R&D and Innovative Wastewater Treatment Technologies

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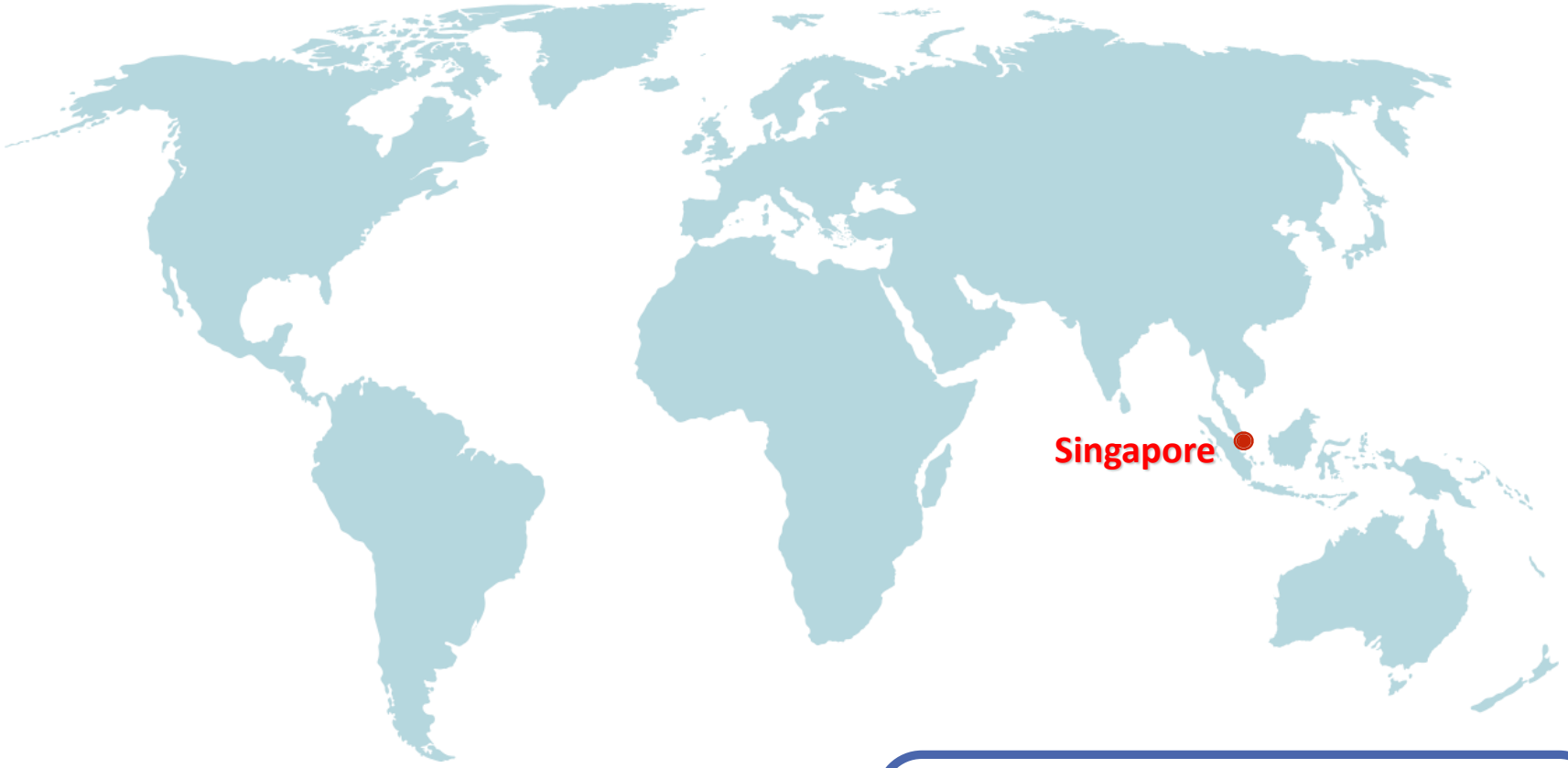
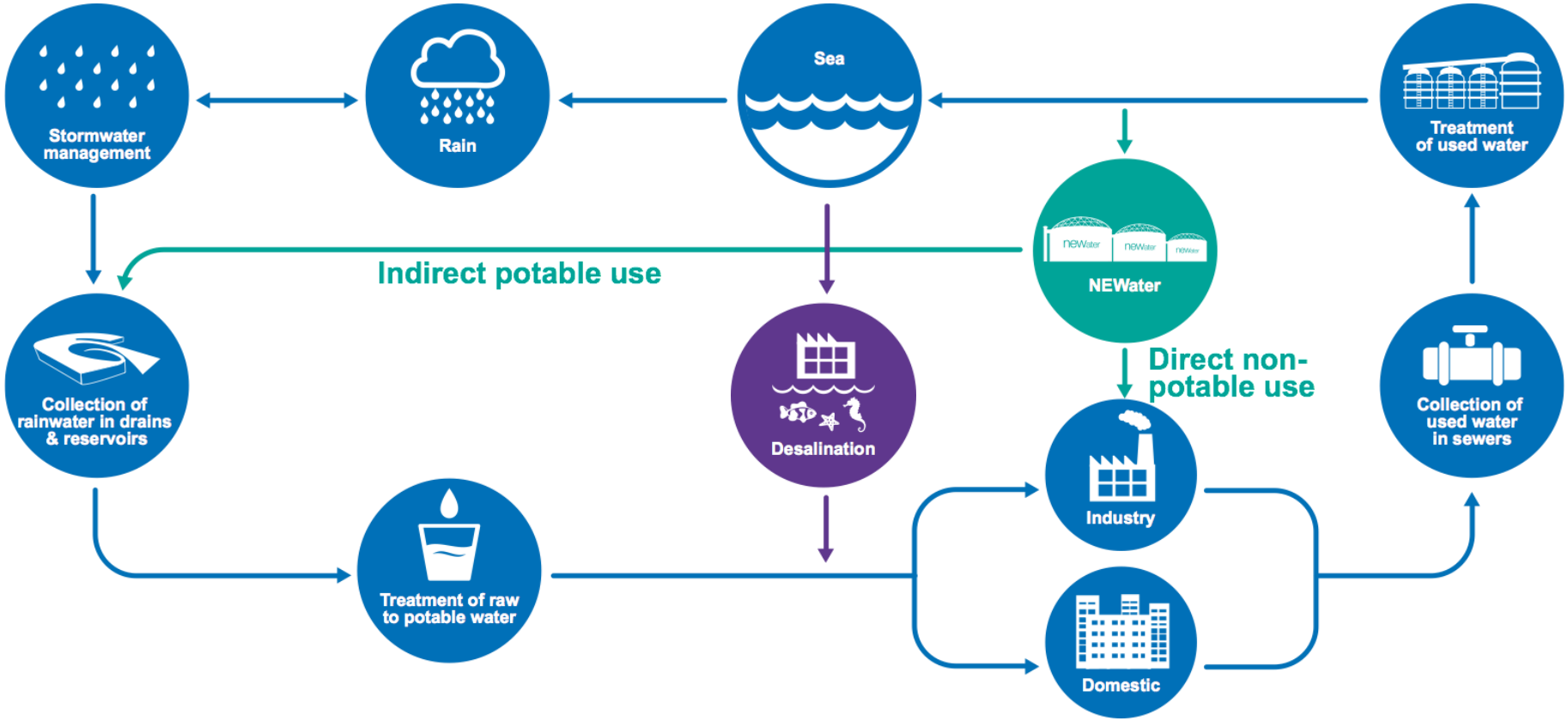
Country Information



