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The Role of Desalination and Water Reuse Today and in the Next Decade

Presented by

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Black & Veatch

WaterSmart08 Innovations
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Water Reuse and Desalination: The Decade Ahead, A New Era of Progress

e technology

The Next Decade

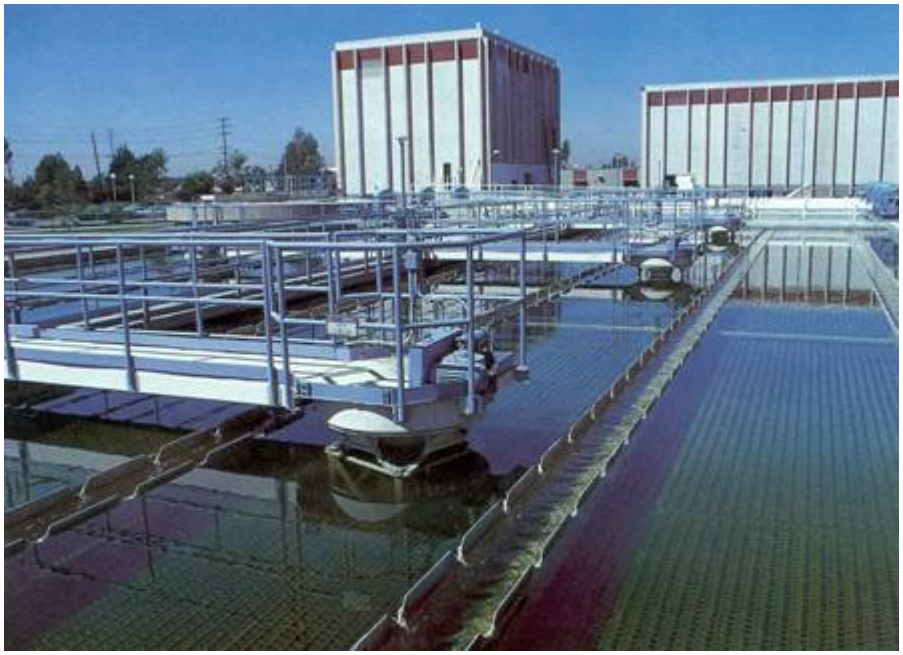
- ***Reuse – continued evolution of the treatment processes***
- ***Ocean Desalination – focus on energy management***

Water Factory 21

Santa Barbara Desalination Plant

Water Reuse Has Been Practiced for Over 30 Years in California

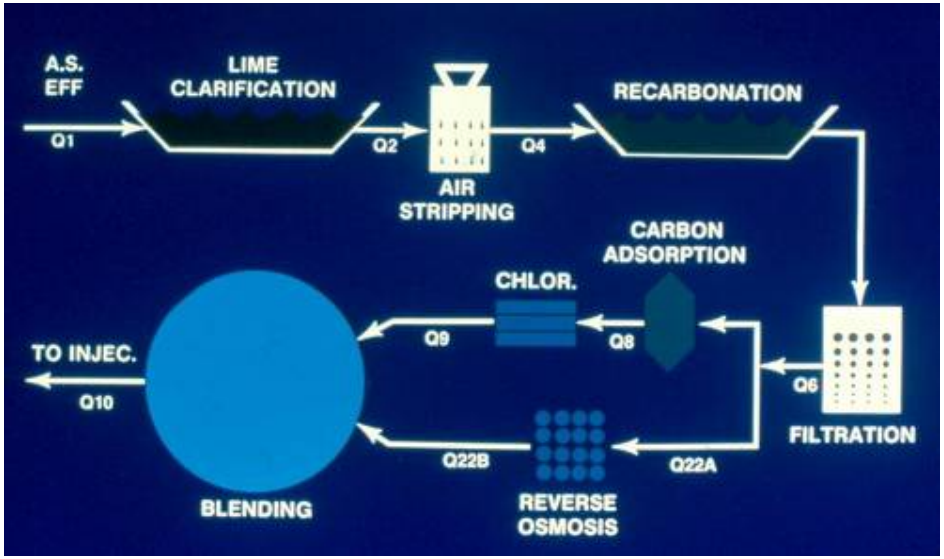
- Water Factory 21
  - First planned indirect reuse project
  - Startup 1976
  - Operated thru 2004



OCWD has expanded and replaced Water Factory 21 with the Ground Water Replenishment System project (GWR)

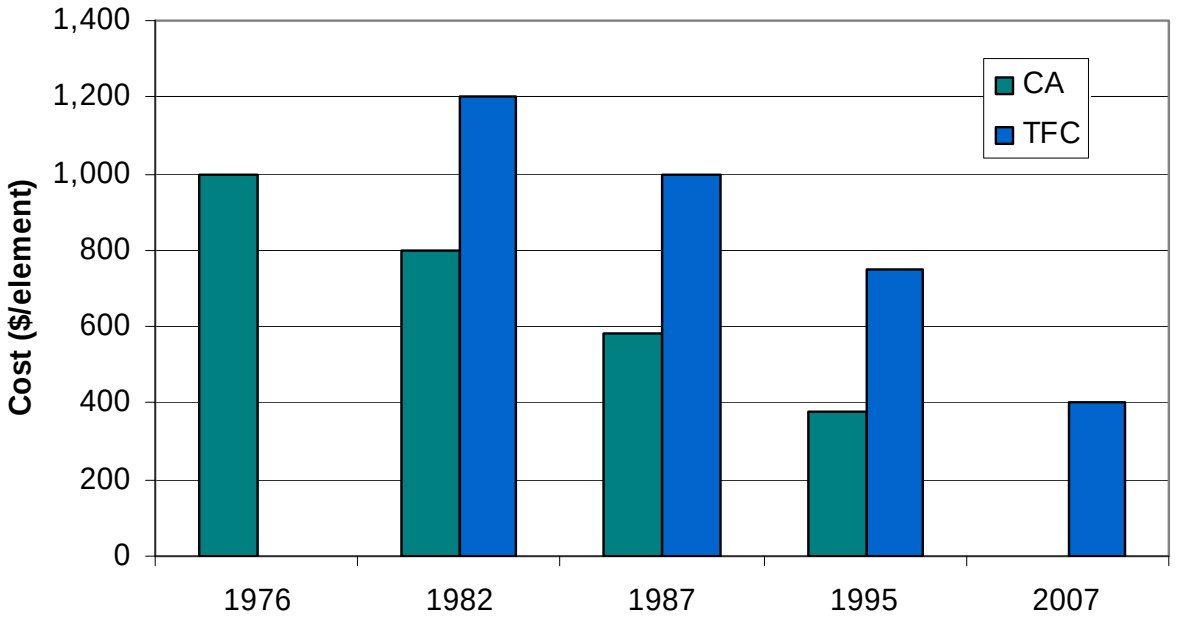
The Past Has Set the Foundation for the Future

- 1980 - 2005 saw great advancements for water reuse and desalination
- The coming decade will show even greater advancements — ***double the impact in half the time***



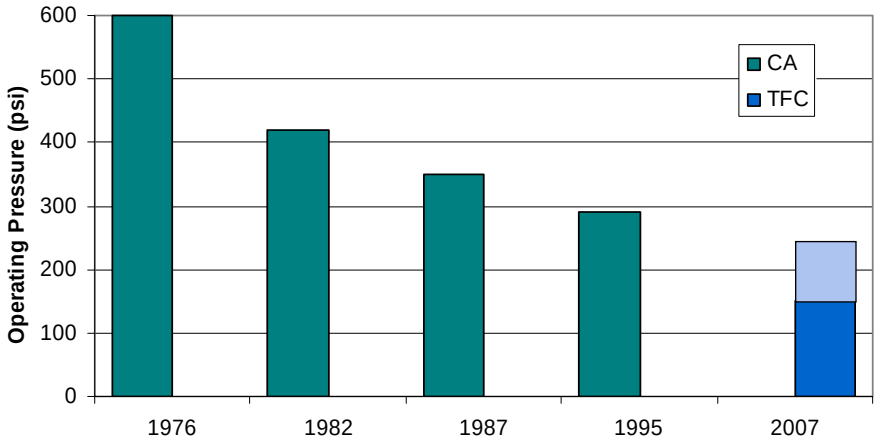
Advancements in Membrane Technology Provide Cost Savings for Reuse Projects

