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THE MIDDLE EAST DESALINATION RESEARCH CENTER

# Cost Estimating of SWRO Desalination Plants

*Day 2: Total Capital Costs and  
O&M Expenditures*

*June 26, 2013*

*9:00-10:30*



Water Globe

## *2.1 Estimating Indirect and Total Capital Costs*

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# Estimating Indirect and Total Capital Costs

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- ▶ Summary of Direct Capital Costs
- ▶ Overview of Indirect Capital Costs
  - Costs for Project Engineering Services
  - Project Development Costs
  - Costs for Enabling Public Participation
  - Project Financing Costs
- ▶ Assessment of Total Capital Costs

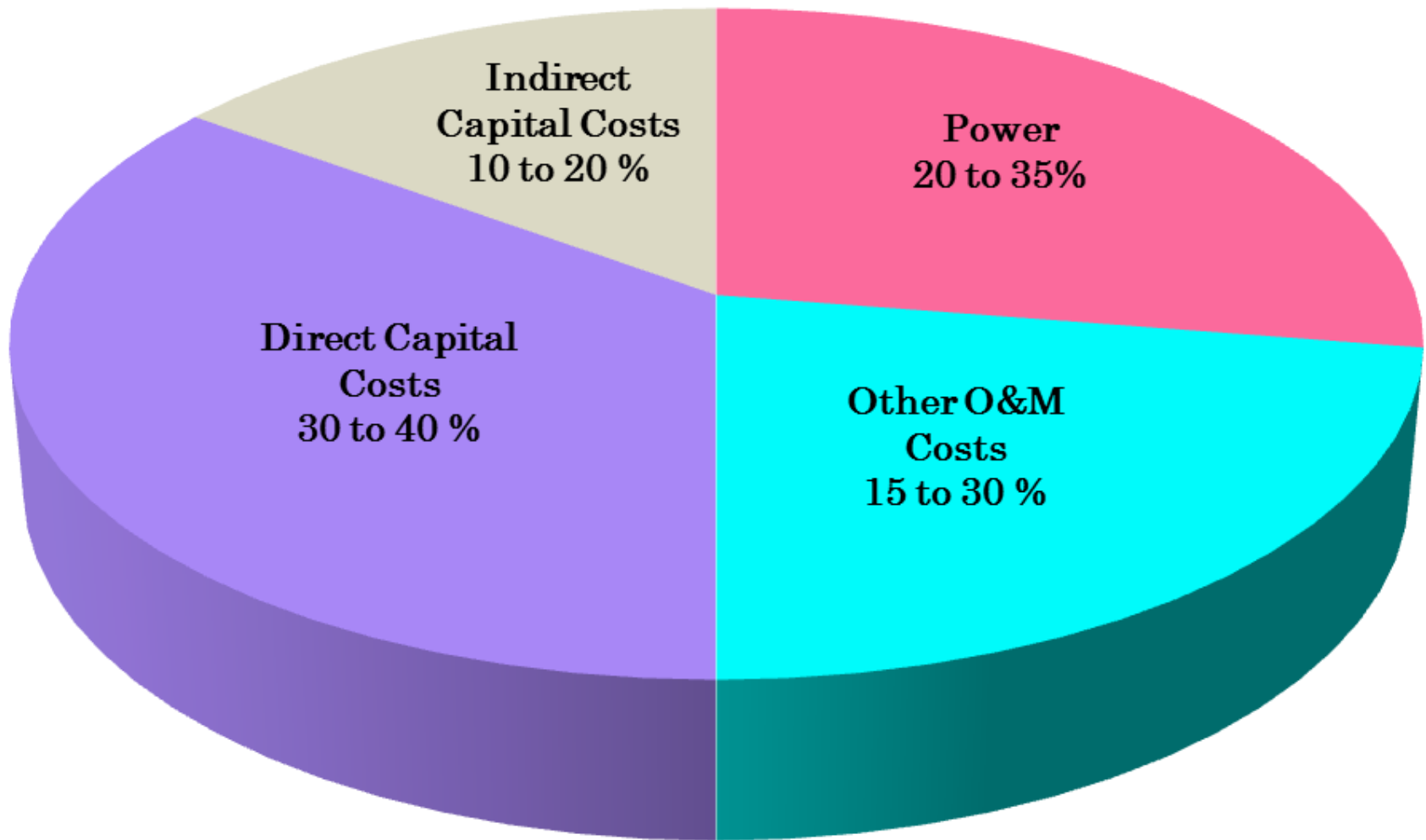
# Desalination Cost Components

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- ▶ Capital Costs:
  - Construction (Direct or “Hard”) Capital Costs;
  - Indirect (“Soft”) Capital Costs.
- ▶ Operation & Maintenance Costs:
  - Variable;
  - Fixed.
- ▶ Cost of Water:
  - Annualized Capital Costs;
  - O&M Costs.



# SWRO Desalination Plant Cost Breakdown



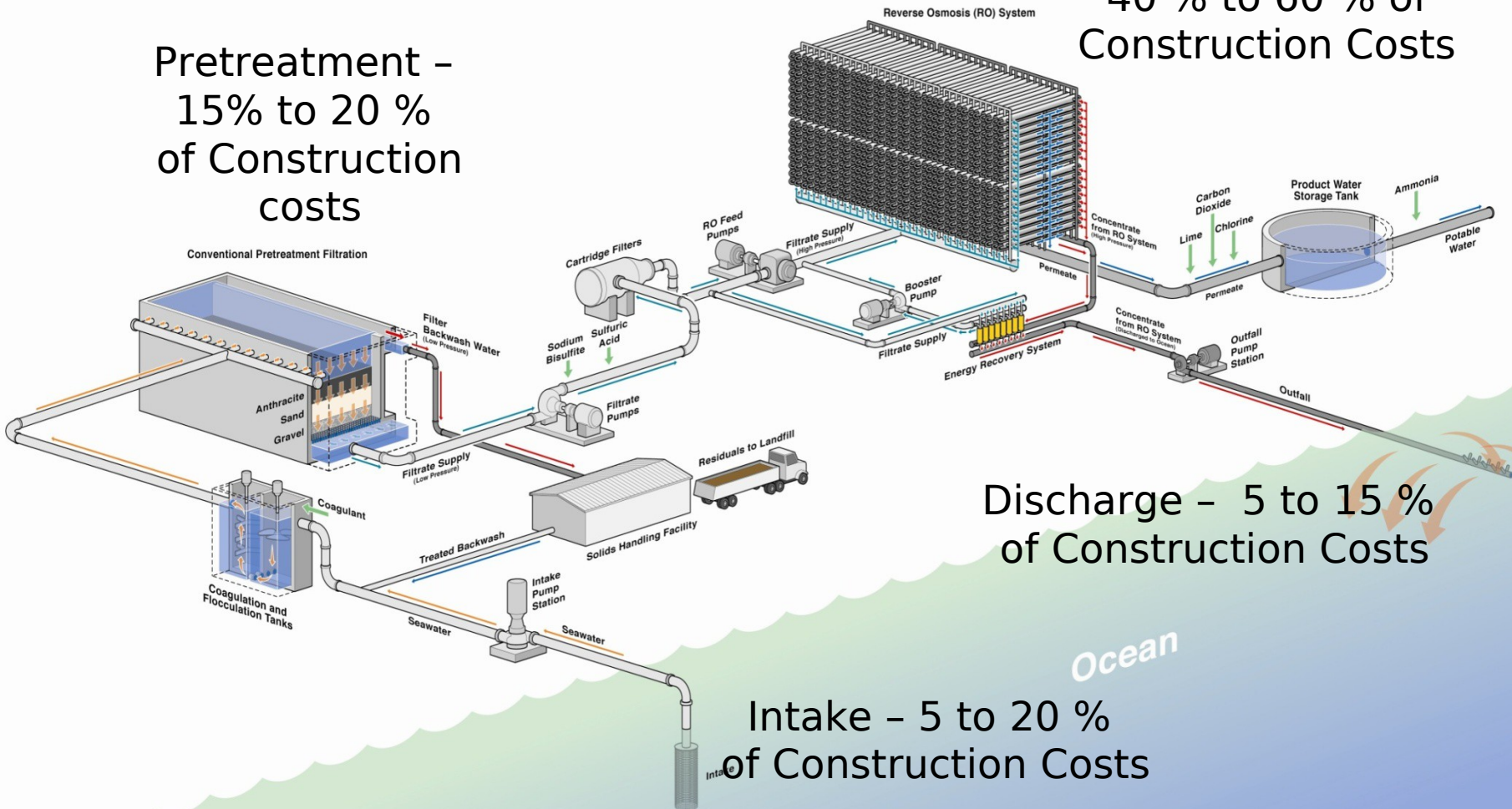
# Seawater Desalination Plant - Construction (Direct Capital) Costs

