

# "Desalination – the past, present and potential future technologies"



GE  
Water & Process Technologies



GE imagination at work

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Water Arabia 2009

# Presentation Outline

## Past:

- > Market Drivers
- > Key Technologies

## Present:

- > Market Drivers
- > Key Technologies

## Future:

- > Potential Market Drivers
- > Key Technology Enhancements
- > New to the World Technology Development



# The Past

## Market Conditions:

- **Evaluation Criteria:** capital cost driven
- **Product Quality:** Drinking water standards primarily US EPA or region specific...Boron is not a concern
- **Discharge:** Brine discharge a non-issue
- **Market Conditions:** some water scarcity in arid regions

# The Past

## Technology:

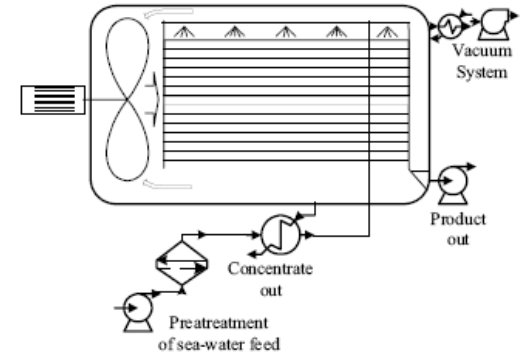
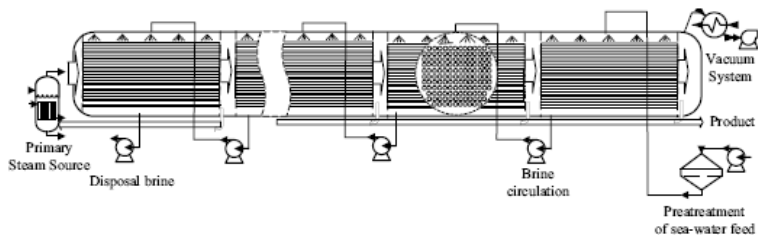
- Thermal was king

## Market Leaders:

- OEM's lead the charge and are the experts

## Multiple Effect Distillation:

- > Saltwater sprayed over hot tubes
- > Vapor collected to heat the tubes
- > Vapor condenses and is collected as potable water
- > Resulting brine collected and is circulated to next effect or exited from system



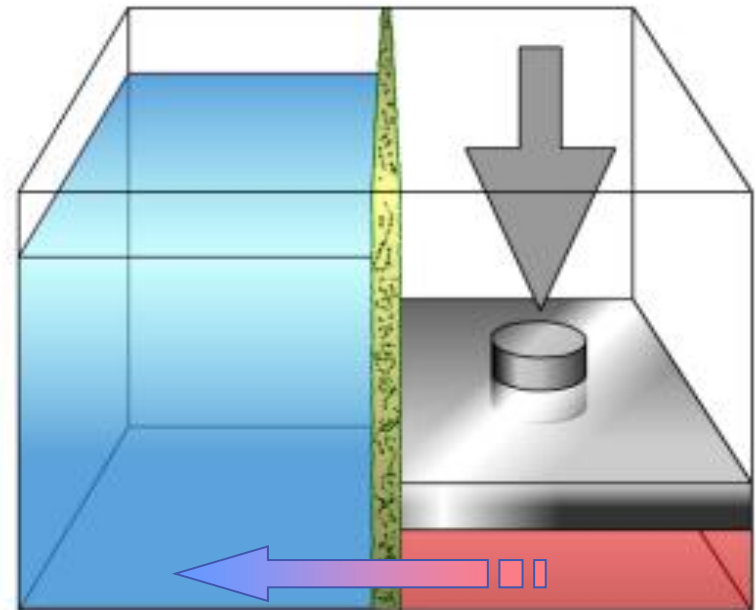
## Thermal Vapor Compression (TVC):

- > Works as first effect of multiple effect evaporation
- > Steam jet ejector compresses vapor for the tubes in the first effect
- > Condenser responsible for condensing the vapor to the final product
- > Increases MEE performance ratio when combined with MEE.

# The Past

## RO Technology:

- > Reverse Osmosis (RO) reduces dissolved solids in waters of up to 45,000 ppm TDS (Total Dissolved Solids)
- > Semi-permeable membrane removes impurities through reversal of natural flow through the membrane
- > The applied pressure (P) must be greater than osmotic pressure of the dissolved contaminants to allow flow across the membrane
- > Pressure ranges from 100 – 1200 psi depending on the type of membrane and feedwater quality



# The Past

## SWRO:

### > Membranes:

- Membranes cost > \$1000/element
- Rejection and production were 99-99.5%
- Flux levels SWRO <4000 gpd (15m<sup>3</sup>/d)

### > Pretreatment:

- Conventional, pressure filters, clarifiers, gravity filters
- Pressure vessels were in limited supply and quite expensive
- Materials of construction for SWRO was 316L...all others were too expensive or too new and unproven

### > Energy Recovery Devices:

- Limited ERD tech - Pelton or Francis wheels

### > Pumps:

- High pressure pumps limited in capacity, lower efficiencies and 316L grade materials, PD pumps are utilized