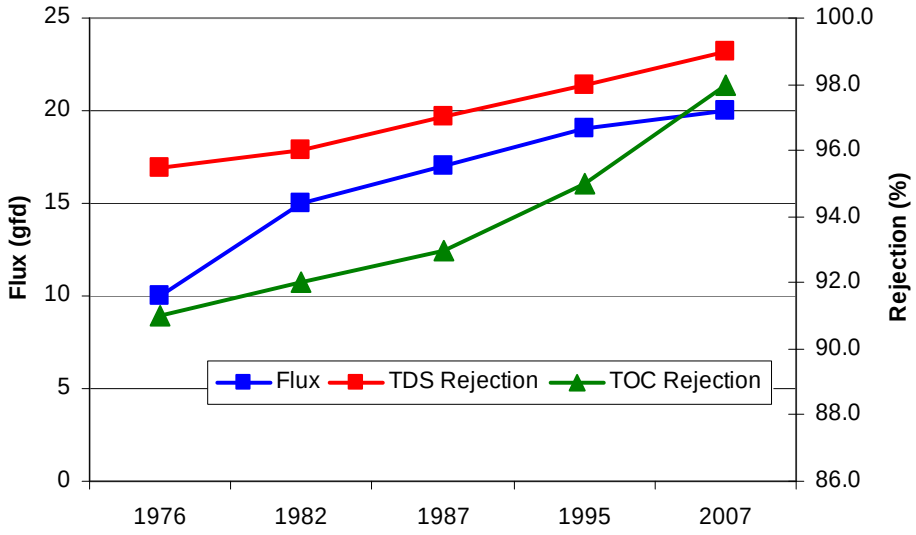
- Development of thin film composite (TFC) membranes
- Higher rejection of contaminants
- Lower operating pressures
- Hydrolysis control (extends life of membrane)



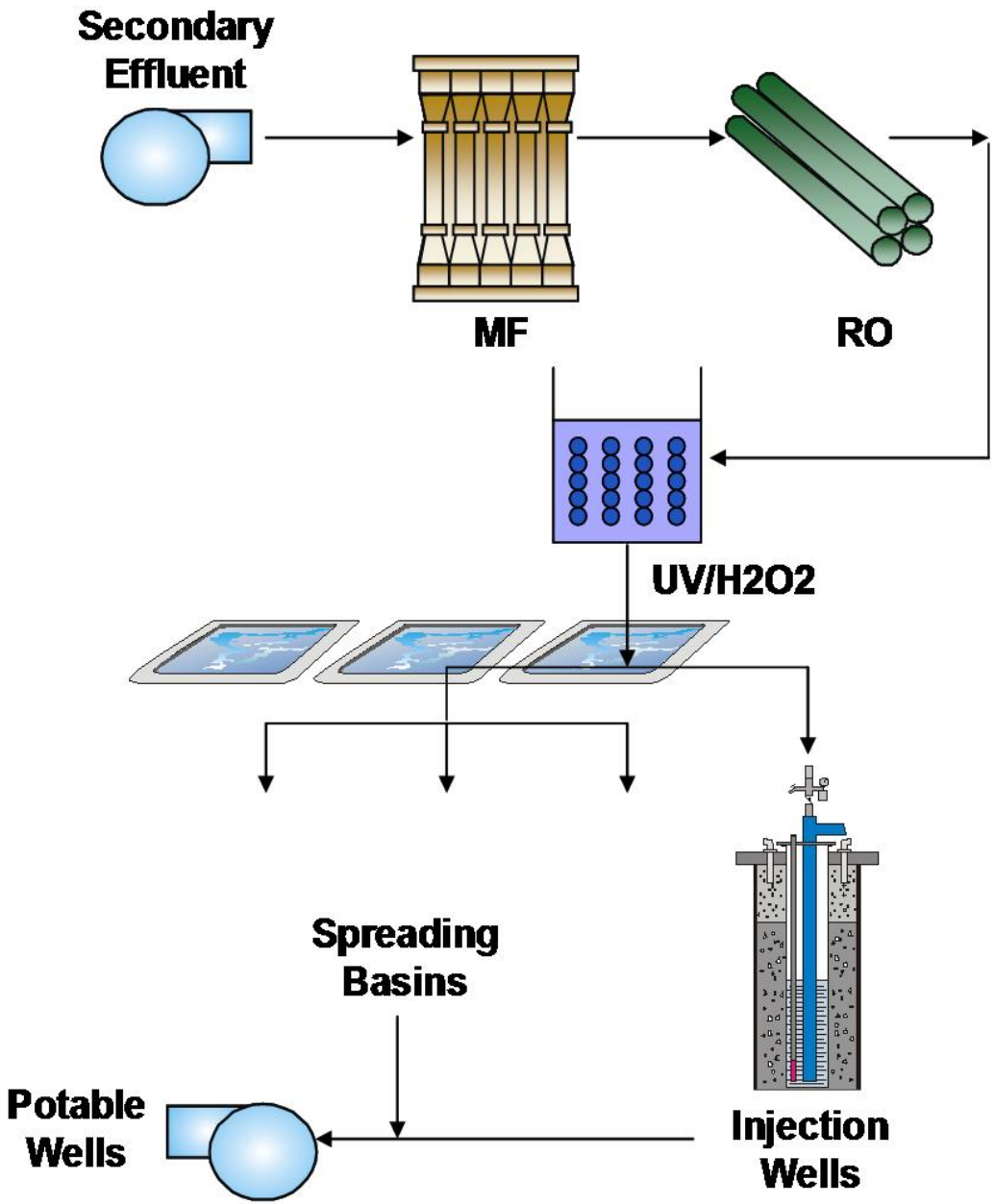
Membrane Treatment Effectiveness Is Increasing

- MF pretreatment produces “cleaner” RO feedwater and reduces cleaning frequency
- Development of TFC Polyamide (PA) Membranes
  - Wider range of flux designs at lower operating pressure

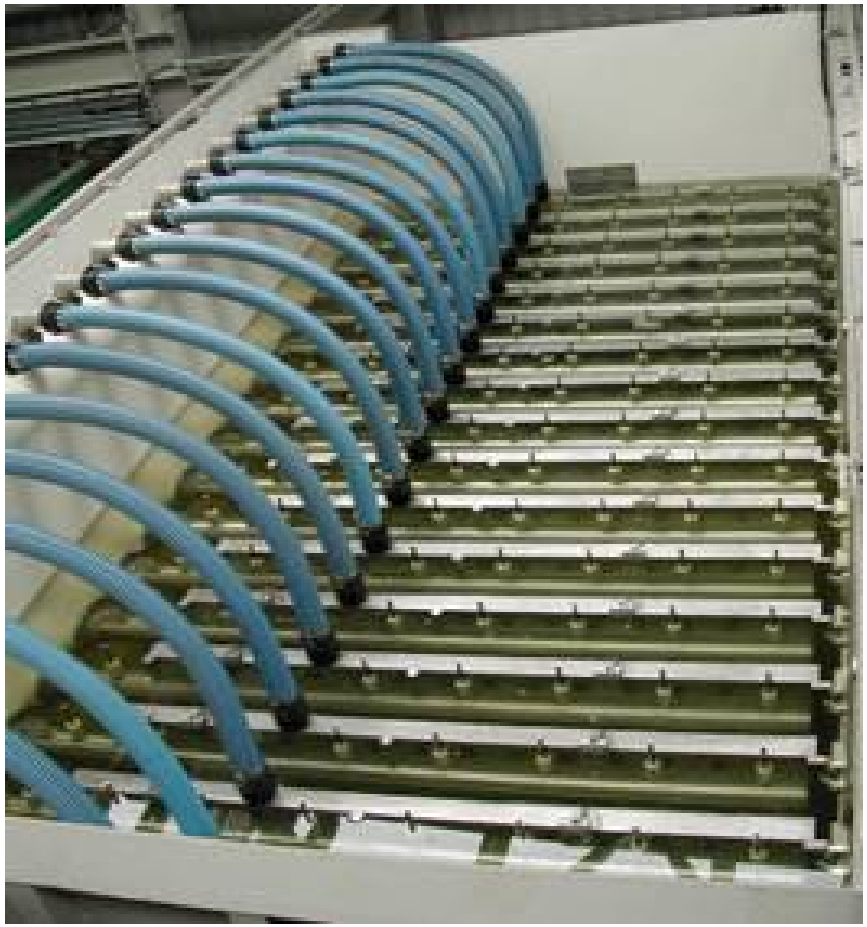




New 265 ML/d (70 mgd) GWR System – U.S. Model of the New Gold Standard for Indirect Potable Reuse



