- Selected for the IES Prestigious Engineering Achievement Awards 2020!



Benchmark

| Feature | I2BioS | Chemical Analysis (ICP-MS. AAS) | Other Methods |
|--|---|---|---|
| Concept | Microbial-Electrochemistry | Spectrometric Measurement | Bioassay Indicators (Fish, Plants, Invertebrates, Microorganisms) |
| Continuous monitoring | ✓ | ✗ | ✗ |
| Measurement time/Sample Preparation | 5 - 20 min / sample preparation is not required | 90 - 120 min / Sample preparation is required | 30 – 90 min / Sample preparation is required |
| Required Maintenance Level | Low | High | High |
| Cost | Low | High | Low |
| Pre-warning System | Yes | No | No |
| AI enabled IoT Platform with Dashboard | Yes | No | No |

The team



Prof. How Yong Ng

Co-Founder and Non-Executive Director

Professor Ng is from National University of Singapore. He is Dean's Chair and Director of the NUS-SembCorp Corporate Lab and IWA Fellow. He has Over 20 years of experience in the field of water/wastewater



Dr. Shailesh Kharkwal

Co-Founder and CEO

Dr. Kharkwal was former Senior Research Fellow at National University of Singapore. He has over 9 years of experience in water/wastewater field. He is leading the overall product development and operation of EnvironSens



Contact:

Prof How Yong Ng & Dr Shailesh Kharkwal

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Wastewater in Denmark

Tanya Gottlieb Jacobsen
Deputy Director
State of Green



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Public - Private
Partnership

Public

Private

Government



**MINISTRY OF FOREIGN
AFFAIRS OF DENMARK**



Danish Ministry of Climate,
Energy and Utilities



**Ministry of Environment
and Food of Denmark**



**MINISTRY OF INDUSTRY, BUSINESS
AND FINANCIAL AFFAIRS**

Business organisations



Confederation of Danish Industry

*Voice of 10,000
Danish companies*



*Representing 60 Danish
energy companies*



*Representing 200 companies
in wind energy*



Danish Agriculture
& Food Council

*Representing 186,000 employees in
the farming and food industry*

Corporate sponsors



*Sustainable energy
technologies*



*Engineering sustainable
constructions*



*Sustainable wind
power solutions*



*Largest trade union,
representing 280,000
employees*



*Trade union for
230,000 workers*



*Developer of
renewable
energy power plants*

PensionDanmark
*One of the 50 largest pension
funds in Europe*



*#1 in energy efficient
pumps*



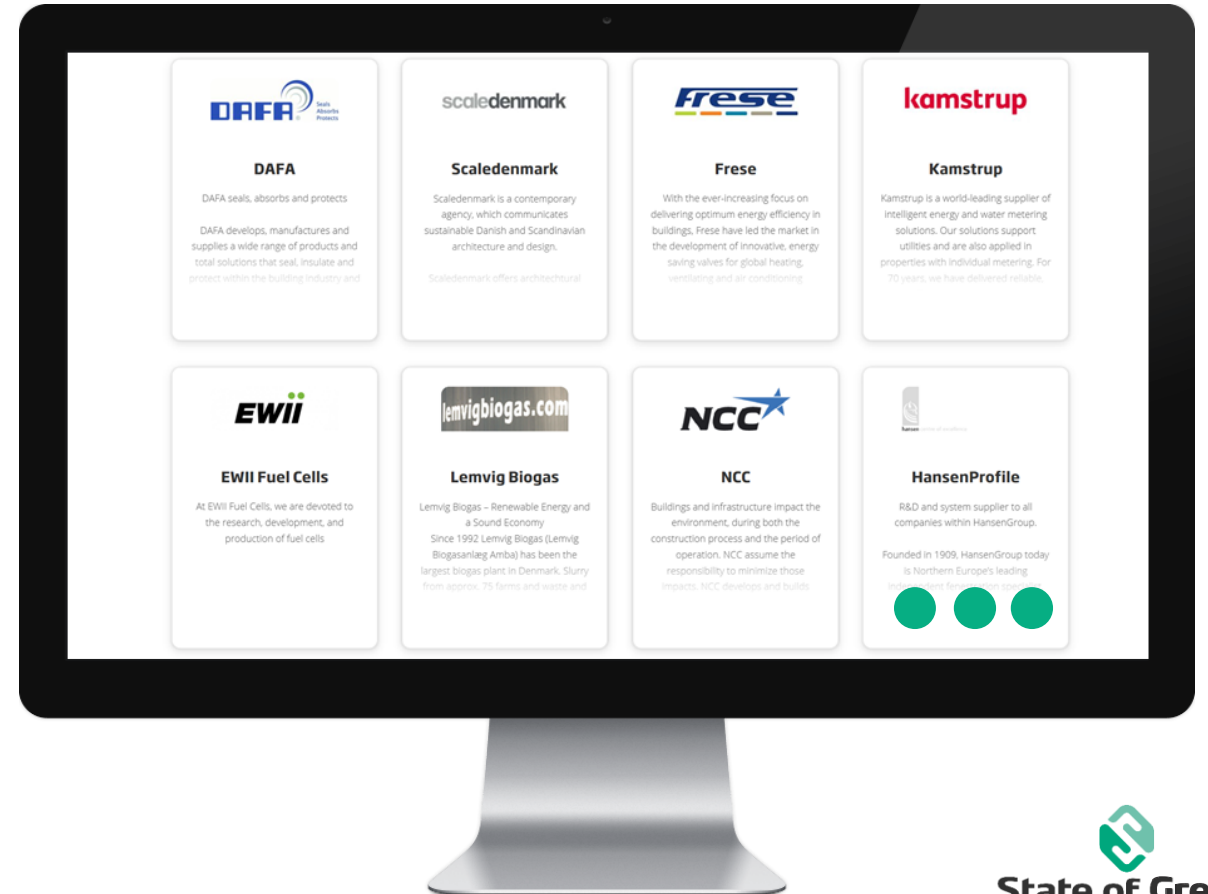
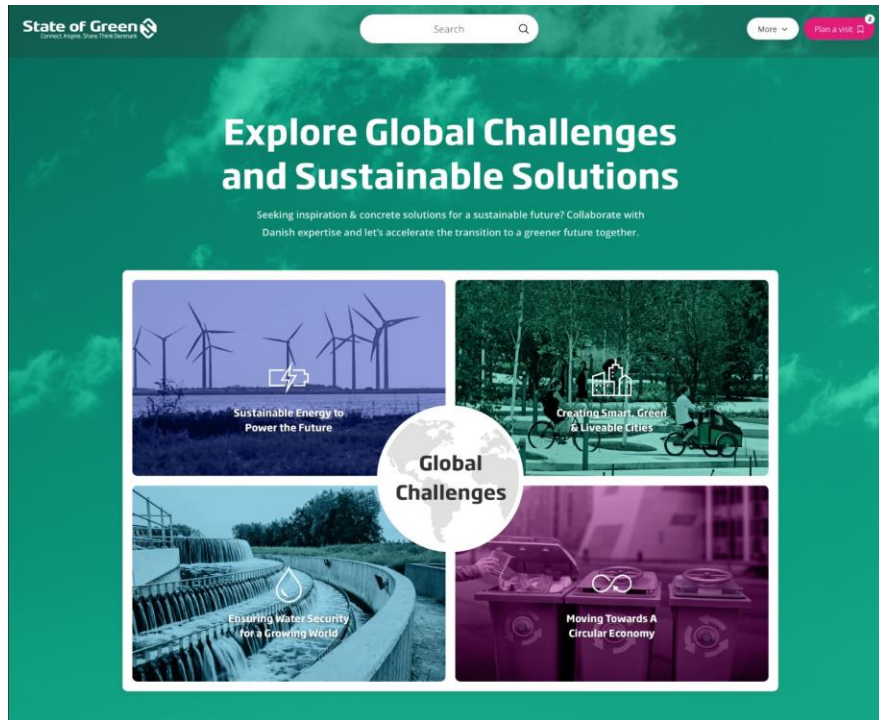
*World leader in stone
based insulation*



*Leading green
energy utility*

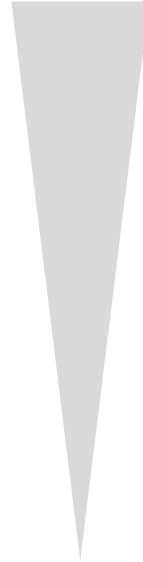


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EU Water Framework Directive



Water administration





EU Water Framework Directive



**Ministry of Environment
and Food of Denmark**

Regulates nature protection, environmental
protection, agriculture etc.



