arwadex 2017

تحت رعاية معالي رئيس مجلس الوزراء المصري المهندس شريف إسماعيل
مؤتمر تحلية المياه الحادي عشر في البلدان العربية
UNDER THE PATRONAGE OF THE EGYPTIAN PRIME MINISTER ENGINEER SHERIF ISMAIL
11TH WATER DISALINATION CONFERENCE IN THE ARAB COUNTRIES
18-19 APRIL 2017 • INTERCONTINENTAL CITY STARS - CAIRO - EGYPT

Forward, Reverse and Hybrid Osmosis Systems: Recent Developments and Future Challenges

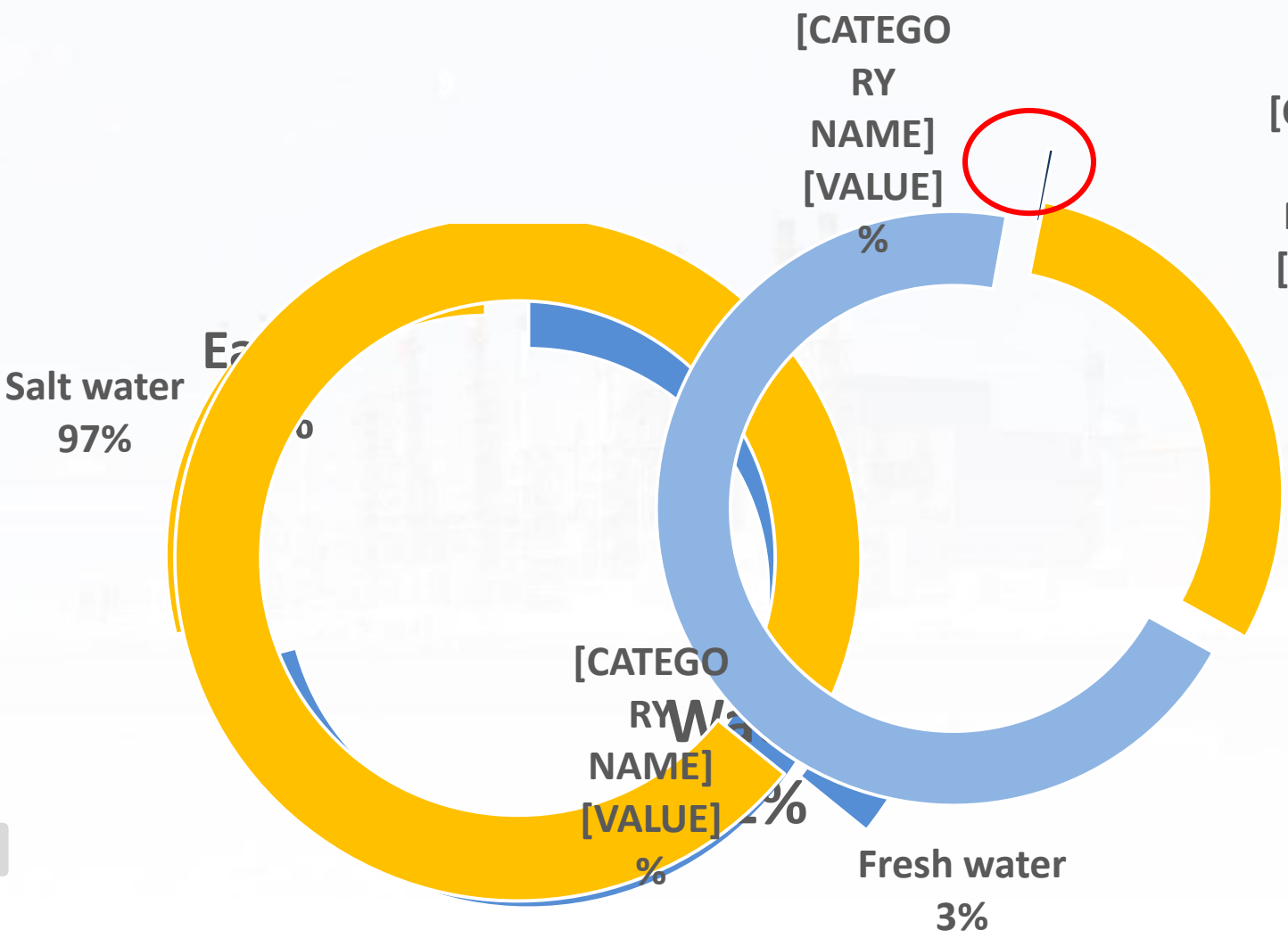
Mahmoud M. Fouad
Director of Drinking Water Quality
Holding Company for Water and Wastewater