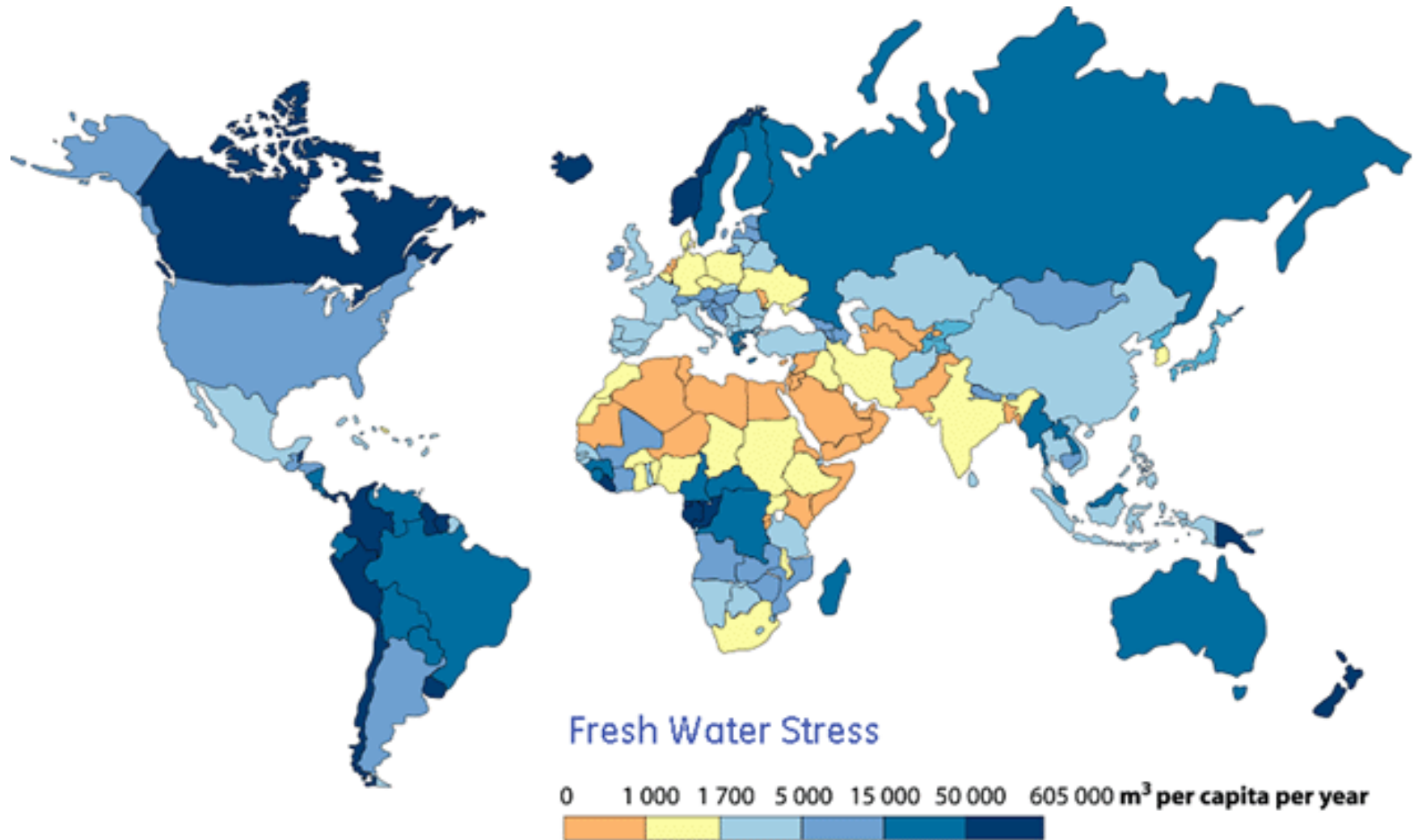


# The Present

## Market Conditions:

- > **Evaluation Criteria:** Life cycle costs critically evaluated ...power consumption is ~58% of operating costs
- > **Product Quality:** Drinking water standards focus on WHO and EPA guidelines worldwide...Boron is a concern outside the USA
- > **Discharge:** In NAM tight monitoring on brine discharges and their environmental impact...global environmental focus growing
- > **Market Conditions:** Water Scarcity is a major issue ...Australia, USA coasts, Middle East, North Africa, Israel, Spain; IWPP plants growing rapidly as concept proves itself in developing economic regions

# Significant water scarcity exists today



Source: World Resources 2000-2001, People and Ecosystems, World Resources Institute (WRI), Washington DC, 2000