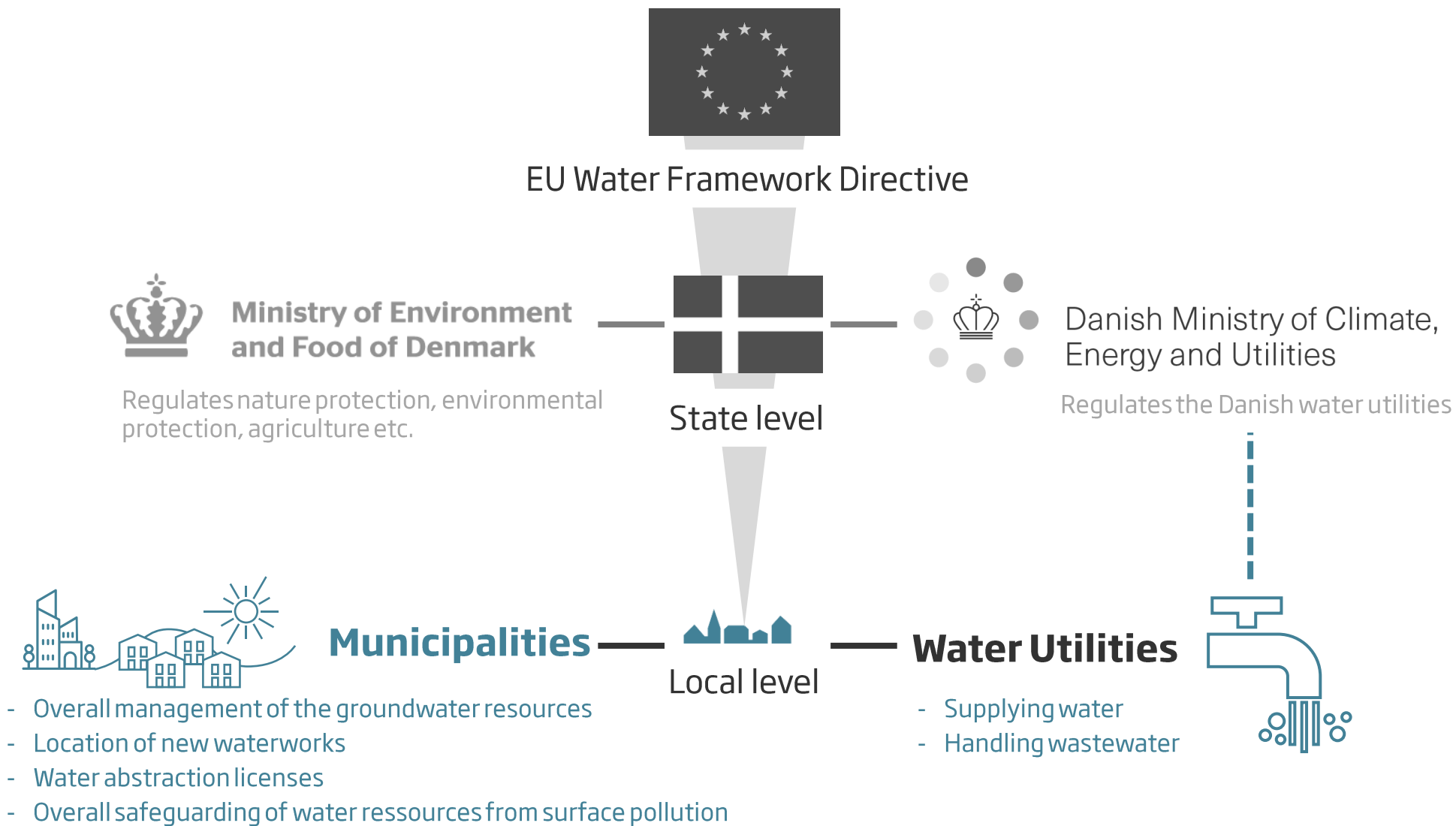
State level



**Danish Ministry of Climate,
Energy and Utilities**

Regulates the Danish water utilities







Danish Ministry of Climate,
Energy and Utilities

Regulates the Danish water utilities

Water Utilities

- Supplying water
- Handling wastewater

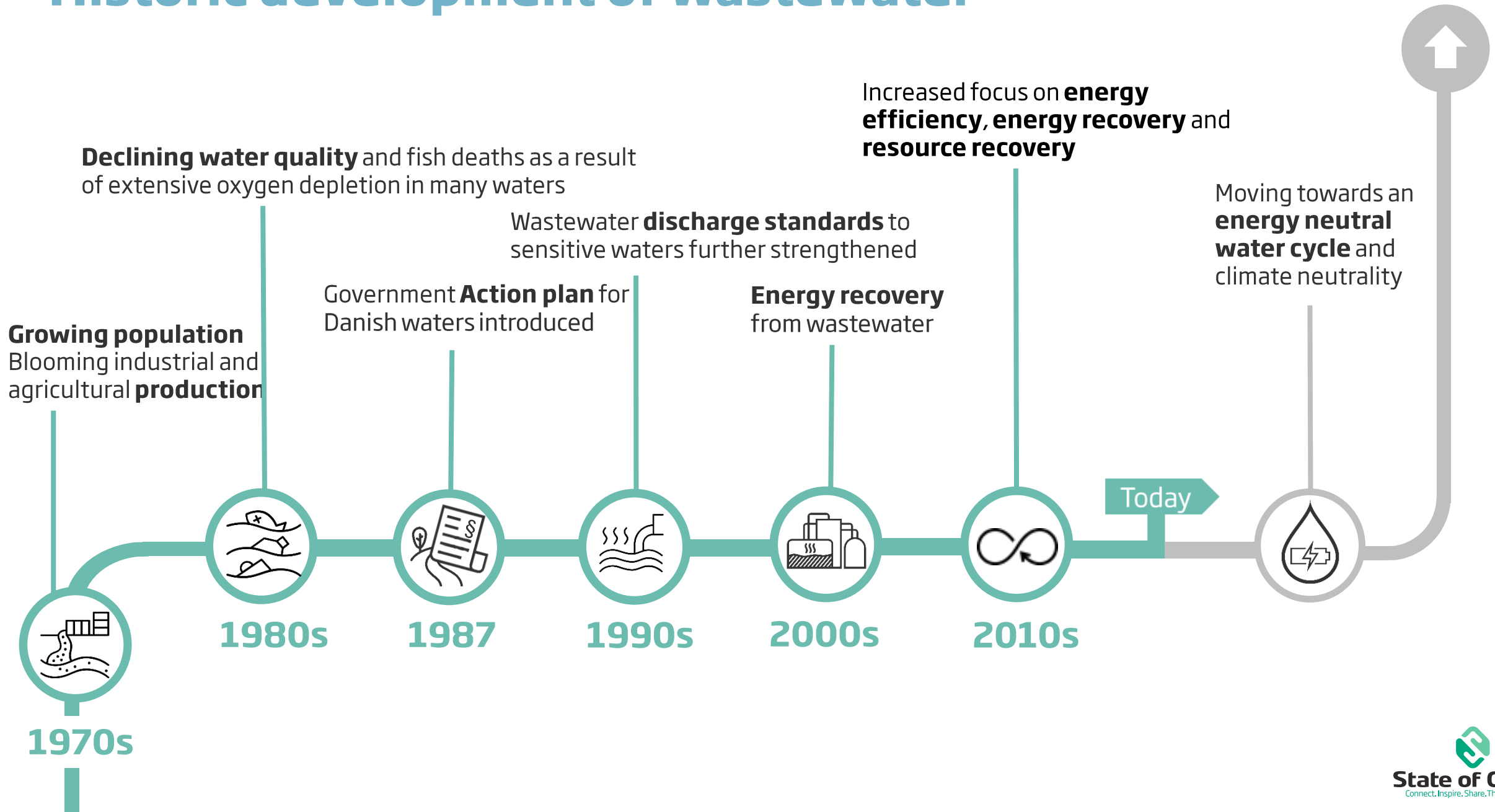


Danish water regulation

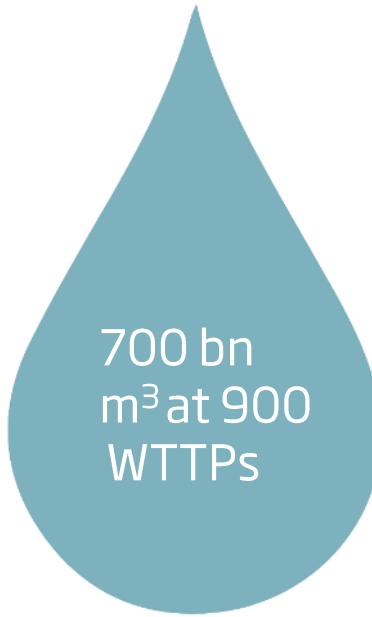
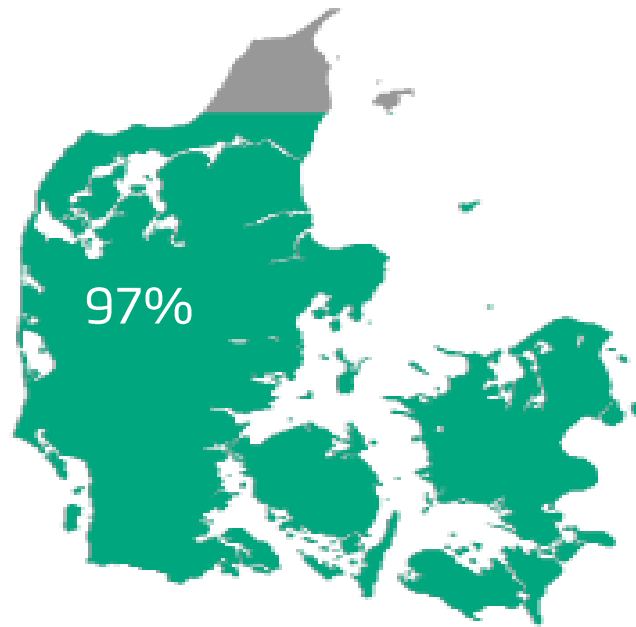
- In 2008: Water utilities become **separate legal entities** - but are fully owned by municipalities
- Drinking water and wastewater utilities must submit specific **economic** and **environmental** performance parameters
