

*2<sup>nd</sup> Blue Summit Switzerland: Keynote Address*

# Sharing of Singapore's Challenges in Water Management



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# Singapore in the 1960s – Before Independence



## Polluted Waterways

Absence of proper sewage facilities and discharge controls turned rivers into open sewers

## Seasonal Floods

Common occurrence in low-lying areas, especially when intense rainfall coincided with high tides

## Poor Sanitation

50% of the population was served by the main sewerage network, while the other 50% depended on nightsoil collection



# Outline of Presentation

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- Singapore is one of the most water stressed countries
- Need to secure water supply
- Key challenges
- Response to key challenges
- Digitalisation journey to meet other challenges

**Singapore is one of the most  
water stressed countries**

## Switzerland vs. Singapore: Water Stress in Context

	 SWITZERLAND	 SINGAPORE
Land Area	41,285 km <sup>2</sup> (56x bigger than Singapore), of which 74% are productive areas	734 km <sup>2</sup>
Total Population	8.96 million ( <i>as of Dec 2023</i> )	6.04 million
Total Water Demand	~550 MGD	~440 MGD
Rainfall	1,000 to 1,500 mm/year	2,400 mm/year
Water Resources	80% from groundwater, 20% from lakes (more than 1,500 lakes)	<b>High rainfall but lack of sufficient space to collect and store all the rain that falls on Singapore</b>



UN classifies Singapore as inherently facing “**extreme water scarcity**” (<500 m<sup>3</sup>/capita/year)  
 (*UN Water Report, 2023*)

# Need to Secure Water Supply

# Secure our Water Supply – 4 National Taps

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## Weather-Dependent Sources



