How Membrane Technology Contributes to Sustainability and Life Sciences

Abhishek Roy

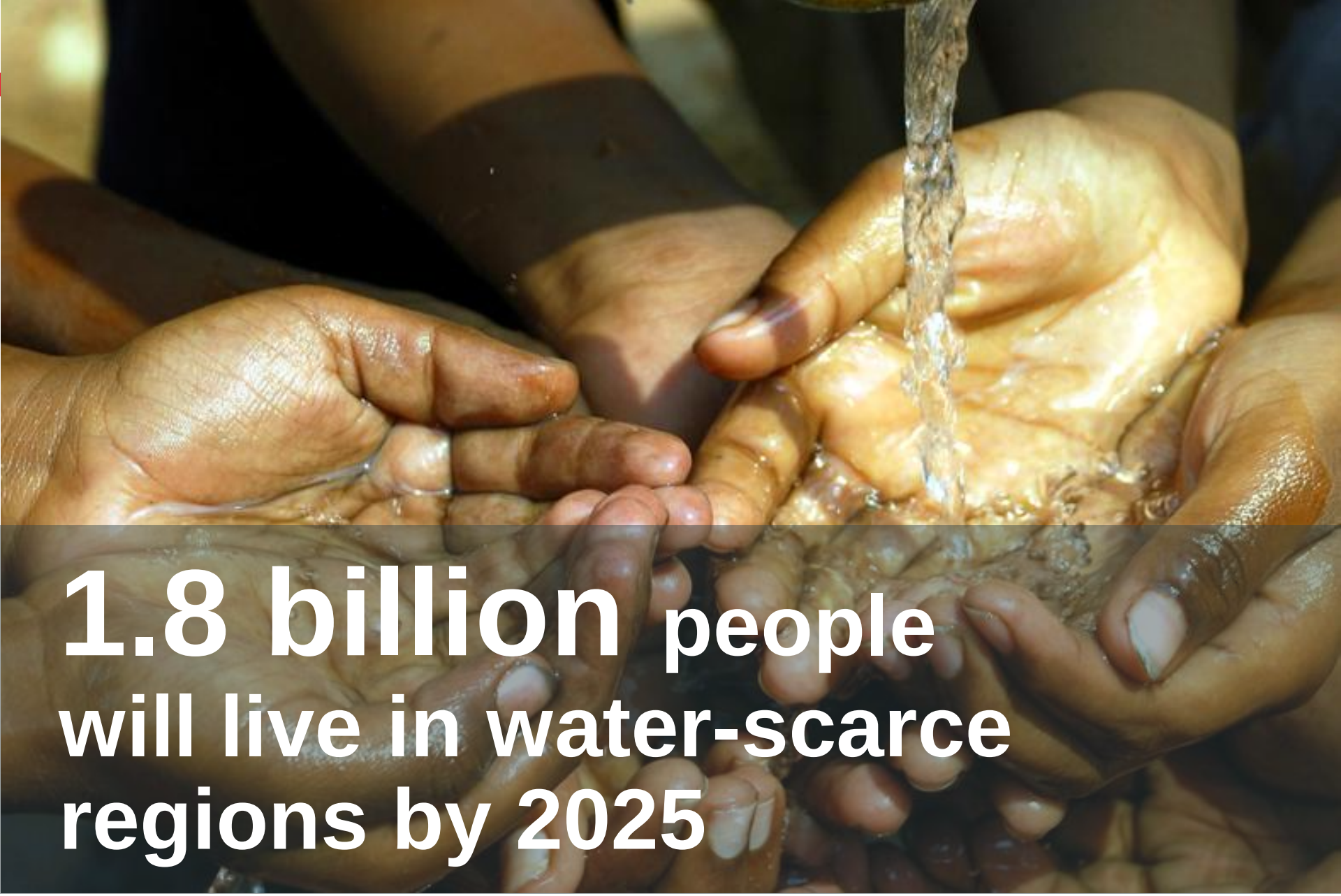
Mike Koreltz, Peter Aerts, Mou Paul,
Steve Rosenberg, Bob Cieslinski, Ian Tomlinson
Steve Jons, Marty Peery

Dow.com

Outline

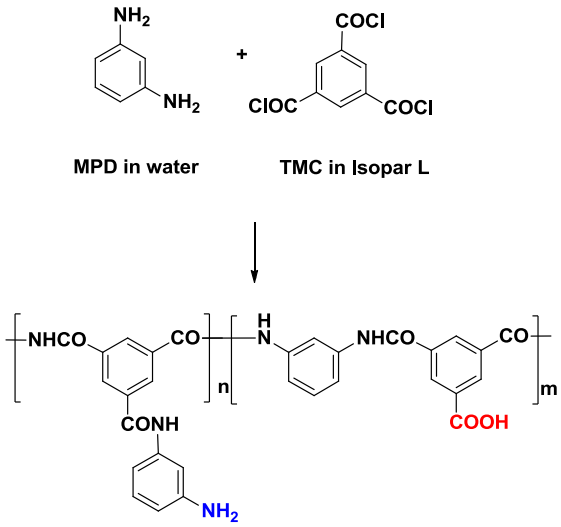
- The world 2030
- Energy and water: trends and challenges
- Innovations for optimizing water-energy
- Applications for Life Science