- All water utilities are **not-for-profit** and operate under a break-even principle based on **full cost recovery**



Historic development of wastewater



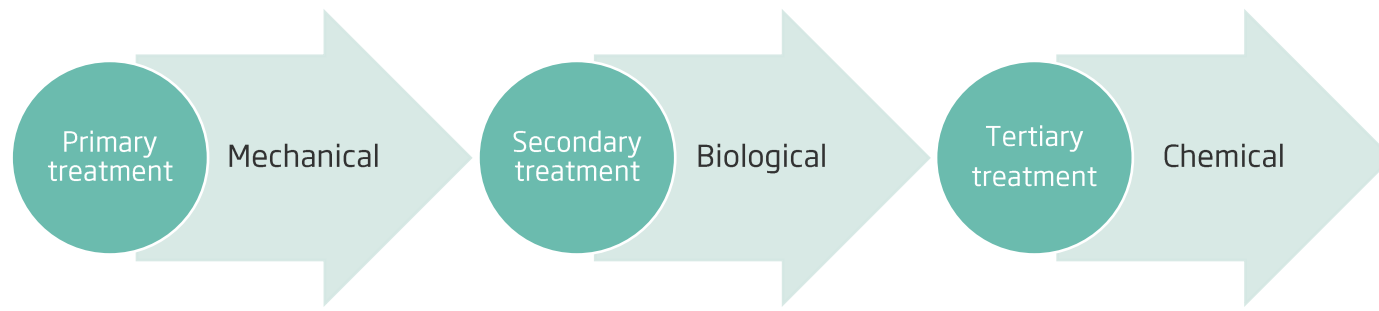
Wastewater in Denmark today



Wastewater treatment



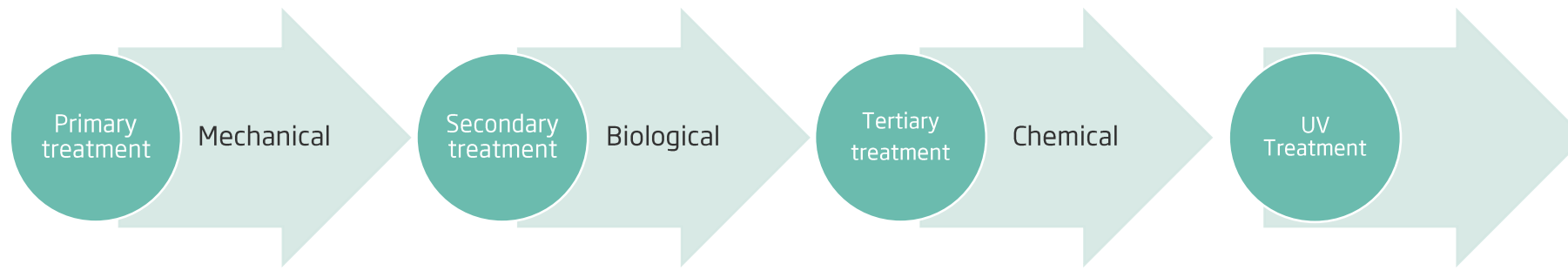
Wastewater treatment in Denmark today



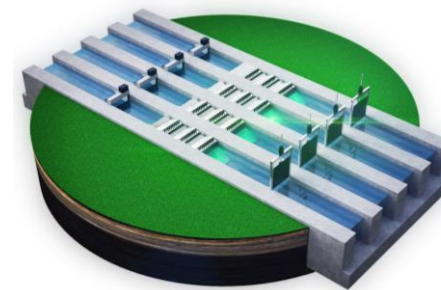
Wastewater treatment



Advanced wastewater treatment



Wastewater treatment



[See example](#)





Legal discharge requirements

+

Tax per kg discharges nutrients

=

Result



Resource recovery

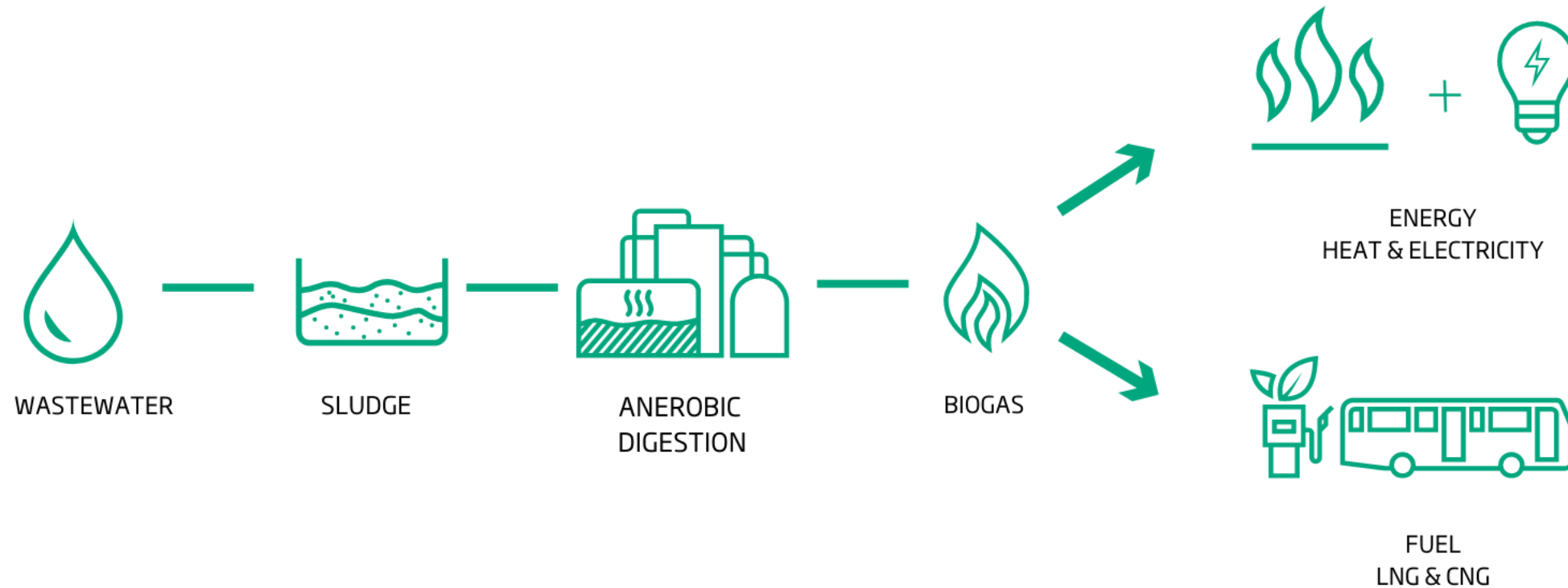


Phosphorus used as fertiliser

[See example](#)