بالتعاون مع
Holding Company for Water & Waste Water
وزارة الاسكان والمرافق والمجتمعات العمرانية
تنظيم
EXICON International Group مجموعة أكزيكون الدولية
www.exicon-specialist.com
WWW. ARWADEX.NET
متعاونوا الدورات السابقة

Contents

- Introduction.
- Forward Osmosis (FO).
- Reverse Osmosis(RO).
- Hybrid Systems (HS).
- Recommendations, Remarks and Conclusions.

Introduction



UN Water, 2012; World resource, 2012

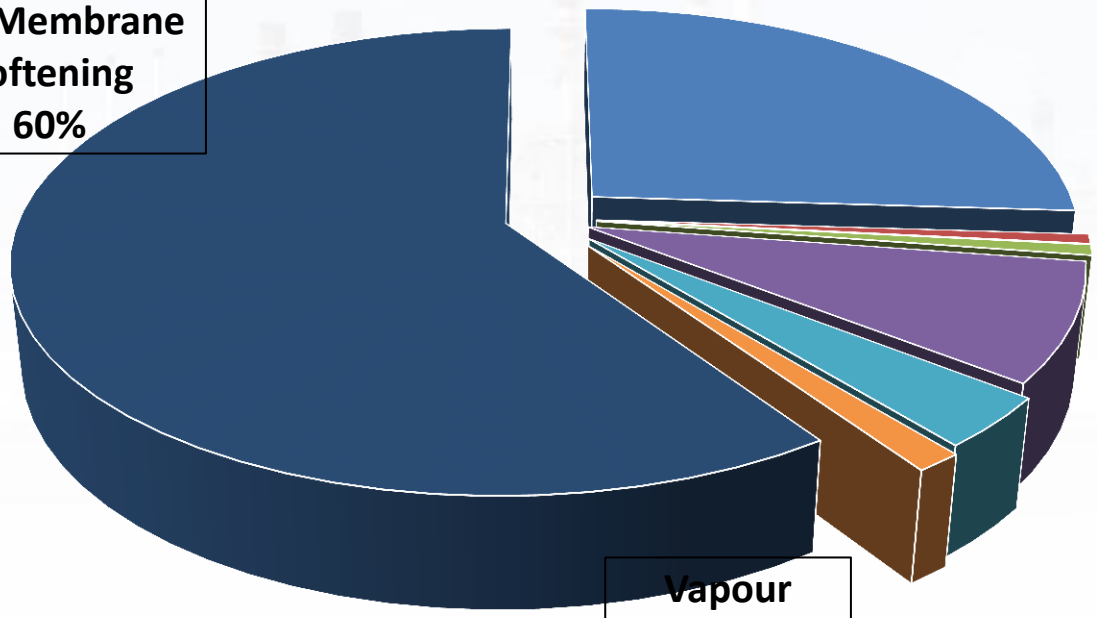
Introduction

Desalination Techniques:

- Reverse Osmosis (RO)
- Forward Osmosis (FO)
- Membrane Distillation
- Biological Desalination
- Freezing Desalination
- Multi Stage Flash Distillation (MSF)
- Hybrid systems
- Others