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





# Summary of Construction (Direct) Capital Costs

Cost Item	Percentage of Total Capital Cost (%)	
	Low-Complexity Project	High-Complexity Project
<b>Direct Capital (Construction) Costs</b>		
12. Site Preparation, Roads and Parking	1.5 – 2.0	0.6 – 1.0
13. Intake	4.5 – 6.0	3.0 – 5.0
14. Pretreatment	8.5 – 9.5	6.0 – 8.0
15. RO System Equipment	38.0 – 44.0	30.5 – 36.0
16. Post-Treatment	1.5 – 2.5	1.0 – 2.0
17. Concentrate Disposal	3.0 – 4.0	1.5 – 3.0
18. Waste and Solids Handling	2.0 – 2.5	1.0 – 1.5
19. Electrical & Instrumentation Systems	2.5 – 3.5	1.5 – 2.5
20. Auxiliary and Equipment and Utilities	2.5 – 3.0	1.0 – 2.0
21. Buildings	4.5 – 5.5	3.0 – 5.0
22. Start Up, Commissioning and Acceptance Testing	1.5 – 2.5	1.0 – 2.0
<b>Subtotal Direct (Construction) Costs (% of Total Capital Costs)</b>	<b>70.0 – 85.0</b>	<b>50.0 – 68.0</b>

# Seawater Desalination Plant - Soft (Indirect Capital) Costs

- ▶ Project Engineering
- ▶ Project Development & Environmental Review
- ▶ Project Financing
- ▶ Contingency



# Summary of Soft (Indirect) Capital Costs Project Engineering Services

Cost Item	Percentage of Total Capital Cost (%)	
	Low-Complexity Project	High-Complexity Project
<b>Project Engineering Services</b>		
5. Preliminary Engineering	0.5 - 1.0	0.5 - 1.5
6. Pilot Testing	0.0 - 0.5	1.0 - 1.5
7. Detailed Design	3.5 - 4.5	5.0 - 6.0
8. Construction Management and Oversight	1.0 - 2.0	2.5 - 3.5
<b>Subtotal Engineering Services</b>	<b>5.0 - 8.0</b>	<b>9.0 - 12.5</b>



# Soft (Indirect) Capital Costs Project Engineering Services – Preliminary Engineering

- ▶ Preliminary Engineering - US\$10 to 100/m<sup>3</sup>.day
- ▶ Includes:
  - Initial Assessment of Project Feasibility
  - Definition of Project Scope and Size
  - Studies required to determine project location
  - Intake and Outfall Assessment Studies, etc.
  - Conceptual and Preliminary Project Design