Energy and resource recovery



Energy recovery



Global implications

The water sector's share of
global electricity consumption is

4%



Global implications

80%

of the world's wastewater
is released untreated

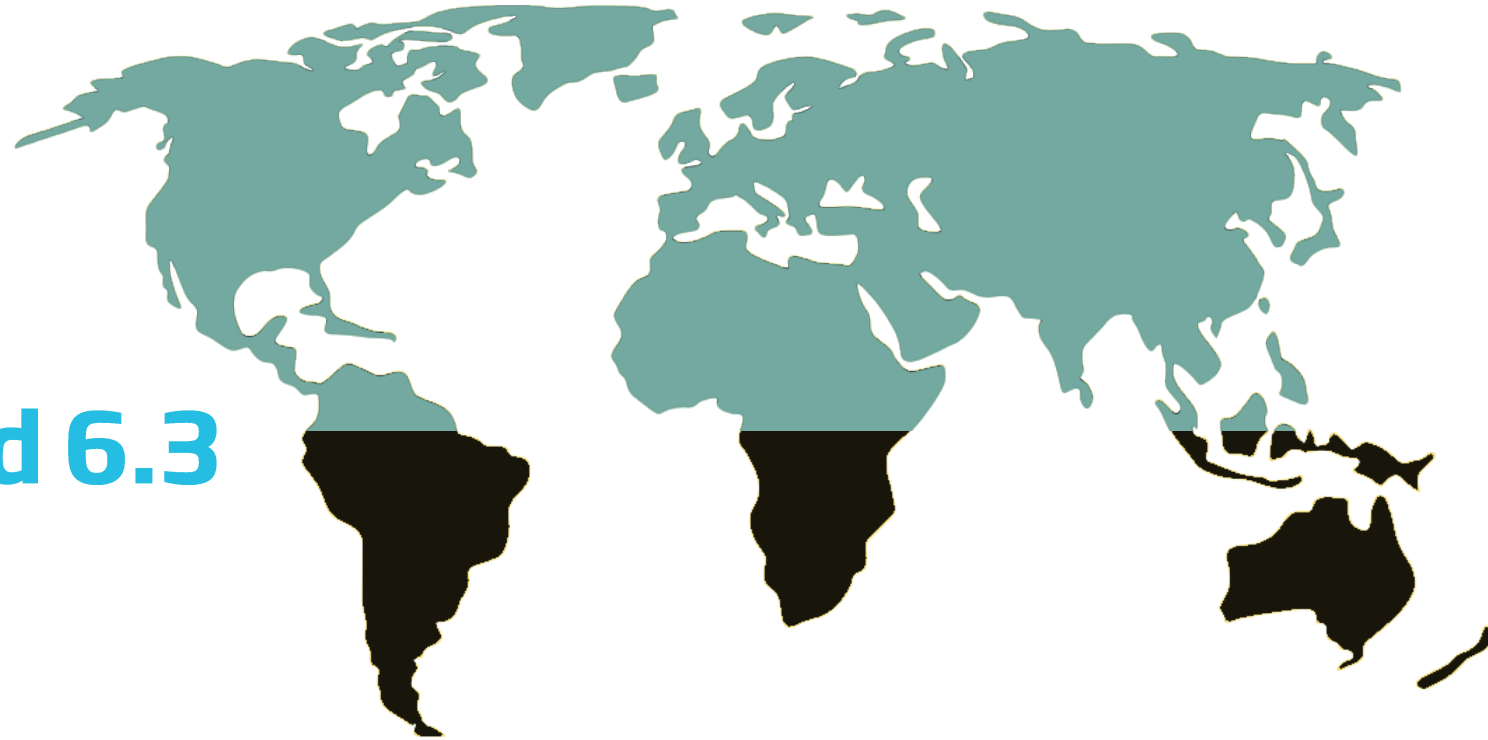


Global implications

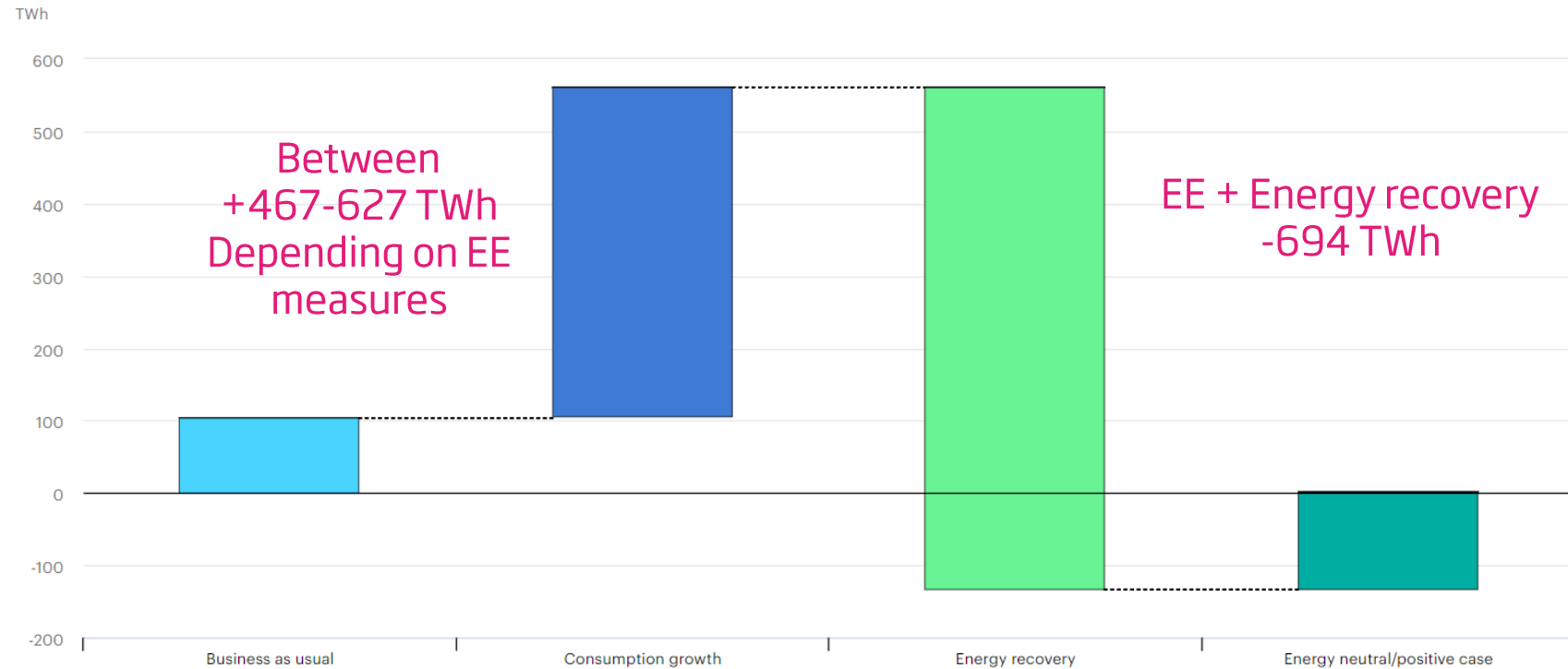


SDG 6.2 and 6.3

aims to halve the amount of
untreated wastewater by 2030



Global implications - electricity use

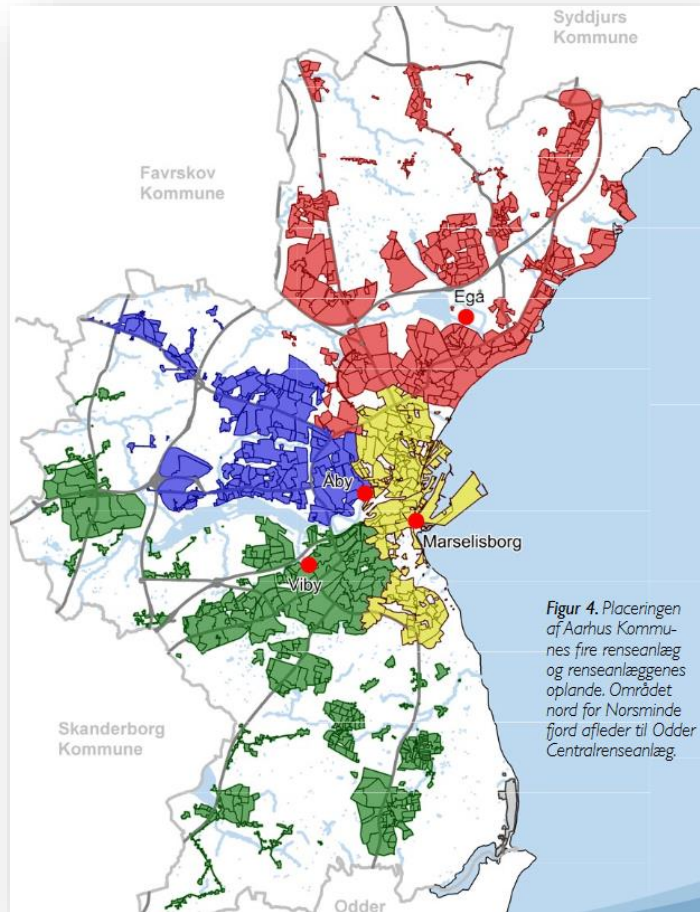