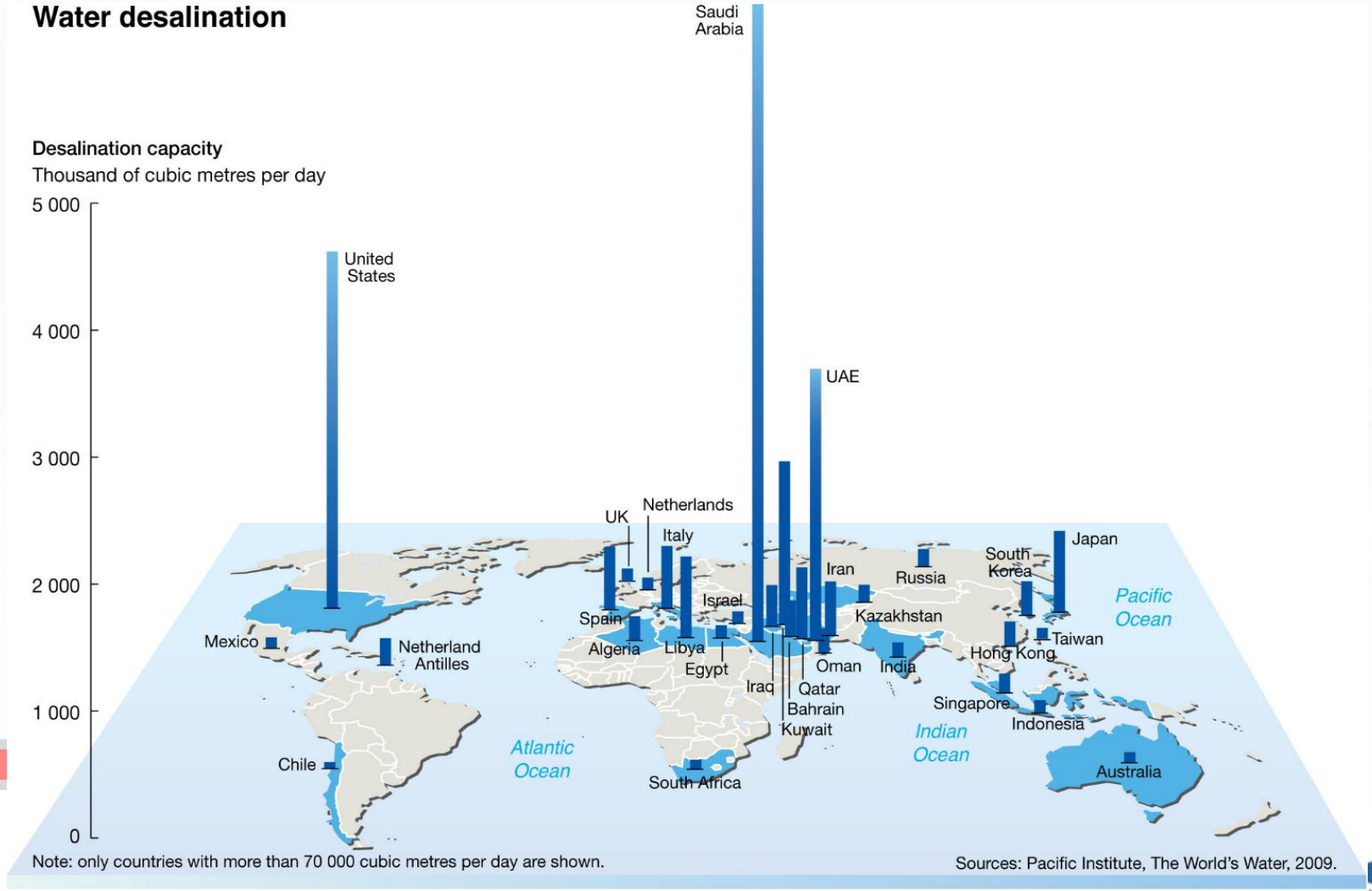
Introduction

Global Desalination capacity
66.4 Million m^3/Day



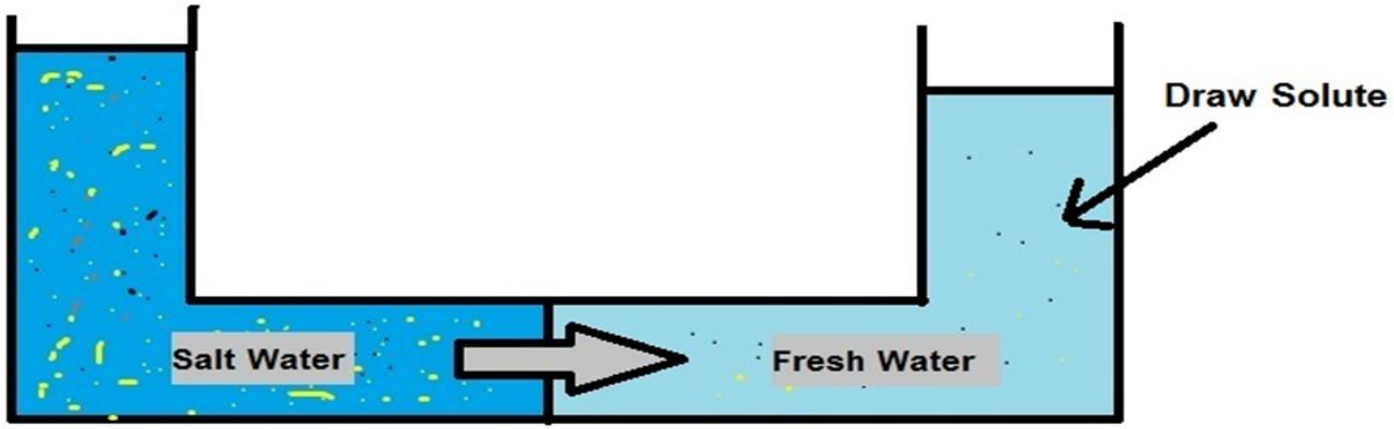
Desalination capacities by technology (as of first quarter of 2012) -