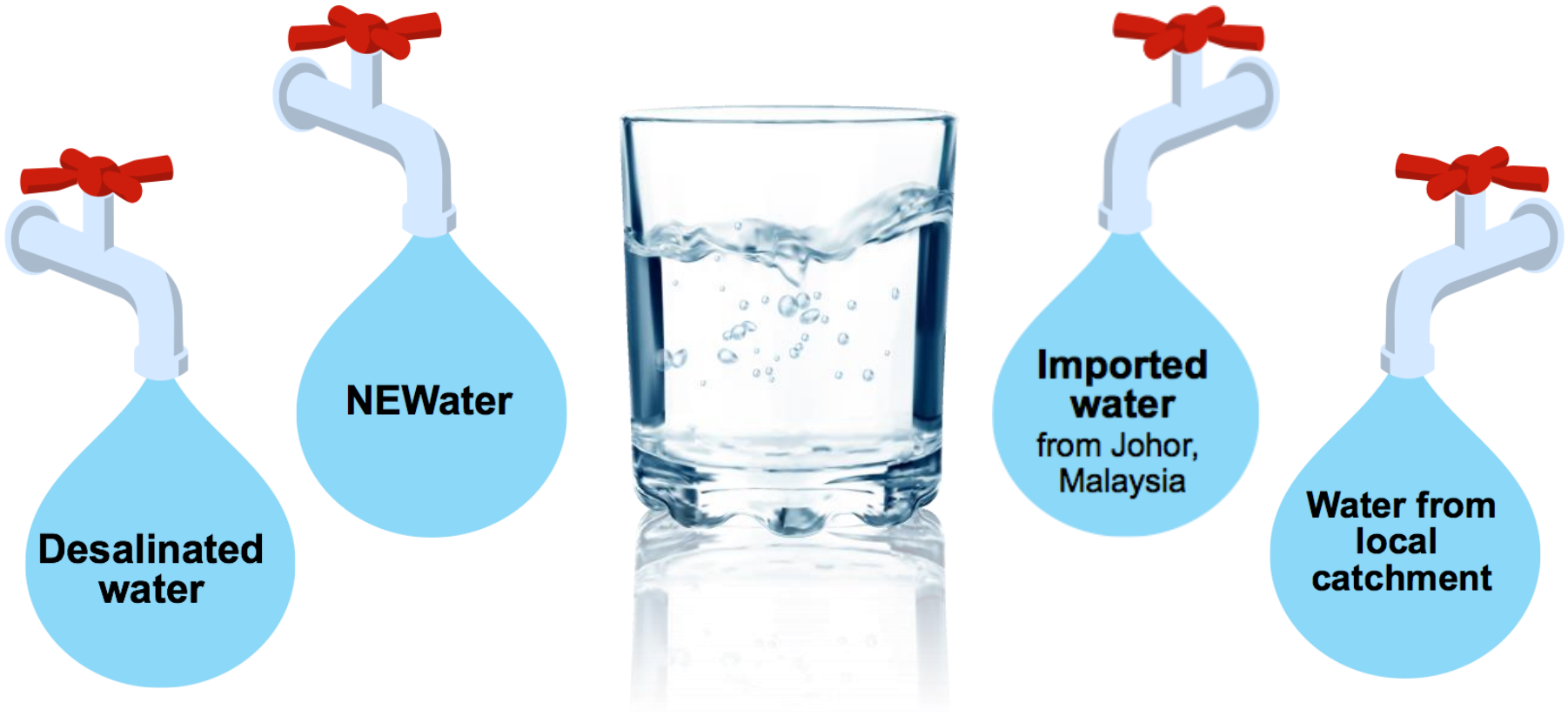
Land Area:	**710km²**
Population:	**5.7million**
Average Annual Rainfall:	**2,330mm**
Average Water Demand:	**430 mgd**

PUB *Singapore's national water agency, a statutory board under the Ministry of Environment and Water Resources*

PUB manages the complete water cycle

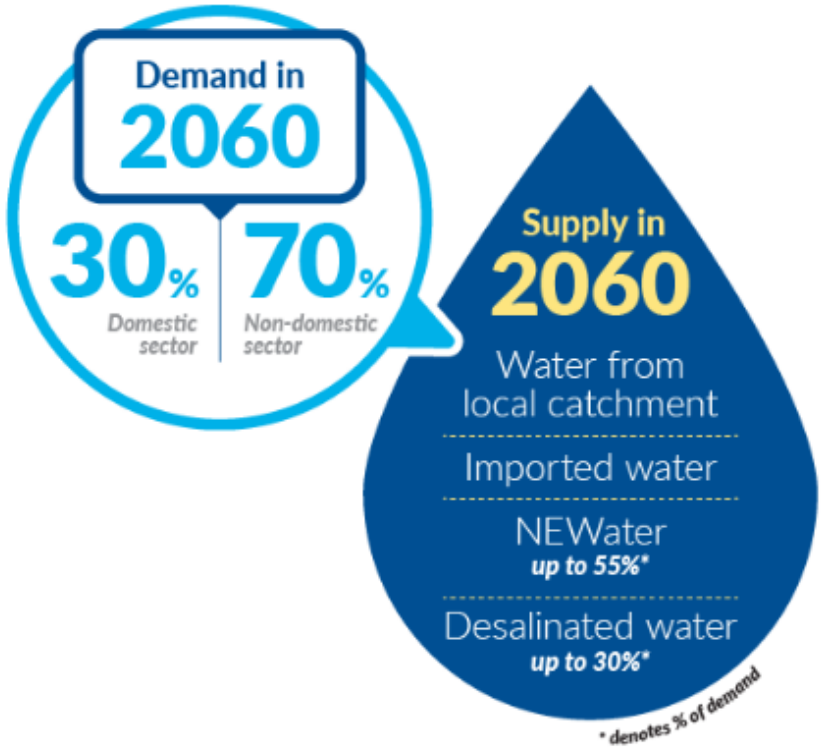


Four National Taps



Water Demand : Today and Future

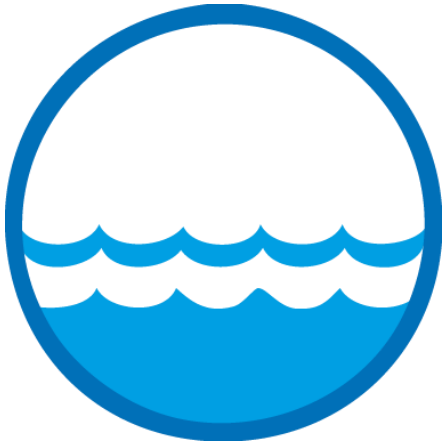
By 2060, demand is expected to be doubled from about 430 MGD today.



