Water for All
Conserve, Value, Enjoy
PUB

Sustainable and Integrated Water Supply: Singapore – A Case Study

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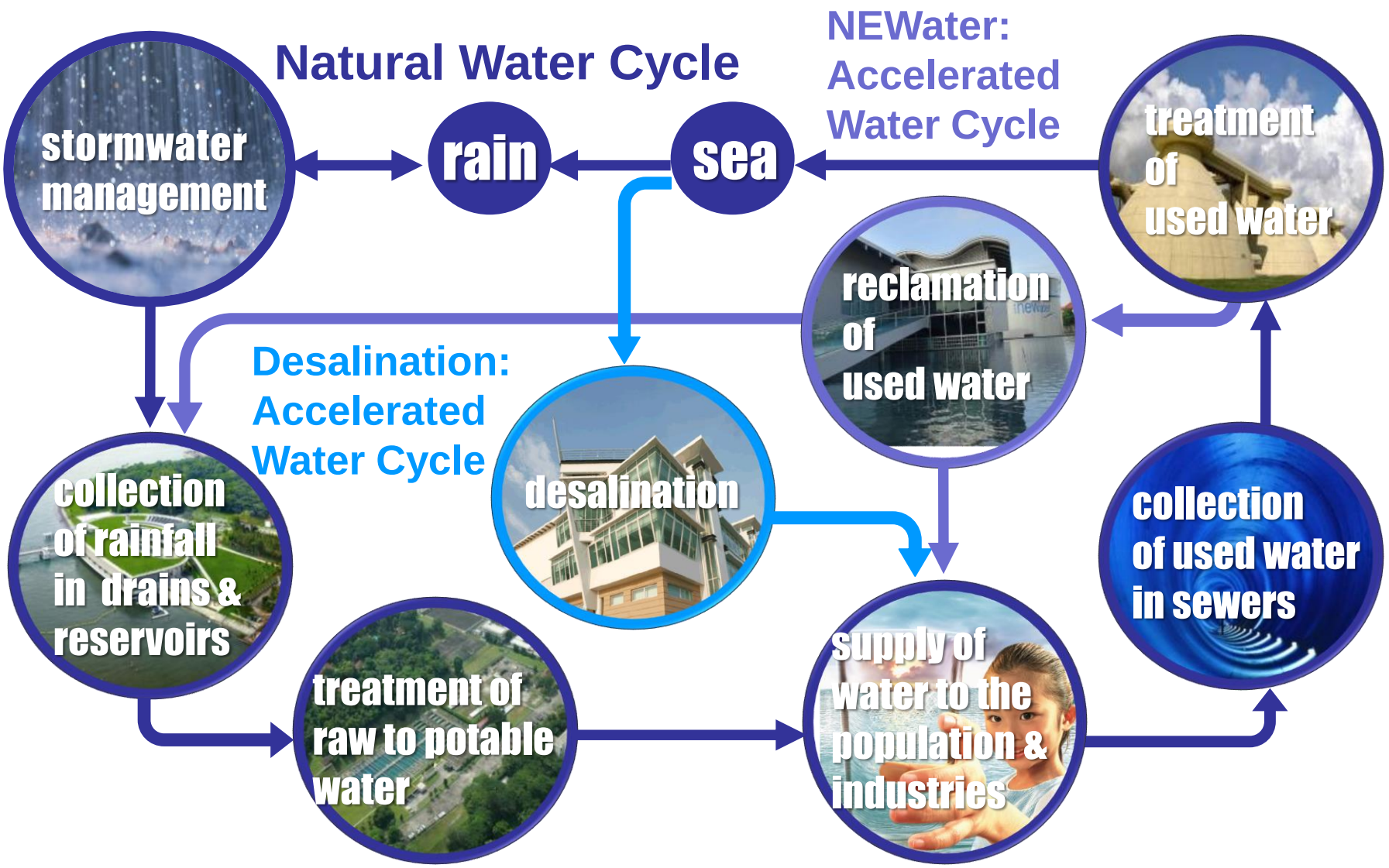
Challenges

- Lack of land to store water
- Lack of natural resources (apart from strategic locations for port, and high population)