Introduction



Forward Osmosis (FO)

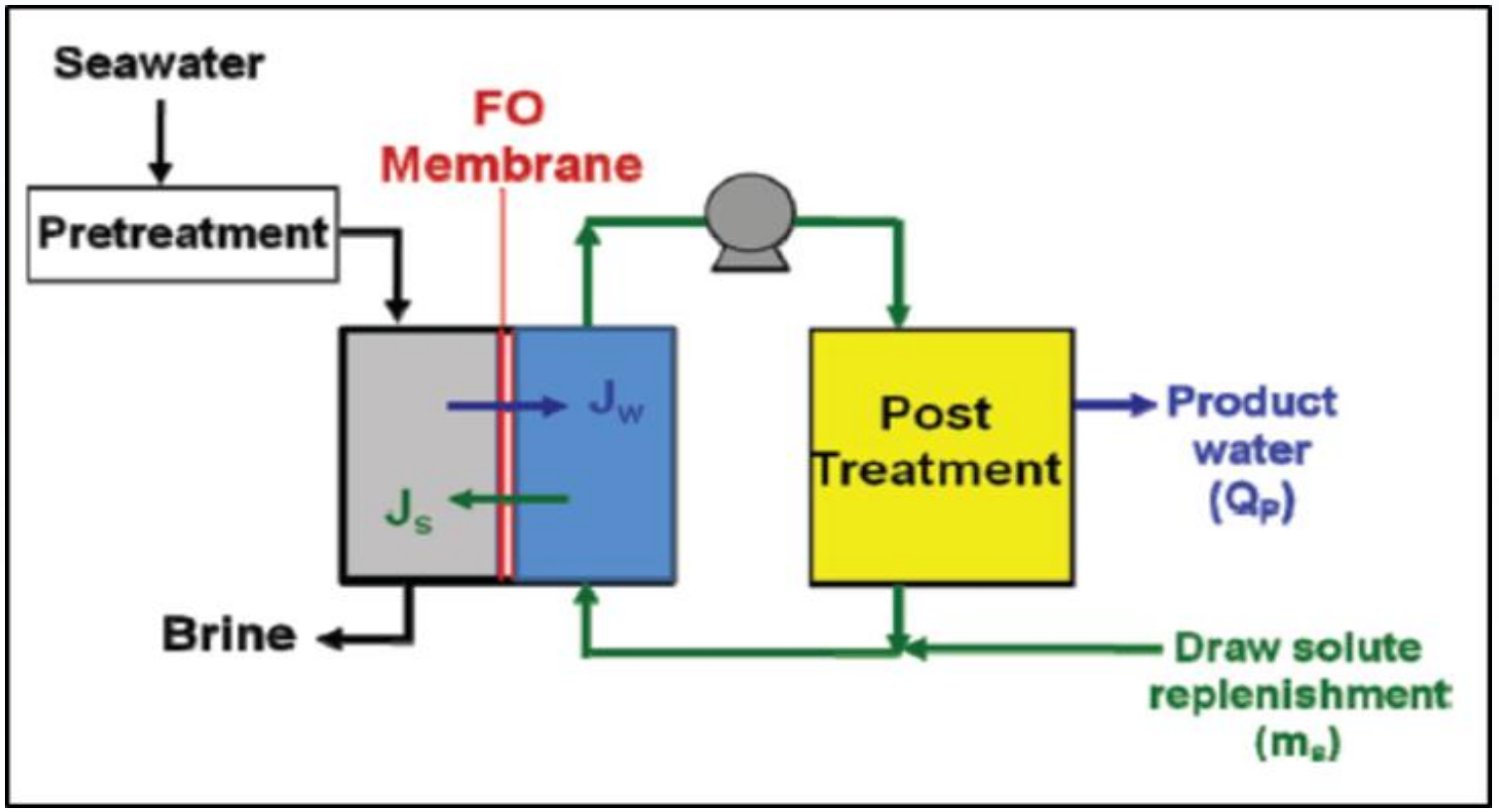
- Background & Principles.
- Energy Consumption & Cost.
- Recent Developments.
- Future challenges.