Principles in play

Collect every drop of water

Reuse water endlessly



Desalinate more seawater

Demand Management remains key approach to ensure water sustainability

Drivers for R&D

Robust, sustainable, affordable and reliable of water supply

Driver:
"Adequate Water Supply":
- Rainfall: 2.4 m/year
- Land area: 710 km^2
- Large domestic and industrial demand

Driver:
"Good Water Quality":
- Unconventional sources of water

Objectives of R&D:

1. Increase water resources
2. Protect water quality and security
3. Reduce production cost

R&D Approach – Bringing Concepts from Pilots to Demos

Demo plant studies

Pilot studies

Upstream fundamental research

Usually carried out in laboratory scale in tertiary and research institutes

NUS National University of Singapore

NANYANG TECHNOLOGICAL UNIVERSITY

SUTD SINGAPORE UNIVERSITY OF TECHNOLOGY AND DESIGN

EWI COI NGEE ANN POLYTECHNIC

A*STAR Agency for Science, Technology and Research SINGAPORE

NEWRI NUS Environmental Research Institute

R&D Approach – Eg. Membrane Bioreactors (MBRs)

Upstream research

Pilot Plant (2003)

Demonstration Plant

(2006- present)

Full-scale implementation

(2013 – present)

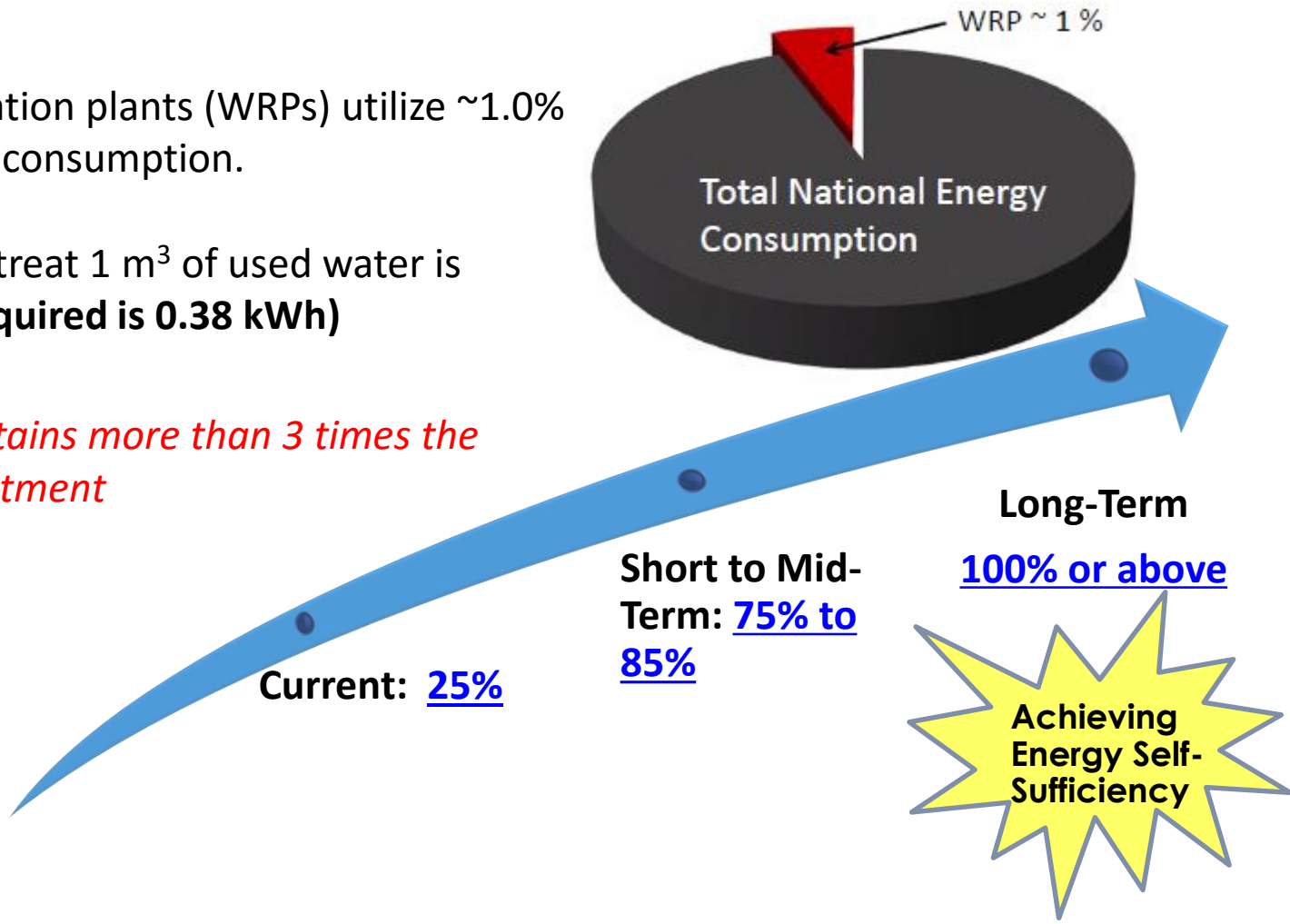
PUB

Wastewater Treatment R&D Objective: *Achieving Energy Self-Sufficiency*

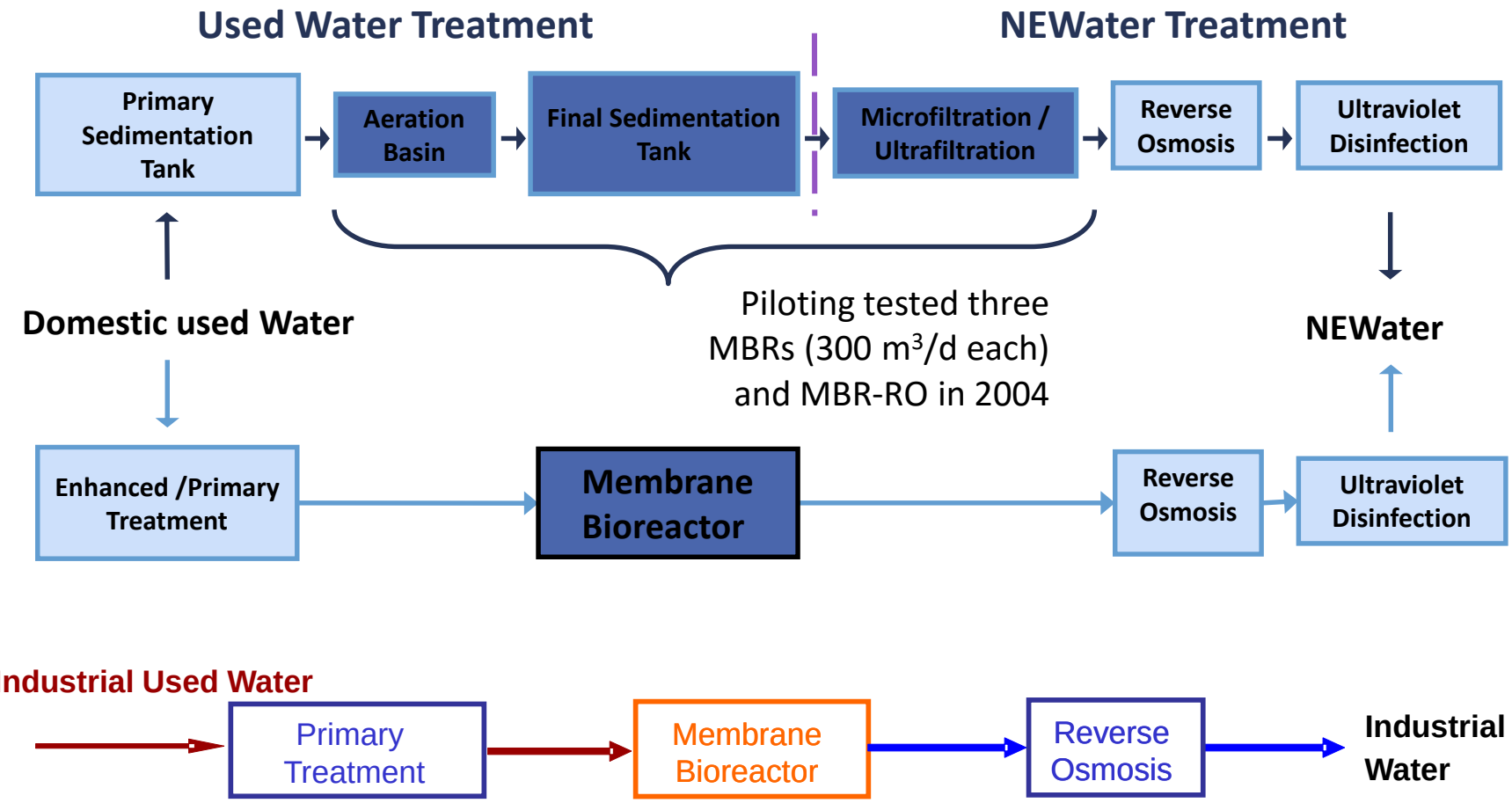
Currently water reclamation plants (WRPs) utilize ~1.0% of total national energy consumption.

The energy required to treat 1 m^3 of used water is **0.5 kWh (net energy required is 0.38 kWh)**

Influent used water contains more than 3 times the energy required for treatment



MBR-RO for NEWater and industrial water production



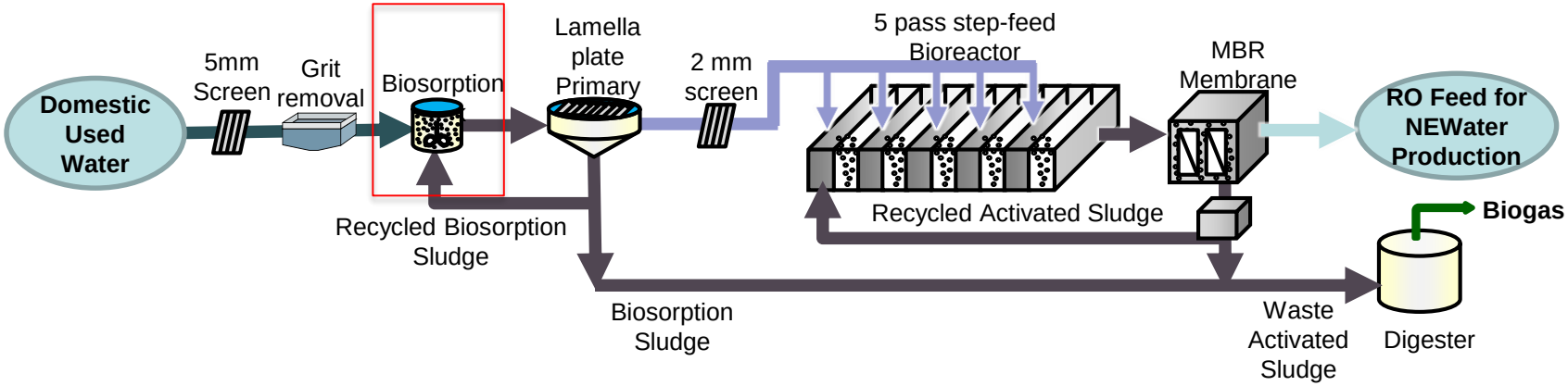
Advantages of MBRs

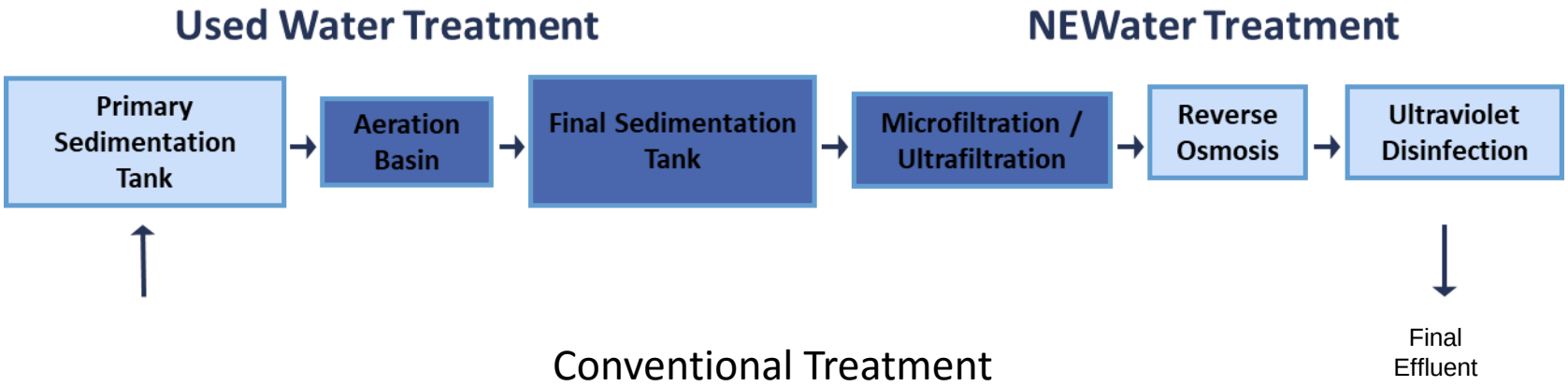
- Higher and more consistent effluent quality
- Lower footprint than having separate aeration tanks and clarifiers
- Provides physical barrier to pathogens
- Lower operating cost than conventional treatment in water reclamation

Biosorption + Step-feed Bioreactor + MBR

Demo plant (12,500 m^3/d) at Ulu Pandan Water Reclamation Plant

Biosorption + Step-feed Bioreactor + MBR





Biosorption + Step-feed + MBR

a) Biosorption can remove up to 60% of organic carbon from used water upstream.