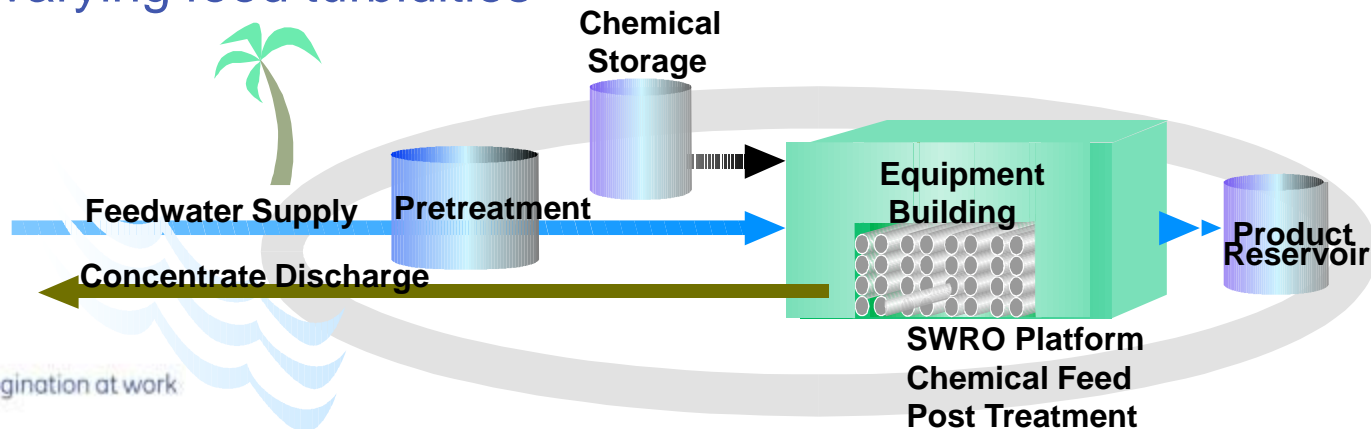


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# The Present

- > **Technology:** Sea Water RO is dominant in most markets
- > **Market Eng Leaders:** OEM's continue as experts through extensive operating experience, but consultants repositioning to become experts, by running pilots, producing reports/papers, moving into the system operations market
- > **Pretreatment:**
  - Conventional is still employed
  - More use of DAF seen
  - UF in market and under evaluation for true benefits - excels in varying feed turbidities







# Clarifier Channels



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# The Present

## SWRO

### > Membranes:

- Membranes cost < \$500/element
- Rejection 99.75% and productivity >6000 gpd
- Specialty membranes available on low energy and high boron rejection

### > Pressure vessels

- In wide supply. New configurations allow OEM's to reduce piping costs. Larger diameter vessels in development

### > Materials of construction for SWRO

- duplex, super duplex, and super austenitic...316L, 317, 904L

### > Energy Recovery Devices:

- Wider variety and in all SWRO systems...WX/PX, Turbo, Pelton, Francis...work exchange technology becoming primary ERD of choice. WX/PX appear to be moving towards rotary direction. Pelton and Turbo excel in low cost of power regions or in special applications where interstage boost is required

### > Pumps:

- HP Pumps - now available in 2x the size of the Hamma pumps, best available efficiencies are ~87%