Microfiltration System

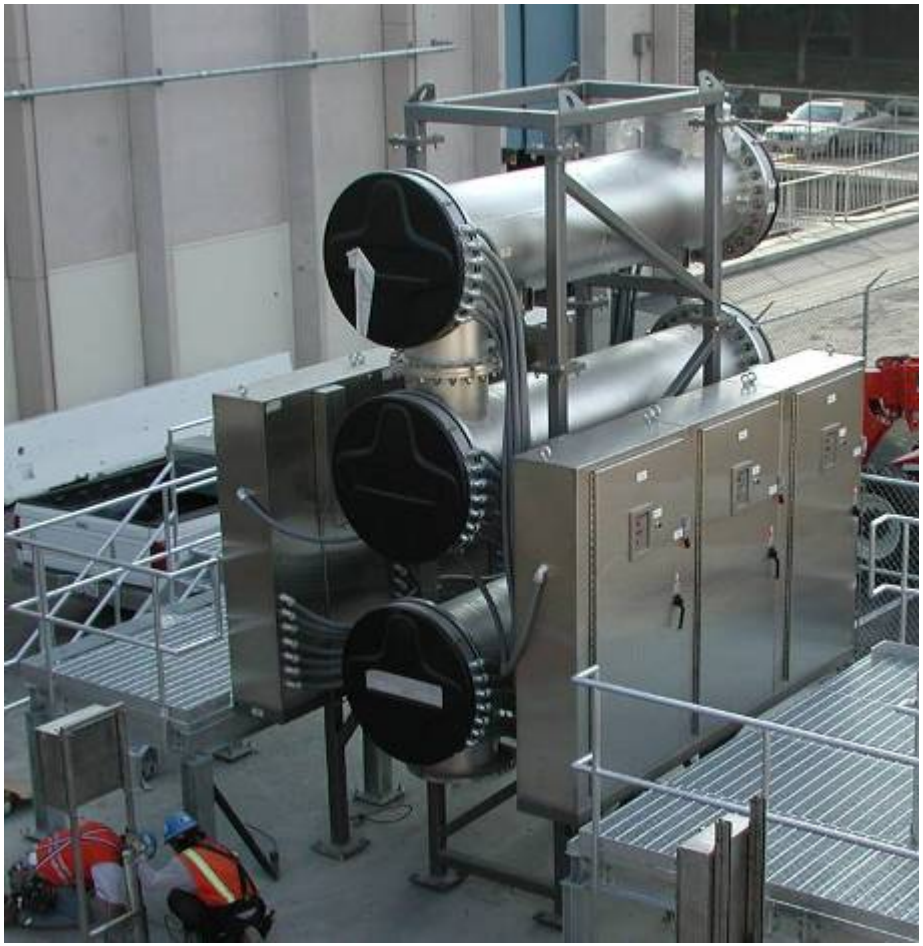


- 325 ML/d (86 mgd) US Filter CMF-S Microfiltration System
- Removes bacteria, protozoa, and suspended solids
- 0.2 micron pore size
- In-basin submersible system

Reverse Osmosis System

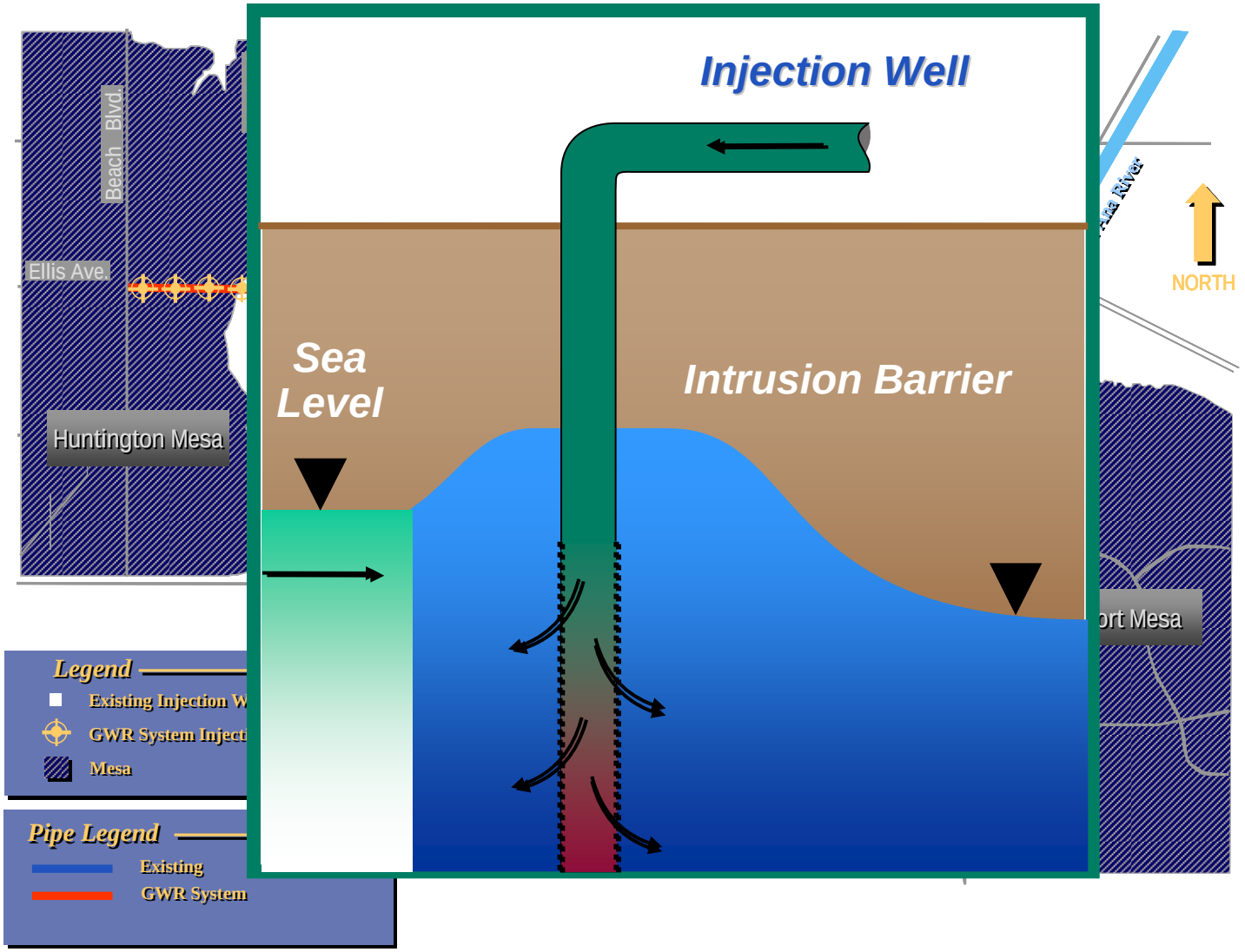
- 265 ML/d (70 mgd) reverse osmosis system
- Hydranautics ESPA-2 Membranes
- Recovery rate: 85%
- Removes salts, viruses, organics and pharmaceuticals
- Pressure range: 10-14 bar (150–200 psi)