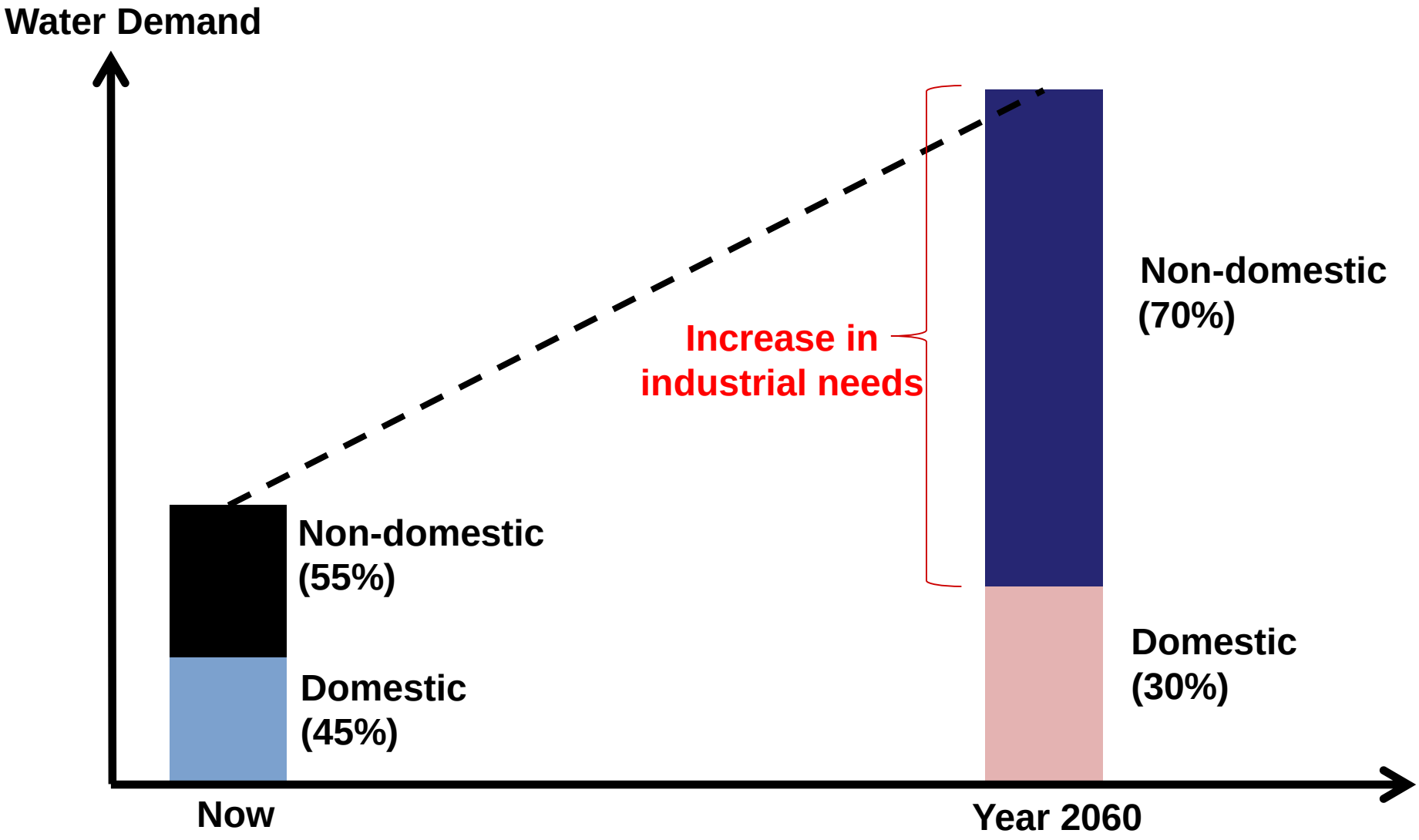
Land Area	~710 km^2
Population	5.5 mil
Average Annual Rainfall	2.4m
Average Water Demand	400MGD (1.82mil m^3/day)

