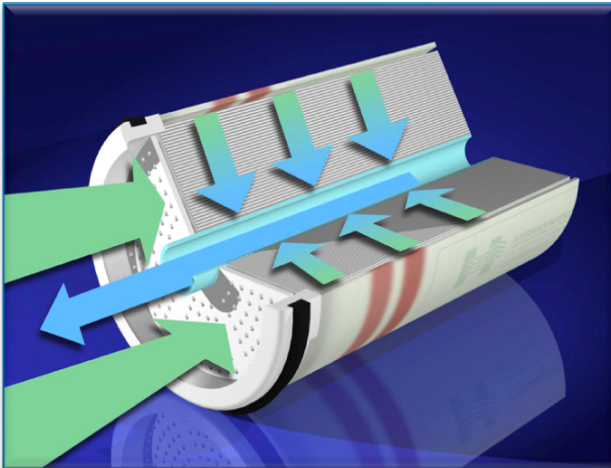


Desalination Experts Exchange



Water Globe
Consulting

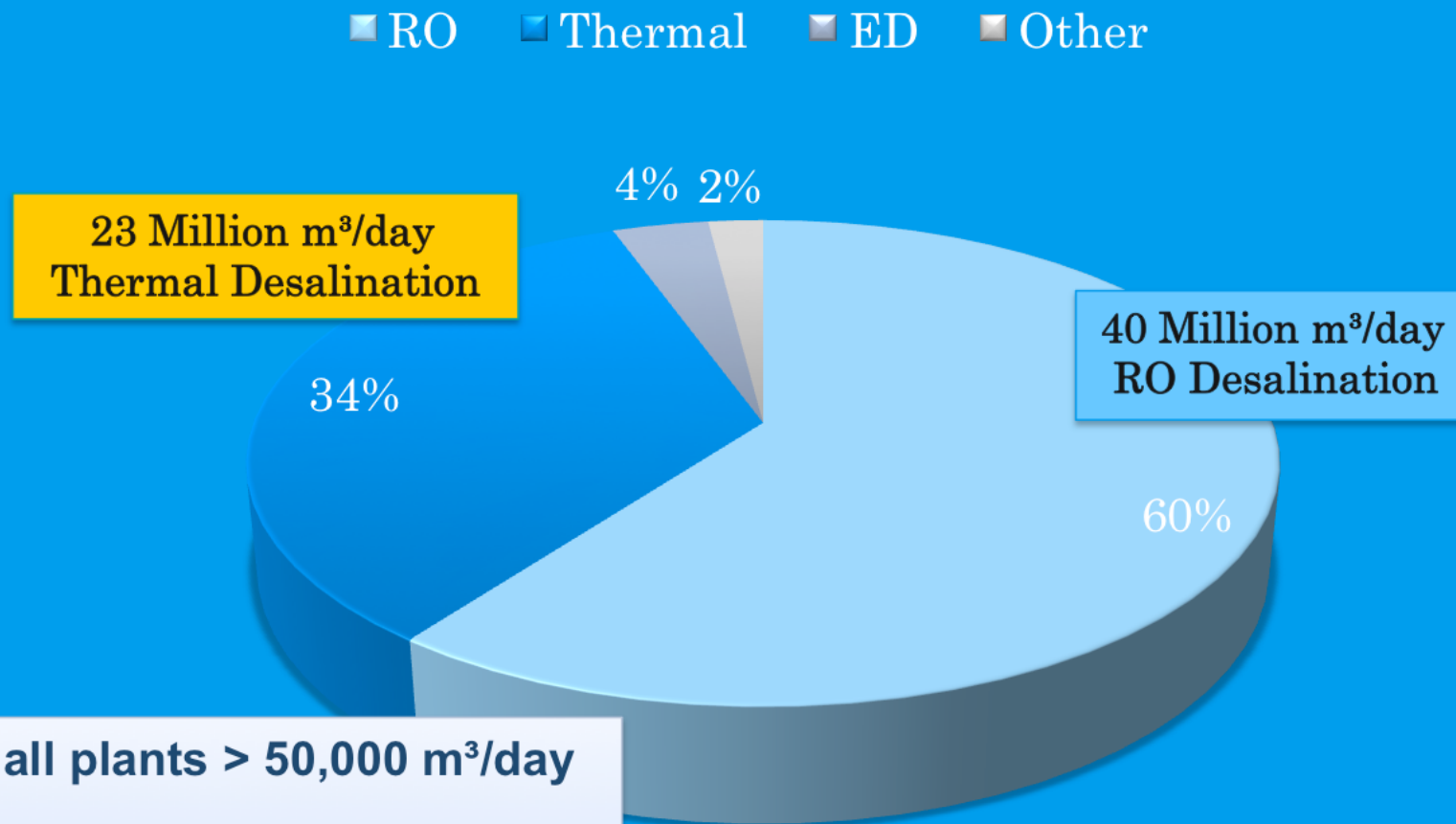
Desalination - Technology Trends & Market Insights

July 2, 2012

Nikolay Voutchkov, PE, BCEE

Desalination – Where Are We Today?

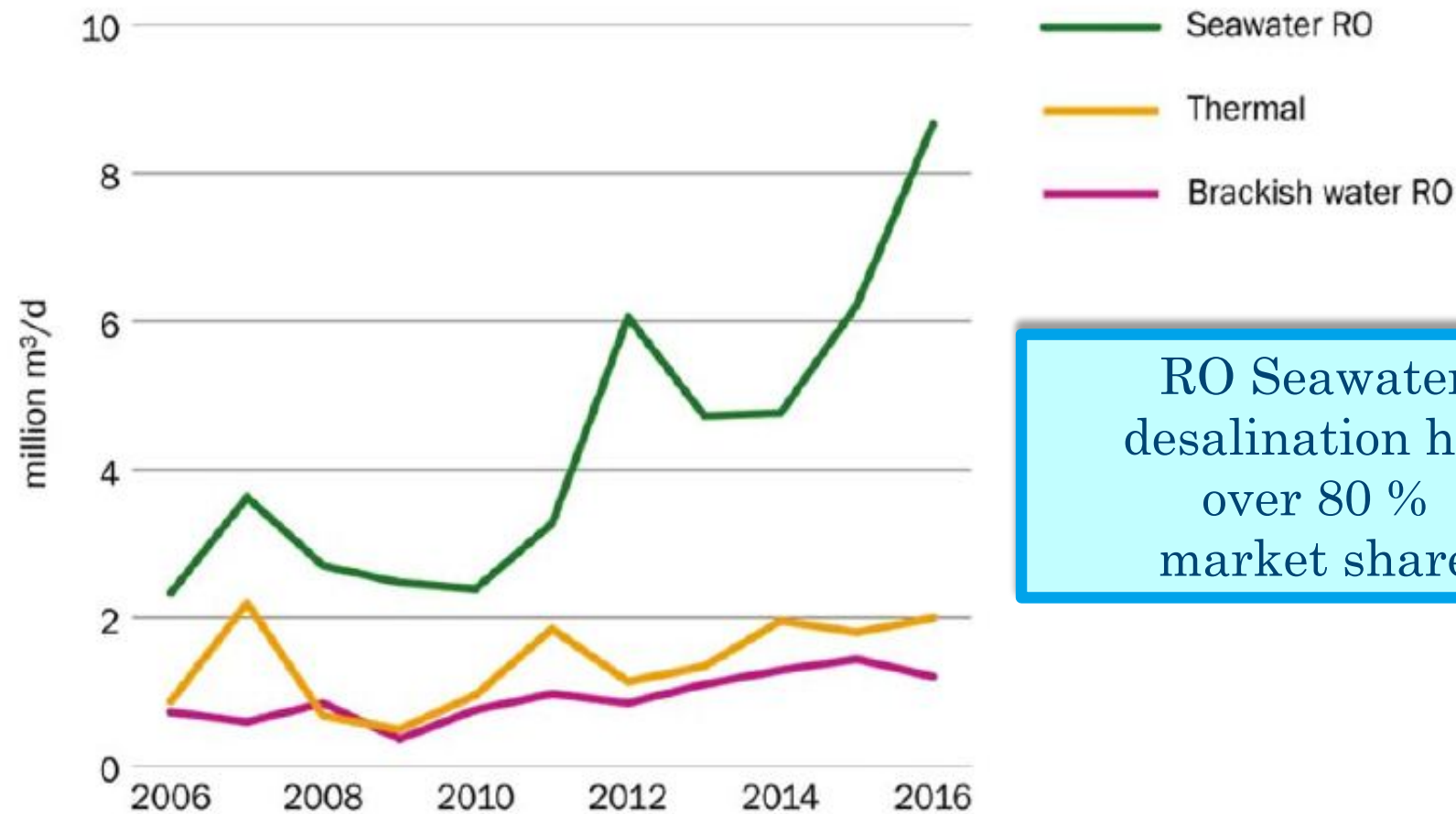
16,000 desalination plants worldwide –
66.4 Million m³/day