**WATER FROM  
LOCAL CATCHMENT**



**IMPORTED  
WATER**

## Weather-Independent Sources

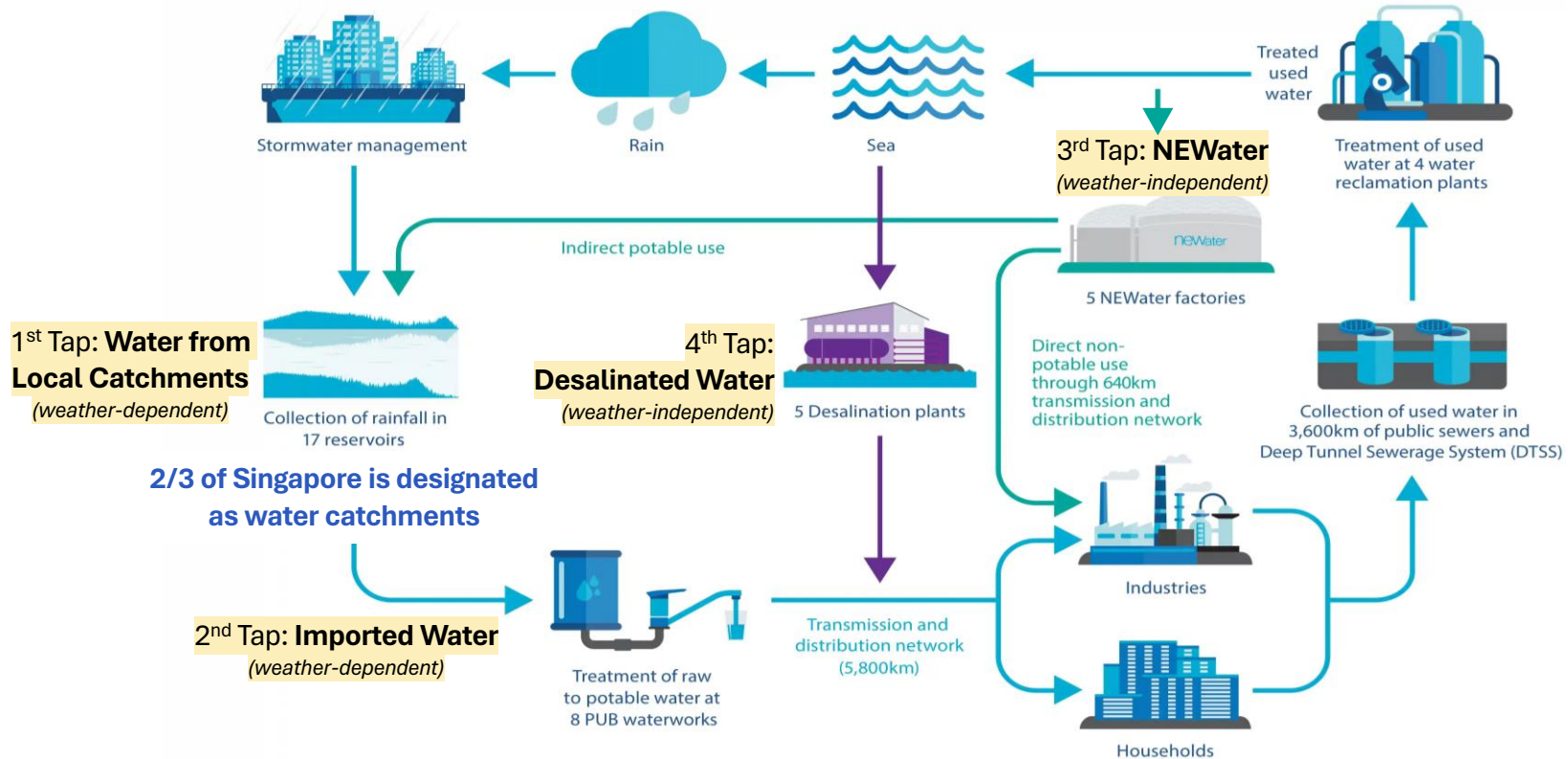


**NEWATER**



**DESALINATED  
WATER**

# Closing the Water Loop is the Key





## 3 Key Principles in Managing Water

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1

Collect every  
drop of water



3

Desalinate  
more

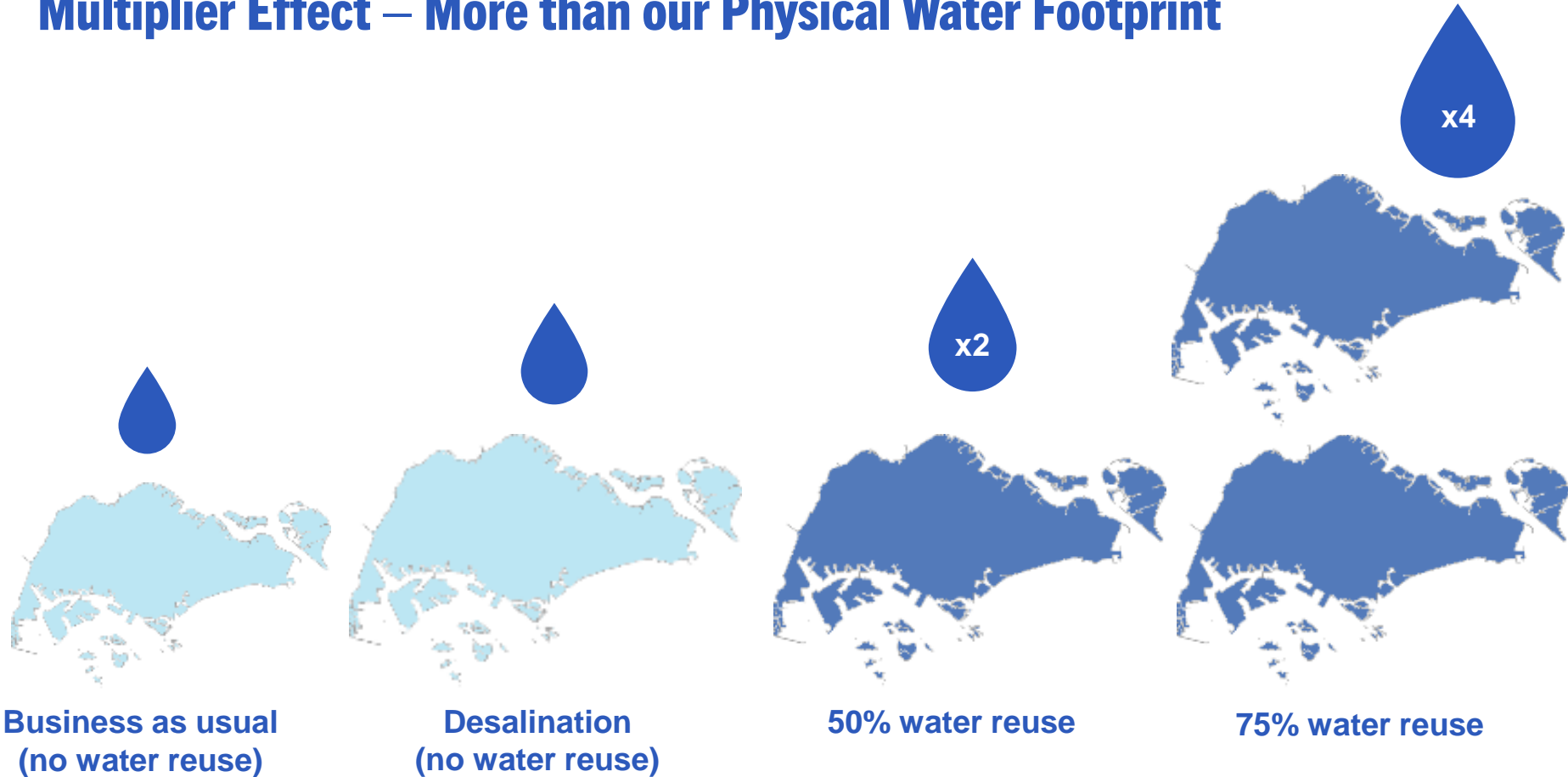


2

Reuse water  
endlessly



# Multiplier Effect – More than our Physical Water Footprint



**Business as usual  
(no water reuse)**

**Desalination  
(no water reuse)**

**50% water reuse**

**75% water reuse**

# Water Pricing – Reflect Scarcity and Strategic Value of Water

- In Singapore, water is priced to reflect its scarcity, value and the full costs of its production and supply.
- Water price was last adjusted in 2017/2018 (30% increase in PW cost), most recent adjustment in 2024/2025 is implemented via 2 phases (18% increase in PW cost).