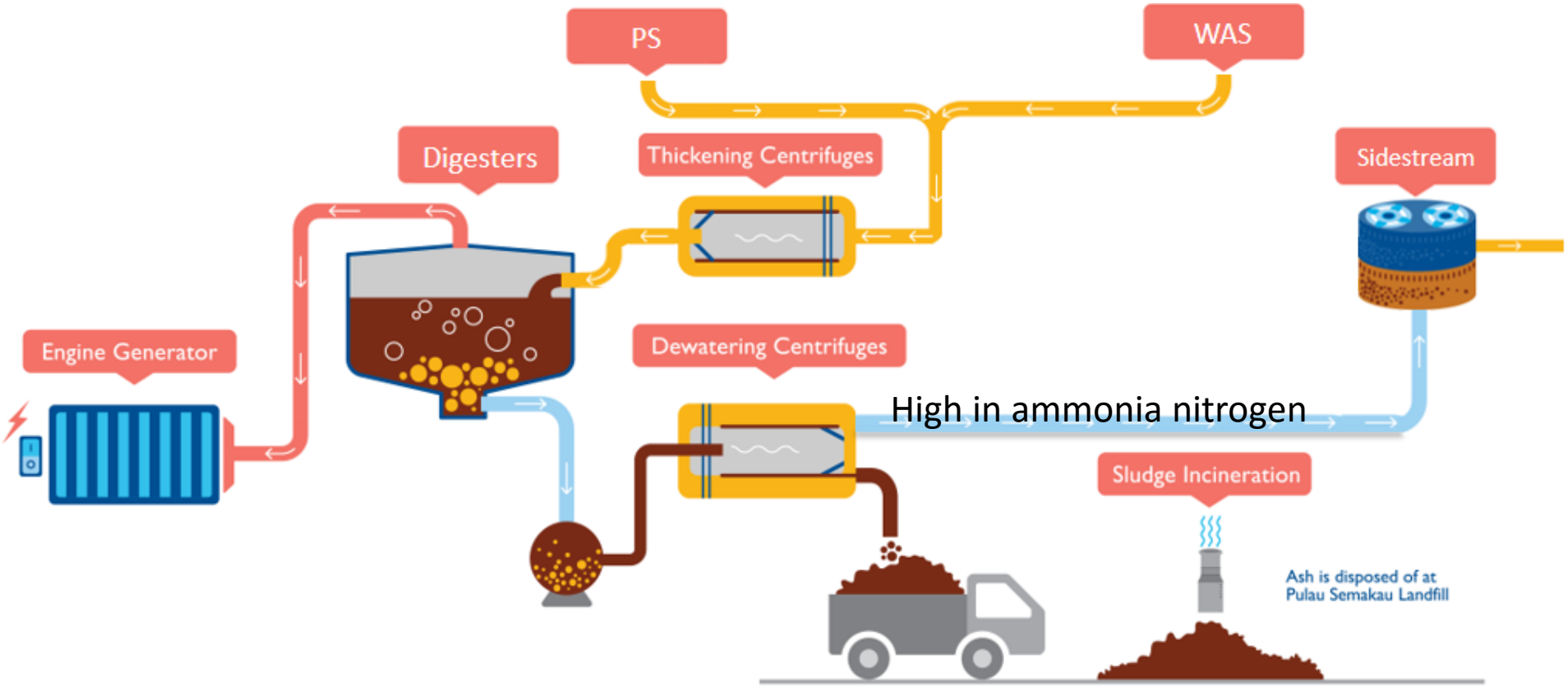
b) With lower organic carbon fed into bioreactor, lower aeration energy and MBR membrane scouring energy is required.

c) Can achieve a process energy consumption as low as 0.3 kWh/m^3 (vs 0.5 kWh/m^3 for conventional treatment).

d) Produces good effluent quality (turbidity < 0.1 NTU and RO permeate (NEWater) TOC at 40-50 ppb).