40 % of all plants > 50,000 m³/day
65 % Installed capacity increase
expected by 2015

Source: IDA Desalination Yearbook 2011-2012

Seawater Membrane Desalination Dominates



RO Seawater
desalination has
over 80 %
market share

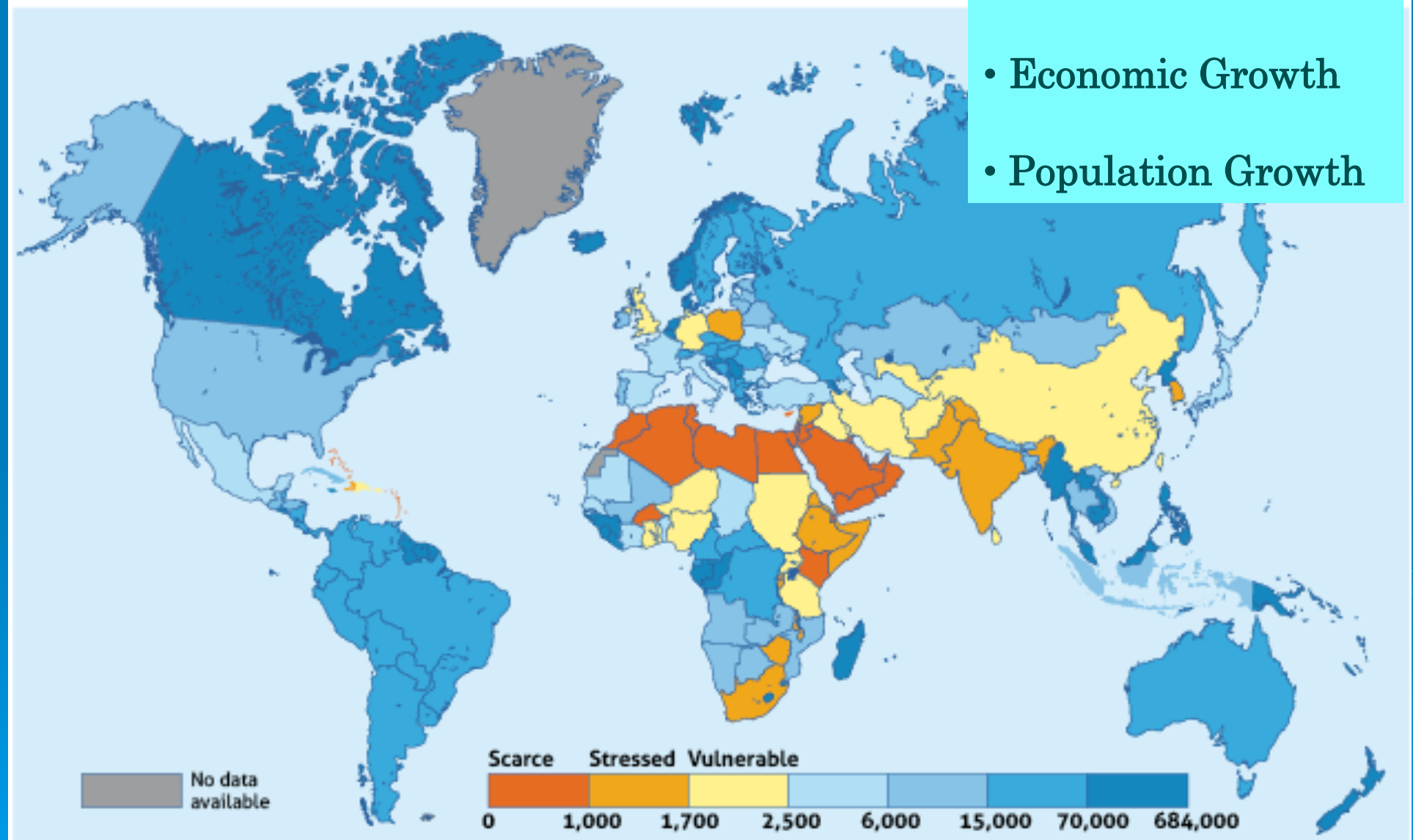
Source: Global Water Intelligence

Membrane Desalination – Key Trends

- SWRO desalination technologies dominate
- Large - (over 15 MGD) and Mega - (over 50 MGD) desalination plants are the wave of the future
- Most large urban coastal centers worldwide have a target to produce 25 % of their drinking water from desalination
- Research & development activities are in 10-year high – likely to yield breakthroughs in membrane and desalination technologies by 2015
- Large SWRO projects are aiming at sustainability – Green is in!

Desalination Market Drivers

Fresh water availability by country (m³ per person per year)

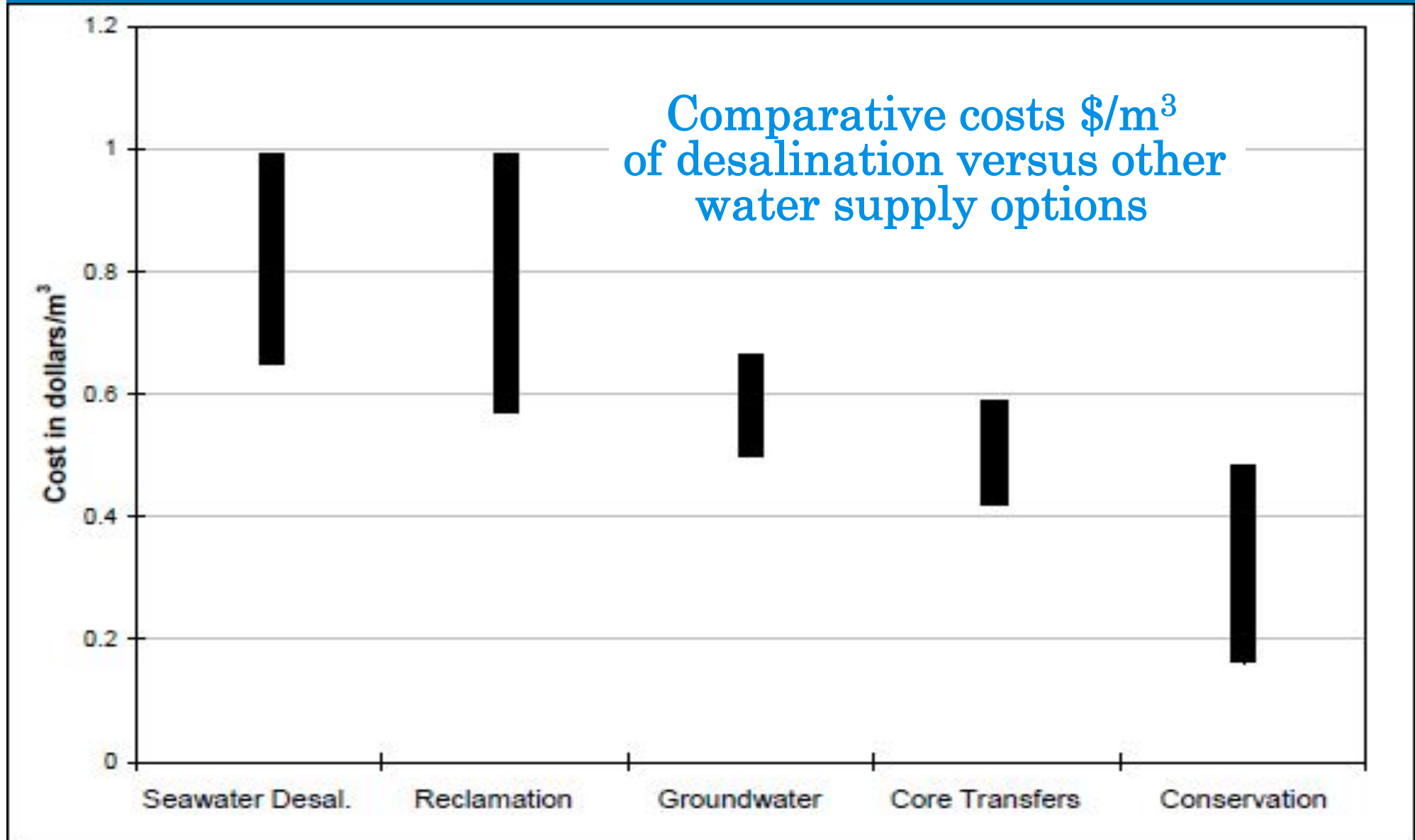


- Water Scarcity
- Economic Growth
- Population Growth

Main Challenges & Industry Response

Challenge	Industry Response
High Fresh Water Production Costs	• Accelerated development of higher productivity RO membranes • Lower cost pretreatment systems and plant components • Investment in Non-RO technologies
High Energy Use	• Advances in low energy desalination • Technologies & RO energy recovery systems
Environmental Impacts	• Coupling of desalination plants with Green power sources (Wind Power)