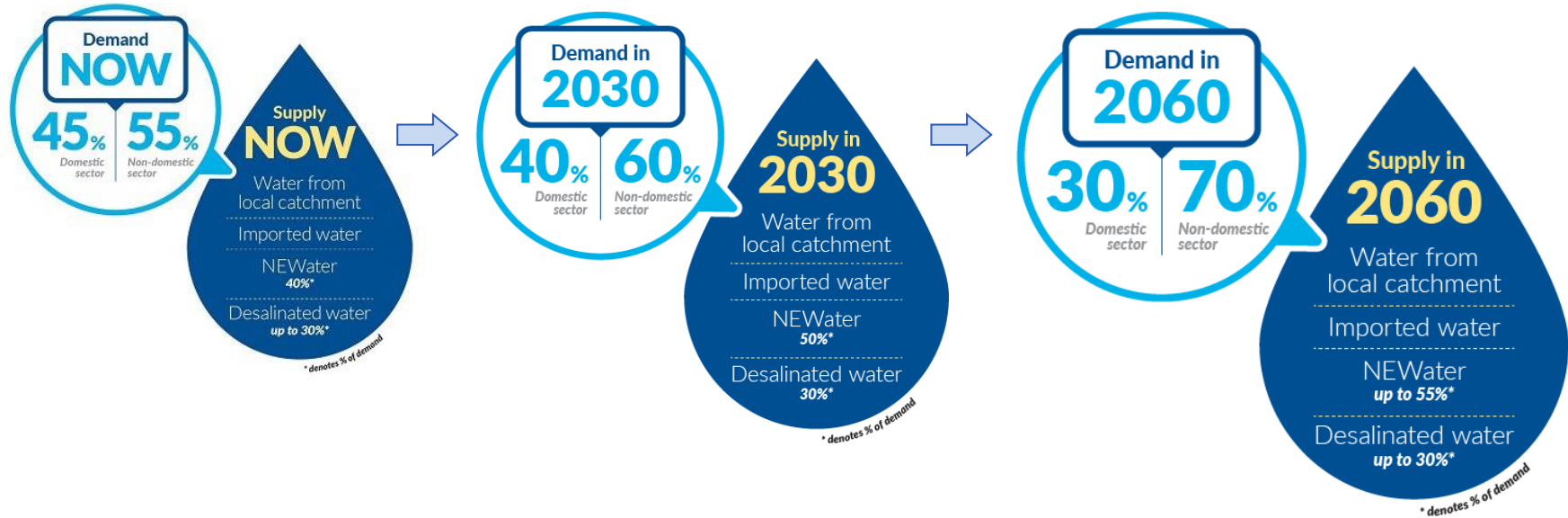
	Domestic Potable Water (PW) Price						Non-Domestic NEWater Price
	Before 1 Apr 2024		From 1 Apr 2024		From 1 Apr 2025		
	0-40m <sup>3</sup>	> 40m <sup>3</sup>	0-40m <sup>3</sup>	> 40m <sup>3</sup>	0-40m <sup>3</sup>	> 40m <sup>3</sup>	
<b>Tariff</b>	\$1.21	\$1.52	\$1.29	\$1.63	\$1.43	\$1.81	\$1.28
<b>Water Conservation Tax</b> <i>(% of Tariff)</i>	\$0.61 <i>(50% of \$1.21)</i>	\$0.99 <i>(65% of \$1.52)</i>	\$0.65 <i>(50% of \$1.29)</i>	\$1.06 <i>(65% of \$1.63)</i>	\$0.72 <i>(50% of \$1.43)</i>	\$1.18 <i>(65% of \$1.81)</i>	\$0.13 <i>(10% of \$1.28)</i>
<b>Waterborne Tax</b>	\$0.92	\$1.18	\$1.00	\$1.25	\$1.09	\$1.40	\$1.09
<b>Total Price</b>	<b>\$2.74</b>	<b>\$3.69</b>	<b>\$2.94</b>	<b>\$3.94</b>	<b>\$3.24</b>	<b>\$4.39</b>	<b>\$2.50</b>