Closing the Water Loop

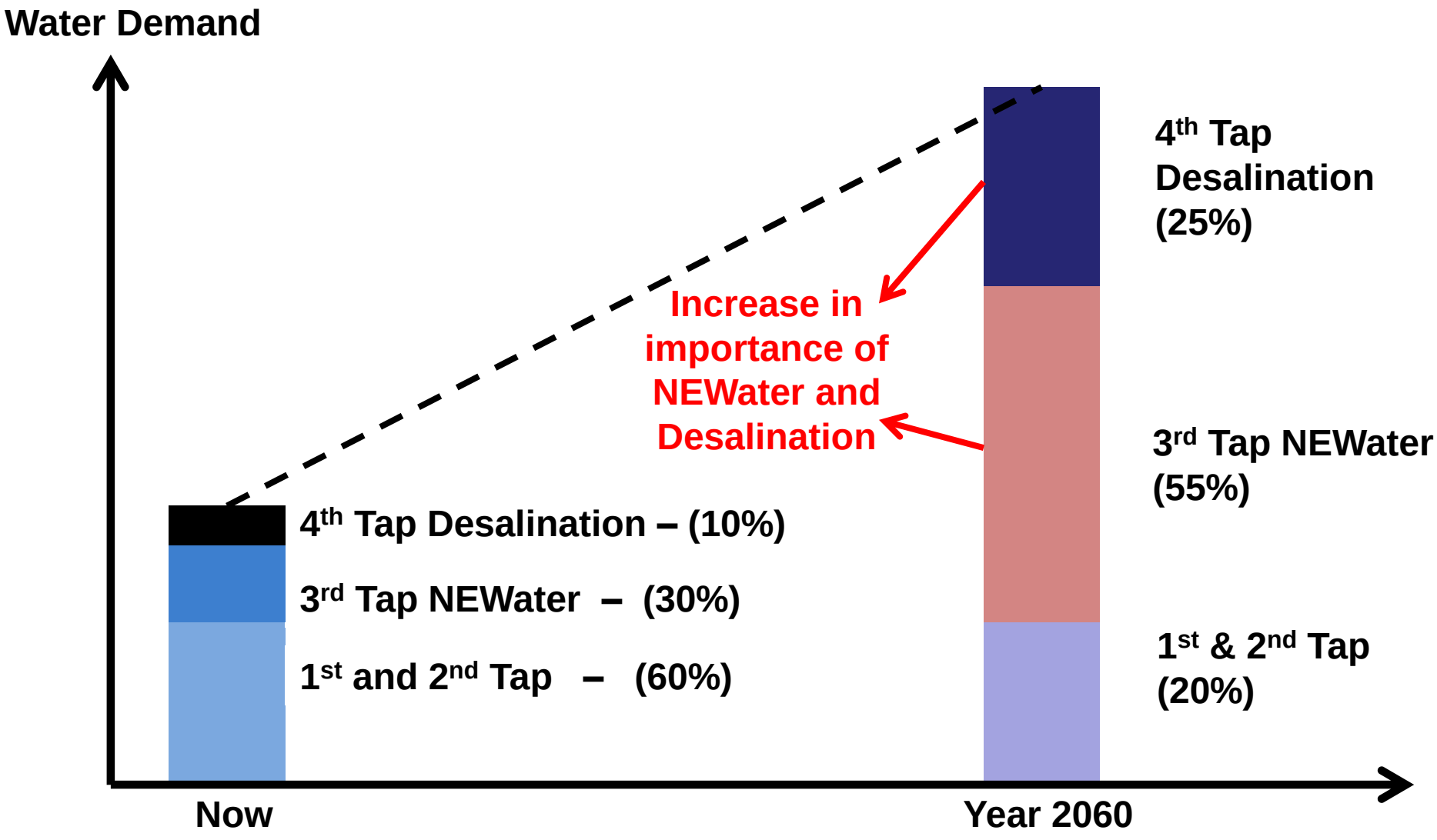


Building Resilience - Four National Taps

Our Challenges - Water Demand



Implications



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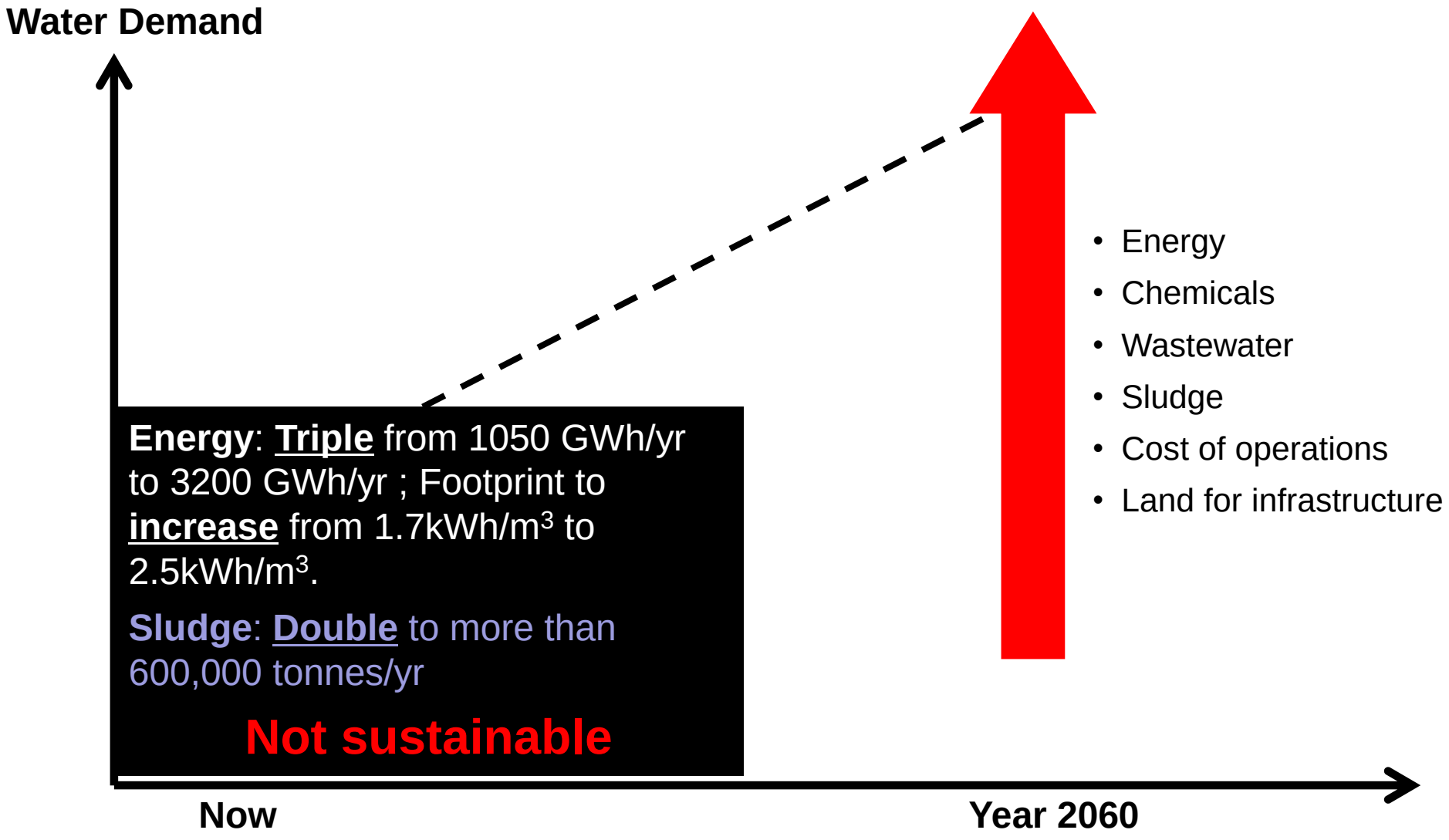


Tackling our Challenges – Looking for Ideas

Leveraging on technological innovation to overcome water challenges

Case Studies

Reducing Energy – Seawater Desalination

Current

3.5kWh/m³

SWRO

Short-term

<1.5kWh/m³

- Variable Salinity Process : 1.7 kWh/m³
- Membrane distillation (with waste heat): 1.0 kWh/m³
- Electrochemical Desalting: 1.5 kWh/m³