Forward Osmosis (FO) process

Forward Osmosis (FO)

- **Background & Principles:**



Forward Osmosis (FO)

- **Energy Consumption & Cost:**

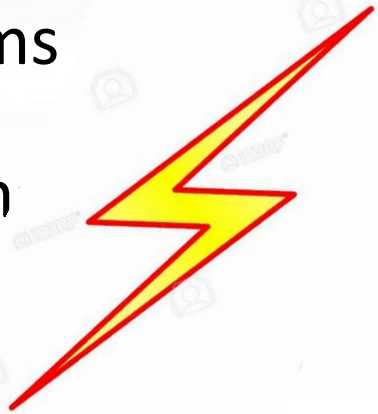
Q: Is the FO technique more Energy efficient than conventional membrane desalination?

FO < Conventional Membrane systems

FO = Conventional Membrane systems

FO > Conventional Membrane system

More Studies are Critically needed



Forward Osmosis (FO)

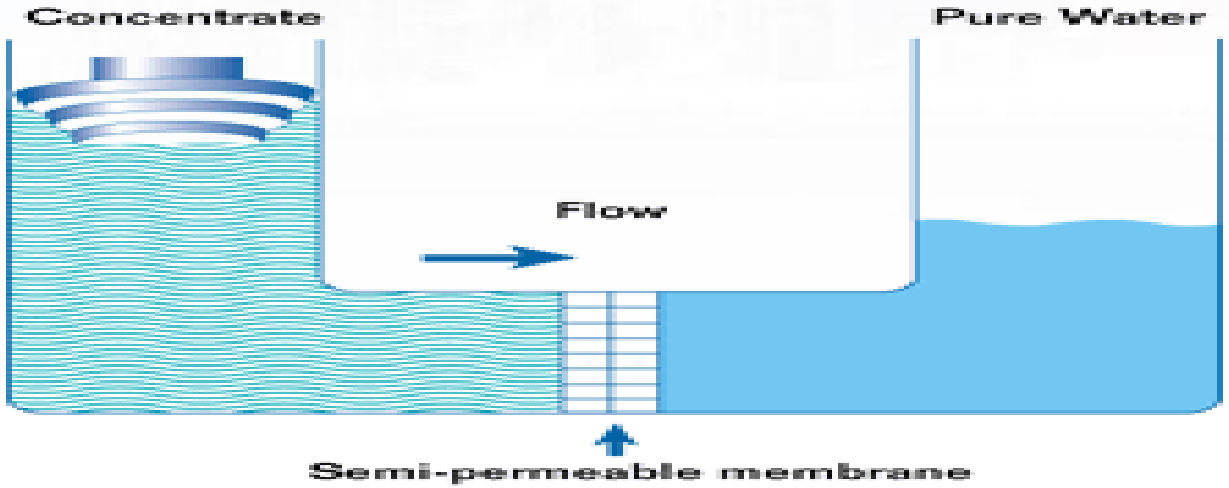
- **<u>Recent Developments and Future Challenges:</u>**