**Note:** Water is charged per cubic metre (m<sup>3</sup>).

# Key Challenges

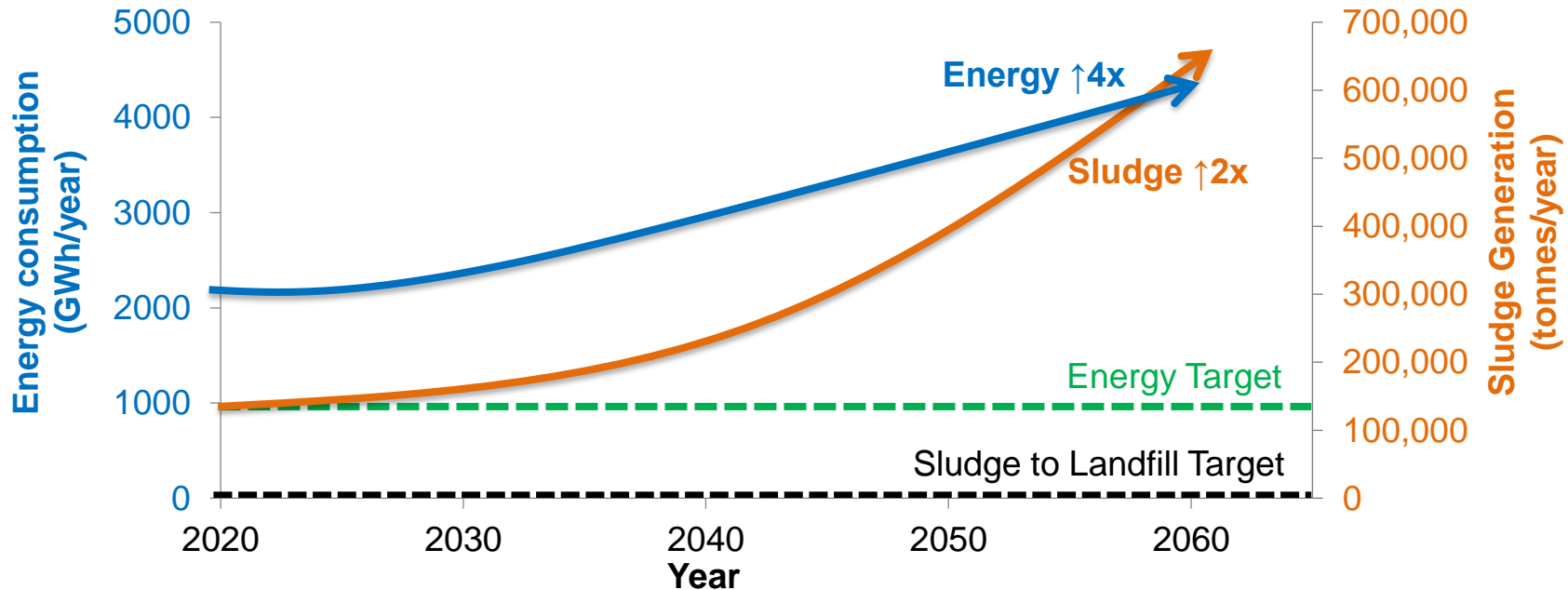
# Water Demand expected to double by 2060

To meet the nation's growing water demand, we will ramp up supply of weather-resilient sources (NEWater and desalination).



## Energy consumption will $\uparrow 4x$ and waste production will $\uparrow 2x$ if BAU

Ramping up production of NEWater and desalination will consume 4x more energy and generate 2x more waste (sludge) if we continue as per current practices.



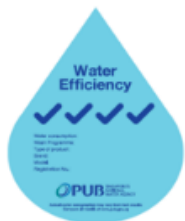
# **Response to Key Challenges**

## **(1) Demand Management**

# Domestic Demand Management

## 165lpcd in 2003 to 130lpcd in 2030

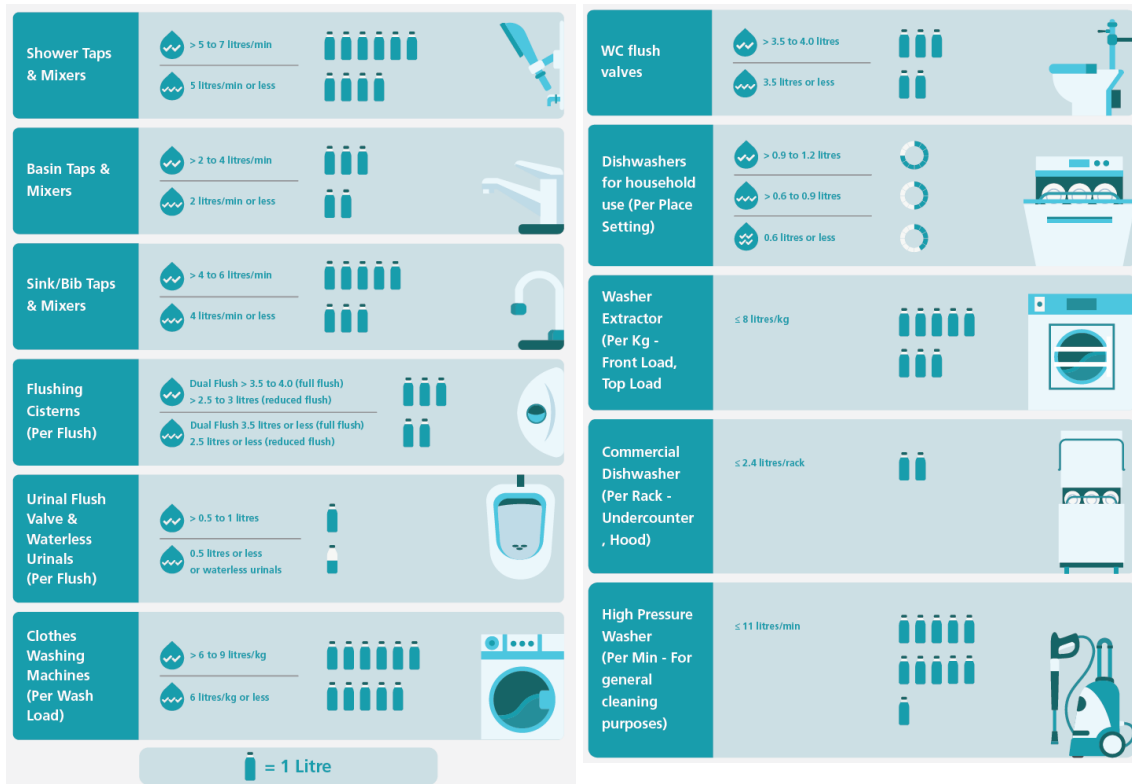
- The mandatory **Water Efficiency Labelling Scheme (WELS)** was introduced in 2009 to help consumers make more informed purchasing decisions and encourage suppliers to introduce more water efficient products into the market.
- All new developments and existing premises undergoing renovation from Apr 2019 onwards are required to install water fittings with at least 2-tick water efficiency rating.