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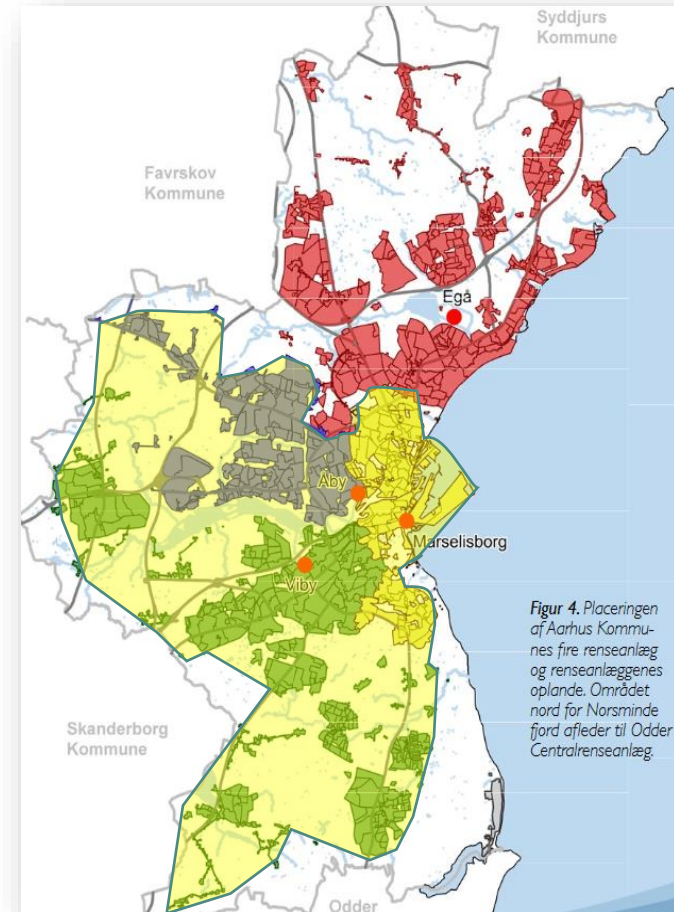
● Electricity consumption ● Electricity consumption ● Electricity consumption ● Electricity consumption

Source: [IEA](#)

Move towards more centralised treatment - Case from Aarhus



Today



In 2028

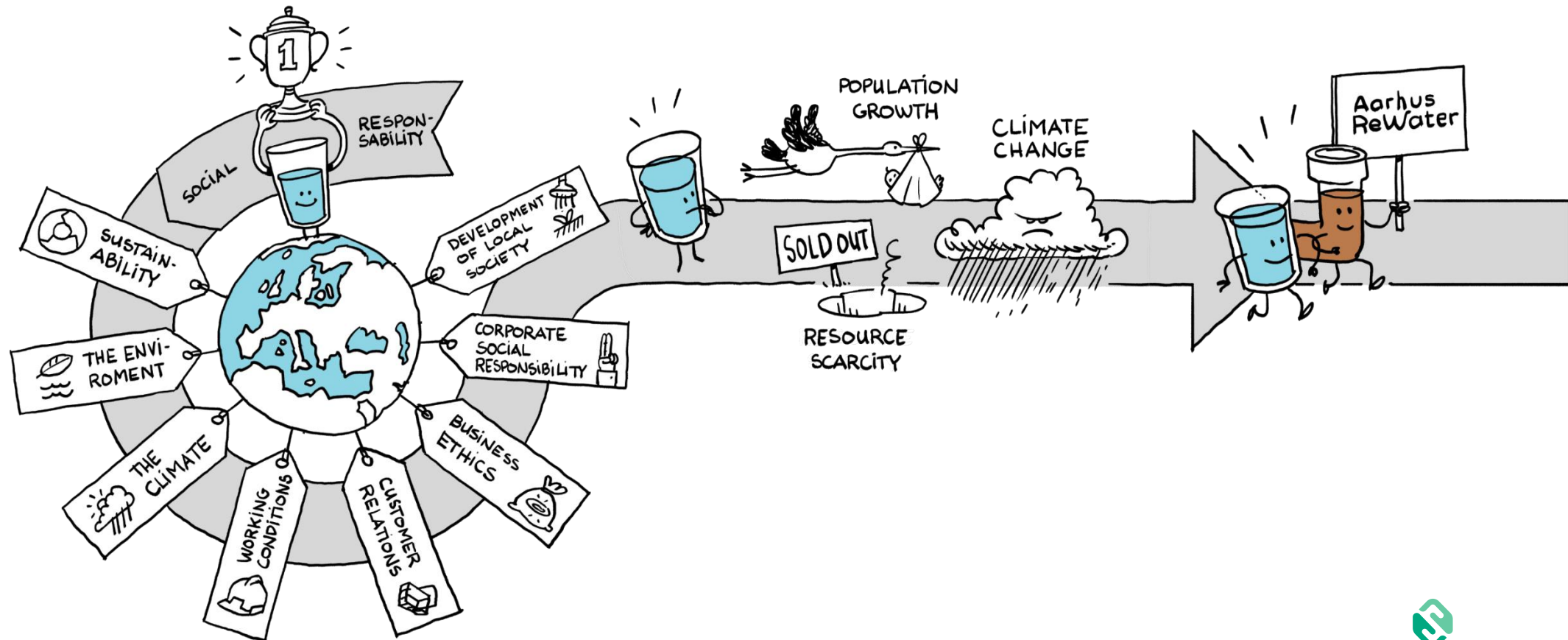


Case: Aarhus ReWater

[Learn more](#)

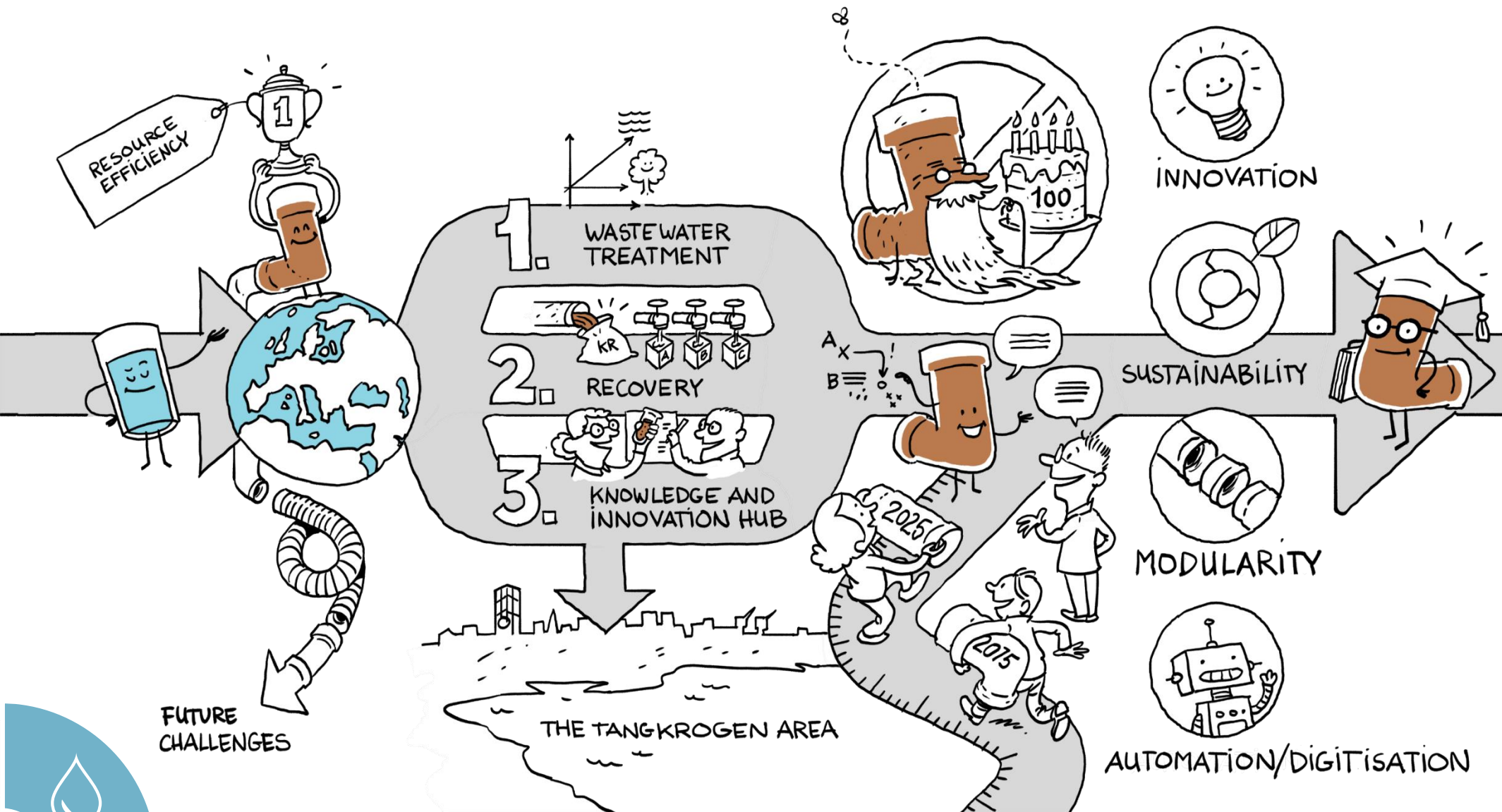
- **Objective:** Build the world's most efficient resource facility and knowledge platform for wastewater treatment

aarhusvand



Case: Aarhus ReWater...