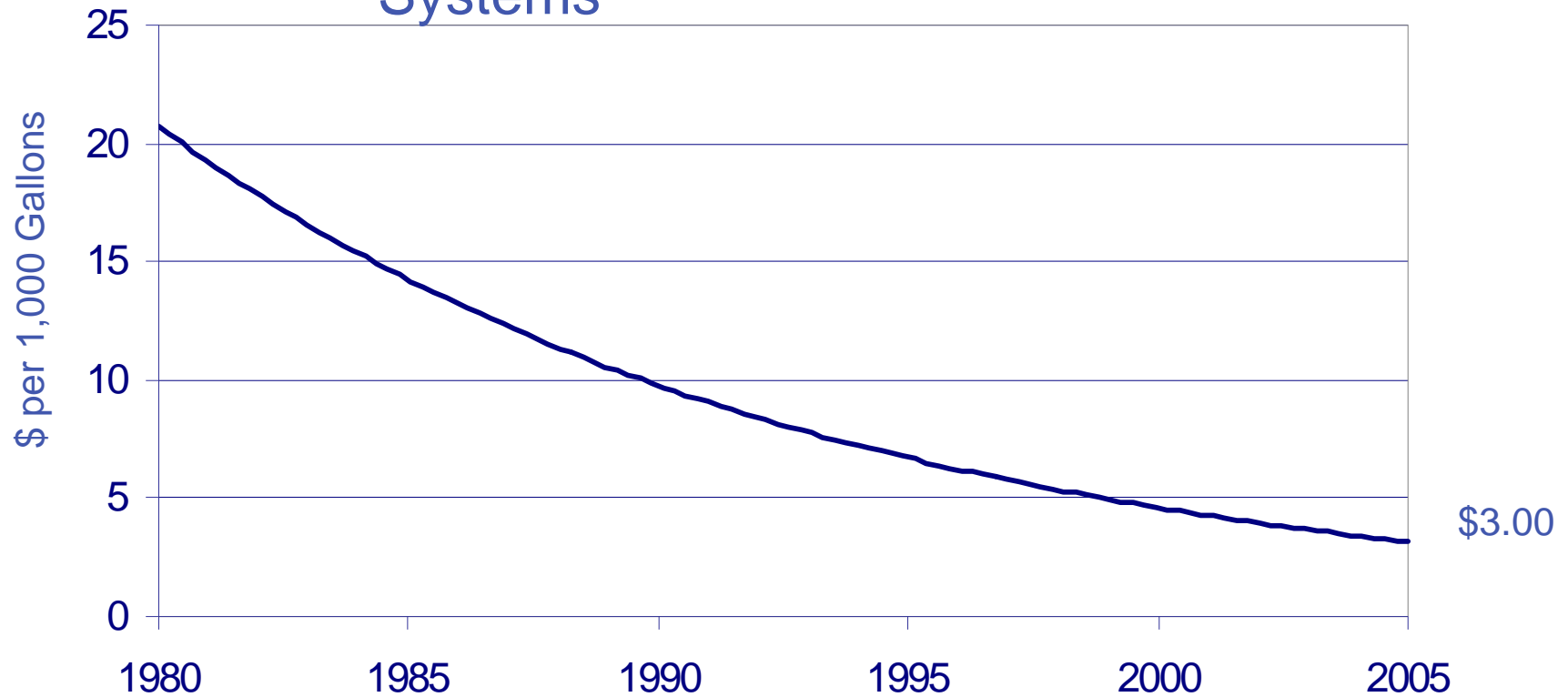
1Q08 Commission

200,000 m<sup>3</sup>/day

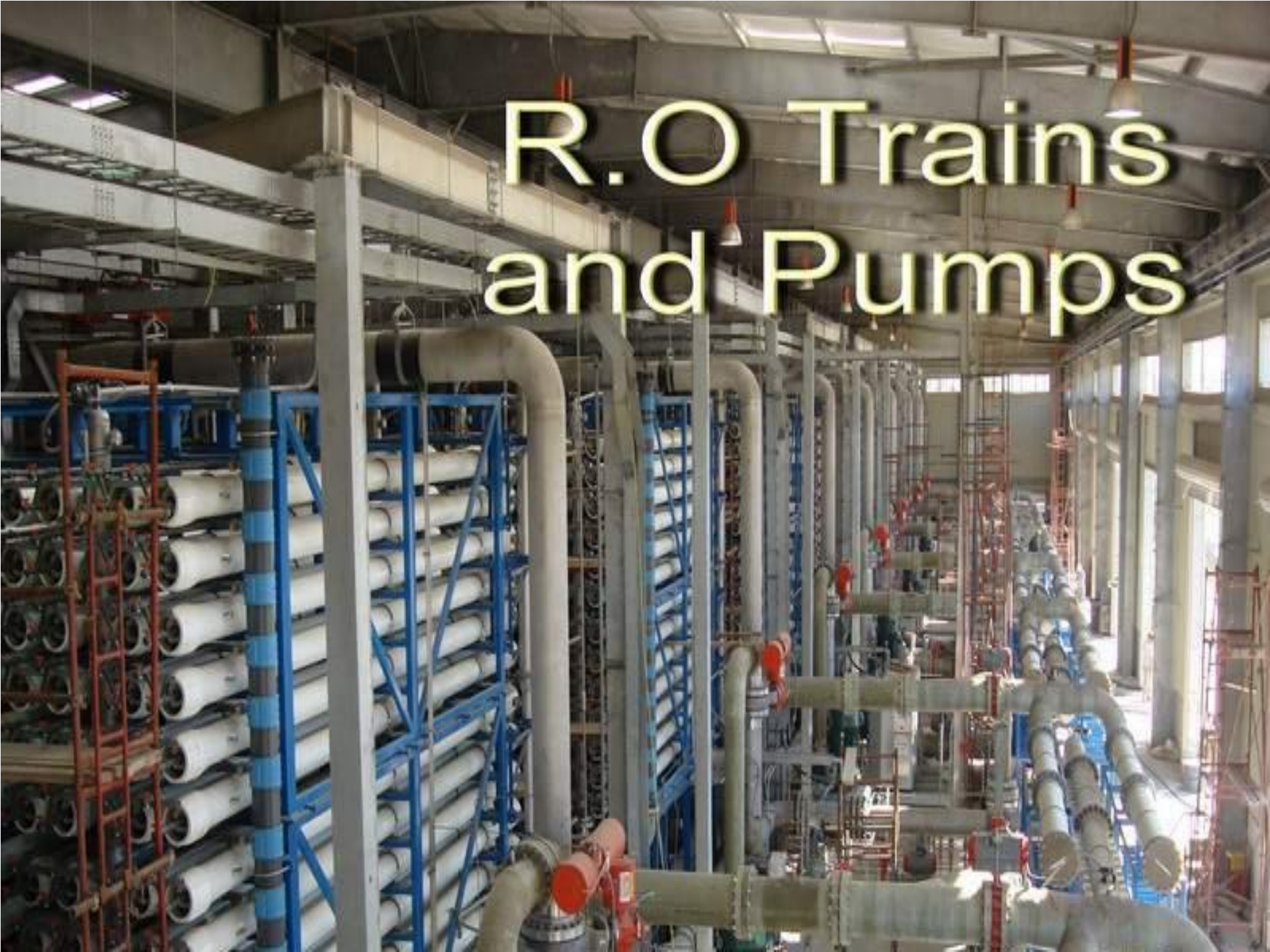
# Seawater Desalination



## Total Water Costs for Large Systems



# R.O Trains and Pumps



# The Future

“The ability to lead innovation will be the primary management focus for this decade.”  
Jeff Immelt