Comparative Costs

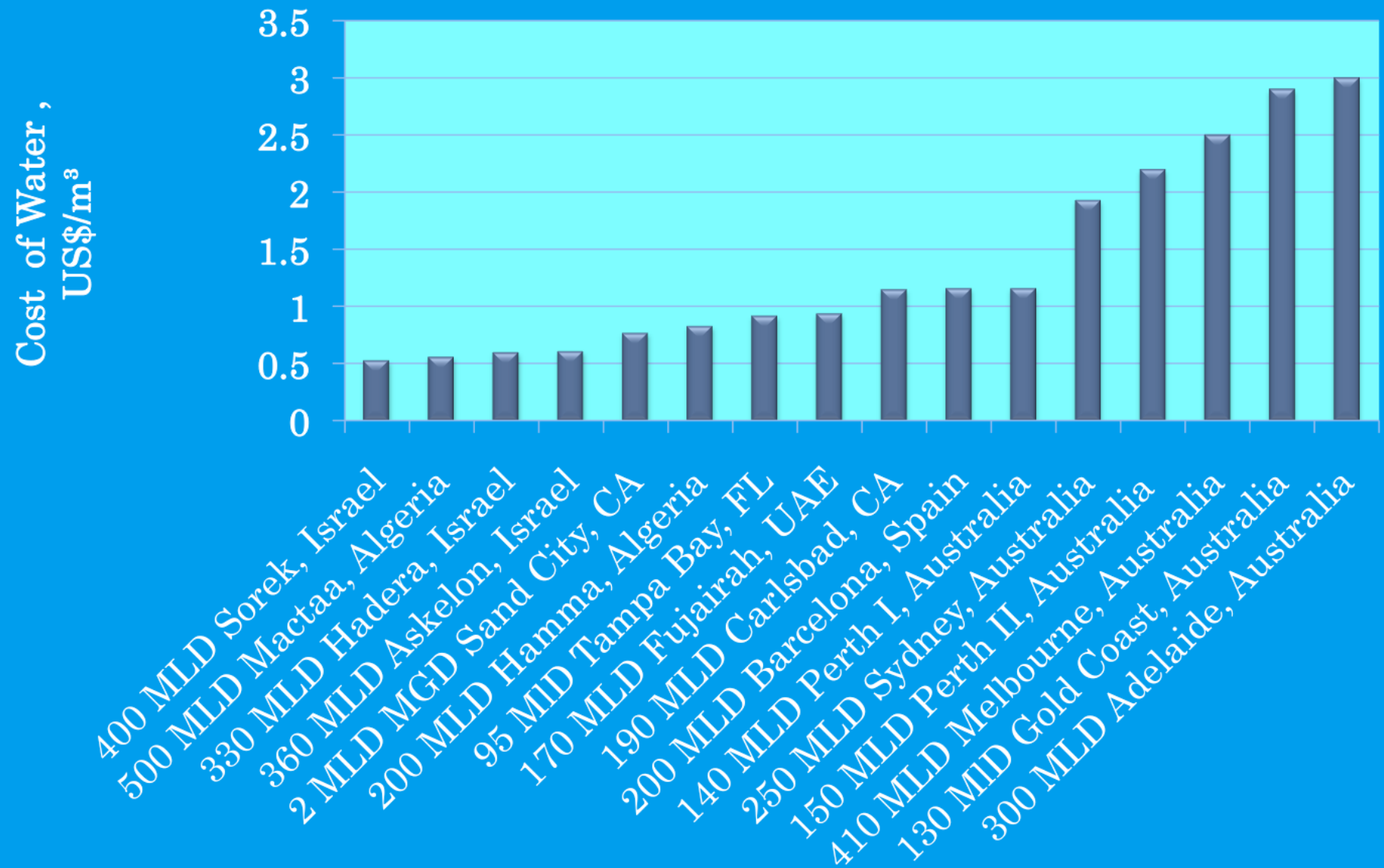


Water Production Costs

(Medium & Large SWRO Plants)

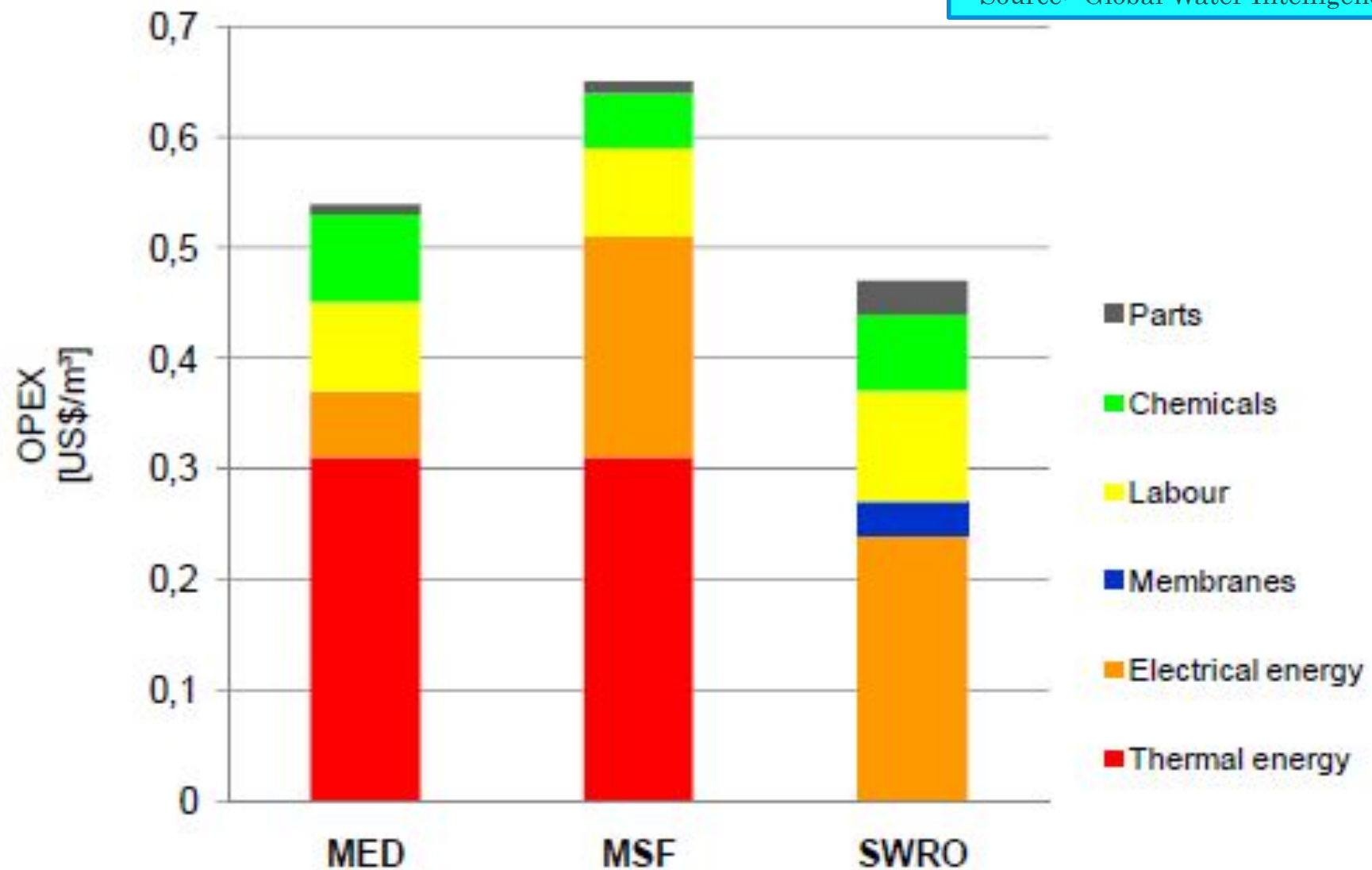
Classification	Cost of Water Production (US\$/m ³)
Low-End Bracket	0.5 – 0.8
Medium Range	1.0- 1.5
High-End Bracket	2.0 – 4.0
Average	1.0