Ultraviolet/Advanced Oxidation System

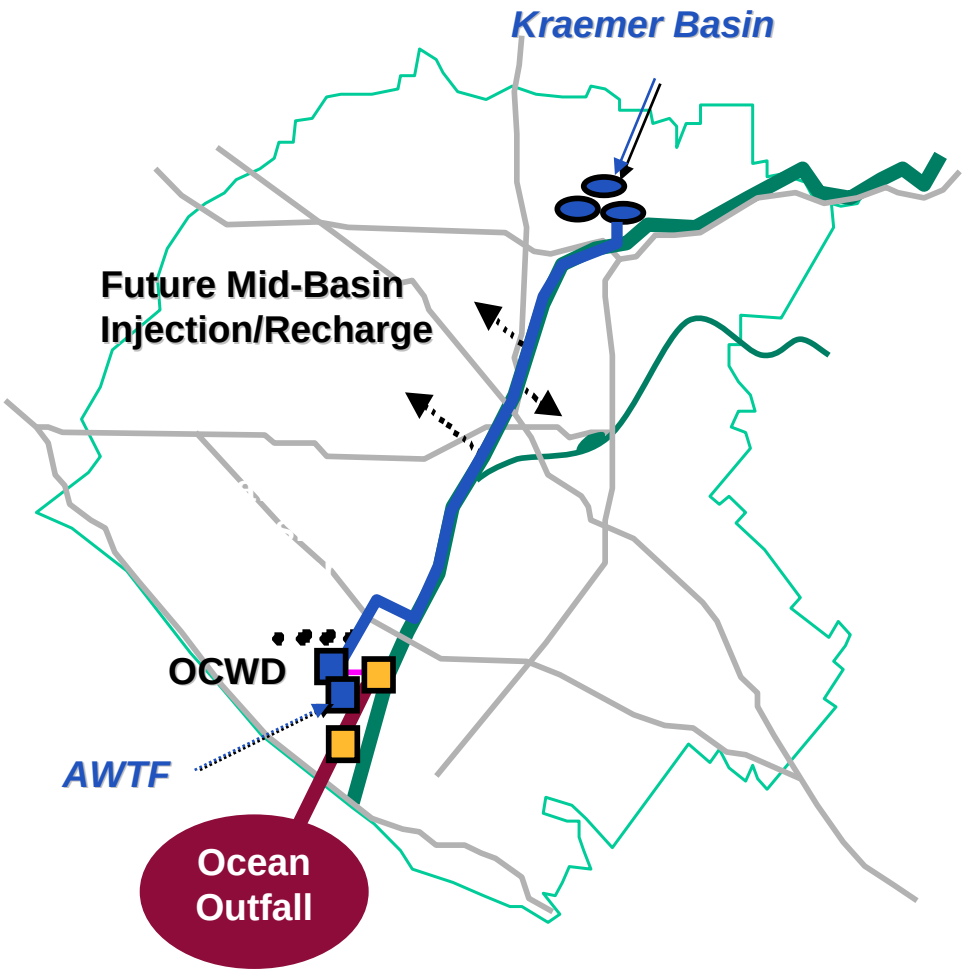


- 265 ML/d (70 mgd) Trojan UVPhox System
- Low pressure – high output lamp system
- Removes trace organics
- Uses hydrogen peroxide to form an advanced oxidation process

Seawater Intrusion Barrier



GWR Pipeline



- 22 km (14 mile) pipeline, 1.5 m to 2.0 m in diameter (60 to 78 inches)
- Sized for ultimate flow
- Future mid-basin injection
- Located along west Santa Ana River levee

Indirect Potable Reuse Projects Provide a Cost-Effective New Water Supply

Water Reuse Capital Costs Summary - GWR	
Advanced Water Treatment Plant	$305 M
Conveyance and Well Facilities	$182 M
Total Capital Cost	***$ 487 M***
Annual O&M Costs	$29.7 M
Total Unit Water Costs	***$0.75/m³ ($2.82/1,000 gal)***

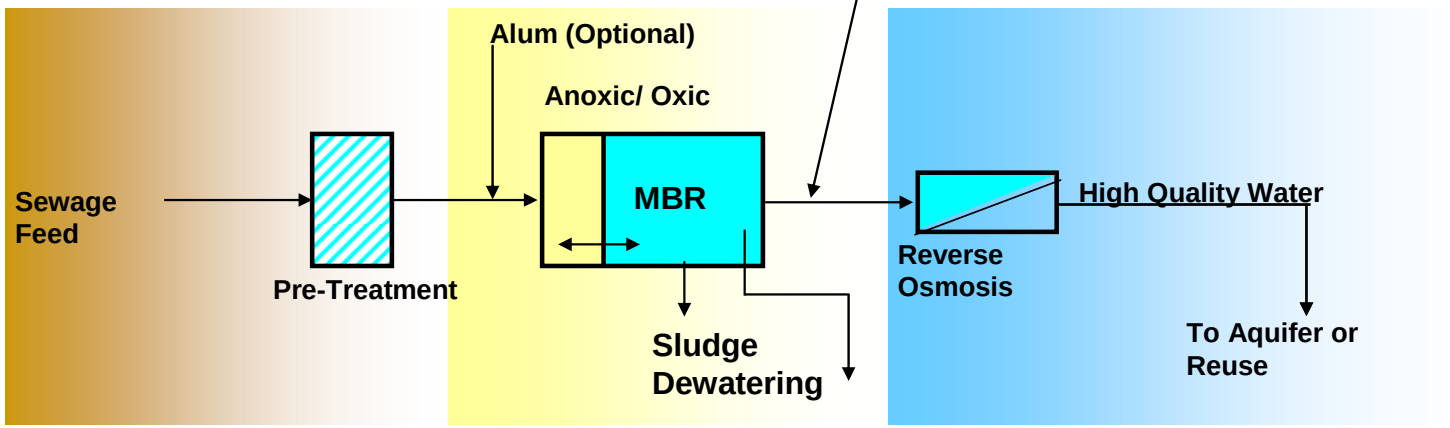
World's Largest Membrane-Based Water Reclamation Projects

LOCATION	PROJECT	CAPACITY
Kuwait	Sulaibiya	375 ML/d
Orange County, California	Ground Water Replenishment System (GWRS)	265 ML/d
Queensland, Australia	Western Corridor Recycled Water Project (WCRWP)	230 – 300 ML/d
Singapore	NeWater	200 ML/d
California	West Basin Projects	66 ML/d
Arizona	Scottsdale Water Campus	45 ML/d

What Will the Next Decade Bring for Indirect Potable Reuse?

- MBRs are highly applicable for reuse/recharge scenarios

•BOD and TSS <1 mg/L
•Turbidity ≤ 0.1 NTU
•NH3-N < 1 mg/L
•TN < 10 mg/L (with anoxic)
•TP <0.1 mg/l (with chemical)
•Fecal coliforms < 100 col/100 ml



? Public Acceptance ?

"If we could produce fresh water from salt water at a low cost, that would indeed be a great service to humanity and would dwarf any other scientific accomplishment."