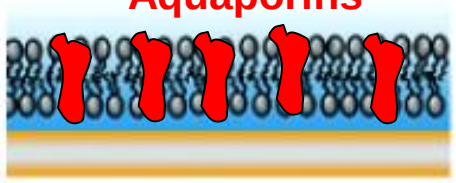
Long-term

<1kWh/m³

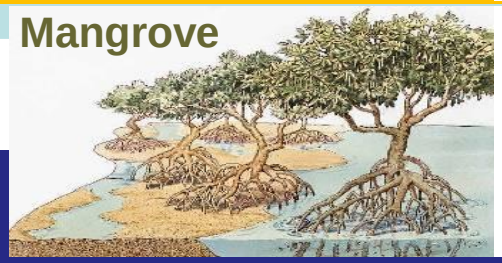
Breakthrough R&D

- Biomimetic
- Biomimicry

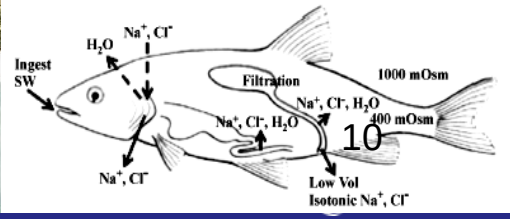
Aquaporins



Mangrove



Seawater



Electrochemical Desalination Technology

Project Start
Matching EWI Grant
Singapore + USA

White Paper

Prototype ED

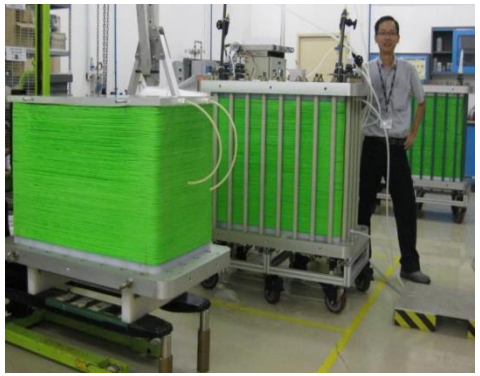
Beta 3

85% Membrane Utilisation
6 x Lower Footprint
Molded commercial components
Automation in assembly