Water Production Costs of Recent SWRO Desalination Projects



Energy Dominates O&M Costs

Source: Global Water Intelligence

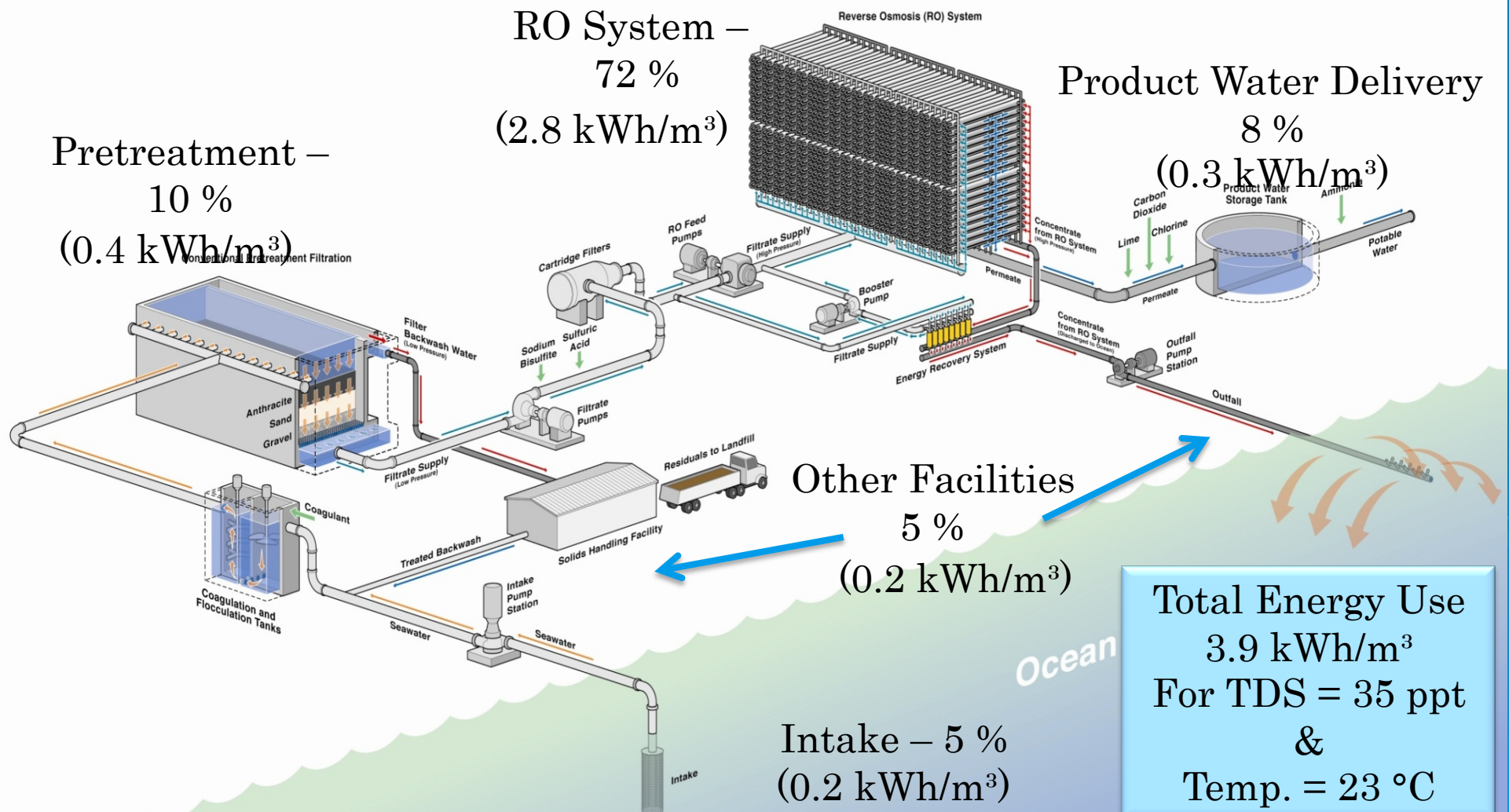


Energy Use for Membrane Desalination

(Medium & Large SWRO Plants)

Classification	SWRO System Energy Use (kWh/m ³)
Low-End Bracket	2.5 – 2.8
Medium Range	3.0 – 3.5
High-End Bracket	4.0 – 4.5
Average	3.0

Energy Use of Typical Large SWRO Plant



Larger Plants Typically Use Less Energy

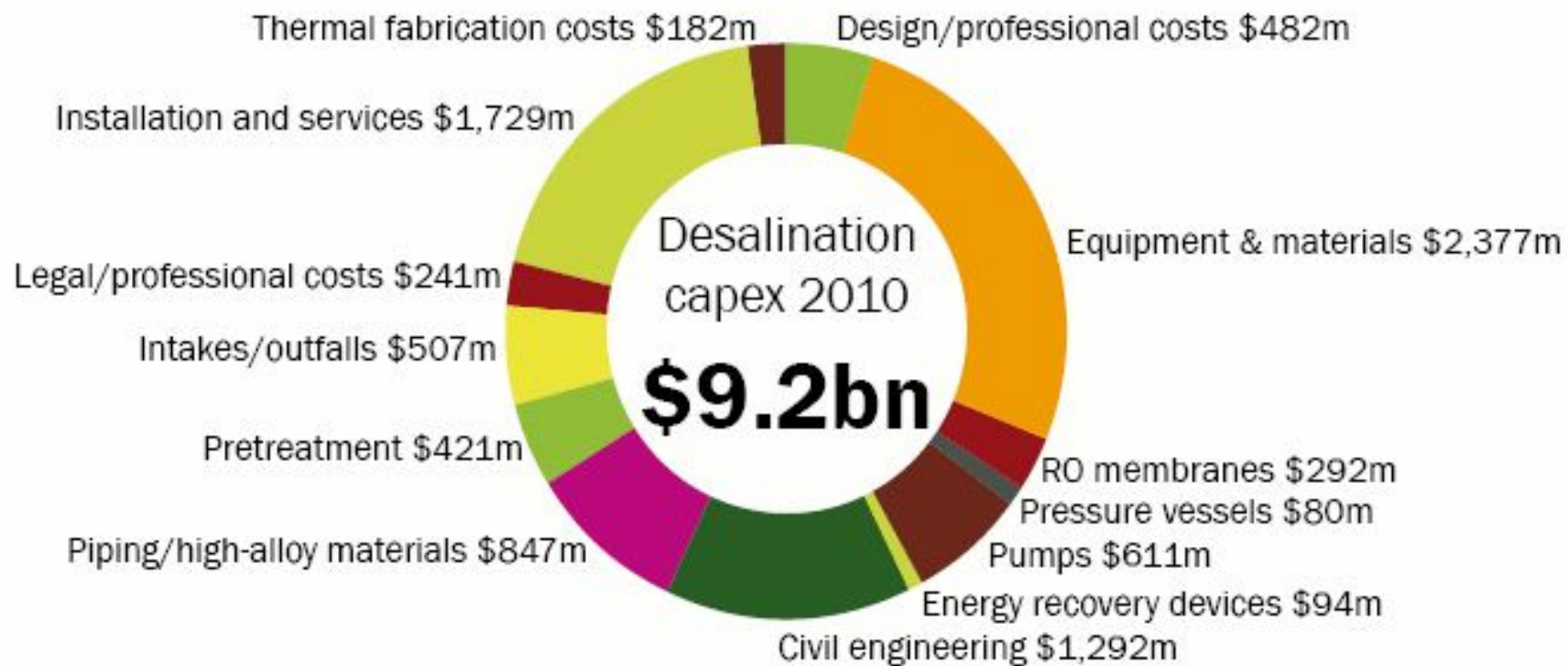
Plant	SWRO System Energy Use (kWh/m ³)
1,000 m ³ /day	3.5-5.0
50,000 m ³ /day	2.8-3.2
200,000 m ³ /day	2.5-3.0

Key Desalination Market Segments

- **Equipment & Manufacturing – 47 %**
 - Membranes & Pumps – US\$0.5 to 0.7 billion/yr. each
 - Energy Recovery Devices – US\$0.08 – 0.1 billion/yr.
- **Engineering & Construction Services – 25 %**
- **Operation and Maintenance Services – 28 %**
- **Top Market – Saudi Arabia**
@ US\$4.5 to 5.5 billion/year