# Soft (Indirect) Capital Costs

## Project Engineering Services – Pilot Testing (Recommended for Plants > 40 MLD)

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### ▶ Pilot Testing

- Construction of Pilot Unit – US\$10 to 50/m<sup>3</sup>.day
- Pilot Unit O&M – US\$15,000 to 20,000/month

### ▶ Includes:

- Installation of Pilot Unit
- Operation for 6 to 12 months (or more)

### ▶ Aimed to Capture Worst-case Source Water Quality Conditions

# Pilot Testing Unit in Carlsbad, California





# Why Pilot Test?

- ▶ Confirmation of Production Capacity;
- ▶ Operation Under Varying Source Water Quality;
- ▶ Selection of Pretreatment System;
- ▶ Evaluation of Alternative Source Water Conditioning Chemicals;
- ▶ Assessment of SWRO Membrane System Performance Under Extreme Conditions:
  - High & Low Temperatures & TDS;
  - Algal Bloom (Red Tide) Conditions;
  - Storms & Heavy Rains;
  - Dredging Operations, Boat Traffic & Other Challenging Events.
- ▶ Testing of Concentrate Management & Product Water Conditioning Alternatives.
- ▶ Public Relations – Explaining the Benefits of Desalination

# Soft (Indirect) Capital Costs Project Engineering Services – Detailed Design

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- ▶ Detailed Design - US\$100 to 300/m<sup>3</sup>.day
- ▶ Includes:
  - Development of Drawings and Specifications
  - Preparation of As-built Drawings





# Soft (Indirect) Capital Costs Project Engineering Services – Construction Management and Oversight

- ▶ Construction Management and Oversight -  
US\$20 to 150/m<sup>3</sup>.day
- ▶ Includes:
  - All engineering activities associated with plant construction
  - Day-to-day management of construction contractors and suppliers
  - Addressing changes in design and construction

# Summary of Soft (Indirect) Capital Costs – Project Development

Cost Item	Percentage of Total Capital Cost (%)	
	Low-Complexity Project	High-Complexity Project
<b>Project Development</b>		
4. Administration, Contracting and Management	1.0 – 1.5	2.0 – 3.0
5. Environmental Permitting (Licensing)	0.5 – 3.5	4.5 – 5.0
6. Legal Services	0.5 – 1.0	1.5 – 2.0
<b>Subtotal Project Development</b>	<b>2.0 – 6.0</b>	<b>8.0 – 10.0</b>



# Soft (Indirect) Capital Costs Project Development – Project Administration, Contracting and Management

- ▶ Project Administration, Contracting and Management:
  - US\$20 to 300/m<sup>3</sup>.day
  - Costs Depend on Owner's In-house Capabilities
- ▶ Includes:
  - In-house Expenditures for Owner Staff
  - Overhead Associated with Project Implementation
  - Costs for Contracting Outside Engineering Consultants and Financial Advisors

# Soft (Indirect) Capital Costs

## Project Development – Environmental Permitting and Community Participation

- ▶ Environmental Permitting - US\$80 to 400/m<sup>3</sup>.day
- ▶ Community Participation – US\$20 to 100/m<sup>3</sup>.day
- ▶ Environmental Permitting Costs Include:
  - Costs for Preparation of Environmental Studies
  - Permit Application and Processing Fees
- ▶ Community Participation Expenditures Include:
  - Preparation and Mailing of PR Materials
  - Organizing Public Meetings the During Environmental Review Period
  - Developing Project Internet Site to Share News and Pictures from Project Implementation

# Community Participation - Public Relation Materials

- Brochure
- Fact Sheets
- Frequently Asked Questions (FAQ's)
- Informational Videos
- Adaptable PowerPoint
- Adaptable Web Pages
- Utility Bill Inserts
- Technical Backgrounders
- Email Broadcasts
- Social Media (Facebook, Twitter, etc.)
- Speakers Bureau/Presentations





# Soft (Indirect) Capital Costs Project Development – Project Administration, Contracting and Management

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## ▶ Legal Services:

- US\$50 to 150/m<sup>3</sup>.day
- Costs Depend on Project Complexity, Controversy and Public Acceptance

## ▶ Includes:

- In-house expenditures for development of contractual documents
  - Negotiations with third parties to secure entitlements
  - Address legal environmental permitting challenges
- 

# Soft (Indirect) Capital Costs – Project Financing

Cost Item	Percentage of Total Capital Cost (%)	
	Low-Complexity Project	High-Complexity Project
<b>Project Financing Costs</b>		
4. Interest During Construction	0.5 - 2.5	1.0 - 4.5
5. Debt Service Reserve	2.0 - 5.5	4.5 - 8.5
6. Other Financing Costs	0.5 - 1.0	3.5 - 4.5
<b>Subtotal Project Financing</b>	<b>3.0 - 9.0</b>	<b>9.0 - 17.5</b>

# Soft (Indirect) Capital Costs

## Project Financing Expenditures – Interest During Construction

- ▶ Interest During Construction – 0.5 to 4.5 % of total Capital Costs
- ▶ Funds for payment of debt service obligations during the period of project construction.
- ▶ Usually during construction phase Owner pays interest only on the money used for construction.

# Soft (Indirect) Capital Costs

## Project Financing Expenditures – Debt Service Reserve

- ▶ Debt Service Reserve:
  - Typically – 2.0 to 8.5 % of total project capital costs
  - Intended to protect project lenders against Owner's inability to repay debt when project revenue generated from plant operation is insufficient.
- ▶ Size of Debt Service Reserve – one of the three values:
  - Maximum annual debt service;
  - 125 % of the average debt service;
  - 10 % of the principal.

# Soft (Indirect) Capital Costs Project Financing Expenditures – Other Financing Costs

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- ▶ Other Financing Costs – 0.5 to 4.5 % of total Capital Costs
  - Working Capital – typically 15 to 20 % of the capital costs and annual O&M costs;
  - Insurance Reserve – for self-insurance or insurance coverage of items not covered by traditional insurance policies.



# Soft (Indirect) Capital Costs Contingency

- ▶ Contingency – 5 to 10% of Total Capital Costs
  - Contractor Cost Overruns
  - Unknown Subsurface Risks
  - Inclement Weather
  
- ▶ Size Depends on:
  - The Accuracy of the Cost Estimate;
  - Project Complexity

# Sources of Project Funding

- ▶ Government Funding:
  - Grants and Subsidies
  - Sovereign Guarantees for Payment for Water Supply Services
- ▶ Conventional (Bond or Construction Loan) Financing - Issuing long term debt:
  - general obligation bonds – 2.5 to 4.0 % interest
  - Tax-exempt public or private activity revenue bonds – 3.5 to 6.0 %
  - Taxable debt/bonds – 4.5 to 8.0 %
- ▶ Commercial bank loans – 150 to 275 points over London inter-bank offered rate (LIBOR)

# Sources of Project Funding - Private Project Financing

- ▶ Private Project Financing:
  - Source of funds – Private Lenders
  - BOOT Projects Funded by private financing.
- ▶ Projects Funded by Combination of Equity and Debt
  - 10 to 25 % Equity @ interest rate of 12 to 20 %
  - 75 to 90 % Debt – Syndicated Loans and/or Bonds
- ▶ Funding by Multilateral Lending Agencies:
  - European Investment Bank – Projects in Israel
  - European Regional Development Fund – Spain, Malta Plants
  - EU Water Sanitation Program

# Comparison of Project Funding Alternatives

## ➤ Government Financing:

- Key Advantage - Lowest Cost for the Final User;
- Key Disadvantages – Scarce & Limited.

## ➤ Bonds and Construction Loans:

- Key Advantage – Low Cost Funds (3 to 8 % rate);
- Key Disadvantages – Limited by the Credit Capacity of the Water Agency & Complex Approval Process.