Washing machines & dishwashers



Taps/mixers, flushing cisterns & flush valves





# Non-Domestic Demand Management

## 28mgd Reduction from around 200 Water Recycling Projects

### 1 – REGULATIONS

Raise standards for the industry via minimum water efficiency/recycling requirements

- Min. water efficiency standards for water fittings
- Min. water efficiency standards for commercial equipment
- Water Efficiency Management Practices (WEMP)
- Mandatory Recycling Measures

### 2 – BUILD CAPABILITIES

Equip the industry with knowledge and skills through courses, technical guides, webinars

- Water Efficiency Management Course
- Technical Guides (Cooling Tower Technical Reference, Best Practice Guides)
- Technical Forums

### 4 - RECOGNITION

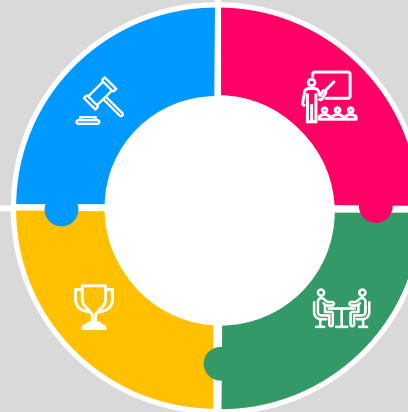
Recognise and profile top water efficient performers through awards/certifications

- Singapore Watermark Awards (SWMA)
- Water Efficiency Awards (WEA) and WEA Projects
- Water Efficient Building – Basic (WEB)

### 3 - FACILITATION

Provide technical advice and financial support via 1-to-1 engagements

- Sectoral Benchmarking
- 1-to-1 engagement with companies
- Financial incentives (WEF/IWSDF)
- Technical support



# **Response to Key Challenges**

## **(2) Reduce Energy Footprint**

## Energy Efficiency

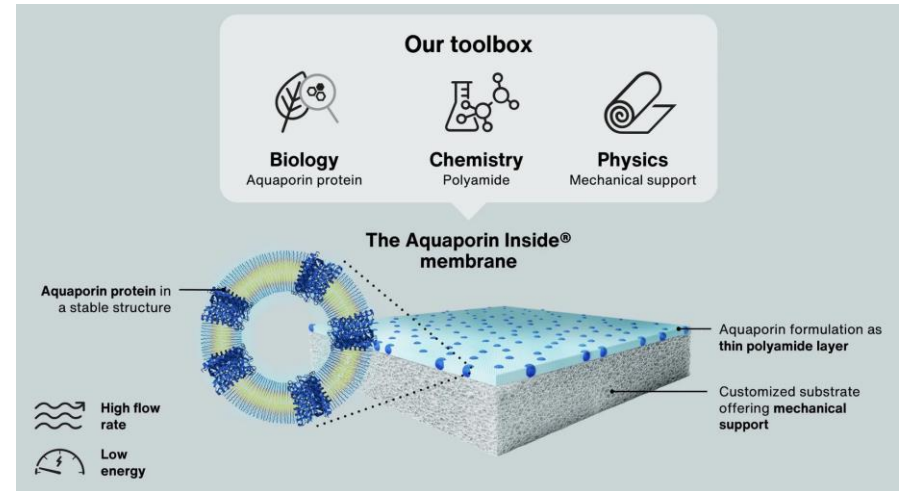
# Lowering NEWater Energy Consumption from 0.7 to 0.4kWh/m<sup>3</sup>

Retrofitting NEWater plants with ROTEC's Flow Reversal (FR)-RO, increasing NEWater recovery rates from 75% to 90%, leading to:

- 20% increase in water production capacity
- 60% reduction in waste brine volume for disposal
- Lower cleaning frequencies and chemical savings

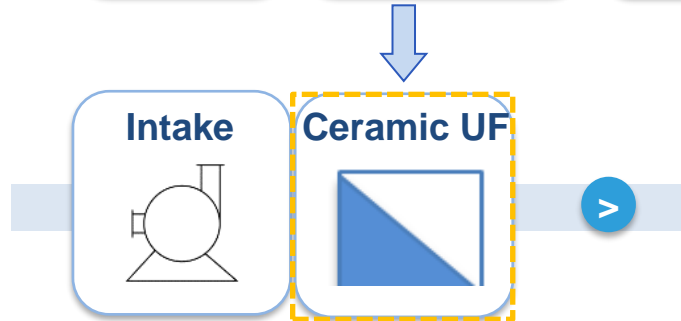


Aquaporin (AQP)-based BWRO membranes incorporate biotech-based protein water channels, allowing improved permeability and lower energy consumption.