Desalination Market Segment Size

Capital expenditure breakdown (thermal and membrane desalination combined)



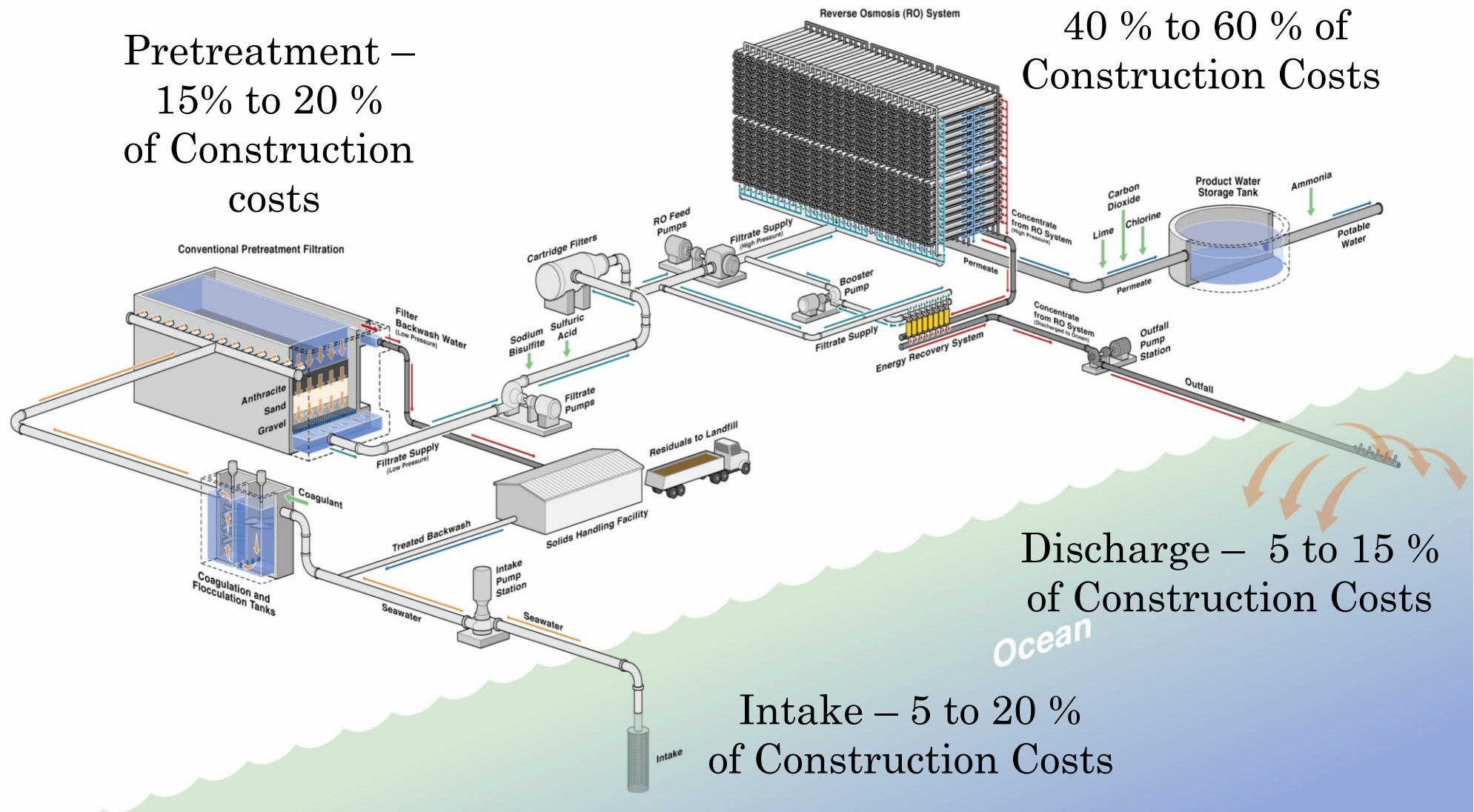
Source: DesalData/Desalination Markets 2010

Equipment, materials and installation constitute over 50 % of the market

Equipment Market Segmentation Follows Key Cost Components

Pretreatment –
15% to 20 %
of Construction
costs

RO System –
40 % to 60 % of
Construction Costs



Discharge – 5 to 15 %
of Construction Costs

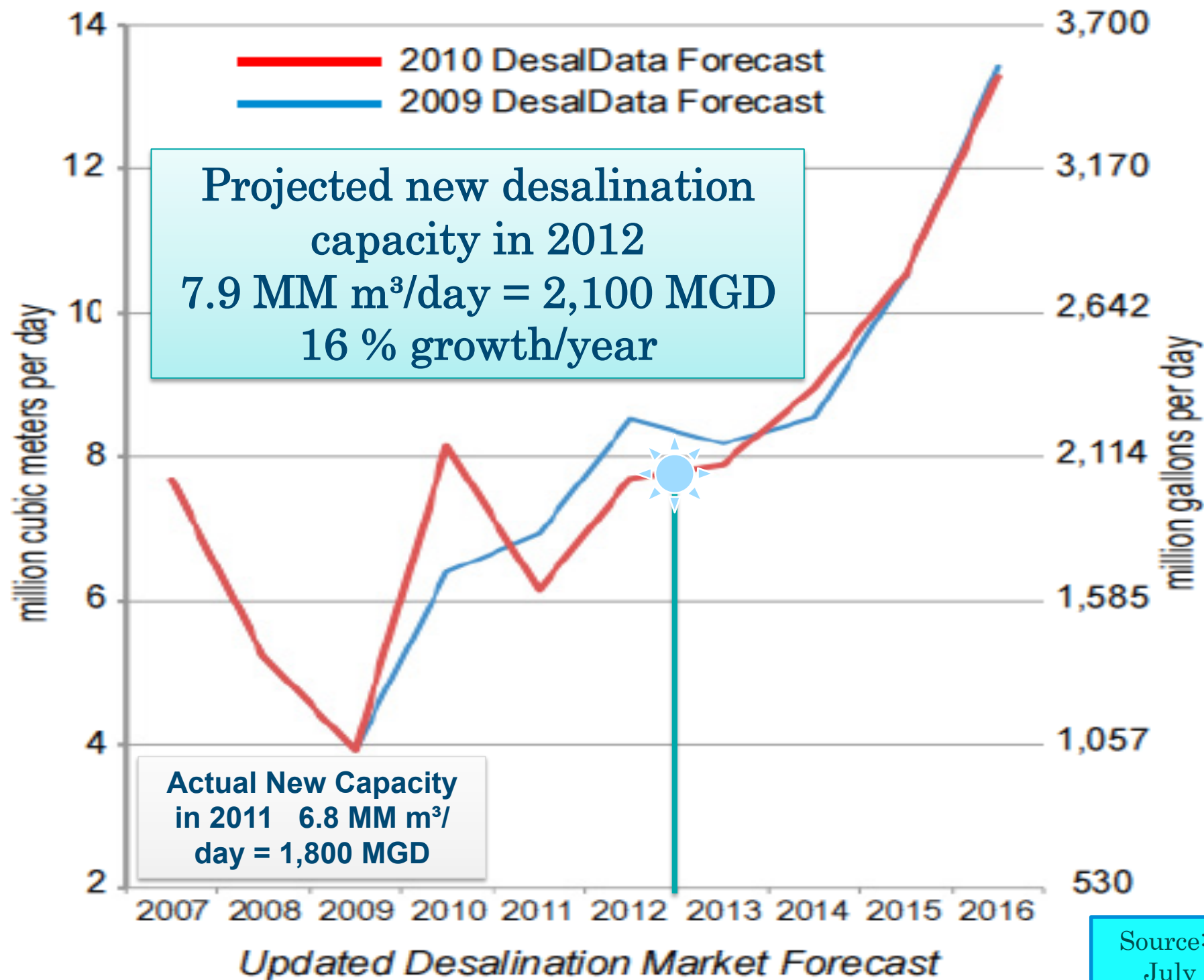
Intake – 5 to 20 %
of Construction Costs

Desalination Market Trends

The desalination market has higher growth rate than any other water market segment