Oct 2007 | Oct 2008 | Oct 2009 | Oct 2010 | Oct 2011 | Oct 2012 | 2014

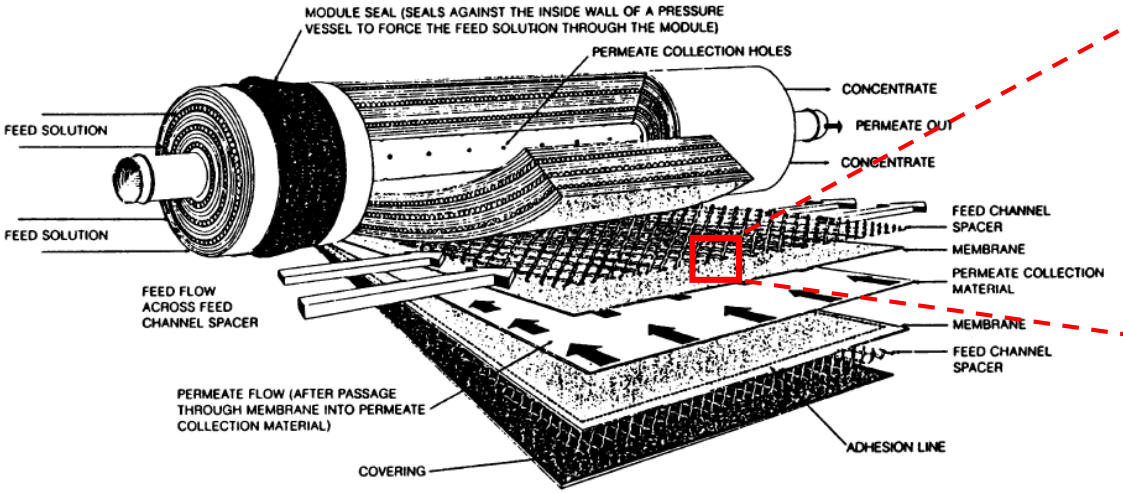
Lab ED

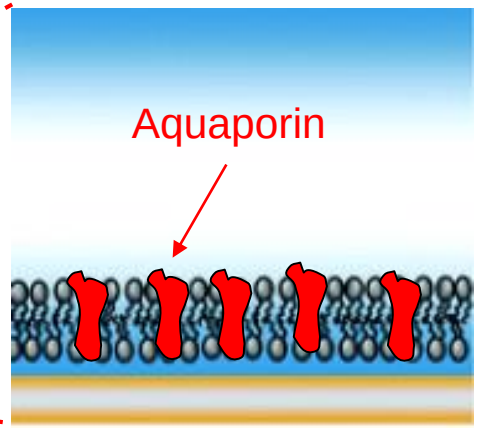
EWI Demo



Commercial ED Design

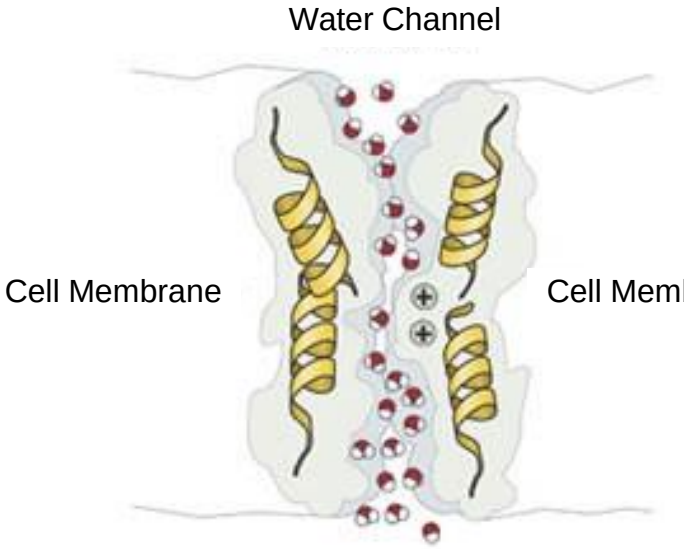
Biomimetic Membranes





Potential Applications:

1. Seawater desalination membrane
   → 3.5kWh/m^3 to < 1 kWh/m^3
2. RO membrane for NEWater production
   → 0.8kWh/m^3 to 0.3kWh/m^3



Aquaporin:

- ✓ High water flux
- ✓ Quantitative rejection of Na^+ and Cl^- ions

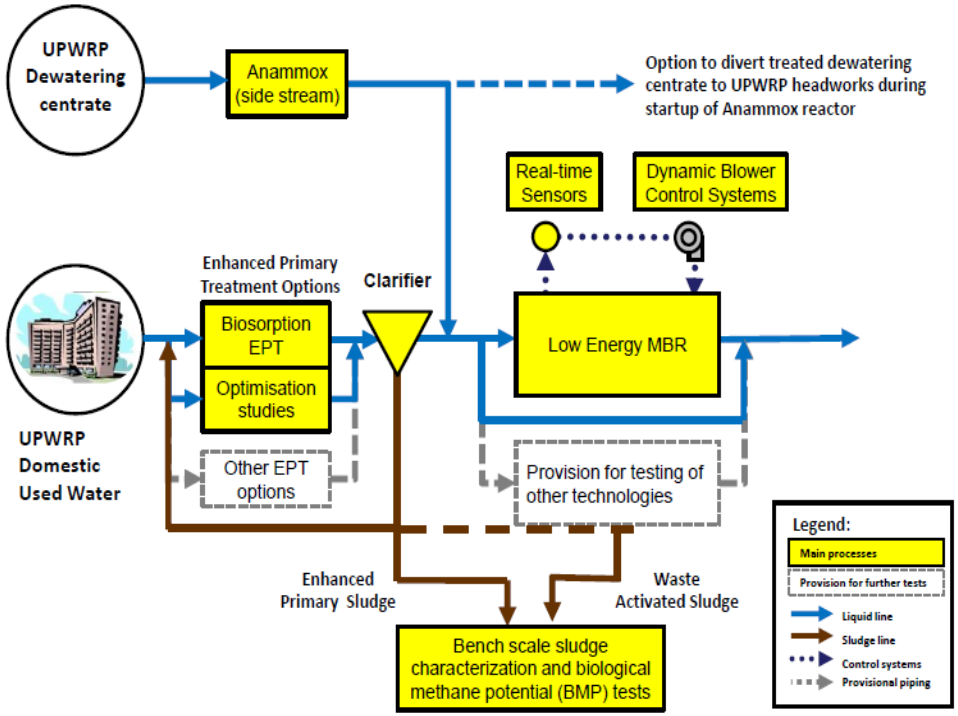
Energy Self-Sufficiency – Used Water Treatment