[Learn more](#)

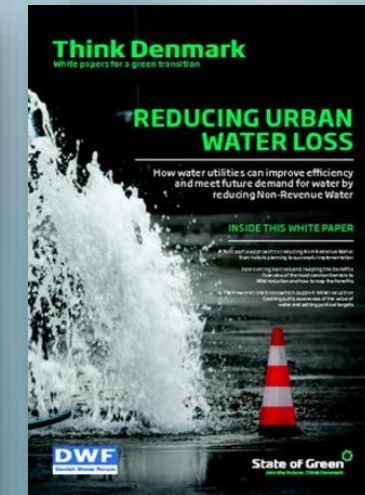


Emerging trends and concerns

- **Making the leap from energy to climate neutrality**
 - National goal: Energy and climate neutral water sector by 2030
 - Focus on N₂O: [Mitigation of N2O wastewater emission](#)
- **Pollutants of emerging concern:**
 - Microplastics: [Measurement and mitigation of microplastics in wastewater](#)
 - Pharmaceutical residues:
 - [Removal of micropollutants in wastewater \(at centralised WWTP\)](#)
 - [Wastewater treatment for pharmaceuticals at hospital](#)
- **Industrial wastewater treatment**
 - Treatment at the source allows for water reuse and conservation:
[See examples in our white paper](#)



White papers for water professionals



Download the white papers at www.stateofgreen.com/publications

IWA WORLD WATER CONGRESS & EXHIBITION 2021

JOIN US IN COPENHAGEN

WATER FOR SMART LIVEABLE CITIES
9-14 MAY 2021

IWA DENMARK
the international
water association

DANVA




www.worldwatercongress.org

Connect. Inspire. Share. Think Denmark

Thank you for your attention

Tanya Gottlieb Jacobsen
tja@stateofgreen.com

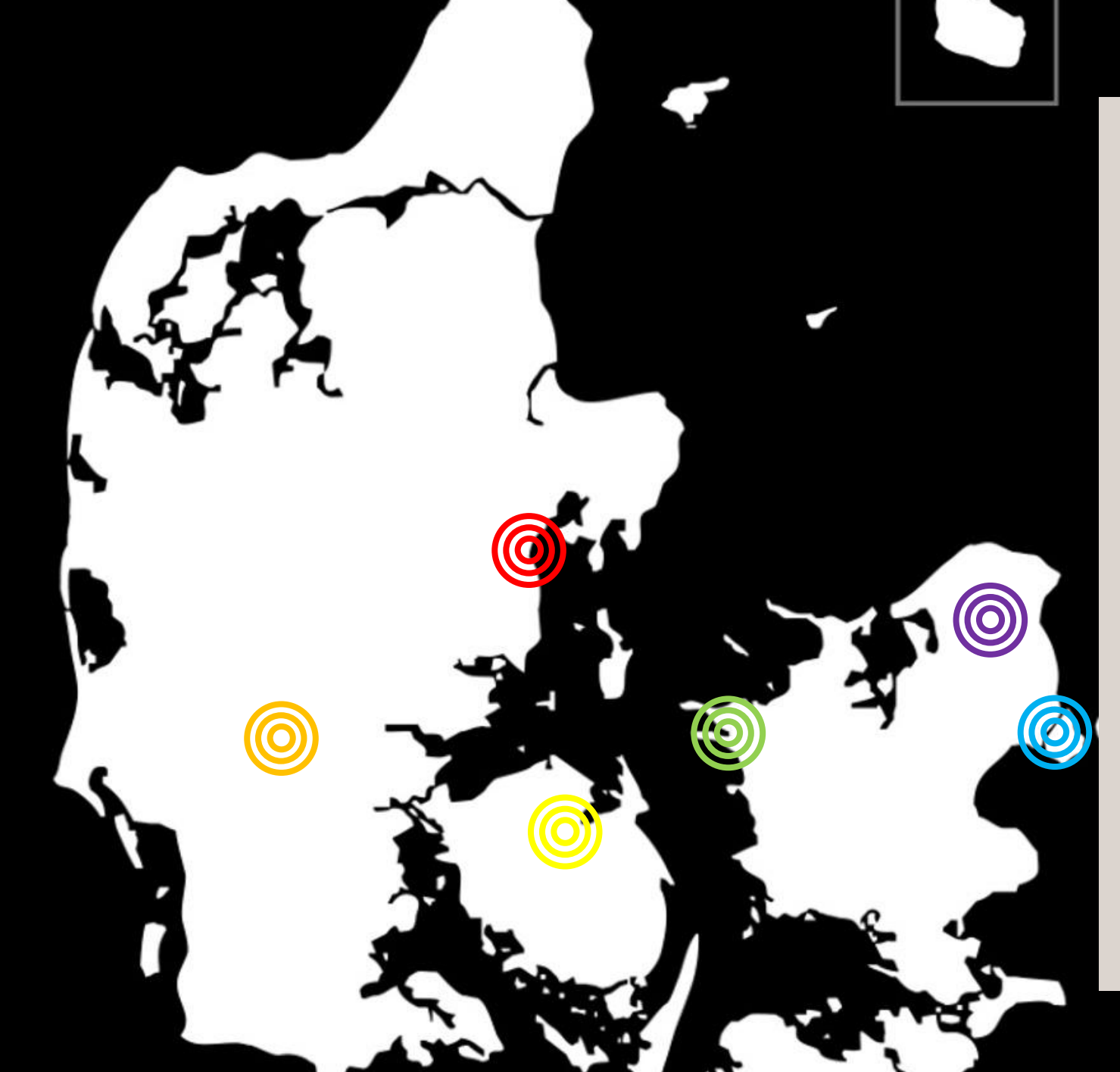
**Explore solutions on www.stateofgreen.com
and follow on Twitter [@Stateofgreendk](https://twitter.com/Stateofgreendk)**

An aerial photograph of a wastewater treatment plant. The facility features several large rectangular basins with green roofs, interspersed with small brown buildings. A prominent circular tank is visible in the bottom left corner. A winding road or path runs along the right side of the facility. The overall layout is organized and functional, showcasing modern wastewater management infrastructure.