# The Future



## Market Conditions:

- > **Evaluation Criteria:** Life cycle costs evaluated in all applications
- > **Product Quality:** One global standard
- > **Discharge:** Brine discharge of continual focus with ZLD and the benefits of mineral extraction production
- > **Market Conditions:** Desal continues to grow as developing countries realize link between water and economic development. Future economic development in developed countries tied to water availability. Alternate sources of water will be utilized (i.e.. WWR...toilet to tap, etc). Greater global focus on green technology and carbon neutral foot prints
- > **Market Eng Leaders:** More partnerships between OEM's, EPC's and A&E's develop as businesses realize synergies and level of expertise... potentially more co-developed projects between competing OEM's



# Maturity of the Market and Suppliers:

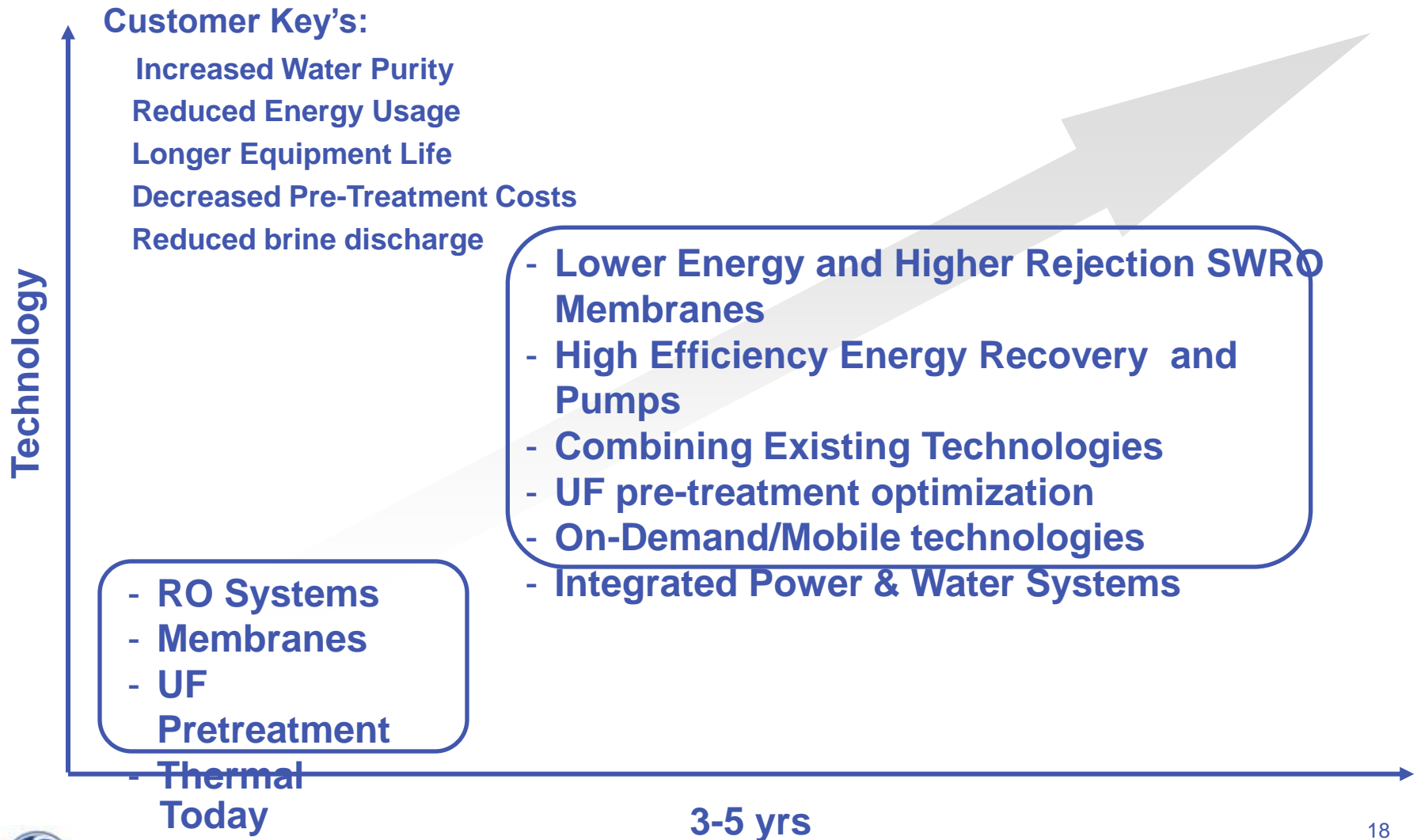
- > Market consolidation creating scale
- > Investment in Core Technology and Growth
- > Common designs and approaches to standardized product offerings
- > Capital Costs
- > Operating Costs
  - Energy
  - Consumables
  - Feed Water
  - Waste Water