Side-Stream DEMON Process

To remove ammonia nitrogen in wastewater

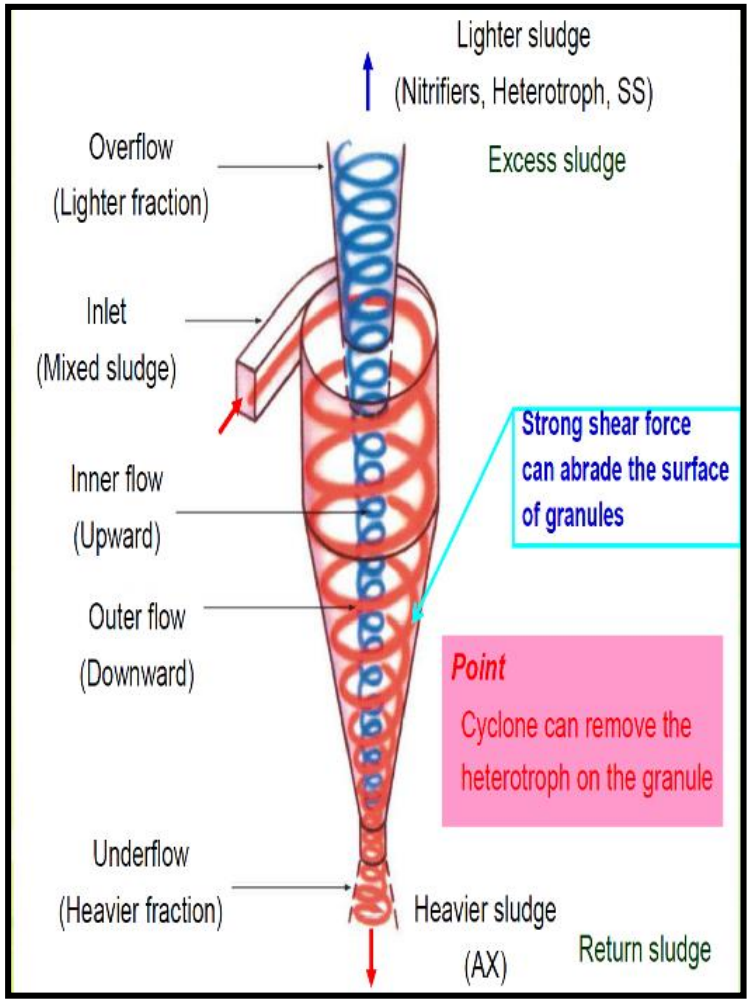


Side-Stream DEMON Process

Demo Plant at Changi Water Reclamation Plant

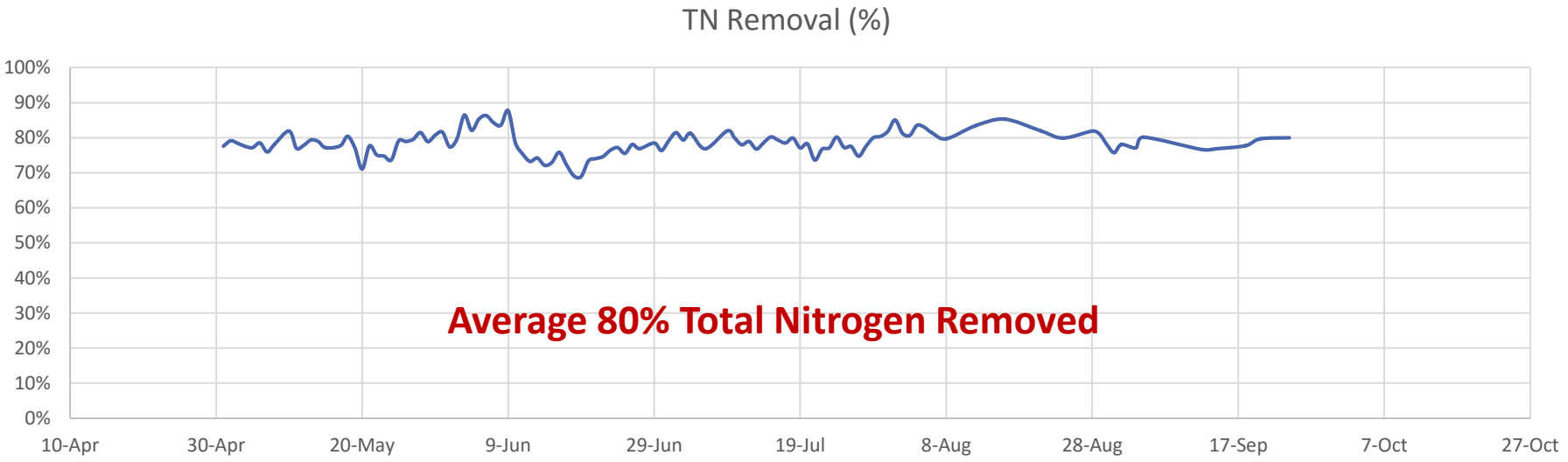
Side-stream DEMON Process

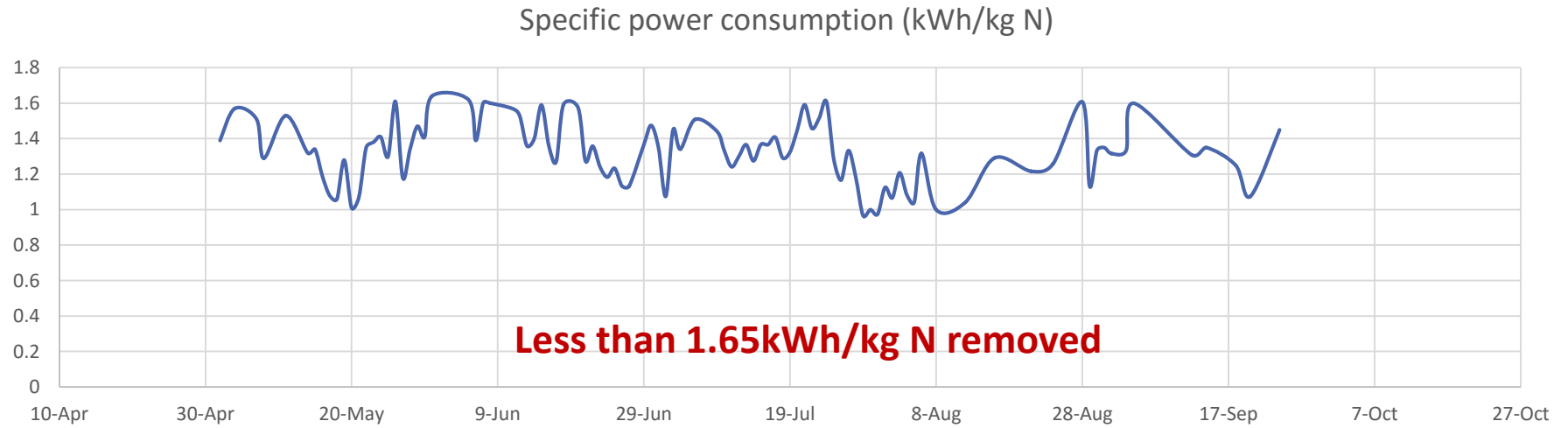
Anammox Bacteria



Cyclone

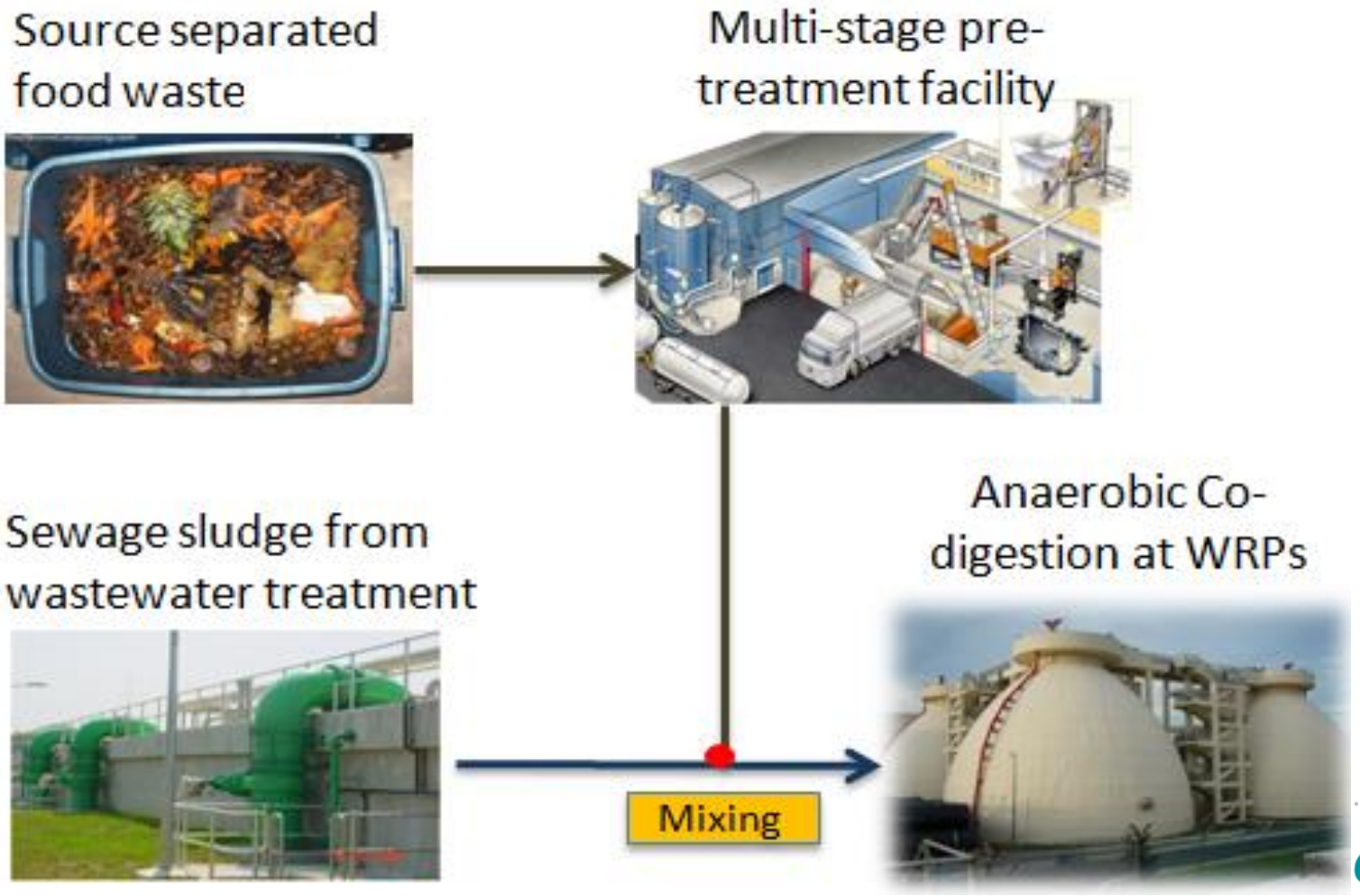
Side-Stream Treatment Facility at Changi WRP