By 2030,
the world's population will reach
8.3 billion

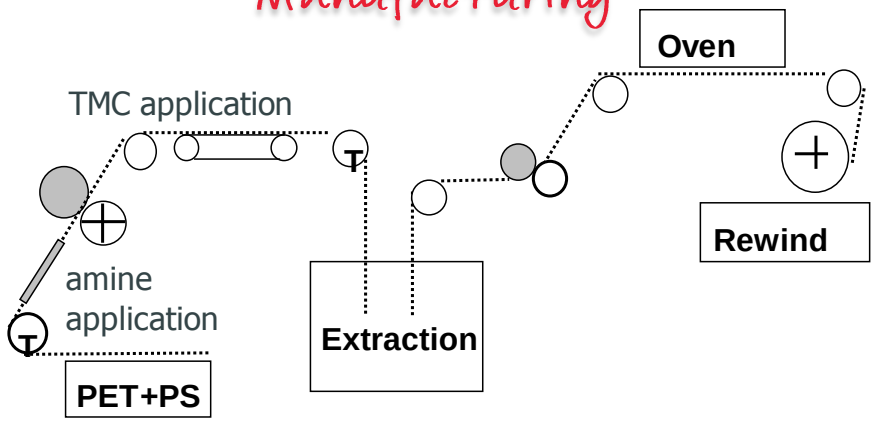

1.8 billion people
will live in water-scarce
regions by 2025

Basics of Reverse Osmosis

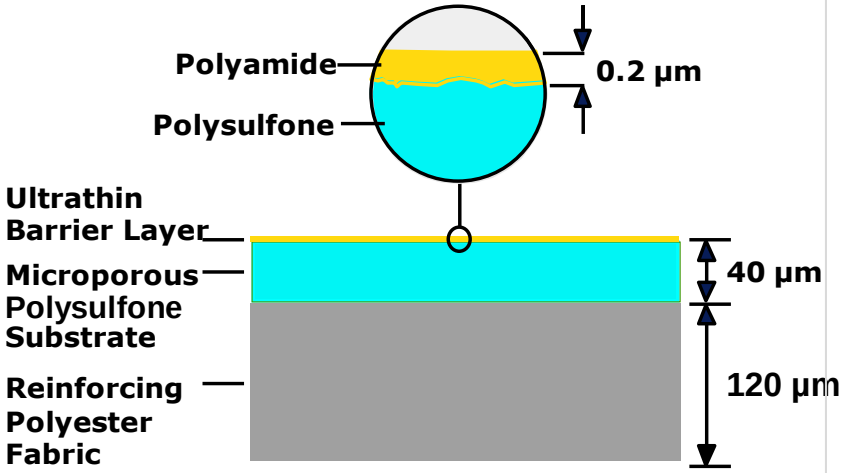
Chemistry



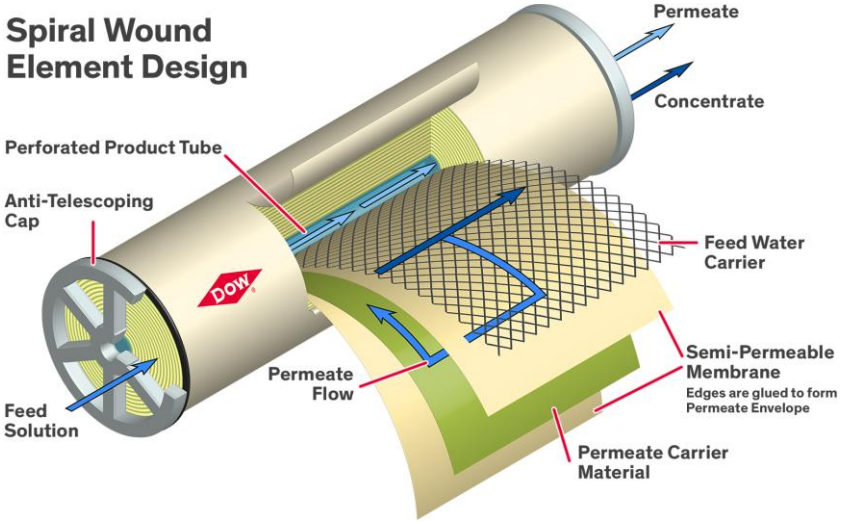
Manufacturing



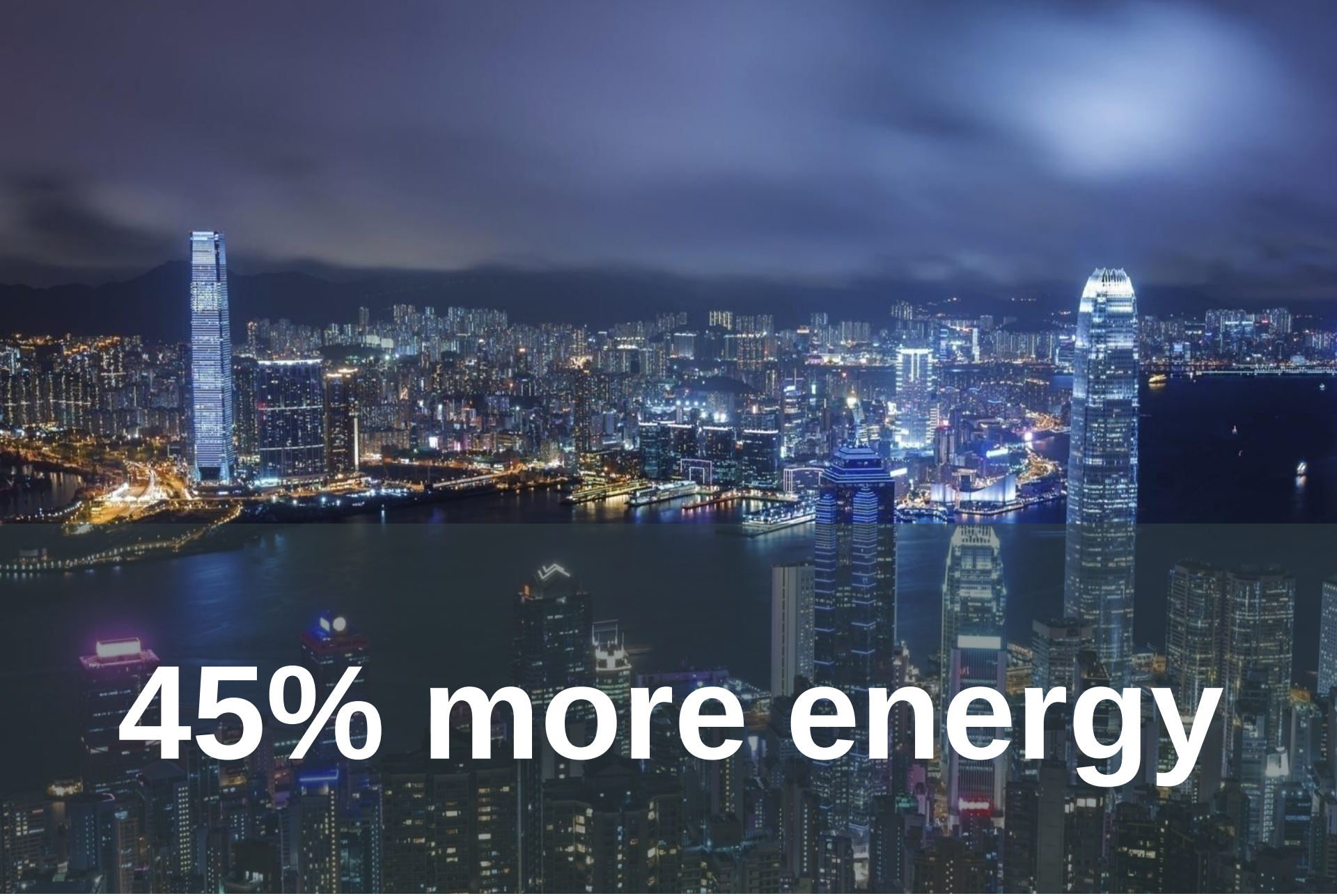
Membrane