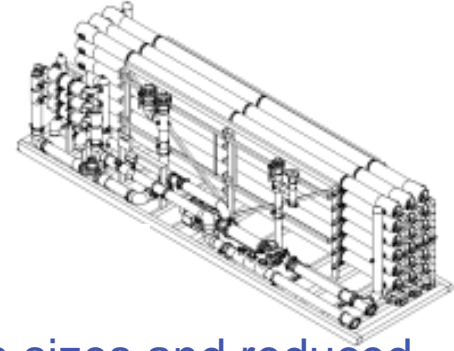
China Technology Center  
Shanghai, China



# Advancing Water Scarcity Technology



# The Future: SWRO



## Membranes:

- > Costs flat or declining – automation, global manufacturing
- > New membrane mechanical configurations to increase system sizes and reduced pressures: 16” diameter and/or other?
- > Investigation in new membrane chemistries with lower pressures, better Boron rejection, more productivity from enhanced flux rates

## Pressure vessels

- > Market investigates the packaging of RO systems and opportunities for cost reduction/simplification

## Materials of construction for SWRO

- > Continued development on lower cost materials to limit market fluctuations

## Pre-treatment:

- > Greater acceptance of MF/UF as long term life cycle benefits realized.... product costs decline with increased commoditization and competitive with conventional

## Energy Recovery Devices:

- > ERD tech continues to evolve - larger in capacity, broader capacity ranges/applications, less mixing/leakage loses, simpler, more reliable.

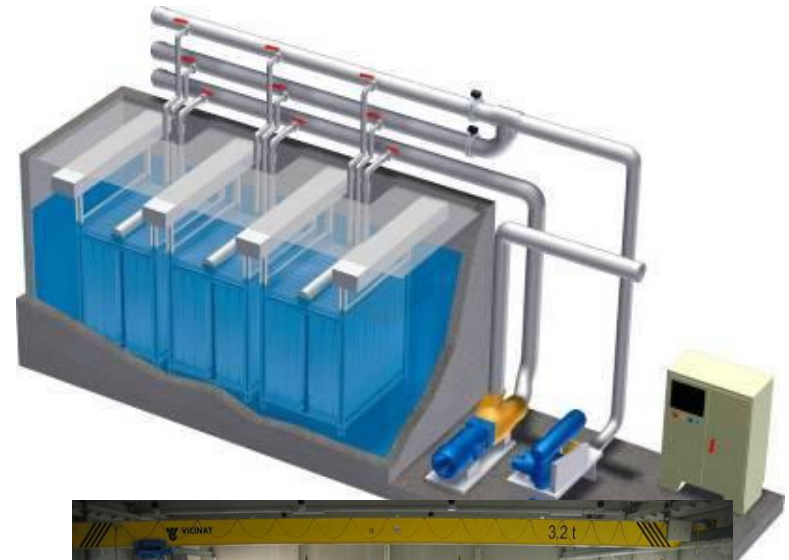
## Pumps:

- > Increasing efficiency, reliability and potentially new materials of construction

# Desalination Solution: UF+SWRO

## Benefits

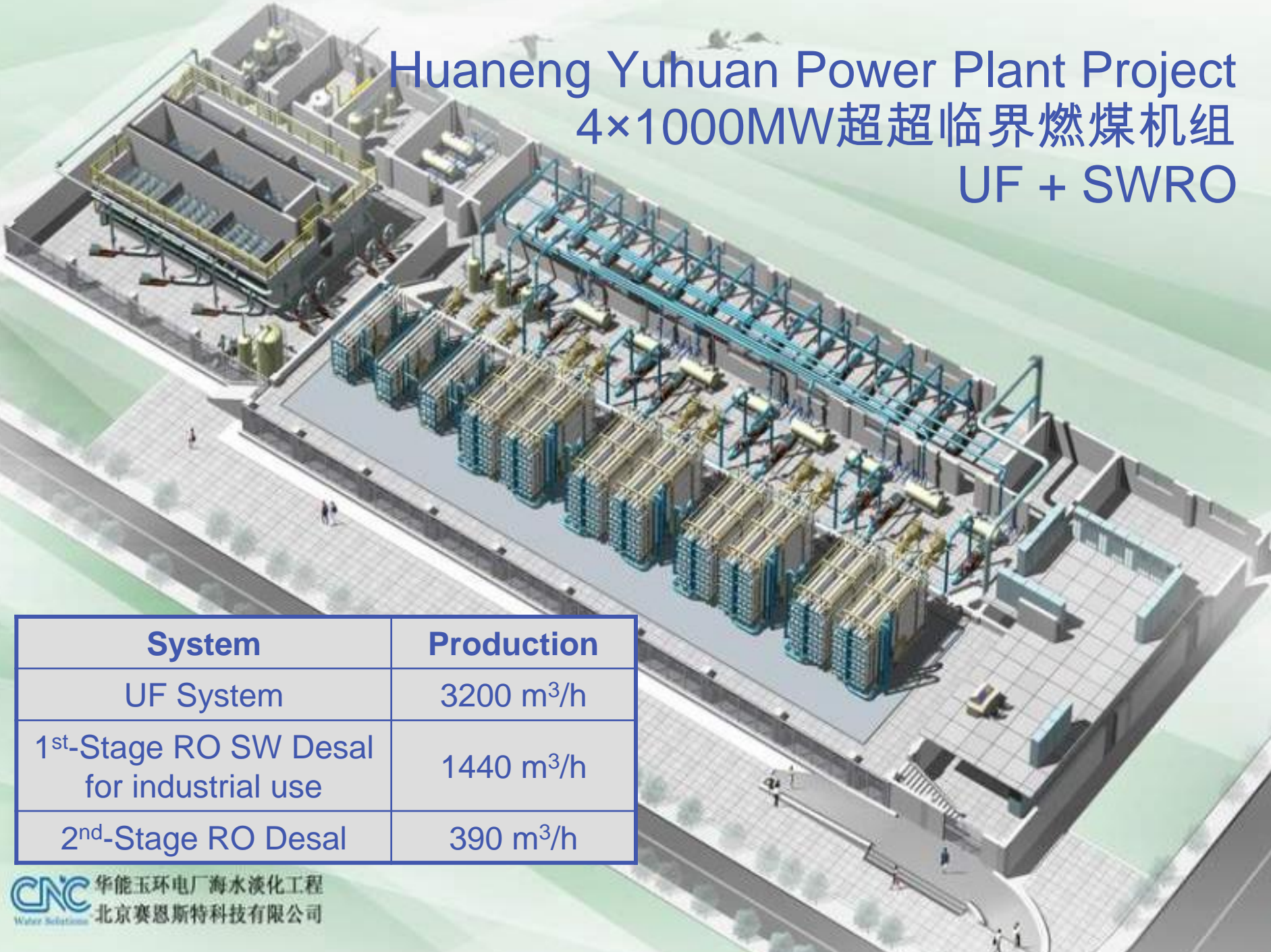
- > Process simplification
- > Superior RO system protection
- > Handles variable feedwater qualities
- > Reduced operating costs
- > Reduced footprint and civil work