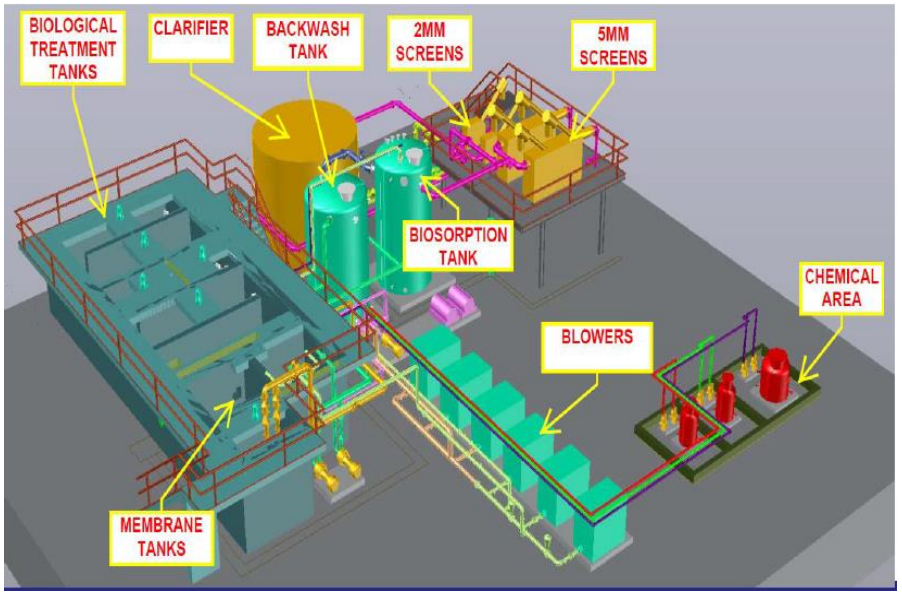
Multi-Dimensional Challenge:

- **Maintain Effluent Quality for NEWater Production**
- **Reduce Energy & Sludge**
- **Minimise Land Use**

Integrated Validation Plant

Energy-efficient Water Reclamation Plants with higher recovery





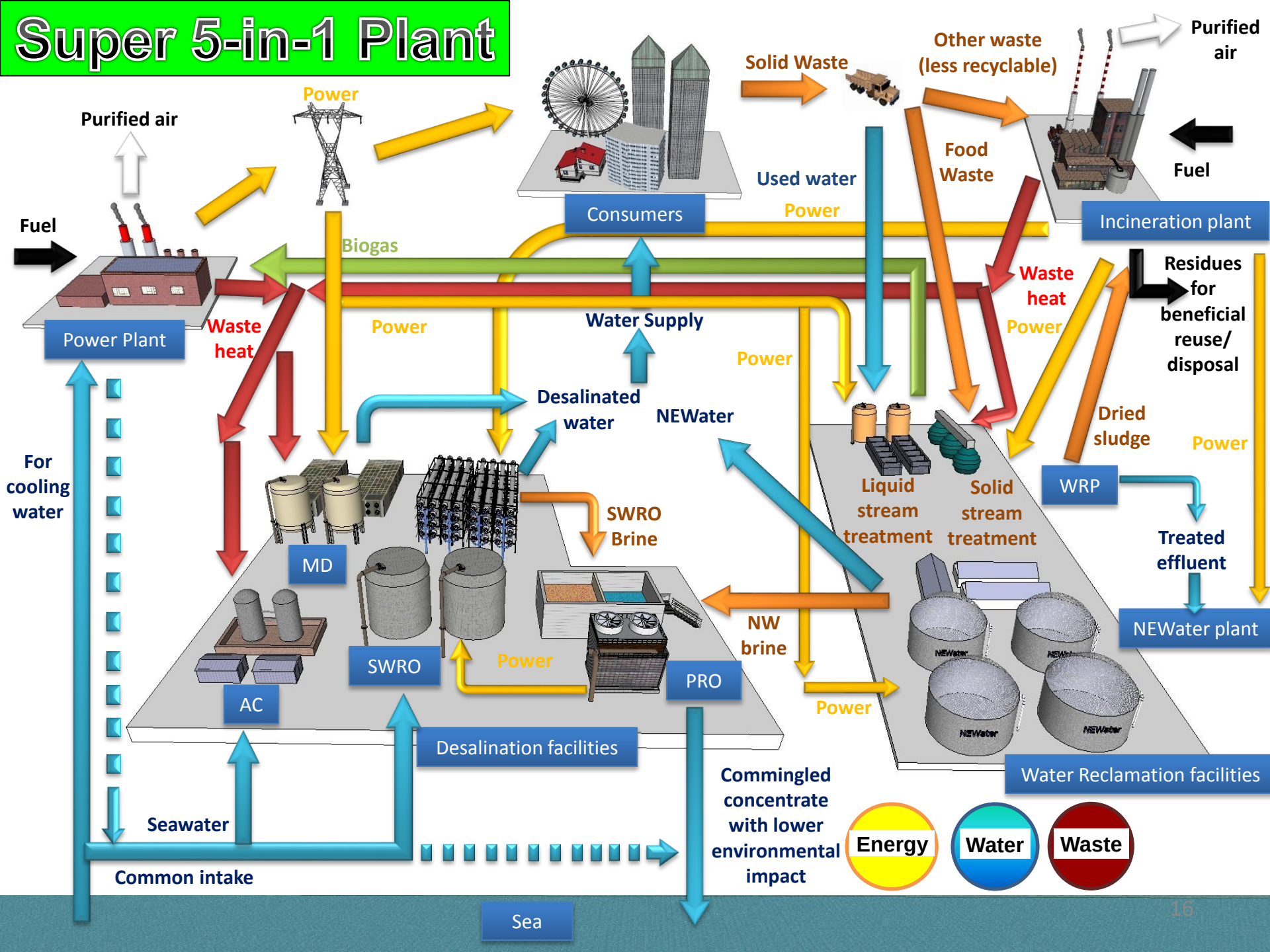
Expected Outcomes of the Integrated Validation Plant