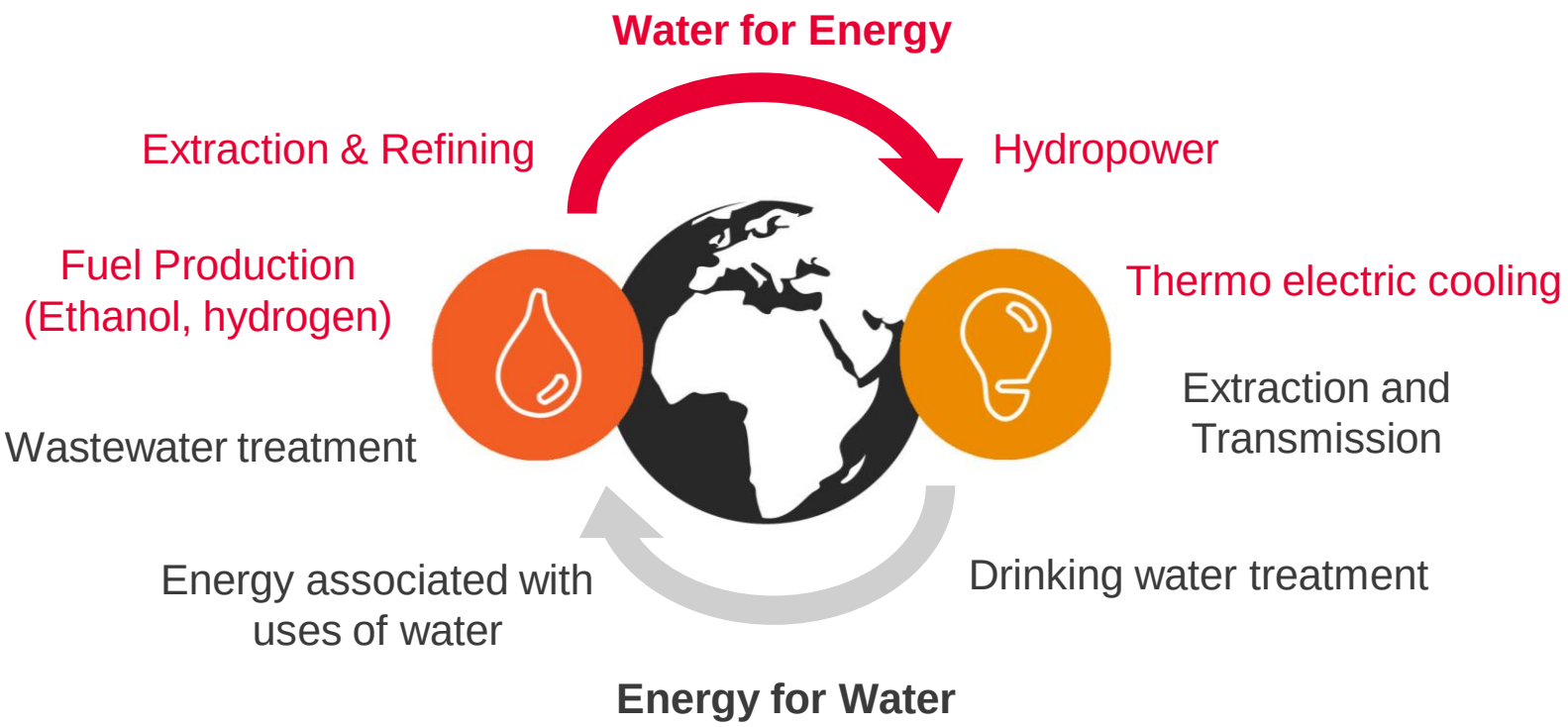
Product




30% more water


45% more energy

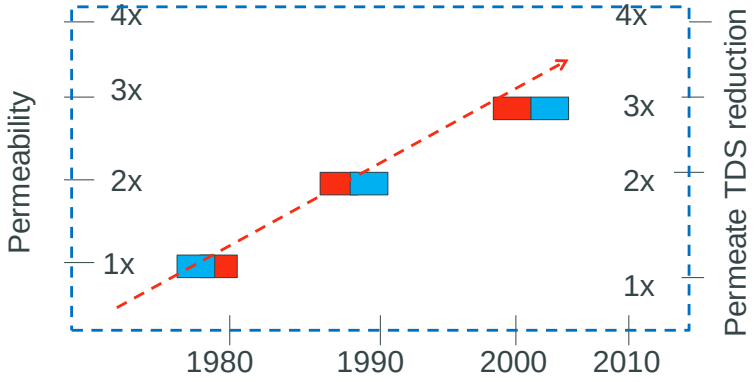
Water Energy Nexus- Sustainability

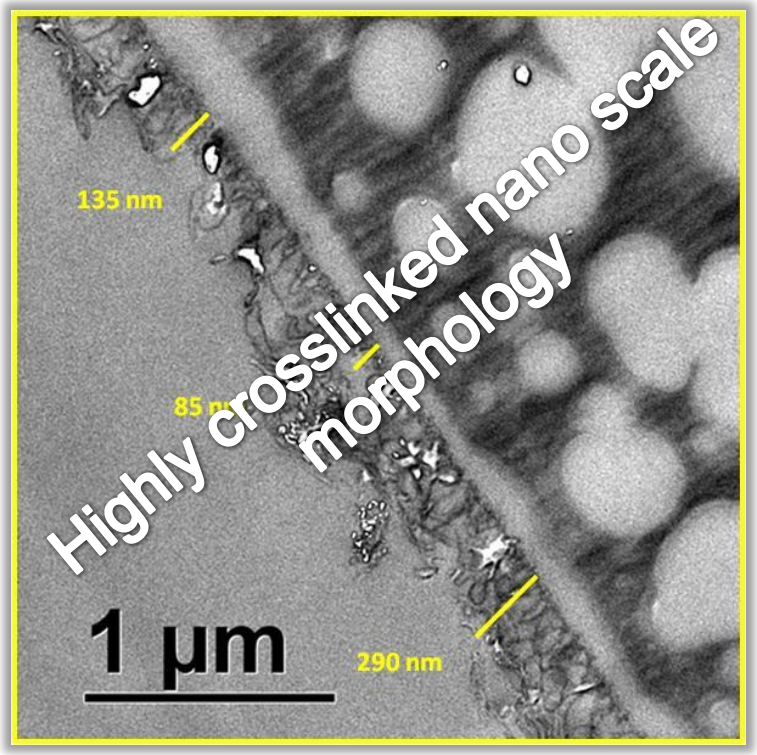


Target -30 % Energy savings, 40 % better Quality

Historical Perspective for Energy Efficient Membranes

Commercialization Reality for FT30