Co-digestion of Food Waste and Sludge

- Co-digestion is the simultaneous AD of a mixture of two or more substrates
- **Synergy of Co-Digestion**: The mixture of food waste and sludge is able to offer a more optimal set of conditions for bacteria, therefore increasing biogas production
- To generate more electricity from the higher net calorific value of food waste

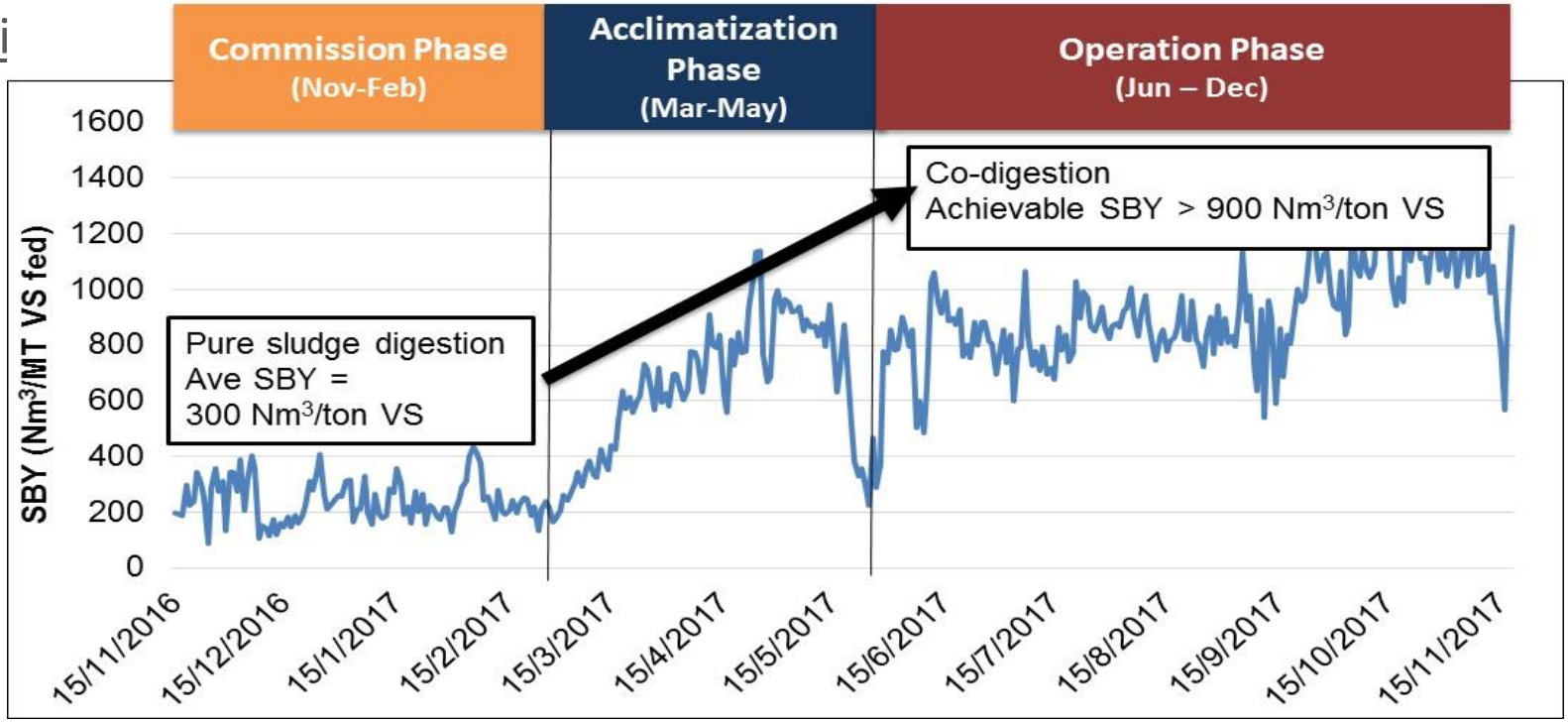


Co-digestion of Food Waste and Sludge

Demo Plant (40 tons/d) at Ulu Pandan WRP

Key Projects: Co-digestion of Food Waste and Sludge

Results: Specific Biogas Yield (SBY) of Pure Sludge Digestion against Co-Di



Potential for Co-Digestion to triple biogas yield

Thermal Hydrolysis Plant (THP)

Objectives:

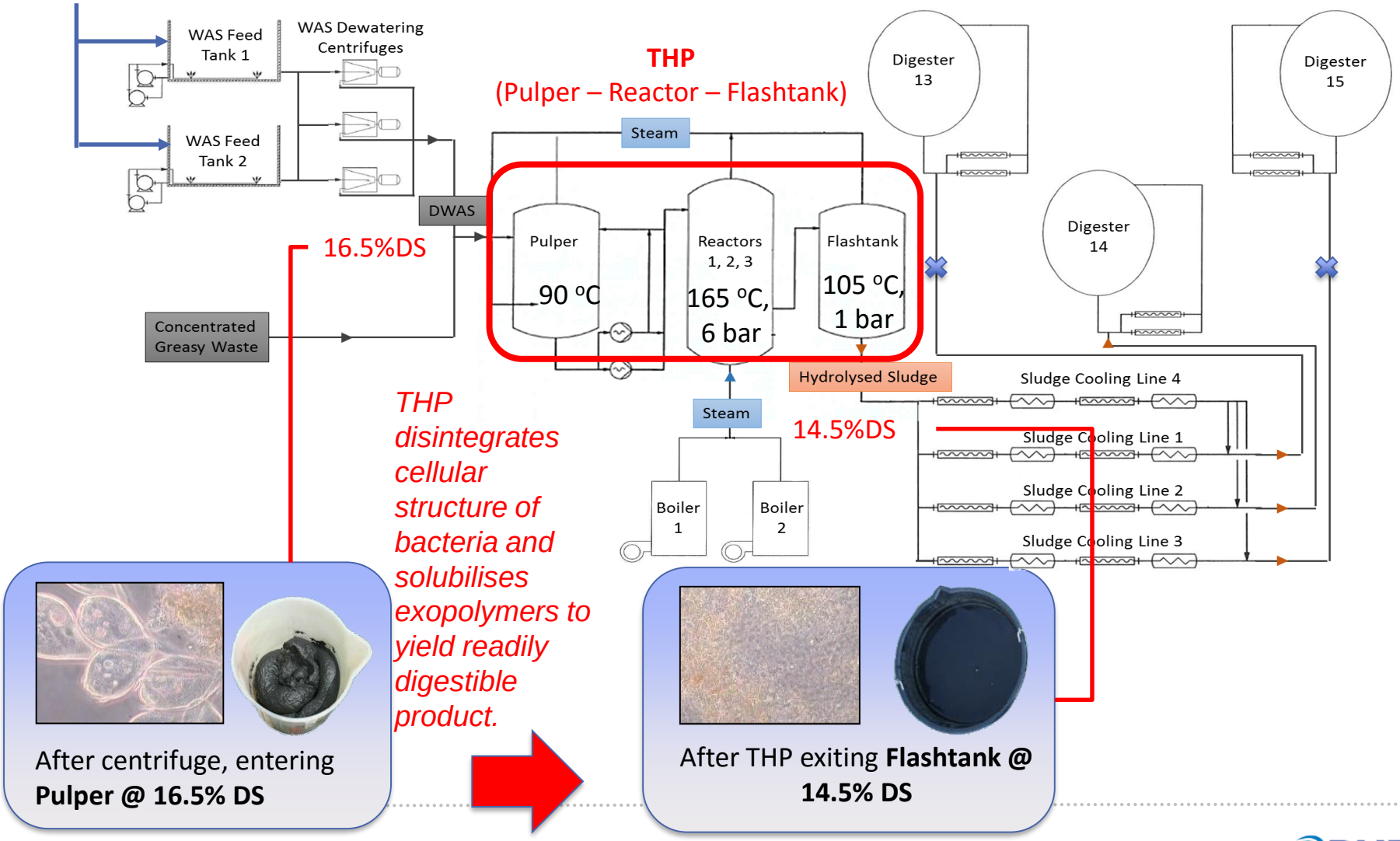
. enhance sludge digestion

. higher gas production

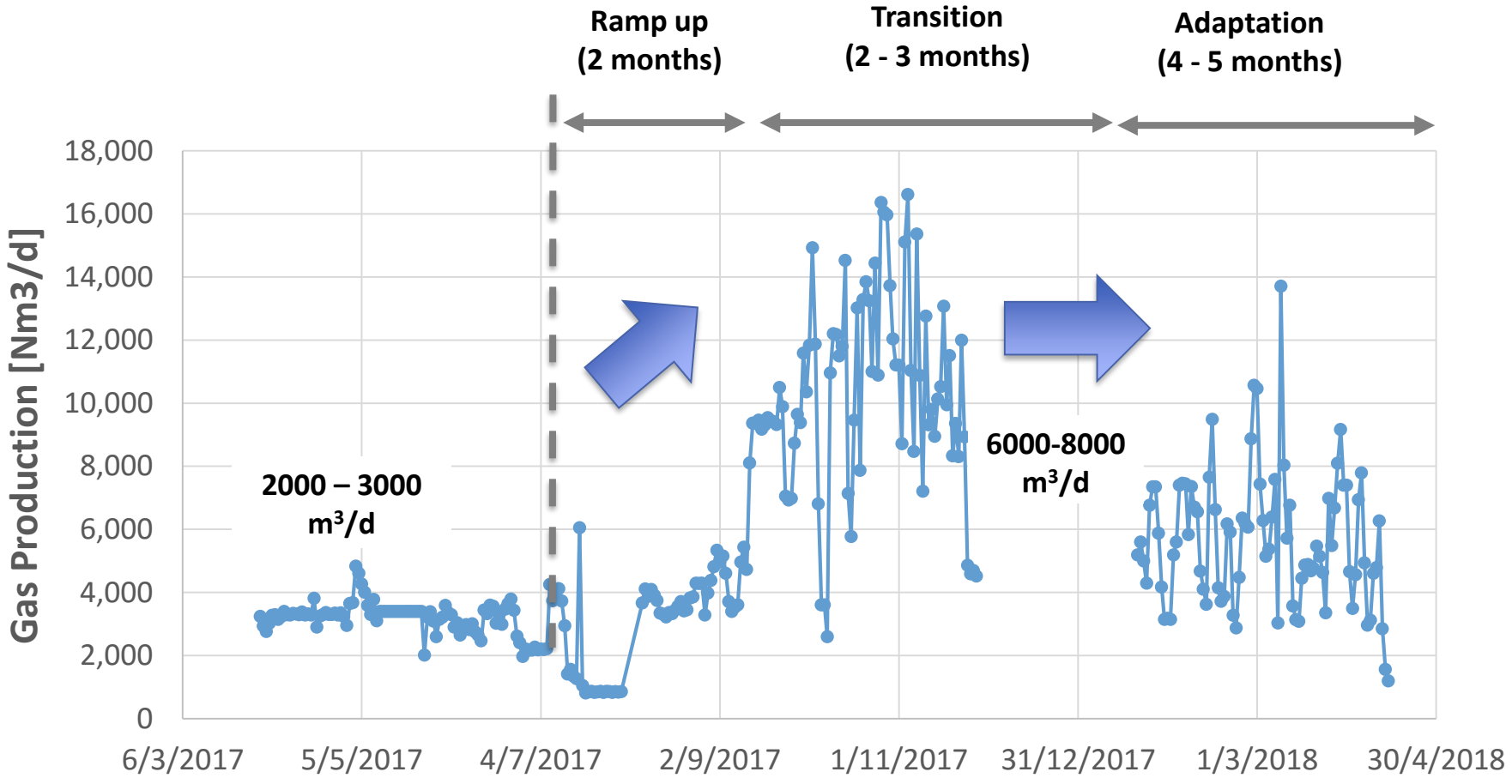
. avoid construction of an additional digester.

THP - Process Schematics

Waste Activated Sludge (WAS)



THP - Results



Gas production in digestors doubled after THP

Global Network of Collaboration Partners

PUB

Thank You

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