- 150% more energy recovery
- 40% reduction of net system energy consumption
- 30% reduction in plant footprint
- 10% reduction in quantity of waste dewatered sludge

Co-location: The Energy-Water-Waste Nexus

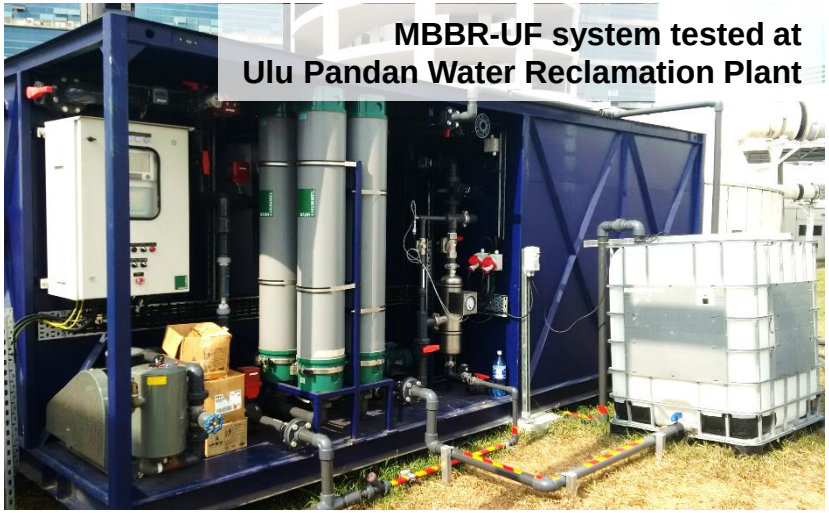
Energy Water & Waste Nexus

Super 5-in-1 Plant



We Cannot Work Alone

To date, working together with from various institutions, industries and partners, PUB has conducted over 500 R&D and test-bedding projects.



MBBR-UF system tested at Ulu Pandan Water Reclamation Plant

LEDIF-STARFISH AUV tested at Pandan Reservoir

Ceramic membranes tested at Choa Chu Kang Waterworks

Enabling Innovation, Driving Collaboration

Singapore International Water Week (SIWW)

Singapore International Water Week

The Global Platform to Share and Co-Create Innovative Water Solutions

- Since 2008, the SIWW has gained traction as a unique global water platform to share and co-create solutions
- **Key highlights** include **Lee Kuan Yew Water Prize, Water Leaders Summit, Water Convention, Water Expo & Business Forums**
- SIWW 2014 had more than 20,000 participants from 118 regions/countries
- **SIWW 2016 will be held from 10-14 July 2016**

Thank you