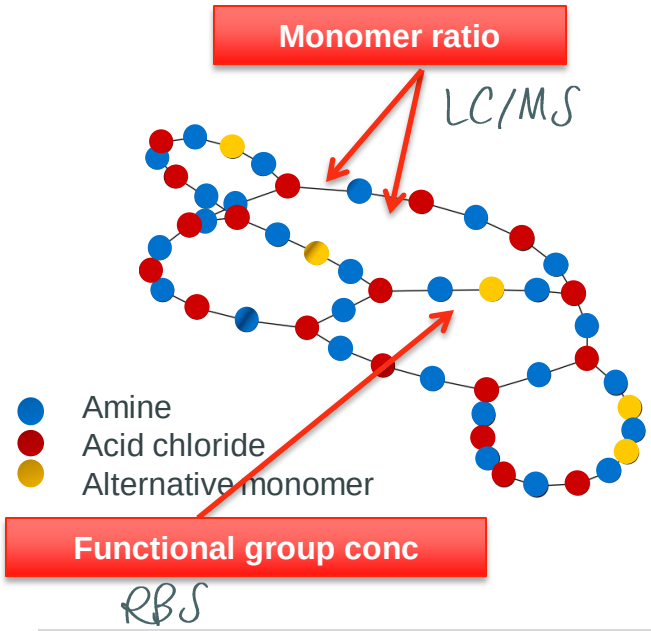


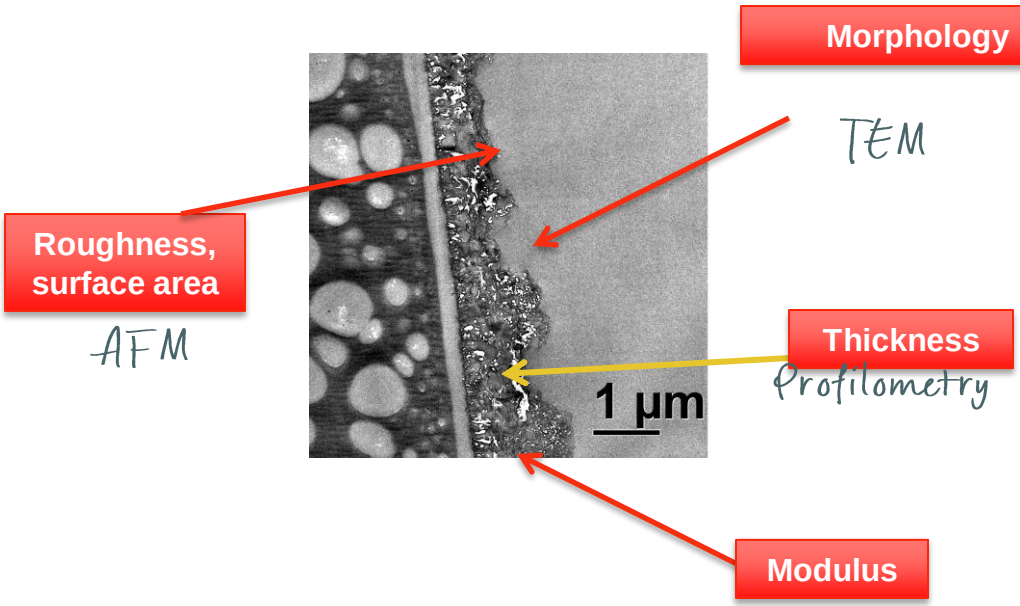


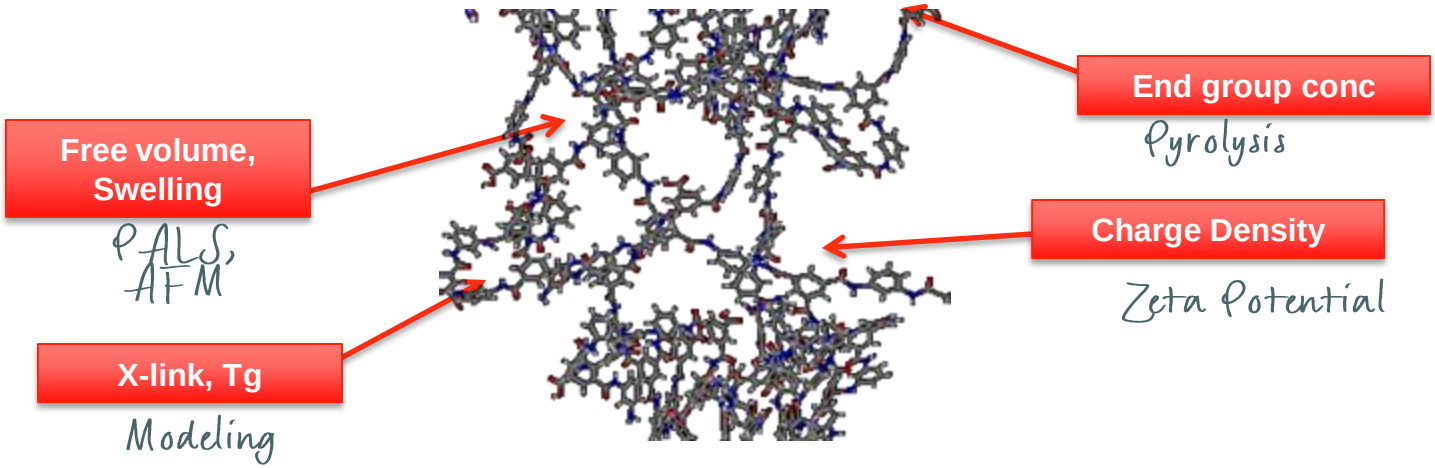
Takes Decades to make the next big change – WHY?

Absence of fundamental structure-property relationship

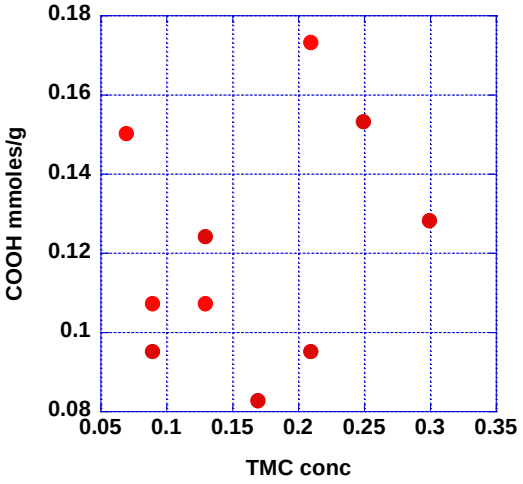
First Step – Understand the Structure – Build Capabilities and Collaborate