JFK - 1962

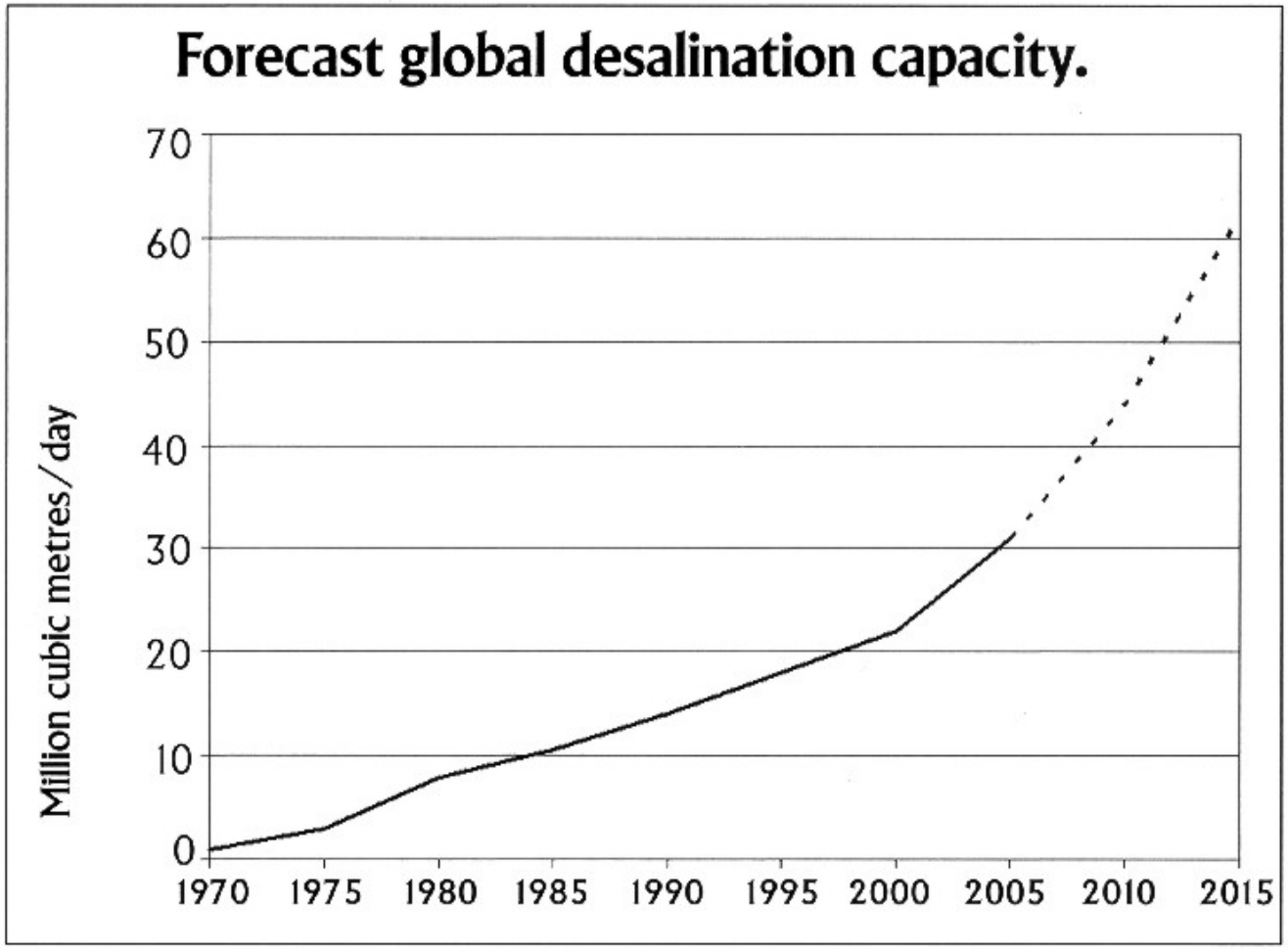
The Decade Ahead: A New Era of Progress

Membranes have been around for many years

Membranes will play a critical role in ocean desalination

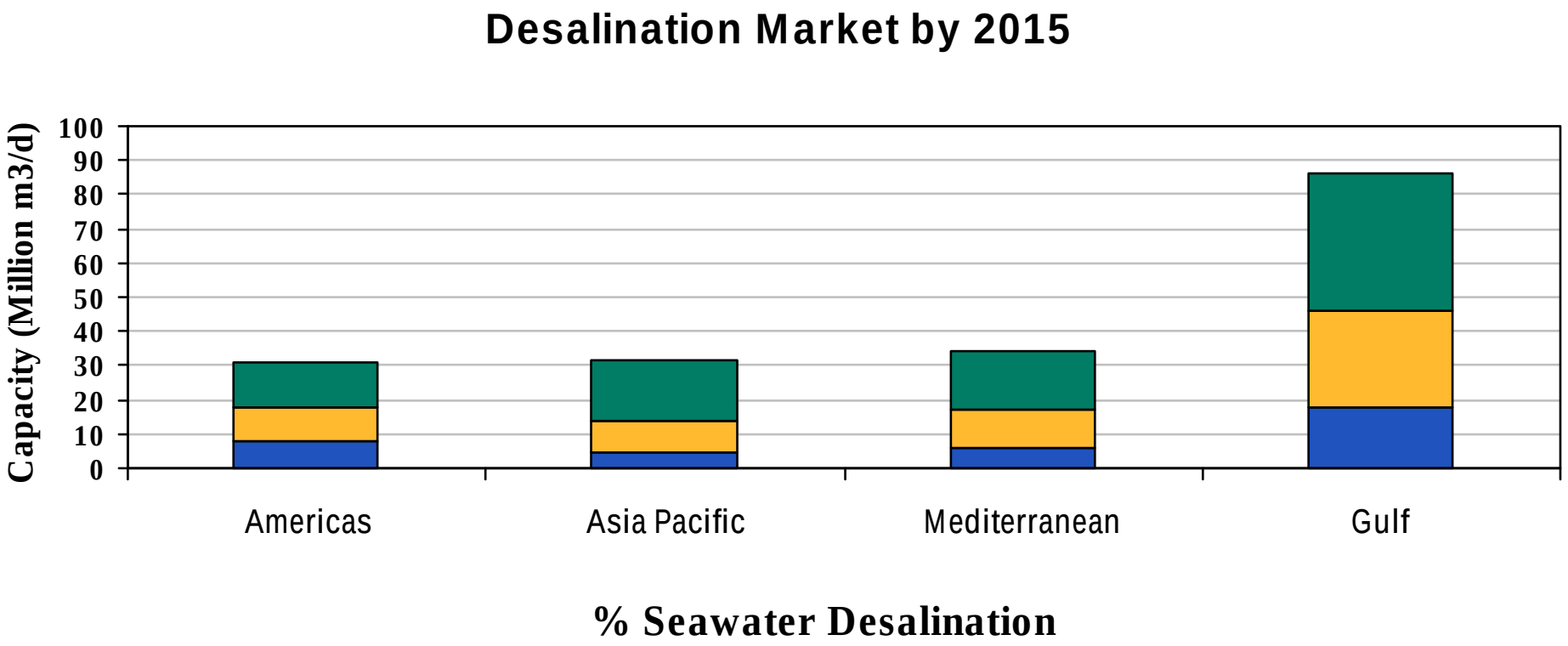
Significant growth in Ocean Desalination is forecasted and it will become global water supply practice.

In the Next Decade, Seawater Desalination Will Double



Source: Global Water Intelligence, 4/2004

Desalination Market Is Becoming a Global One



Source: Global Water Intelligence, April 2004

Climate Change Is Getting Increased Attention

- U.N.'S Intergovernmental Panel on Climate Change (Fourth Report issued February 2007)
- *The Effects of Climate Change on the Hydrology and Water Resources of the Colorado River Basin* (University of Washington – Seattle)

Water planners in the Western U.S. aren't waiting for it to rain.

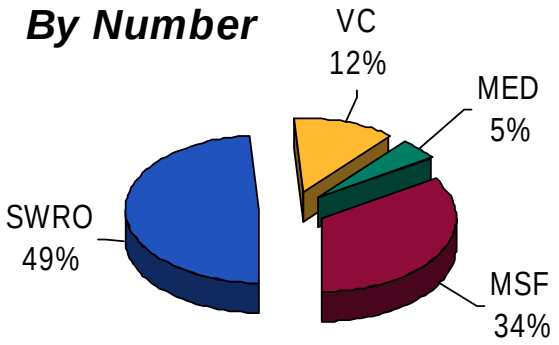
Pressure on the Colorado River System Will Drive Need for Additional Water Supply Projects

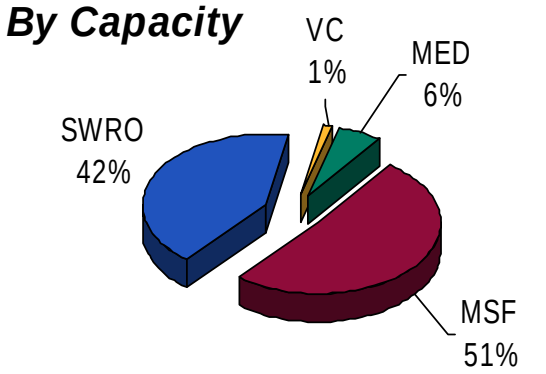
	Business as usual		
	2010 – 2039	2040 - 2069	2070-2098
Reductions in Annual Runoff	14%	18%	17%
Storage Reductions	36%	32%	40%

Ocean desalination is being evaluated to offset this shortfall.