Unlocking the potential of wastewater

Danish perspectives and best practices

22TH SEPTEMBER 2020



Solrodgaard WWTP



Hillerød
Forsyning



BIOFOS



Symbiosis Center Denmark



VandCenter Syd



Billund BioRefinery



Aarhus ReWater

aarhusvand

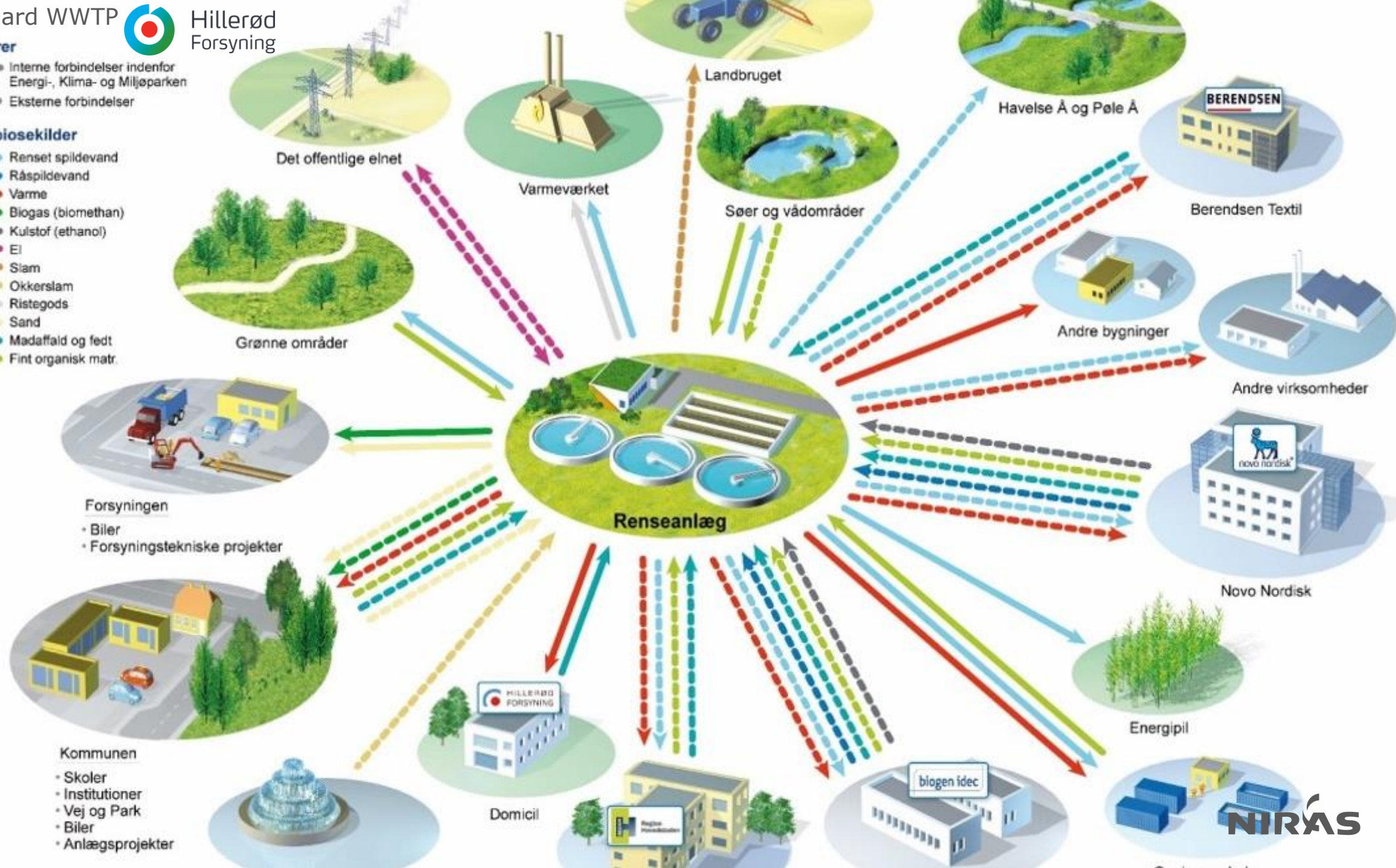
NIRAS

**Aktører**

- Interne forbindelser indenfor Energi-, Klima- og Miljøparken
- - - Eksterne forbindelser

Symbiosekilder

- Renset spildevand
- Råspildevand
- Varme
- Biogas (biomethan)
- Kulstof (ethanol)
- El
- Slam
- Okkerslam
- Ristegods
- Sand
- Madaffald og fedt
- Fint organisk matr.



Focus and modifications

(Inlet pumping station at BIOFOS WWTP
Avedøre)

Savings +

01

New pumps (higher efficiency)

02

Frequency converters

03

Changing steering system
(SCADA)

04

New aeration system (bottom)