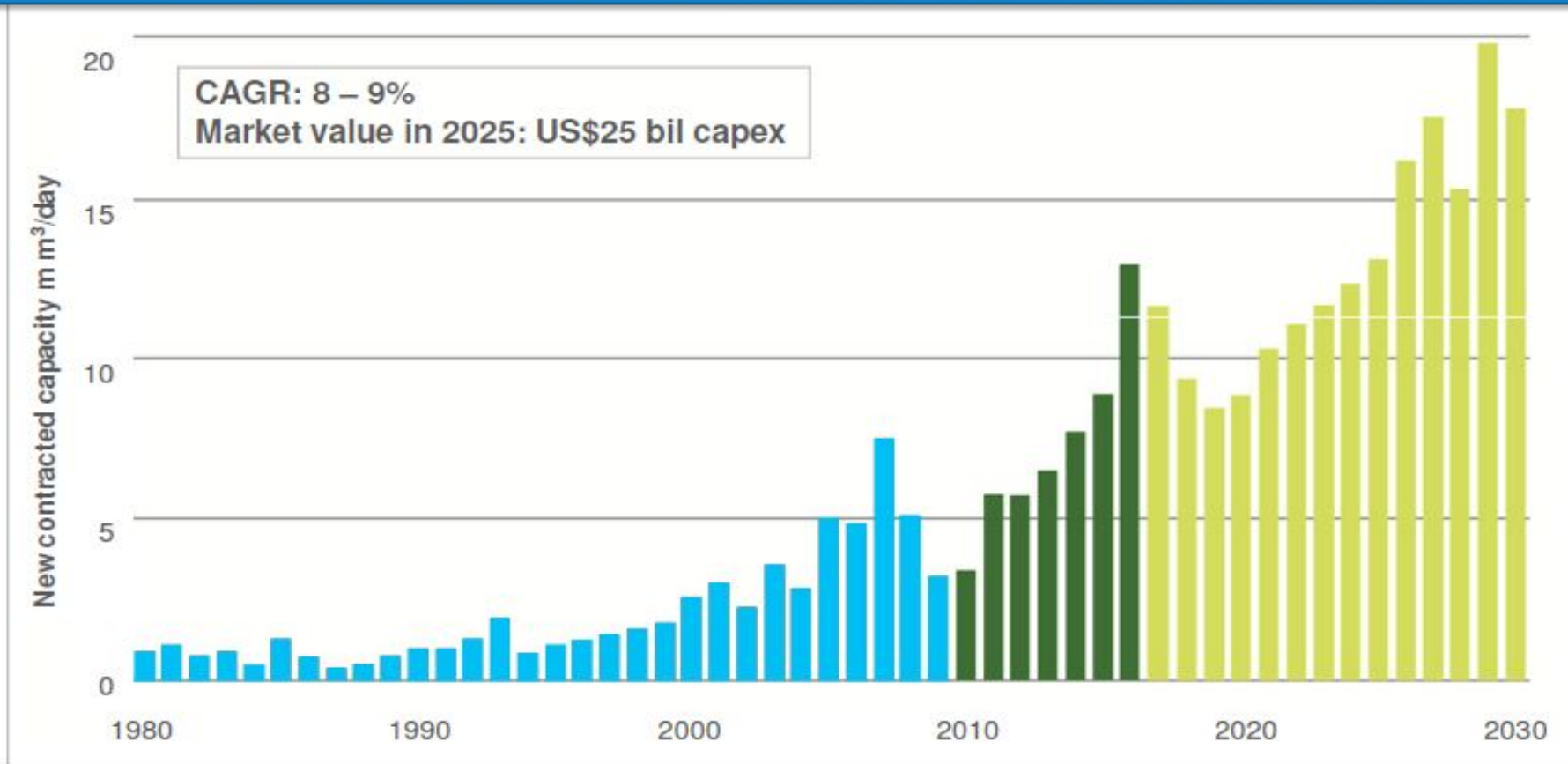
2011 market size of US\$ 6.9 Billion
projected to double by 2016



Source: WDR,
July 2010

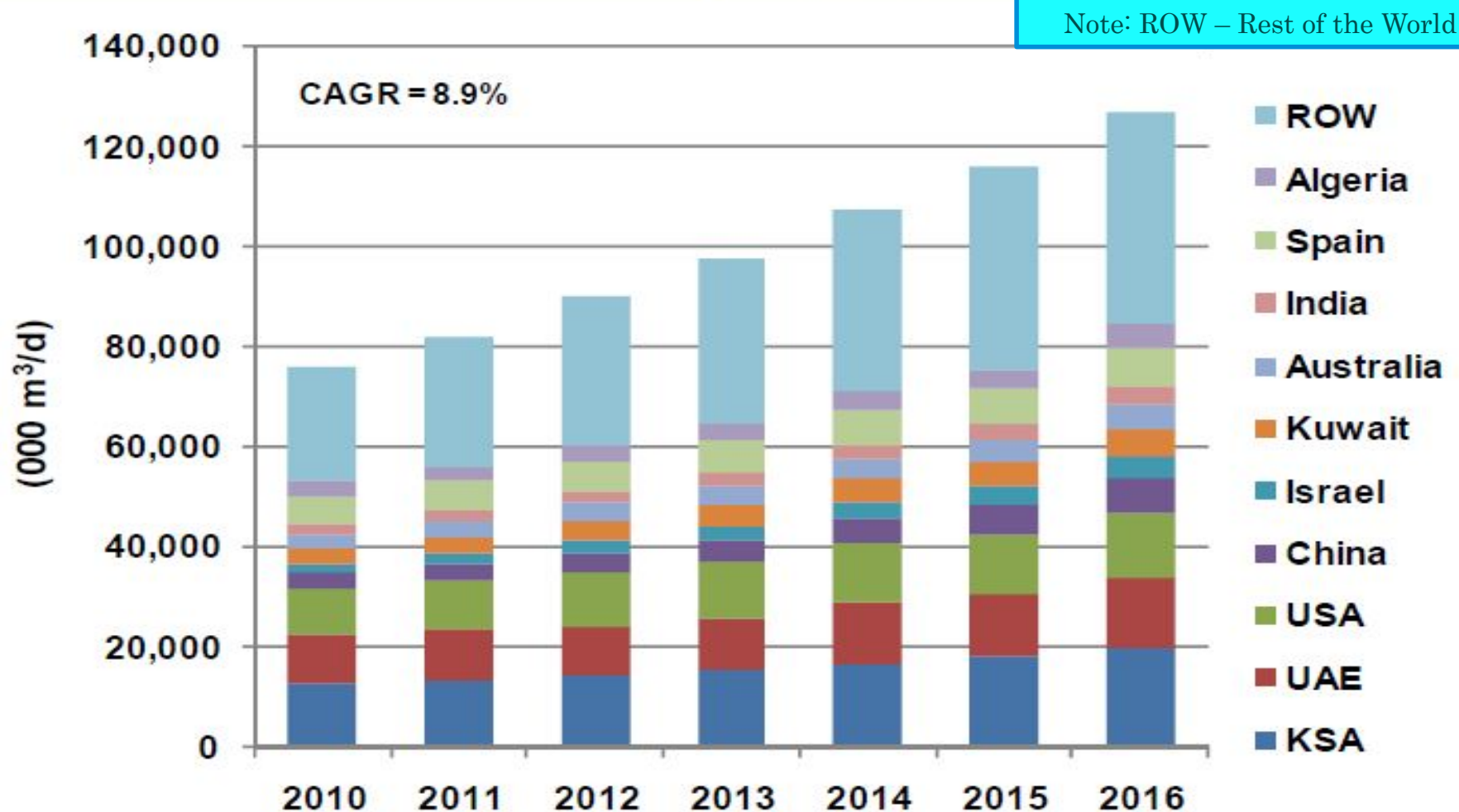
After “Arrested Development” in 2010 the Market is Recovering and Accelerating

Market deceleration in 2009 & 2010 mainly due to traditionally high-growth markets in Algeria, Spain and Australia reaching planned maximum capacity & water demand setbacks in the Western US, Florida, Southern Spain and UAE