Advances in Membrane Technology Have Driven Improvements in Seawater RO

- Advantages
  - Lower costs
  - Ideal for small installations
  - Ease of scalability
  - Lower energy requirements
  - Smaller footprint
- However ….
  - Energy costs still high

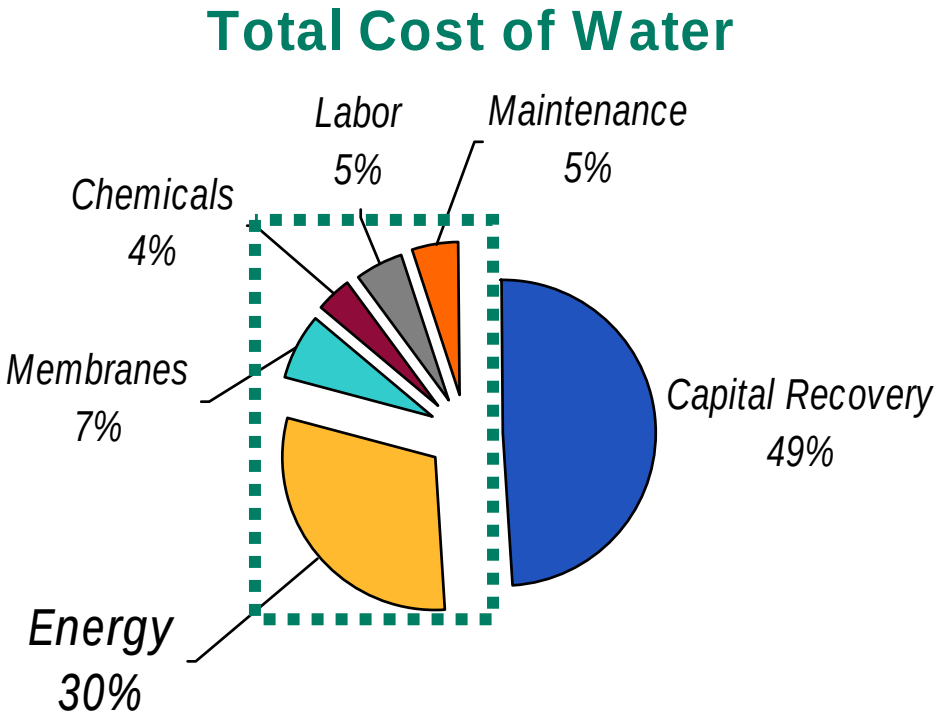




SWRO	*= seawater reverse osmosis*	*MED*	*= mechanical effect distillation*
VC	*= vapor compression (distillation)*	*MSF*	*= multistage flash*

Energy Component of SWRO Water Cost

- Energy contributes to approximately 30% of water cost
- Excluding amortization cost, energy accounts for more than 50% operating costs



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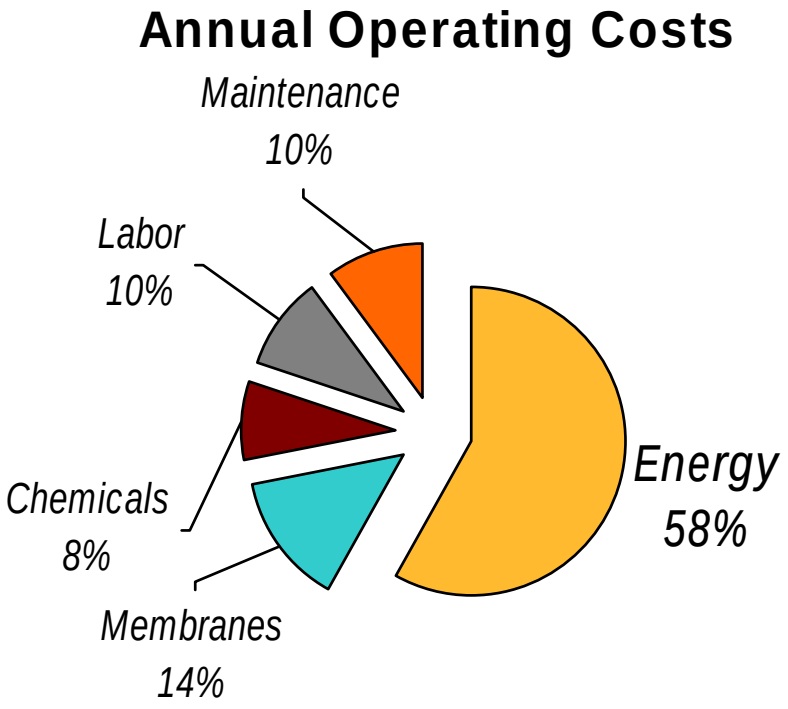

Strategies to Manage Energy Should Be a Focus for the Next Decade

- Improved Permeability
- Hybrid Process Alternatives
- Renewable Energy Sources
- Energy Recovery System

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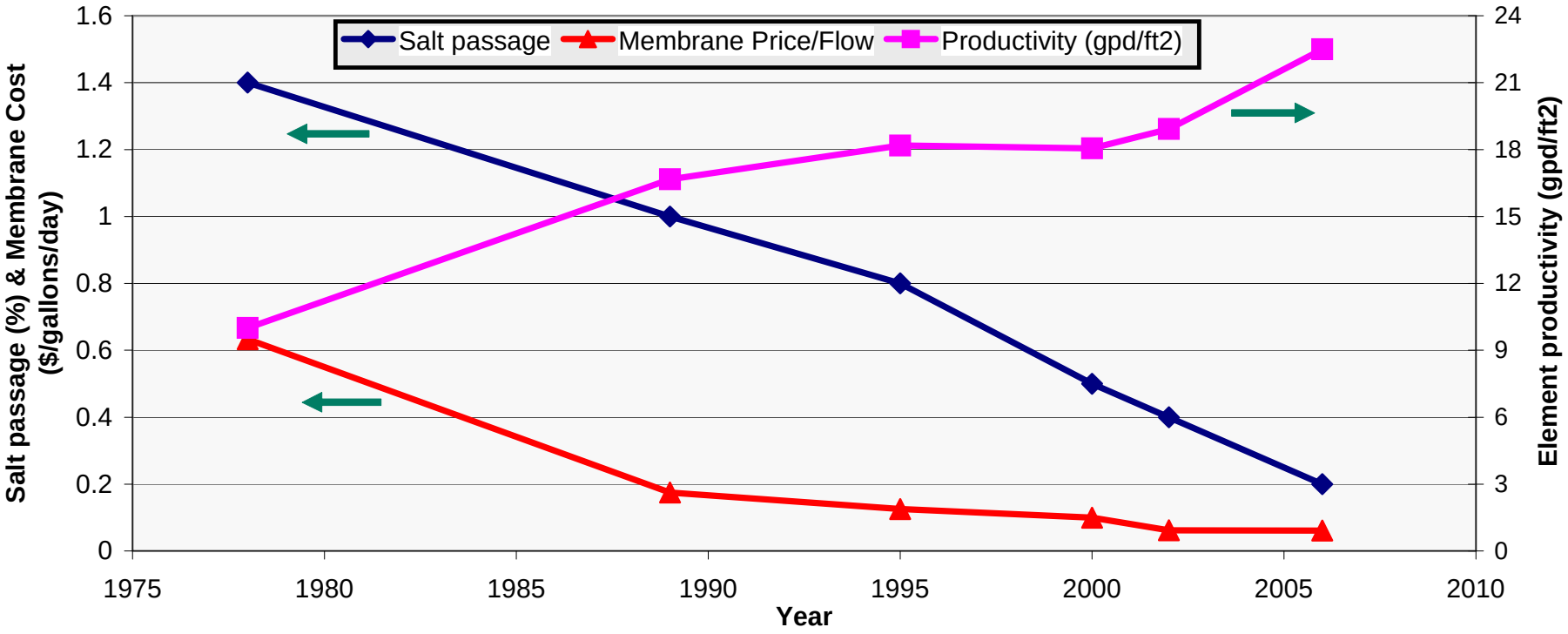
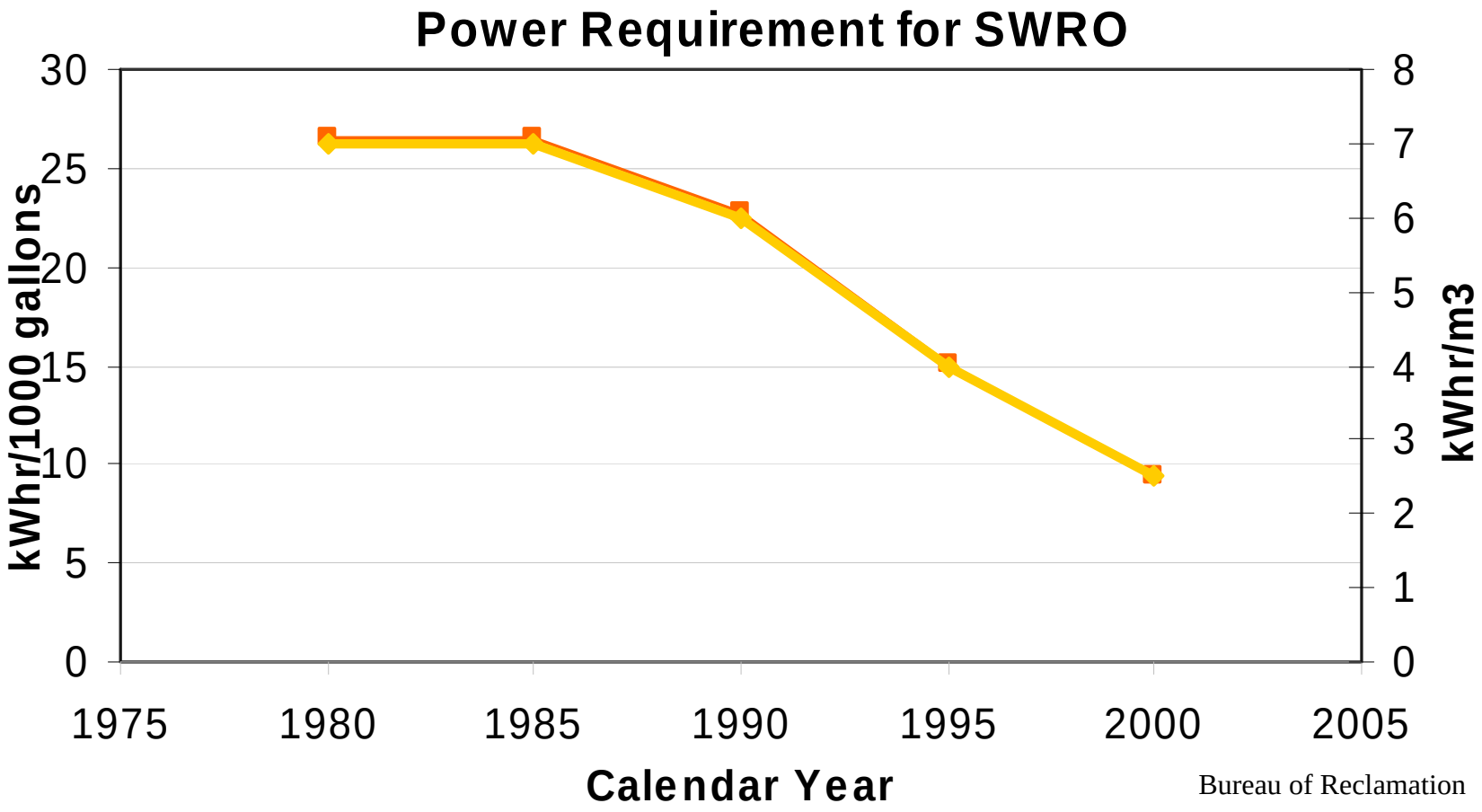
- Improved Permeability