Energy recover ++

01

External carbon source

02

Biogas production and upgrade

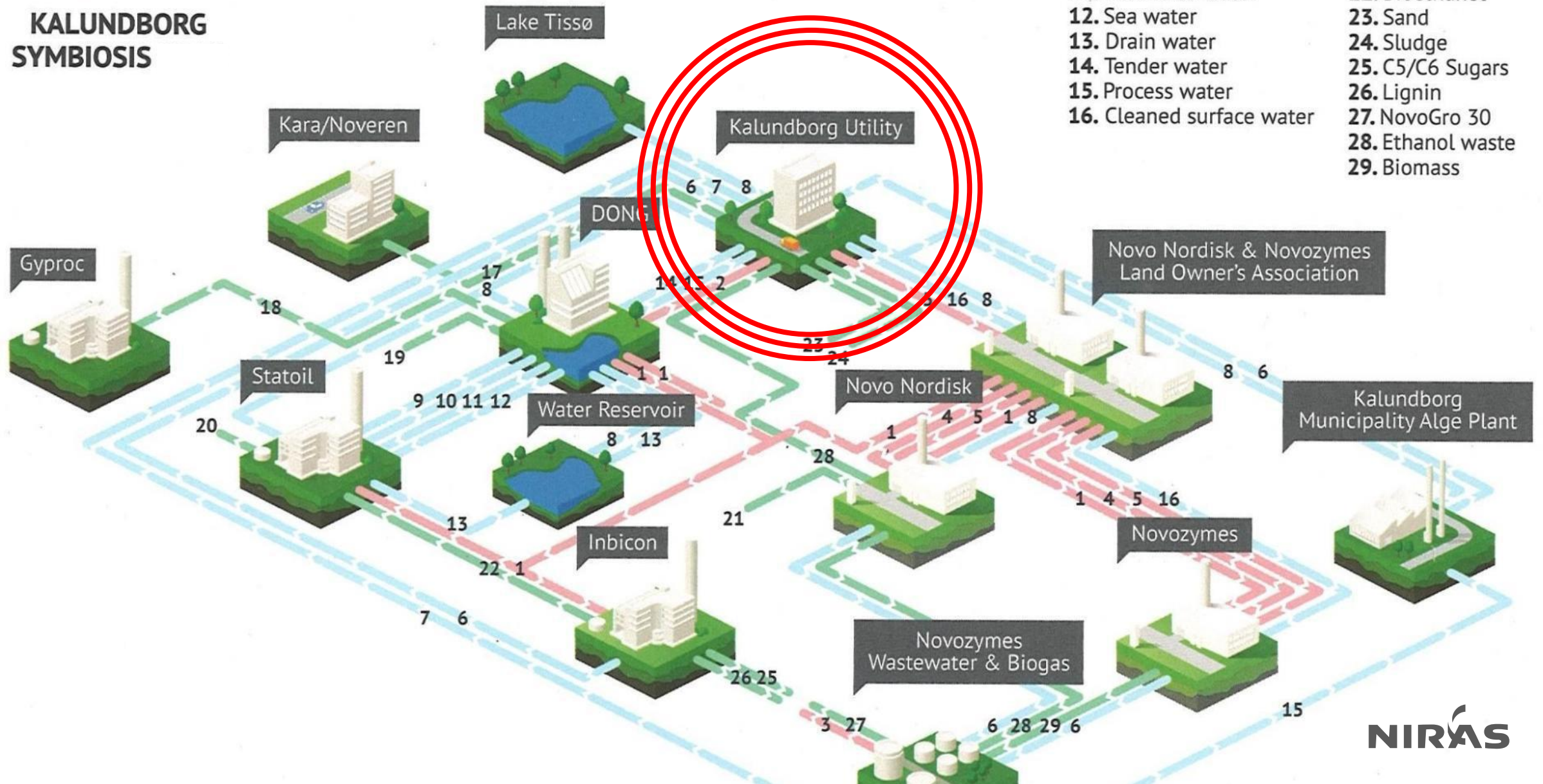
03

Incineration





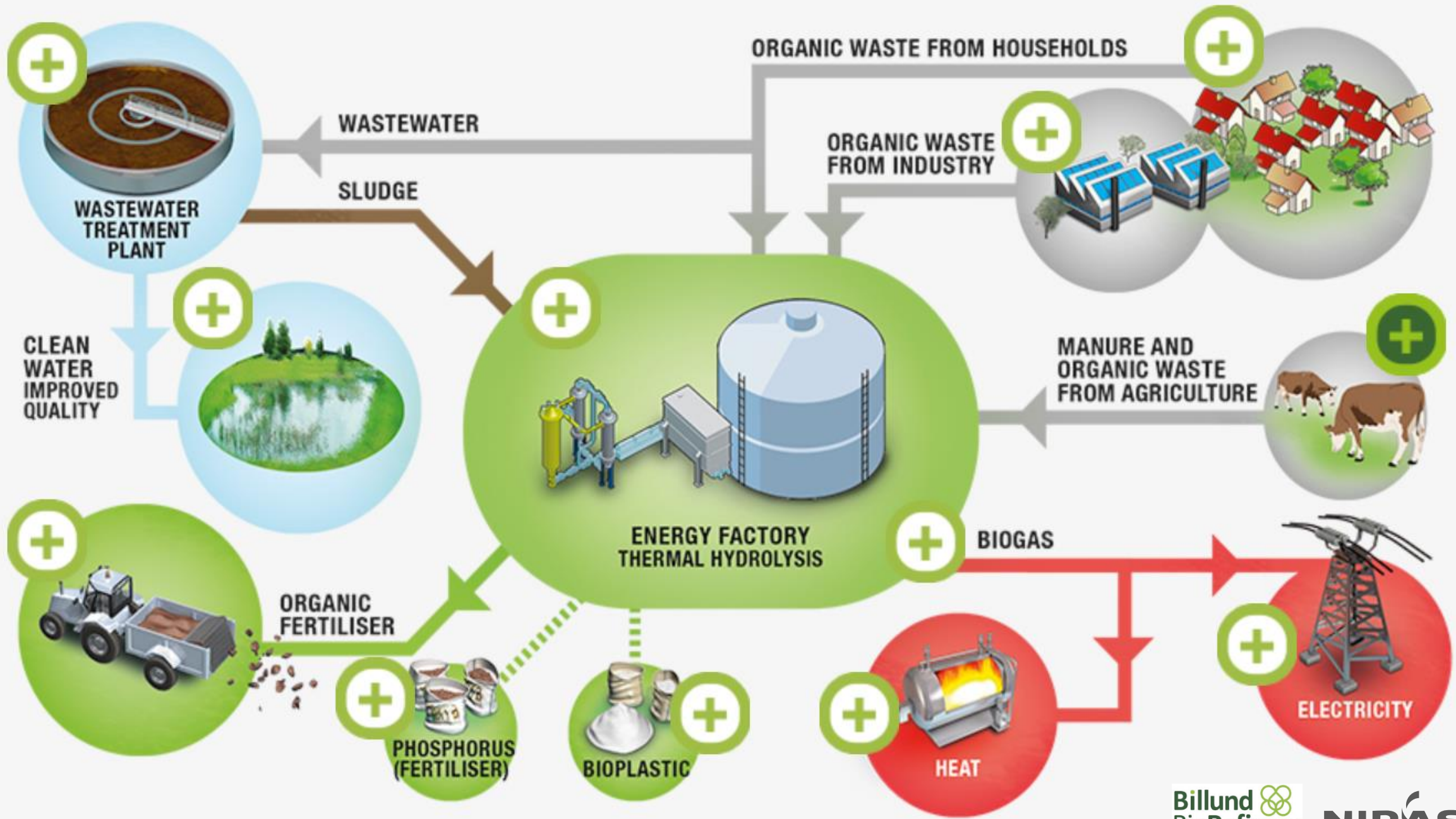
KALUNDBORG SYMBIOSIS





- **Utility to utility**
- **Membrane Aerated Biofilm Reactor (MABR), demonstration facility**
- **Demon®**
- **Self sufficiency WWTP**

Picture: Jacobs (CH2M Hill)



Prospectus

Concept and process description for the realisation of Aarhus ReWater
1 May 2019

**Aarhus
ReWater**



aarhusvand

NIRAS

“Earth, water, fire and
wind. Where there is
energy there is life”

Quote: Suzy Kassem

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Thomas Jensen

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Phone: +45 60340948

Landia's Wastewater Technologies

and adaptability towards local demands in Singapore



Landia[®]



Thorkild Maagaard

Sales Director/CSO

Engineering background

Singapore experience since 1998



Fergus Clark

Area Sales Manager – Asia Pacific

8 years of experience with Asia & Singapore



Family owned
Est. 1933
5 Business Units
132 employees





- Clean Water
- Renewable Energy
- Animal Welfare
- Recycling

Businesses



The Products



Mixers



Flowmakers



Chopper Pumps



Jet Aerators



Digester Mixing



Municipal WWTP, USA
Aeration Tank



Digester Mixing
Malaysia



Leachate Treatment
Lorong Halus, Singapore



Sludge Pumping Application,
Beijing, China

Landia[®]

First large scale project in Singapore



Seletar Sewage Treatment Plant

| | |
|-----------------------|---|
| Year Completed | 2001 |
| Main Contractor | Hyundai Engineering & Construction Co Ltd |
| Work Type Carried Out | R.C & W.T Works |
| Facility | Public |

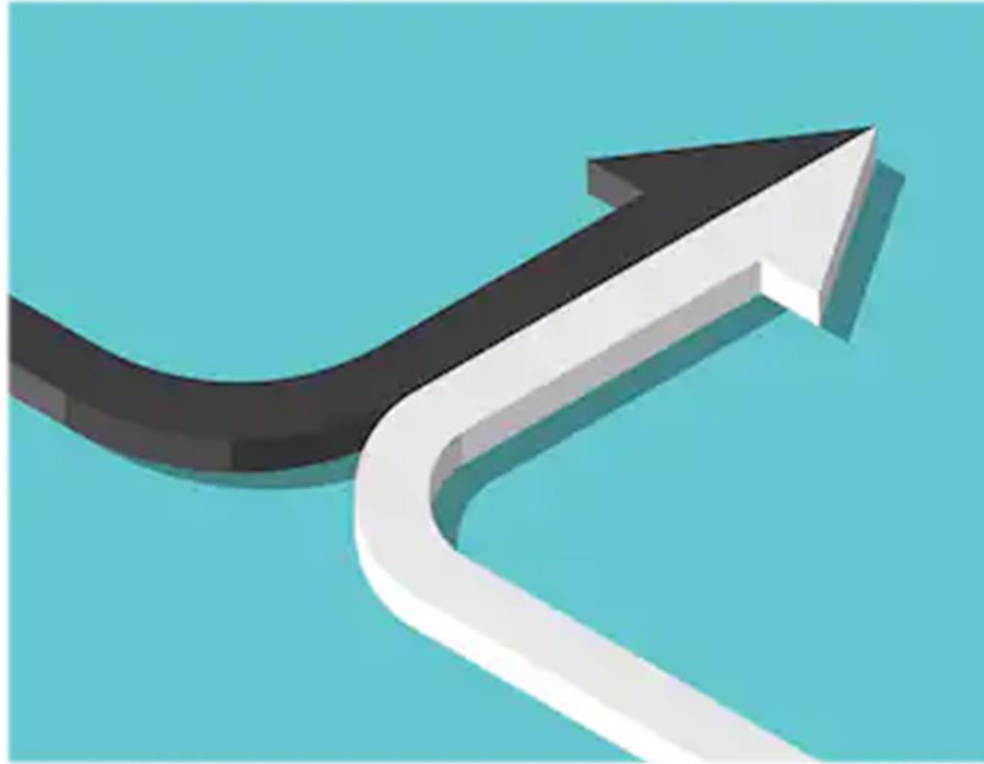
Landia won the order because:

We were able to comply to
Tender Specifications!



Tuas Water Reclamation Plant (TWRP)

**Tender
Specifications**



**Landia
Specifications**

Merge and Comply

TWRP Detailed Design: Biosolids Sludge Mixing

| Name | Type | Number | Active Volume (each) [m³] | Nominal Diameter [m] | Nominal Height [m] | Contents | Contents Concentration Range [%DS] | Remarks |
|-----------------------------|--|--------|---------------------------|----------------------|----------------------|--|---|---------------|
| DLM PS Holding Tanks | Cylindrical concrete with <u>odour cover</u> | 2 | 6,008 | 15 | 18 | Domestic primary sludge and scum | Ave. 0.77 Max. 1.13 | 1 m freeboard |
| ILM PS Holding Tanks | Cylindrical concrete with <u>odour cover</u> | 1 | 3,004 | 15 | 18 | Industrial primary sludge and scum | Ave. 1.66 Max. 1.97 | 1 m freeboard |
| WAS Holding Tanks | Cylindrical concrete with <u>odour cover</u> | 2 | 6,008 | 15 | 18 | Waste Activated Sludge | Ave. 0.70 Max. 0.71 | 1 m freeboard |
| TPS Holding Tanks | Cylindrical concrete with <u>odour cover</u> | 2 | 6,008 | 15 | 18 | Thickened Primary Sludge | Ave. 8.0 Max. 8.5 | 1 m freeboard |
| DS Holding Tanks | Cylindrical concrete with <u>odour cover</u> | 2 | 6,008 | 15 | 18 | Digested Sludge | Ave. 5.4 Max. 5.5 | 1 m freeboard |
| GW Holding Tanks | Cylindrical concrete with <u>odour cover</u> | 2 | 804 | 8 | 9 | Screened and <u>degripped</u> <u>tankered greasy waste</u> | Ave. 3.4 Max. 3.4 | 1 m freeboard |
| FW Holding Tanks | Cylindrical concrete with <u>odour cover</u> | 2 | 804 | 8 | 9 | <u>Homogenised</u> screened food waste | Ave. 12.6 Max. 12.6 | 1 m freeboard |
| Digesters | Concrete as in diagram | 10 | 10,000 | Digesting Solids | Ave. 5.4 Max. 5.5 | 30 - 40 | Inlet <u>concn.</u> Ave. 9.4 Max. 9.4 | |

Challenge: How to comply and meet the requirements?

- Combination of standard, well proven solutions and the ability, and mindset, to adapt
- Sometimes we feel a request is unnecessary – an example is the hardening of the mixer nozzles (for the Tuas Project). We look at it and try to argue against and educate. However we can comply to, which show we need in depth discussions with PUB at the design phase.



Challenge: How to comply and meet the requirements?

- Small, engaged team taking responsibility of the project
- This is important in order to keep on track. An "organisation" instead of a team will slow down the process and focus will be lost



Challenge: How to comply and meet the requirements?

- Stay focused on details – and see the big picture
- Details are important but always have the goal in mind



A small ship manoeuvres quicker than a large vessel