# Huaneng Yuhuan Power Plant Project

## 4×1000MW超超临界燃煤机组

### UF + SWRO



System	Production
UF System	3200 m <sup>3</sup> /h
1 <sup>st</sup> -Stage RO SW Desal for industrial use	1440 m <sup>3</sup> /h
2 <sup>nd</sup> -Stage RO Desal	390 m <sup>3</sup> /h

# Efficient Power- Water Generation: Hybrid Desalination

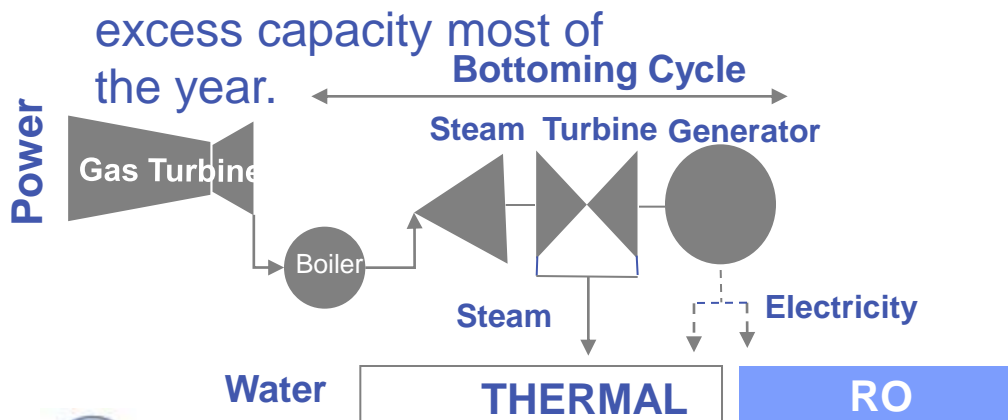
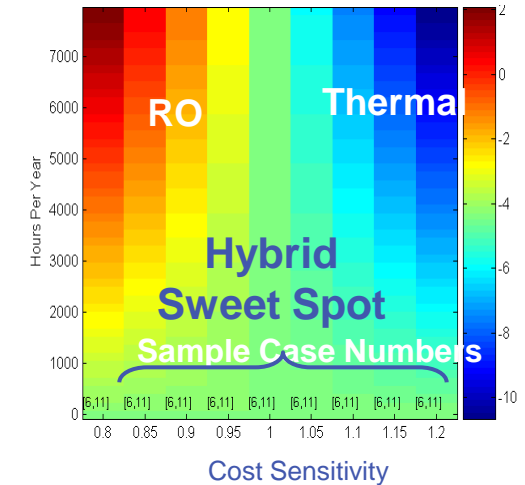
## Market Need

- In some markets, significant Seasonal/Daily demand variations create Power-Water Mismatch
- Peak load design requirements give excess capacity most of the year.