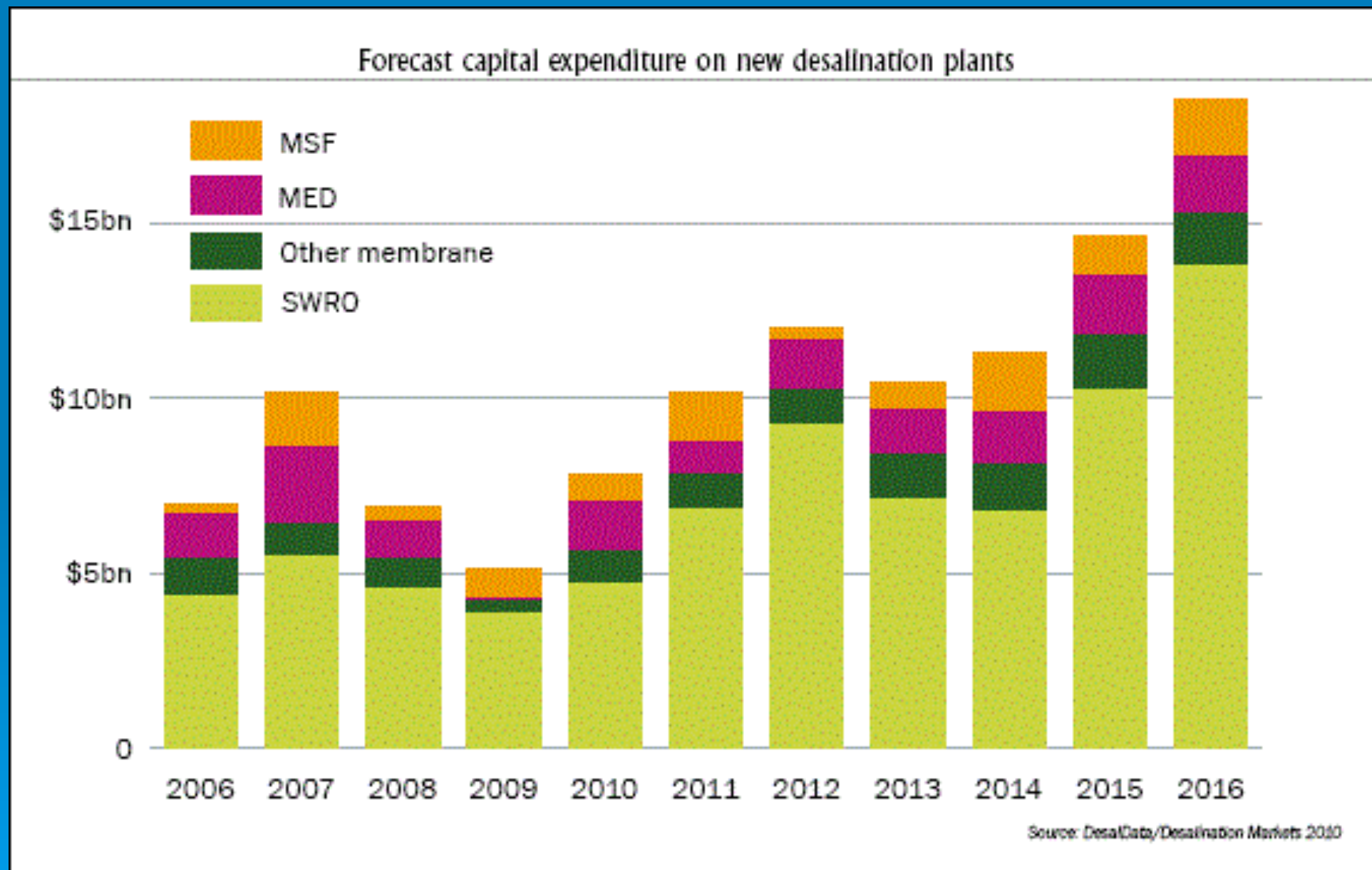
Desalination Market Growth Forecast

Cumulative Installed Desalination Capacity, Top Growth Markets: 2010-2016



(Sources: IDA, World Bank, Pike Research)

Thermal vs. RO Desalination



Where is Desalination Happening in the Next 5 Years?

Desalination Plant Market: Market Hot Spots (World), 2009-2015

North America

- Serious investment commitments made in the USA, namely in California, Texas and Florida.
- Need for water will drive investments across Mexico.

Africa

North Africa, especially Algeria but also Egypt, Libya and Morocco will drive growth for desalination in Africa during the next 5 years.

Middle East

The Middle East represents in 2009 close to 50% of the world desalination markets. This is expected to remain unchanged over the next 5 years.

South America

- Peru and Chile consider investments in desalination fundamental for their economic development and projects will be put to tender in 2009-2011.

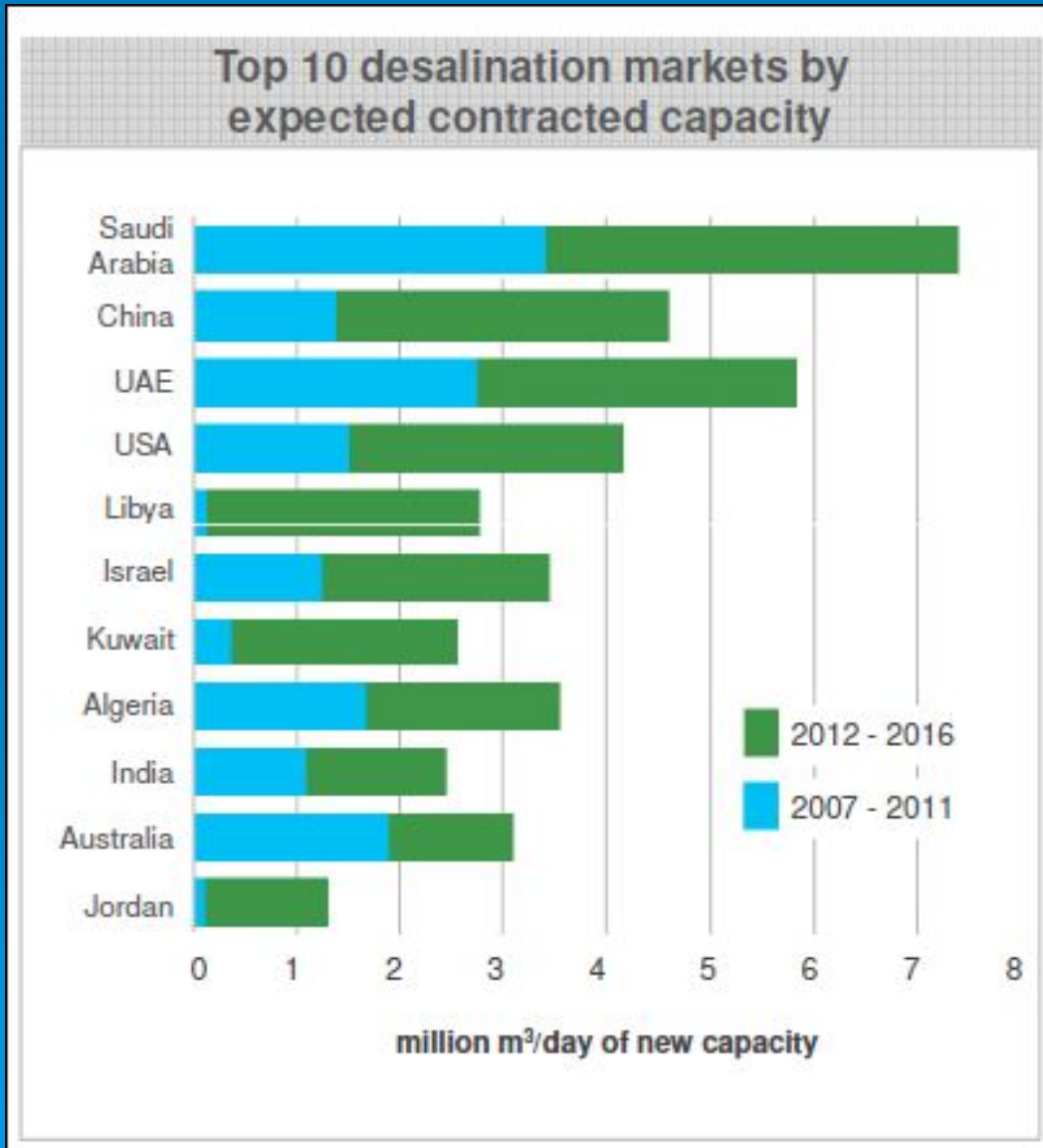
Asia and the Pacific region

- China, India and Australia will be the most important markets in desalination for the region.
- Projects are expected in most Southeast Asia countries during the next 5 years with emphasis for The Philippines, Bangladesh, Vietnam and Indonesia.