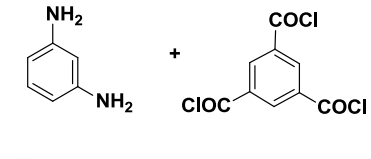


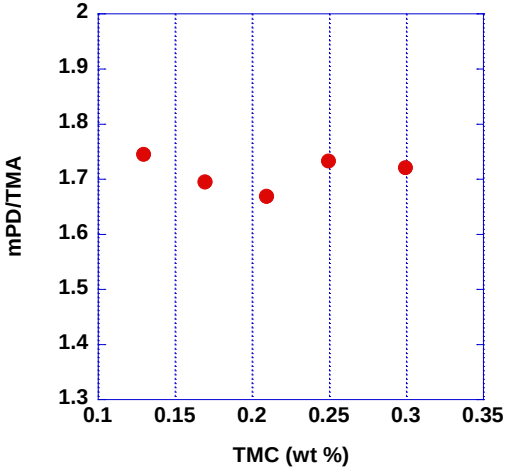


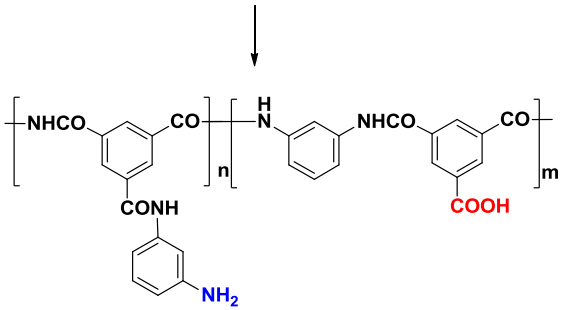


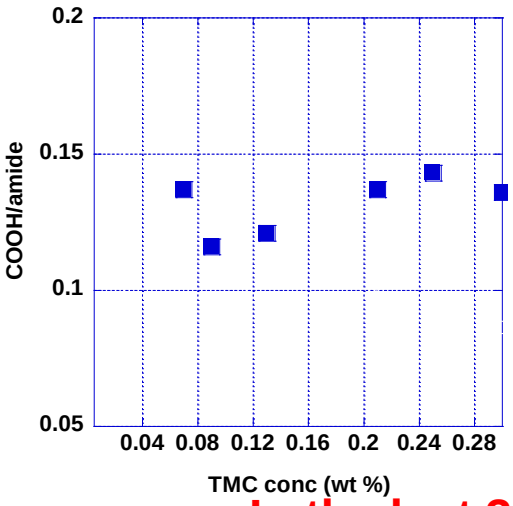
Our approach – Expand the Compositional and Structural Envelope

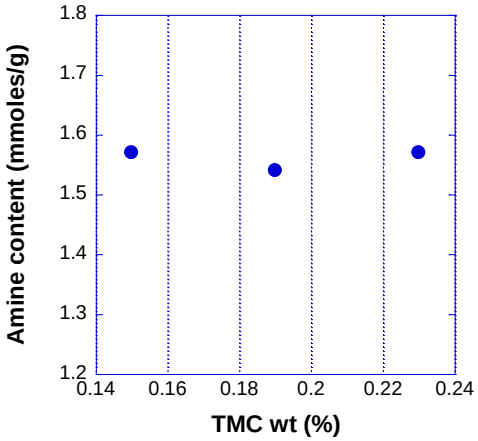








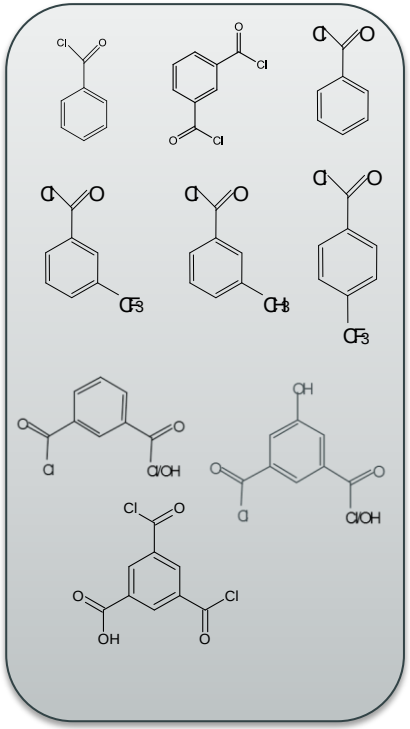




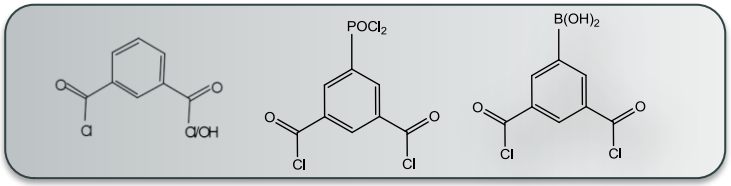
In the last 30 years we are locked in a narrow compositional window- Let's expand ….