Thirty years ago, an element with today's rejection and permeability would have cost 150 times more

Improved Permeability - RO Membrane Reduces Energy Cost



Bureau of Reclamation

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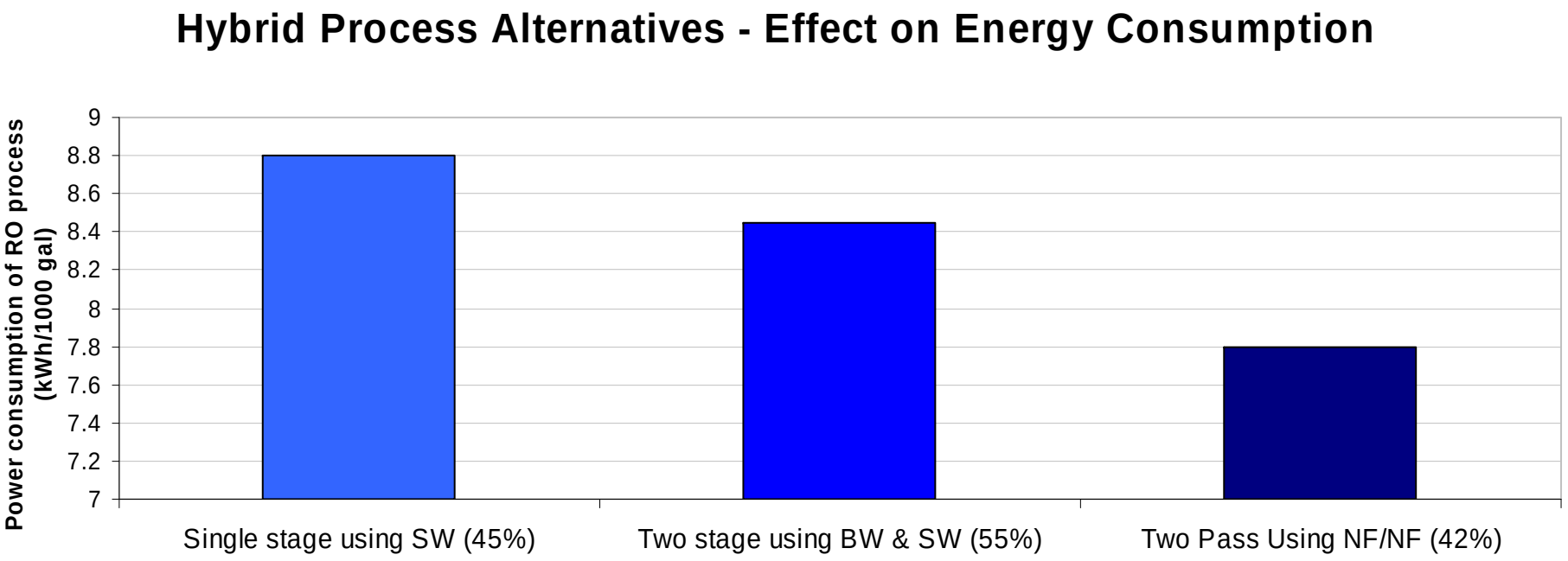

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Strategies to Manage Energy Should Be a Focus for the Next Decade

- Renewable Energy Sources – Perth, Australia

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Energy Recovery

- Positive displacement device
- Transfers energy from concentrate to feed directly
- Operating at ~95% efficiency at Tuas
- Largest DWEER installation

136ML/d Tuas Plant, Singapore

AwwaRF Project

- Recently awarded a research project titled:

  "Desalination Facility Design and Operation for Maximum Energy Efficiency"

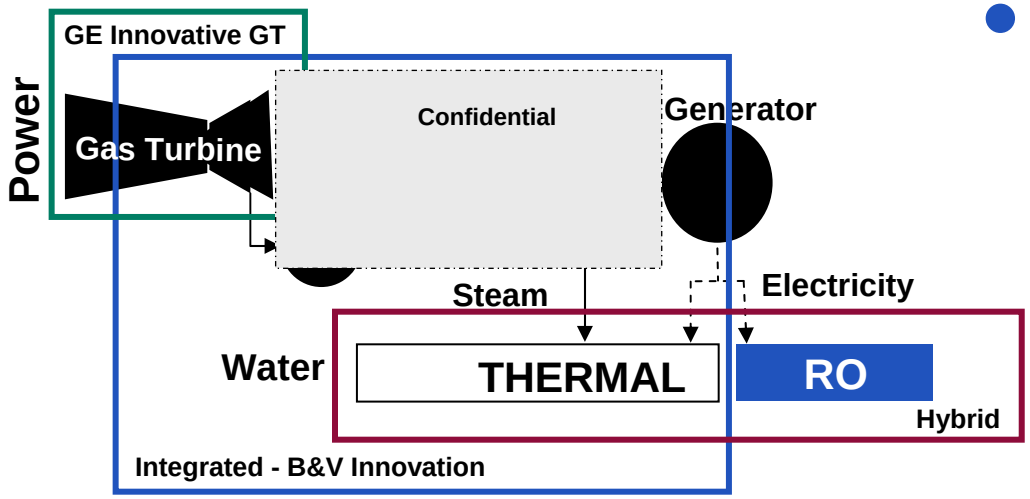
- The project will:
  - Evaluate energy efficiency of current technologies
  - Evaluate potential energy efficiency improvements and technologies
  - Encourage alliances with global partners