 Strong Growth  High Growth  Moderate Growth

Source: Frost & Sullivan

10 Highest Growth Markets the Next 5 Yrs



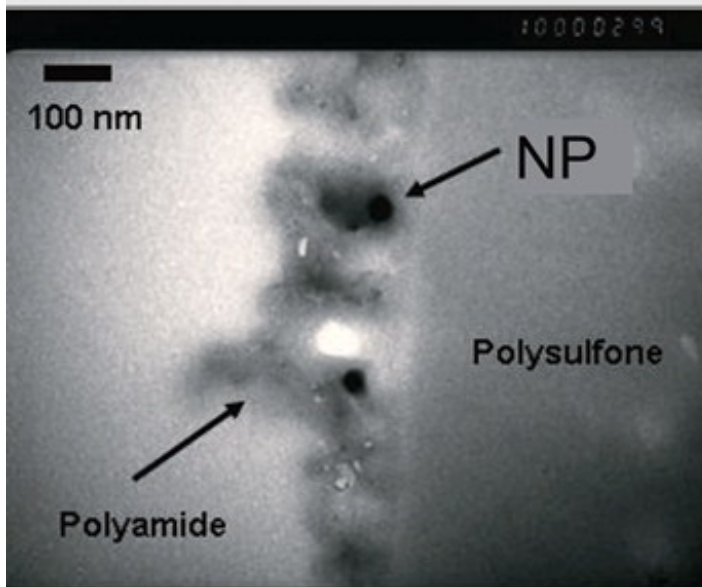
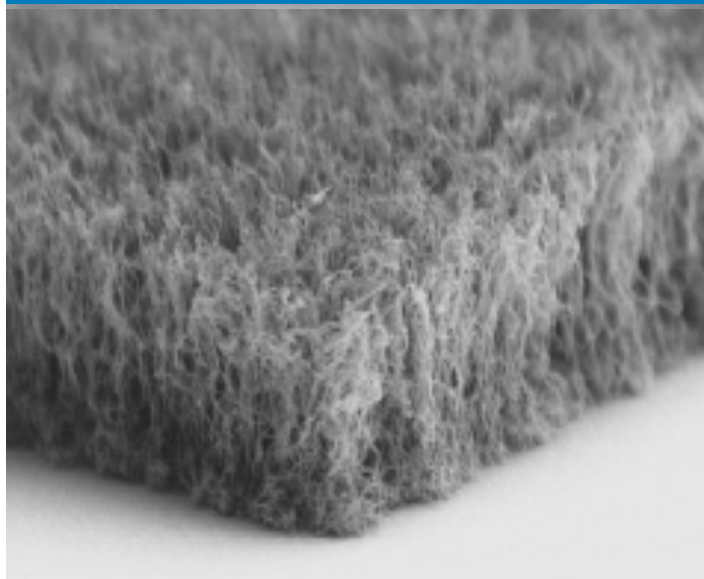
- ❖ Slow economy likely to keep market growth just below 10 % next 3 years
- ❖ Double-digit growth projected past 2015
- ❖ Materials & membranes expected to experience highest growth
- ❖ Chemicals market expected to be curtailed dramatically
- ❖ Turnkey BOO method of delivery will dominate until the market matures

Where future cost & energy reduction breakthroughs would come from?

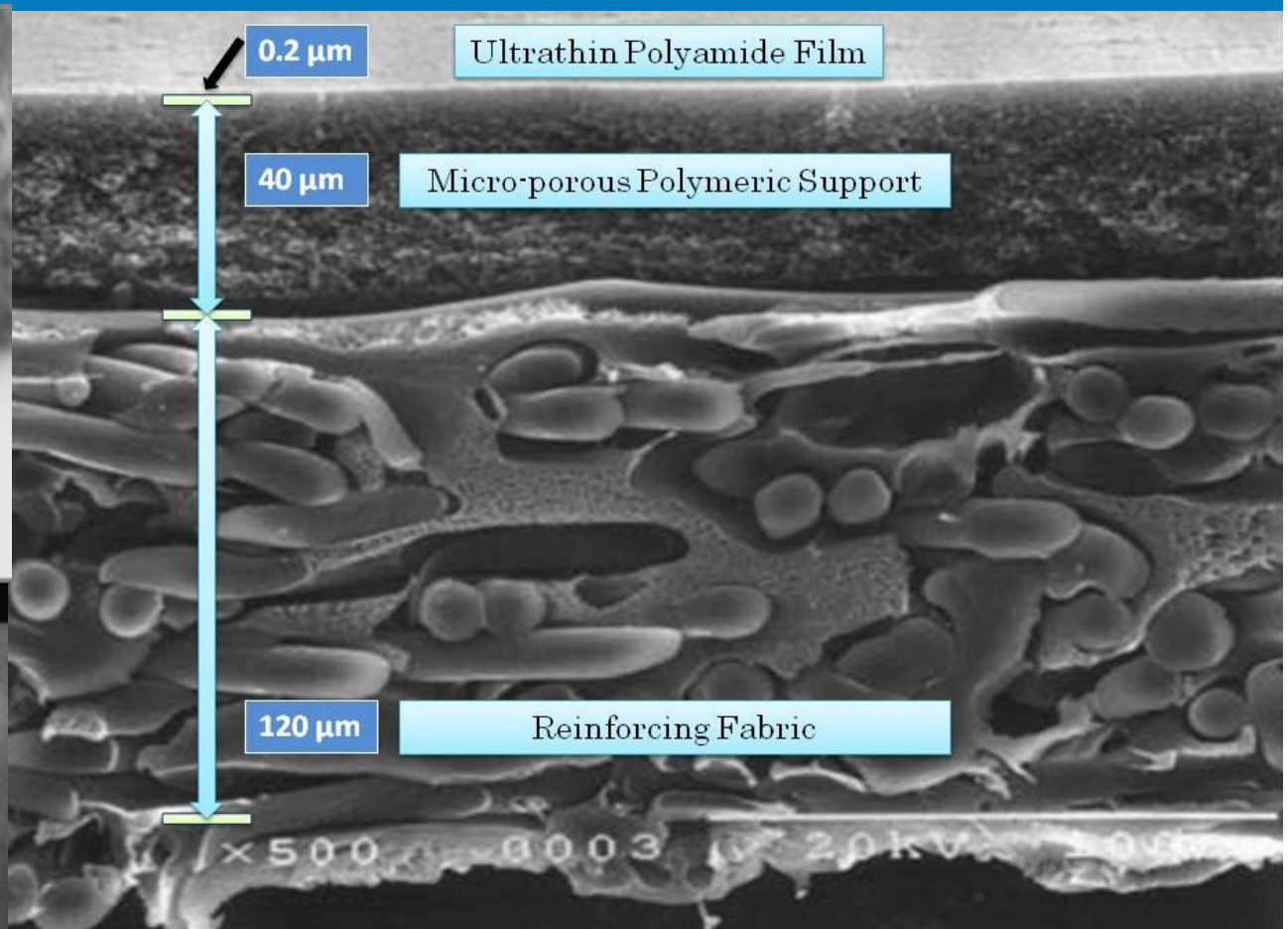
- Materials science



Nano-Structured SWRO Membranes



B



Main Cost Savings in the next 5 Years (20 % cost & power reduction)

- Improvements in Membrane Element Productivity:
 - Polymetric membranes (incorporation of nano-particles into membrane polymer matrix)
 - Bio-membranes & enzymatic transport of water
 - Carbon nanotube membranes
- Increased Membrane Useful Life and Reduced Fouling:
 - Smoother membrane surface
 - Increased membrane material longevity
 - Use of systems for continuous RO membrane cleaning
 - UF/MF membrane pretreatment
- Commercial Forward Osmosis Systems
- Larger RO Elements, Trains and Equipment

“The Best” of Seawater Desalination – Present Status & Future Forecasts

Parameter	Today	Within 5 Yrs	Within 20 Yrs
Cost of Water (2011 US\$/m ³)	US\$0.5-0.8	US\$0.4-0.6	US\$0.2-0.4
Construction Cost (US\$/m ³ /day)	1,200-2,200	1,000-1,800	500-1,000
Power Use of SWRO System (kWh/m ³)	2.5-2.8	2.0-2.3	1.4-1.8
Membrane Productivity (m ³ /day/SWRO membrane)	28-47	35-55	95-120
Membrane Useful Life (years)	5-7	7-10	10-15
Plant Recovery Ratio (%)	45-50	50-55	55-65

Desalination Market Concluding Remarks

- Continuing to grow at accelerating rate of 8 to 9 % per yr
- Expected to exceed US\$10 billion in 2012
- Persian Gulf Countries, China and India are likely to fuel sustained market growth the next 3 to 5 years
- Economic recovery in traditional desalination markets is forecasted to double the market growth by 2016
- Long-term investment in research and development has the potential to reduce the cost of desalinated water and propel market size to US\$25 billion by 2025.

Questions ?



Nikolay Voutchkov, PE, BCEE

Water Globe Consulting

nvoutchkov@water-g.com