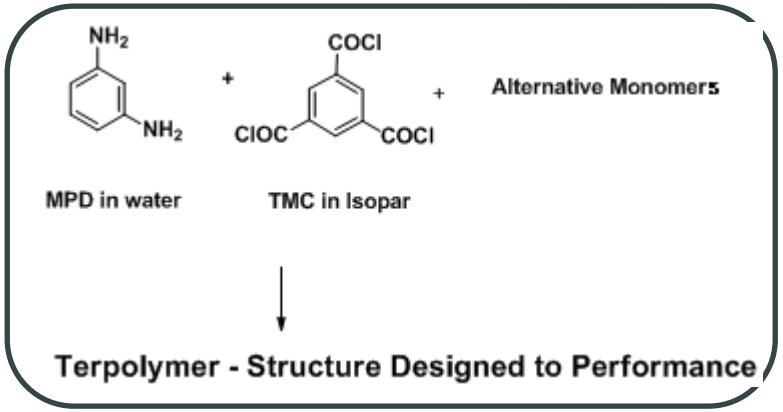
A Terpolymer Approach – An Example

Functionality

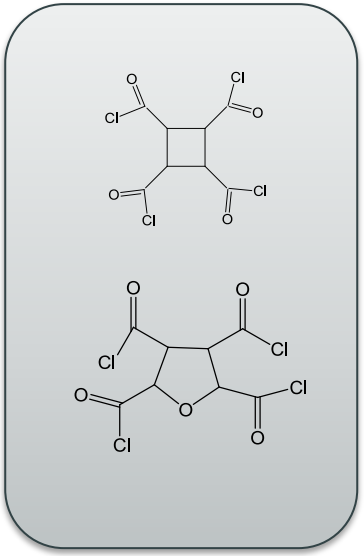


Charge

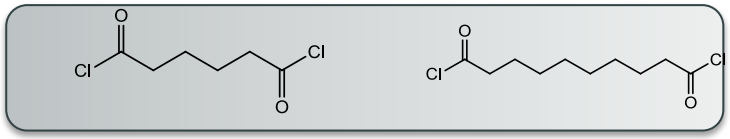




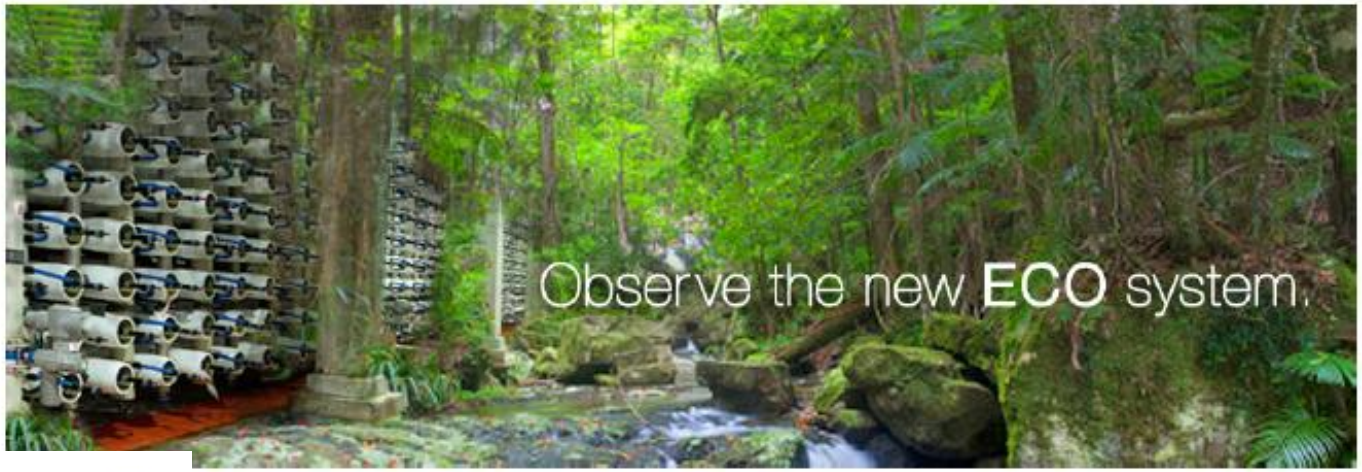
Rigidity



Flexibility



Our Contribution to World Challenges

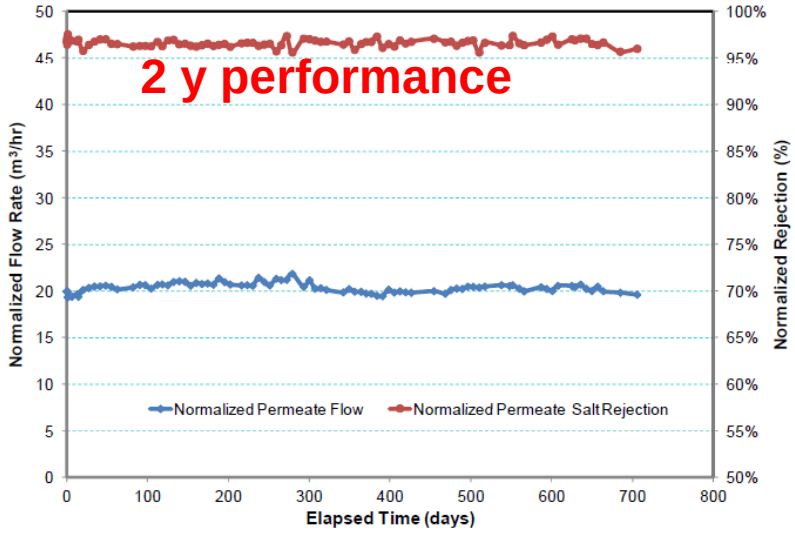


EDISON AWARDS
HONORING INNOVATIONS & INNOVATORS

DOW FILMTEC™ ECO RO Elements

40% less salt passage

30% less energy



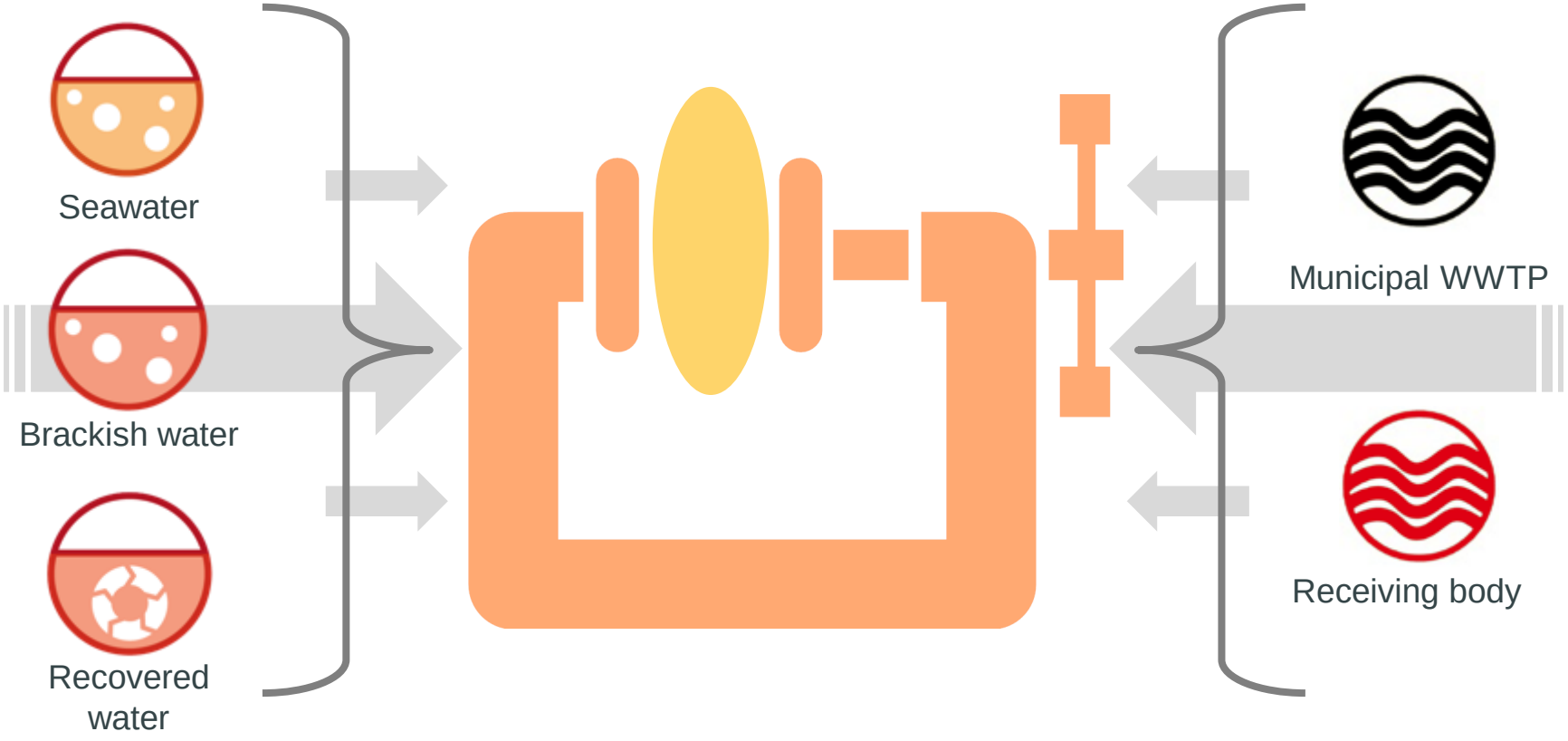
Saves 2 billion kilo watts of energy and reduces 1.5 million metric tons of CO2 emissions over 10 years

Water Customers Are Being Squeezed on Both Ends

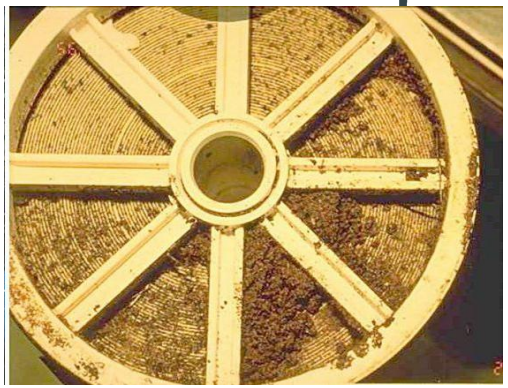
Water/energy scarcity and declining feed water quality