## Energy Efficiency

# Lowering Desalination Energy Consumption from 3.5 to 2.5 kWh/m<sup>3</sup>



Seawater pre-treatment using submerged ceramic membranes



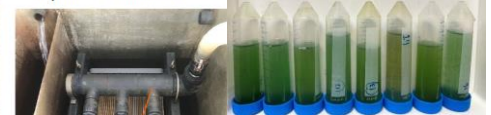
Single module tower (10 m<sup>2</sup>)



Aerator

Membrane module

Top view of membrane tank



Permeate header

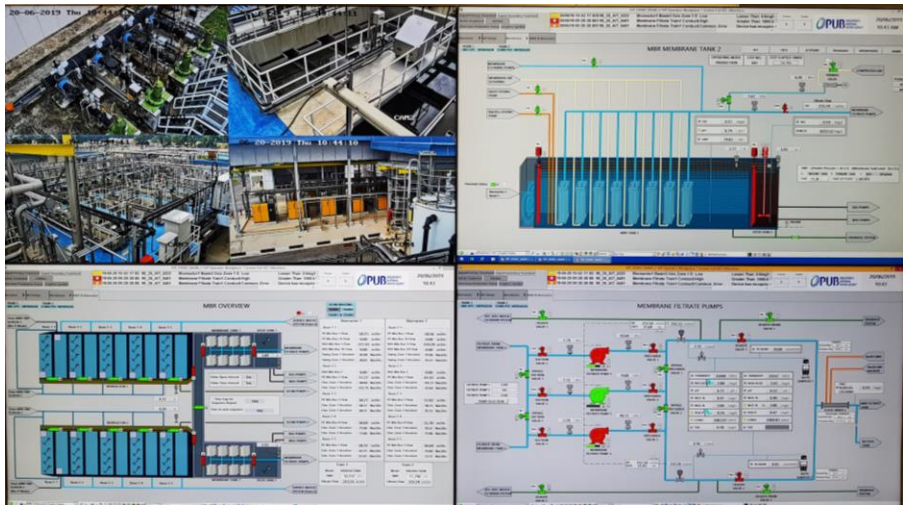


7MGD Demo Plant at Tuas Desalination Plant

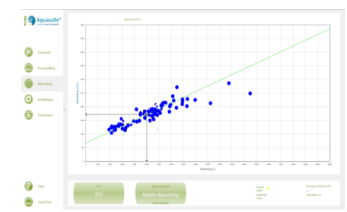
# Energy Efficiency

# More Efficient Operations through Automation and Real-time Monitoring

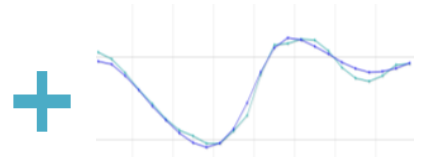
Enhancing operational efficiency with SCADA



Advanced process control for load prediction and real-time aeration control



Machine learning



Incoming load prediction



Optimised aeration control

## Energy Generation

# Floating Solar Photovoltaics (PVs) Deployment on Reservoirs

*Solar energy is the most viable green energy source in Singapore. Hence, PUB aims to yield 382MWp from solar energy by 2030.*