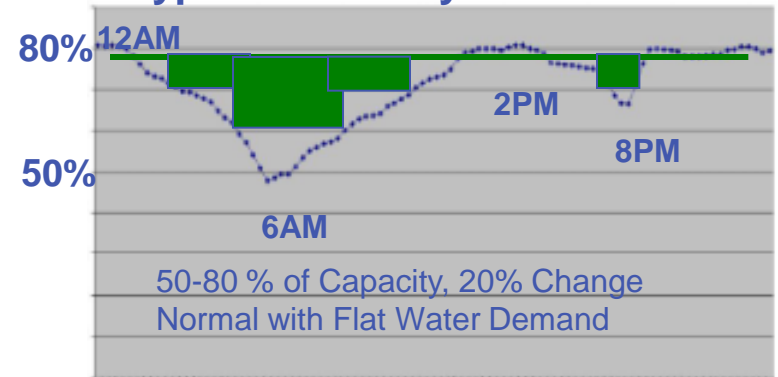
## Value Proposition

- A sizable reduction in Cost of Water and Cost of Electricity. Use of electricity to create water during off-peak hours
- 50-300 MW plants targeted

3 D Water Technology Modeling



Typical ME Daily Power Demand

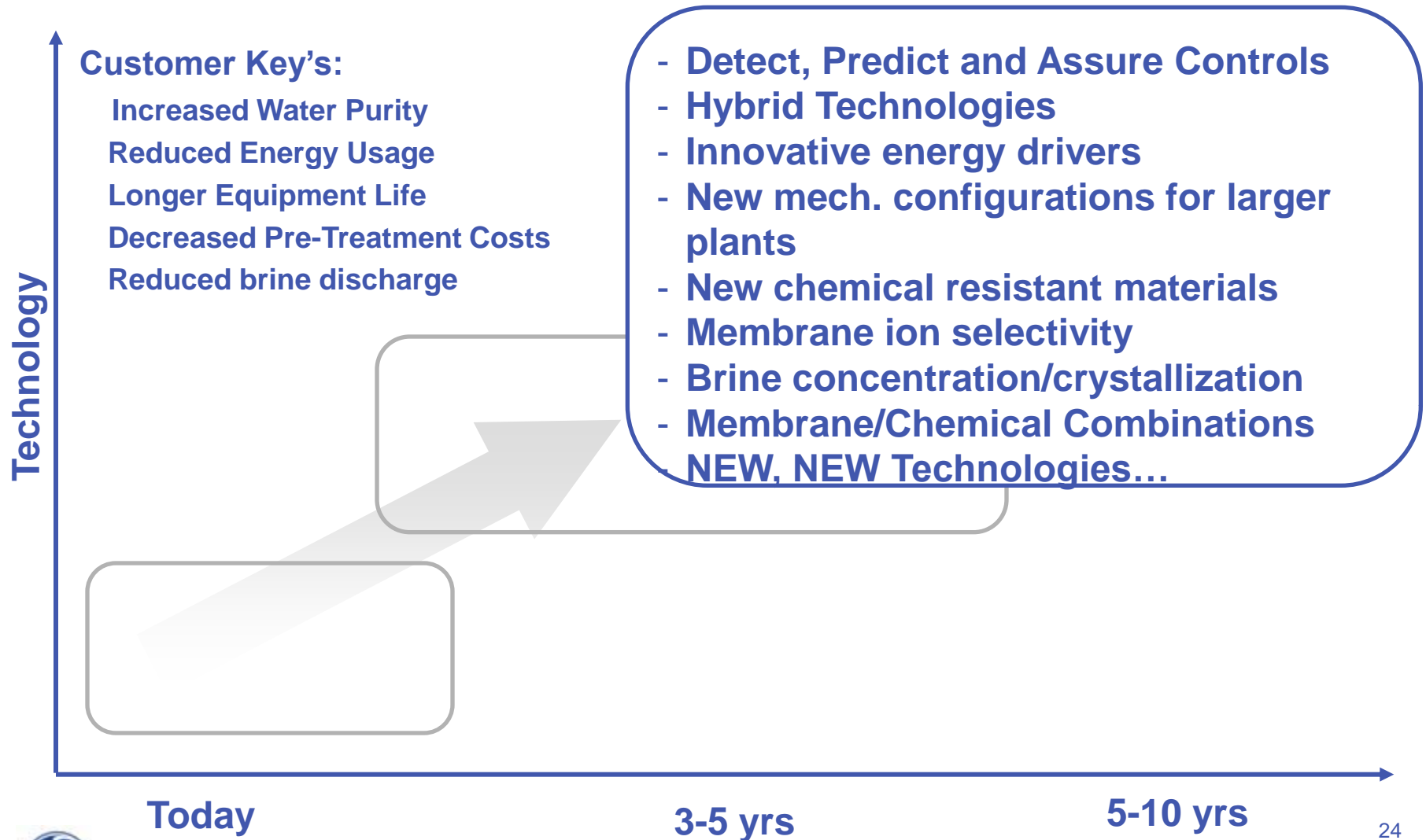


# Decentralized Benefits

- Optimized efficiency ... **15%-30% Improvement** over traditional Thermal Desalination through innovation.
- Broad system capability ... **Smaller water/power ratios**, plant turn-down important for seasonal and daily load variation
- **Distributed Generation** capability ... >40,000 m<sup>3</sup>/day Water Production @ 100 MW with High Fuel Efficiency without long distribution systems saves >7% in line losses and
- **Operational flexibility** ... High full load and part power efficiencies with minimal performance impact for hot day operation
- **Availability** ... On-site and “on condition” maintenance provides up to 10 additional days of run-time.
- **Standardization** ... multiple power and water blocks



# Advancing water scarcity technology





# Questions?