## Private Project Finance:

- Key Advantage – Utility Responsible to Pay for Services & Borrowing Capacity Not Impacted;
- Key Disadvantages – Usually More Expensive for Small and Low-Risk Projects.

# Summary of Soft (Indirect) Capital Costs

Cost Item	Percentage of Total Capital Cost (%)	
	Low-Complexity Project	High-Complexity Project
<b>Project Engineering Services</b>		
5. Preliminary Engineering	0.5 - 1.0	0.5 - 1.5
6. Pilot Testing	0.0 - 0.5	1.0 - 1.5
7. Detailed Design	3.5 - 4.5	5.0 - 6.0
8. Construction Management and Oversight	1.0 - 2.0	2.5 - 3.5
<b>Subtotal Engineering Services</b>	<b>5.0 - 8.0</b>	<b>9.0 - 12.5</b>
<b>Project Development</b>		
4. Administration, Contracting and Management	1.0 - 1.5	2.0 - 3.0
5. Environmental Permitting (Licensing)	0.5 - 3.5	4.5 - 5.0
6. Legal Services	0.5 - 1.0	1.5 - 2.0
<b>Subtotal Project Development</b>	<b>2.0 - 6.0</b>	<b>8.0 - 10.0</b>
<b>Project Financing Costs</b>		
4. Interest During Construction	0.5 - 2.5	1.0 - 4.5
5. Debt Service Reserve	2.0 - 5.5	4.5 - 8.5
6. Other Financing Costs	0.5 - 1.0	3.5 - 4.5
<b>Subtotal Project Financing</b>	<b>3.0 - 9.0</b>	<b>9.0 - 17.5</b>
<b>Contingency</b>	<b>5.0 - 7.0</b>	<b>6.0 - 10.0</b>
<b>Subtotal Indirect Capital Costs (% of Total Capital Costs)</b>	<b>15.0 - 30.0</b>	<b>32.0 - 50.0</b>

# Total Capital Costs – Sum of Direct and Indirect Capital Expenditures

Cost Item	% of Total Capital Costs	
	Low Complexity Project	High Complexity Project
<b><i>Subtotal (A) - Construction (Direct Capital) Costs</i></b>	<b>70-85 %</b>	<b>50 – 68 %</b>
Engineering Services	5-8 %	9-12.5 %
<b>Project Development</b>	<b>2-6 %</b>	<b>8-10 %</b>
Project Financing	3-9 %	9-17.5 %
<b><i>Subtotal (B) - Soft (Indirect Capital) Costs</i></b>	<b>15-30 %</b>	<b>32-50 %</b>
<b>Total Capital Costs (A + B)</b>	<b>100 %</b>	<b>100 %</b>



# Indirect Capital Cost Comparison

- ▶ Conventional Water Treatment Plant:  
Indirect Costs - 15 to **25 %** of Capital Costs;
- ▶ Seawater Desalination Plant:  
Indirect Costs - 15 to **50 %** of Capital Costs.
- ▶ Where Does the Difference Comes from? – **Cost of Project Related Risks (Intake and Source Water Quality; Permitting; Technology; Reliability, etc.).**

**This Difference Helps Understand Why Majority of the Large SRWO Projects Worldwide are Mainly Completed Under BOOT Delivery!**

# Capital Costs of Key Desalination Plants in Algeria

(Cost of Water - US\$0.7-1.1/m<sup>3</sup>)

Plant	Capacity (MLD)	Total Capital Cost (Million US\$)
Hamma	200	258
Skikida	100	136
Ben Saf	200	240
Fouka	120	180
Mostaganem	200	291
Cap Dijinet	100	138
Magtaa	500	492
Tenes	200	231
Honaine	200	291



**Questions?**

# Coffee Break



**Coffee Owls**

**Half-Caf**

**Decaf**

**Espresso**

**Regular**