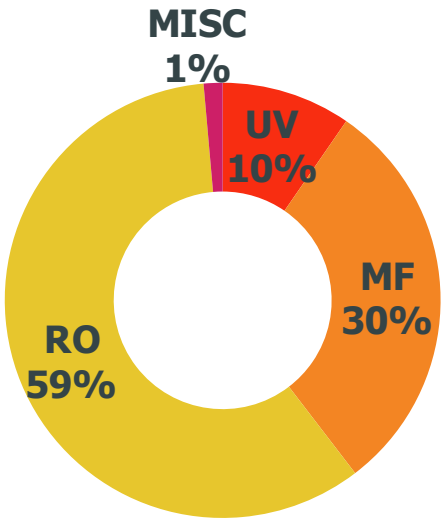
Water customers

Increasing discharge requirements / Zero discharge

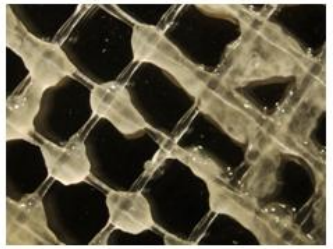


Fouling and Sustainability – An Emerging Critical topic



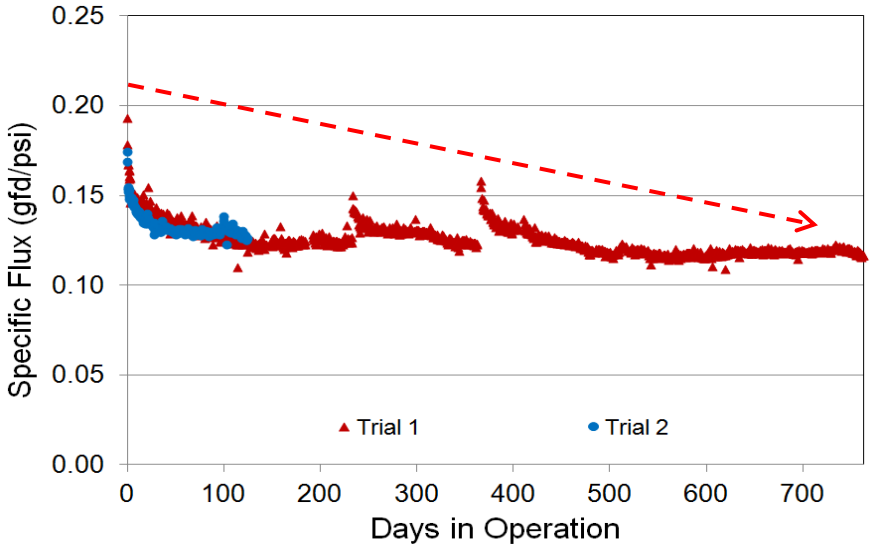


Energy cost breakdown



Biological Fouling (↑ΔP)

Organic Fouling (↑TMP)



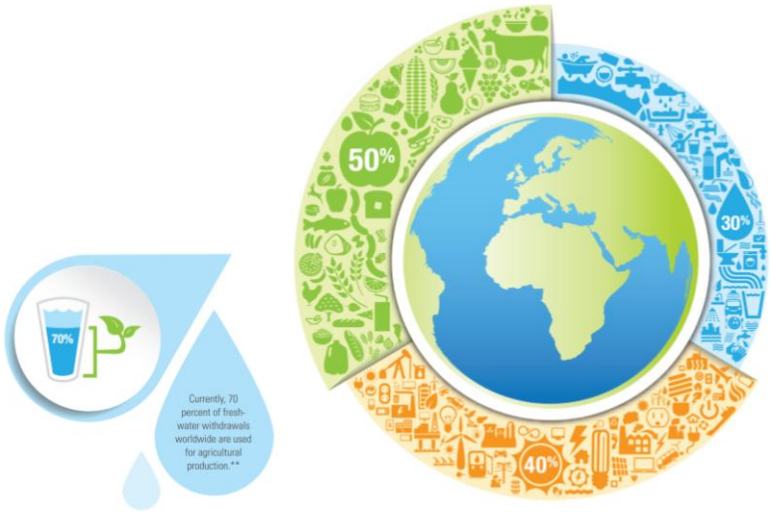
1. Energy
2. Cost of cleaning chemicals
3. Reliability

Ref: OCWD, Shu et al AWWA- 2015

Innovations in Water Treatment can optimize the Water-Energy Nexus

Research

1. Fouling control and mitigation
2. Understanding 3D structure
3. Computational high throughput research
4. Increasing discharge requirements / Zero discharge



Membranes for Life Science

Residential – Higher Productivity, Better Quality and Reduce Footprint

Salt Permeability (GFD)