1MWp floating solar testbed on Tengeh Reservoir



2016



2021

60MWp Tengeh Floating Solar Farm

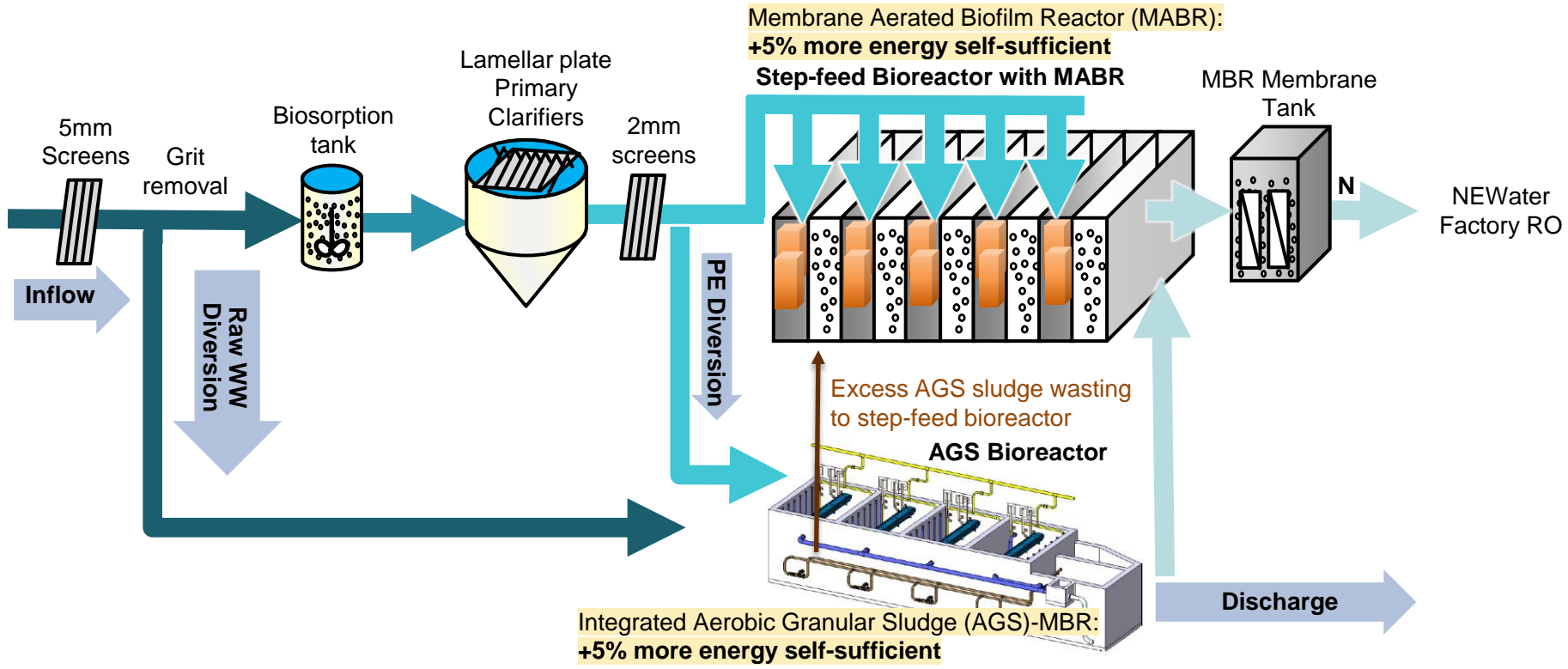


**5-15% better performance than typical rooftop solar PV system** in Singapore due to cooler temperatures of reservoir environment, and absence of shading from nearby buildings.

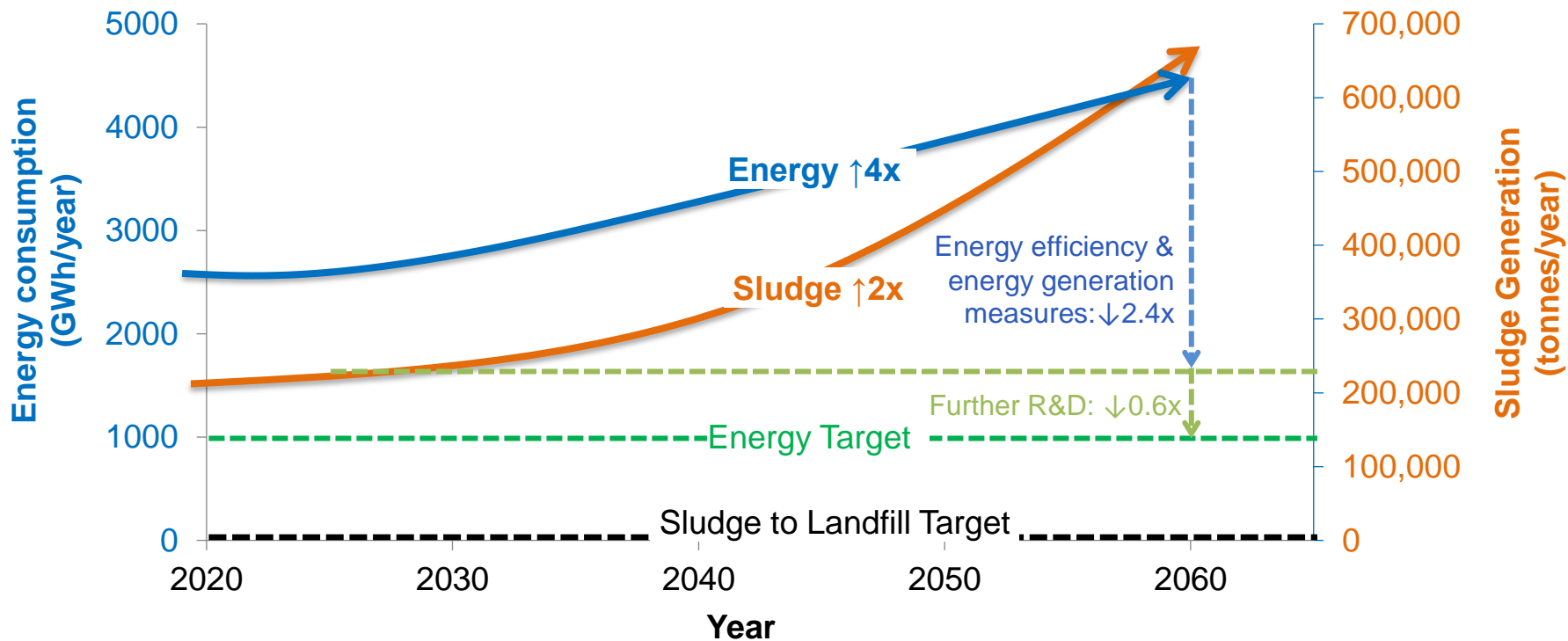
- One of the world's largest inland floating solar farms
- Occupies 45ha, or one-third of the reservoir's surface
- Clean energy generated powers PUB's water systems, equivalent to taking 7,000 cars off the road