B&V/GE – Global Technology Leaders Are Developing an Integrated Hybrid Water and Power Plant

MARKET NEED

- Significant seasonal/daily demand variations create power-water mismatch not fully solved in the today's power water market

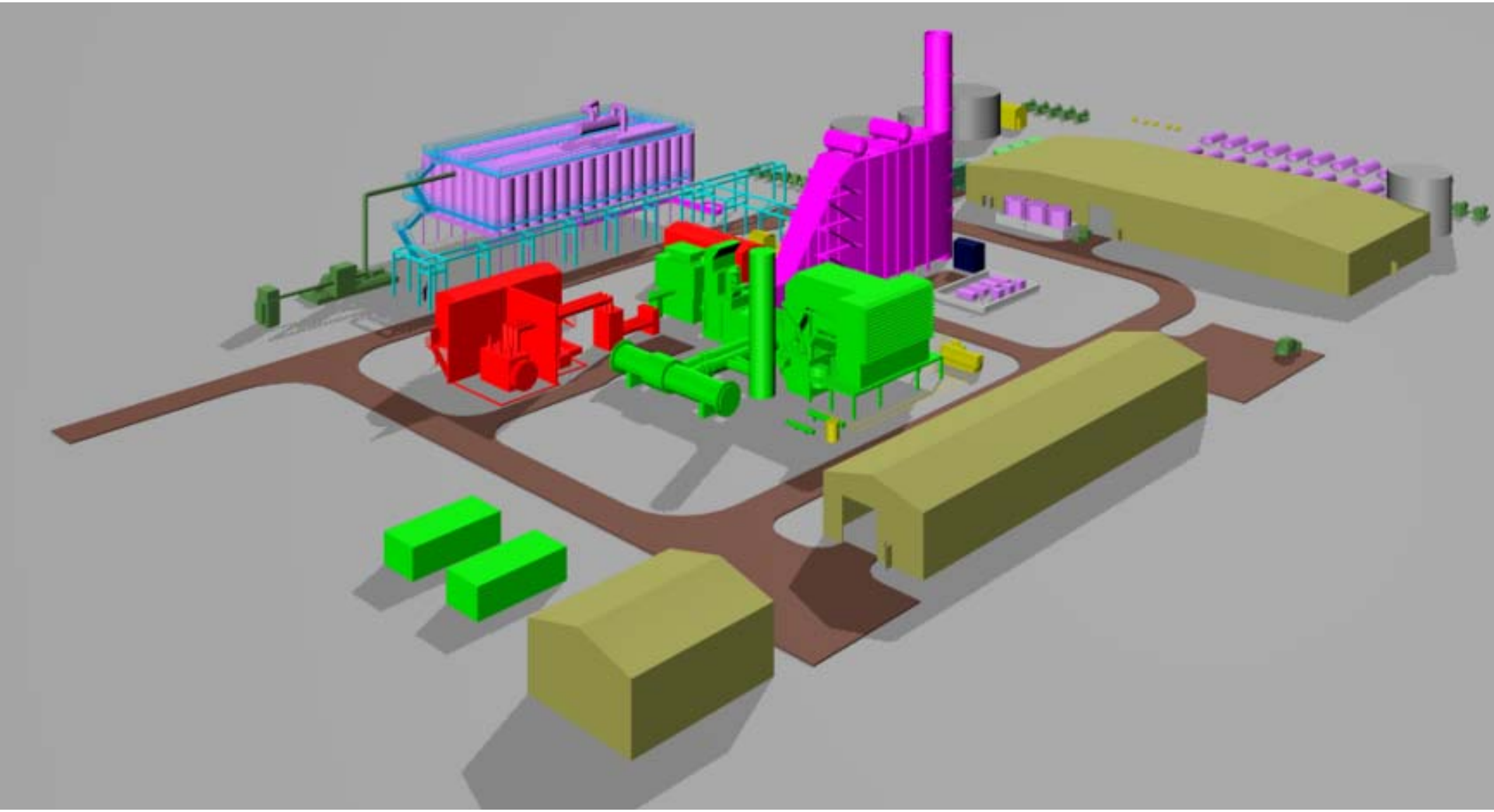
OUR SOLUTION



BENEFIT

- Operating in base load improves efficiency of power and water production
- Lowers production cost of water by utilizing waste heat

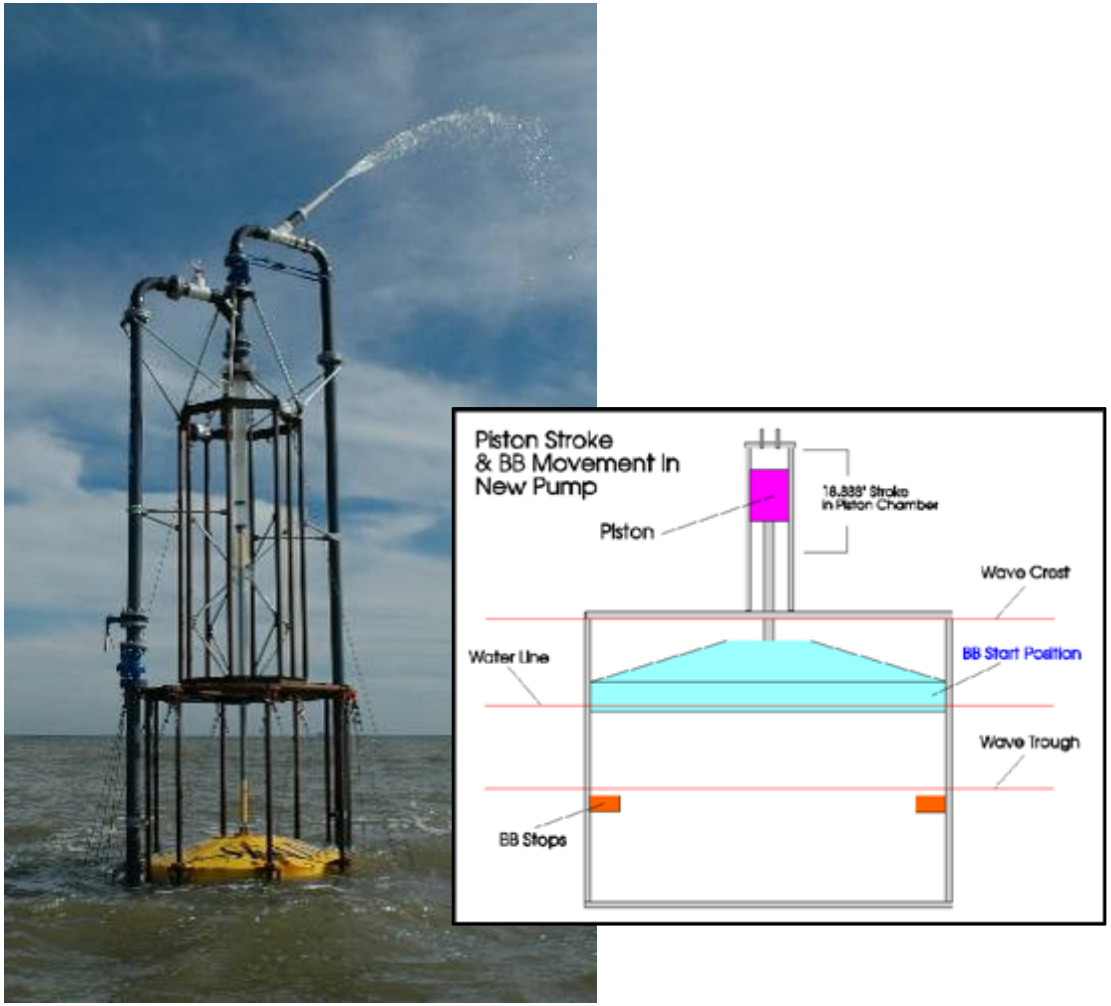
LMS100® HWPP™ Plant Overview



Trends for the *Future* Future

- Nanotechnology
- Forward osmosis
- Renewable energy
- Biofouling Control

Nanotubes



Wave Energy

Questions