0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0

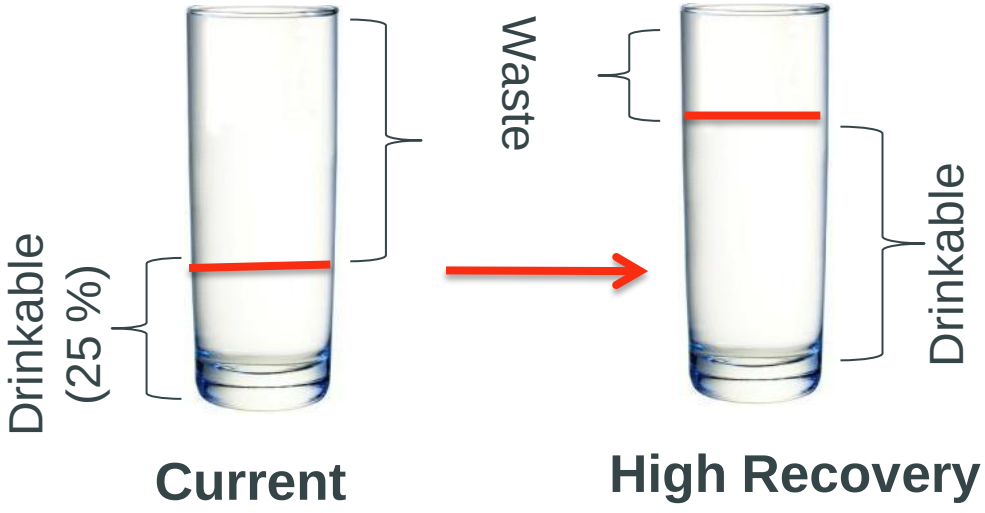
0.1 0.15 0.2 0.25 0.3 0.35 0.4 0.45

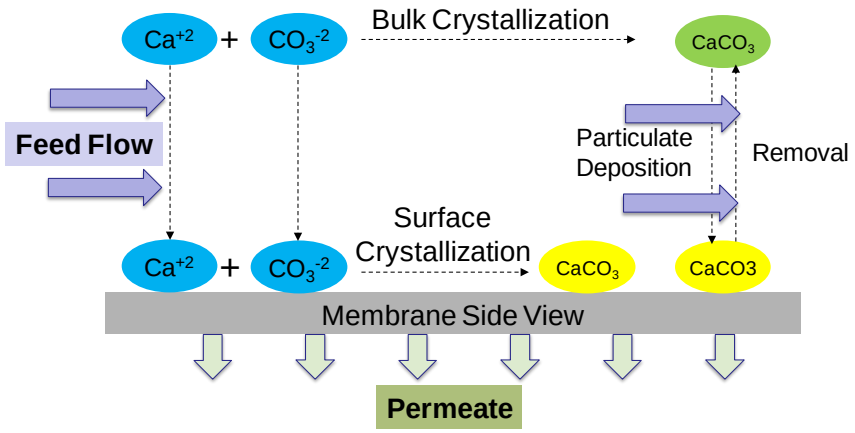
Water Permeability (GFD/psi)

70 psi
100 psi
125 psi
Ind STD
200 psi
ECO
Tankless

99.0 %
99.3 %
99.5 %
99.7 %

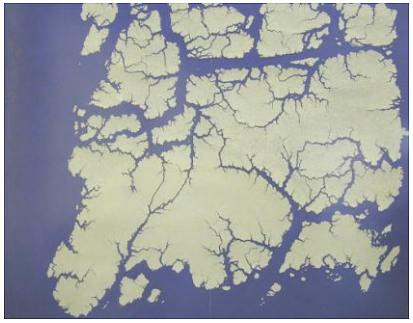
Market's Demand -High Recovery Operation





Problems

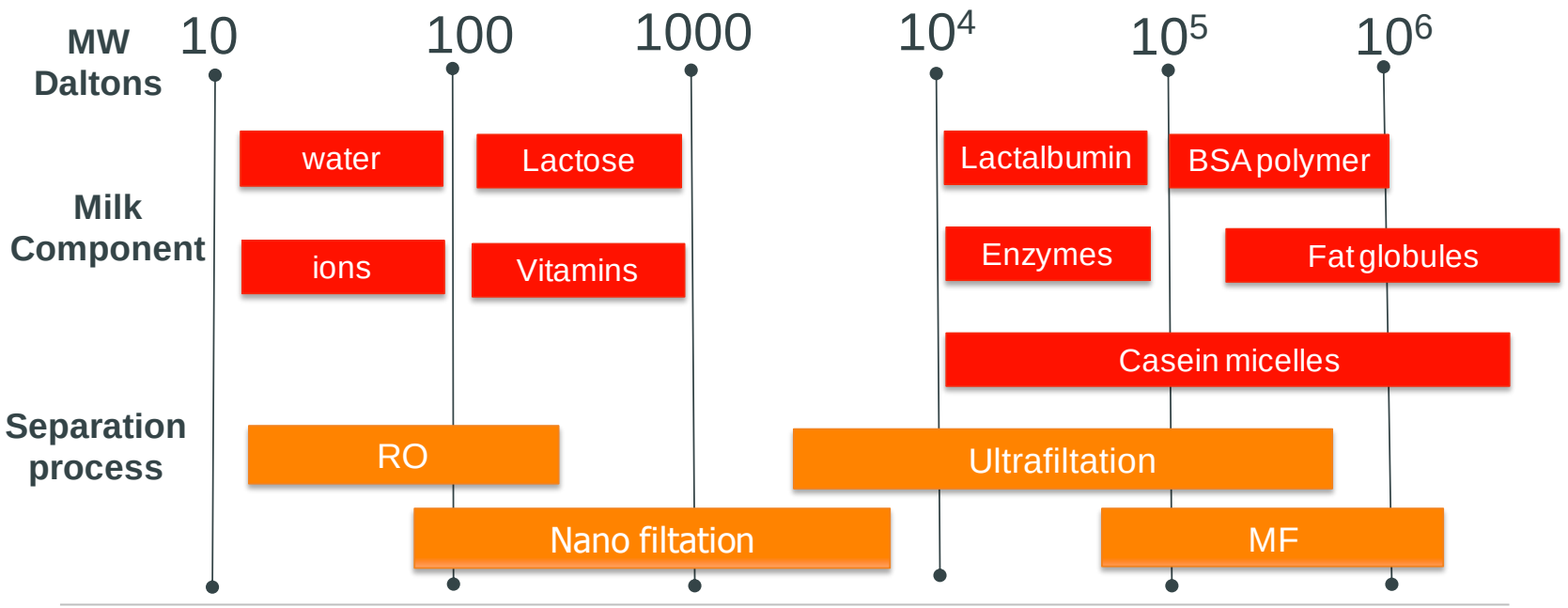
- Scaling of membrane
- System efficiency
- Application knowledge



Approach

- Improved module design
- Fundamental research around scaling

Membranes for Dairy Application



Research

1. High throughput vs Nitrogen rejection
2. Water reuse vs waste water production
3. Cleanability vs life time

Ref: Wisconsin Dairy Institute

Solvent Stable NFs for Pharma and Biotechnology

Material

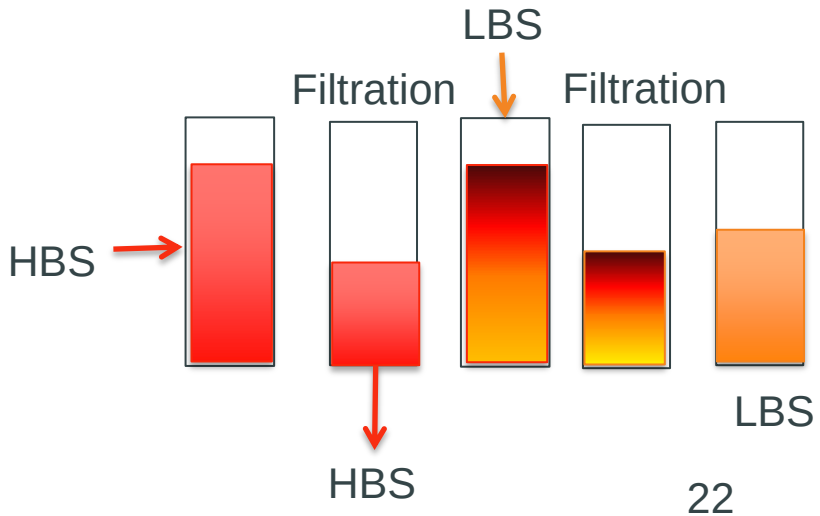
- ✓x-linked Polyimides, PDMS, Pan support

Advantages

- ✓Replace solvent extraction
- ✓Replace crystallization
- ✓Replace distillation

Challenges

- ❖Stability of membrane
- ❖Rejection dependent
- ❖solvent/solute/membrane interactions



Where Science Can Help

Addressing water availability, water quality, cost and energy efficiency