# Energy Generation/ Efficiency

## Increasing Energy Self-Sufficiency of Used Water Treatment to 95%



## Where are we today?

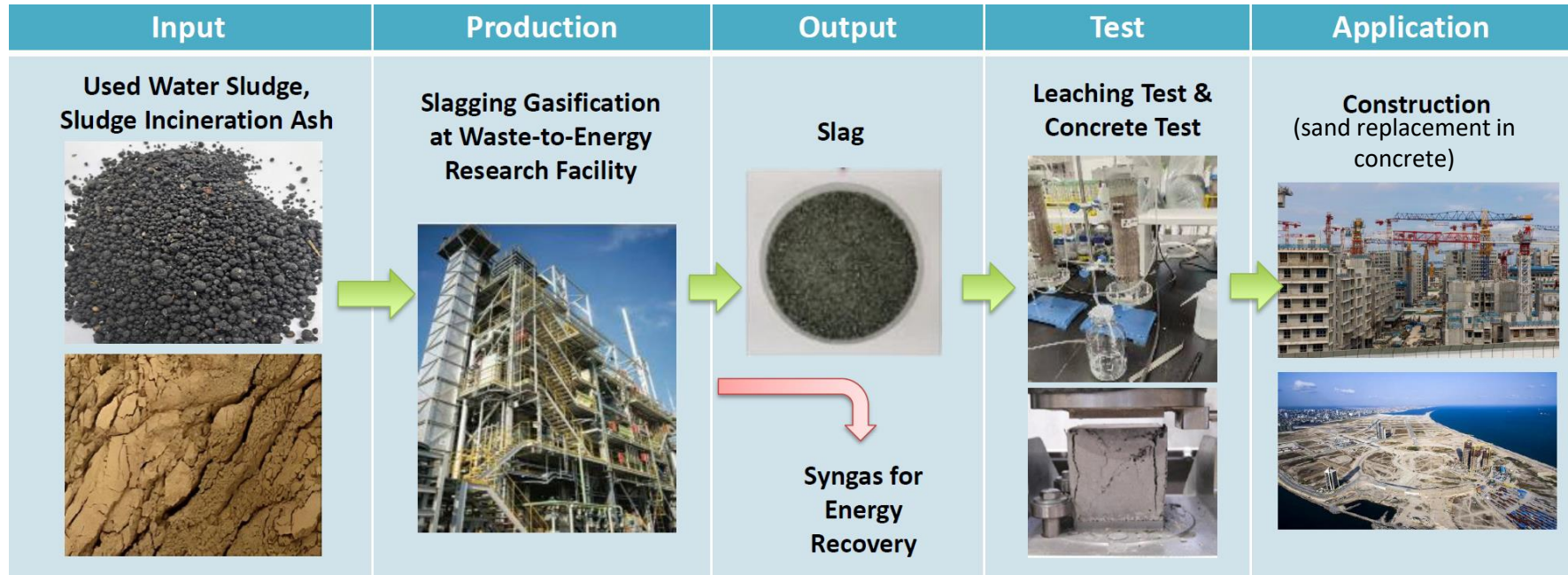




# **Response to Key Challenges**

## **(3) Zero Waste to Landfill**

# Converting Used Water Sludge to Slag via Gasification

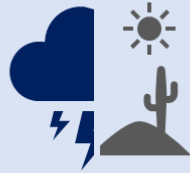


- For waterworks sludge, PUB is exploring the use of sintering technology to produce lightweight aggregates.

# **Digitalisation Journey to meet other Challenges**

# Other Challenges

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**Climate Change**



**Manpower  
Crunch**



**Rising Costs**



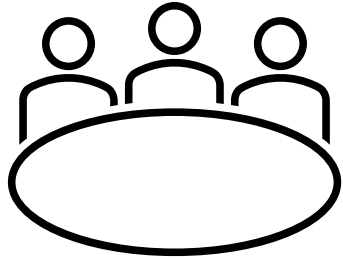
**Rising Public  
Expectations**

# Opportunities and Benefits of Digitalisation

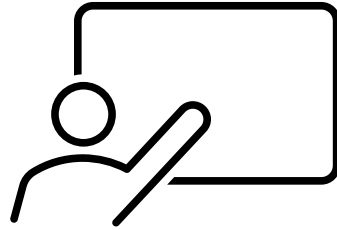
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- Less manpower to deliver our Mission
- Lower energy footprint
- Extending asset life through condition monitoring / assessment
- Move from preventive to predictive maintenance
- Safer working environment
- Better mental health / work-life balance
- Better customer service
- System levels to draw fresh insights

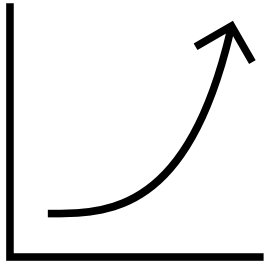
# Digitalisation Journey – We Focus on our People



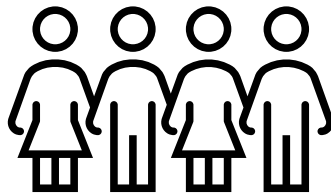
Engage staff early



Training



Demonstrate benefits



Leave no one behind



# Preparing for the Future in Partnership with the Industry

## Institutes of Higher Learning (IHLs)



## Companies



## Research Institutions



## Utilities



...and many more!

# Thank You

Marina Reservoir –  
Singapore's 15<sup>th</sup> Reservoir,  
first in the heartlands

Marina Barrage