Areas of Developments
and future researches include:

- Draw Solutes.
- Membrane materials and Characteristics.
- Energy consumption estimation.
- Overall cost assessment in comparison with other conventional desalination technologies.

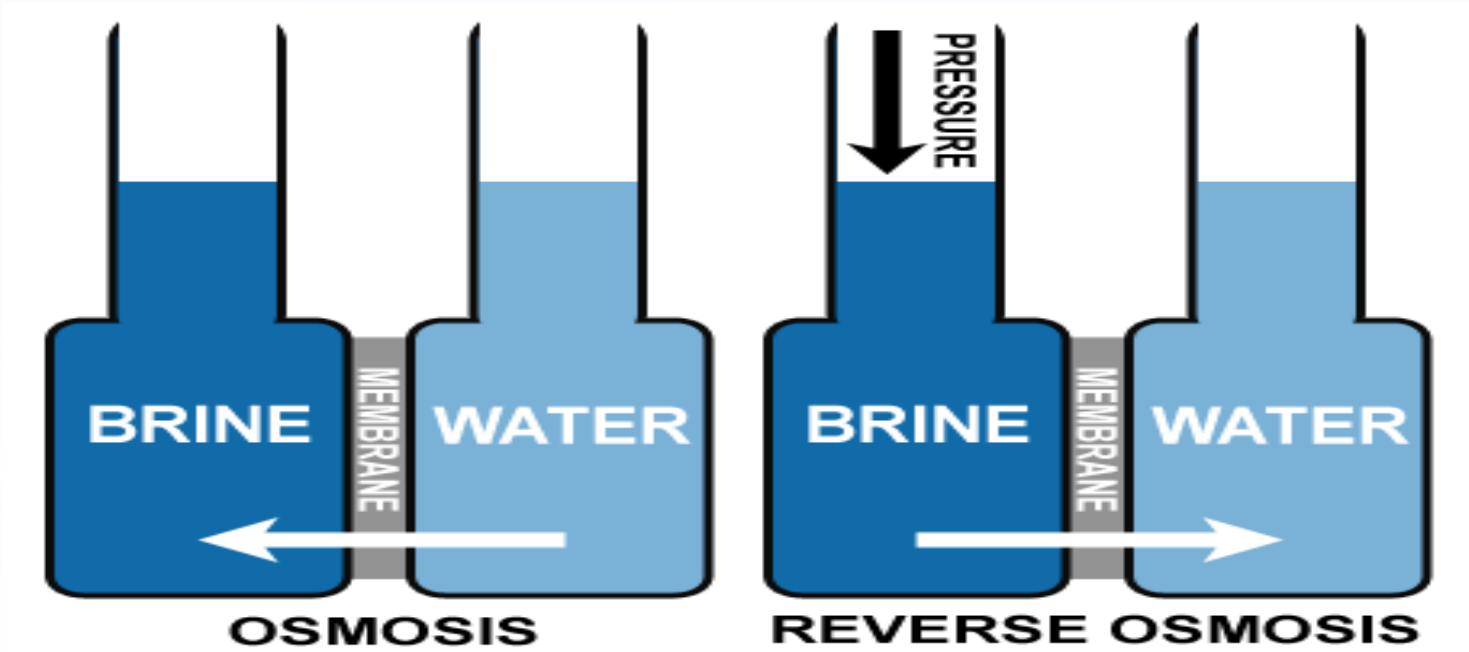
Reverse Osmosis (RO)

- Background & Principles.
- Energy Consumption & Cost.
- Recent Developments.
- Future challenges.



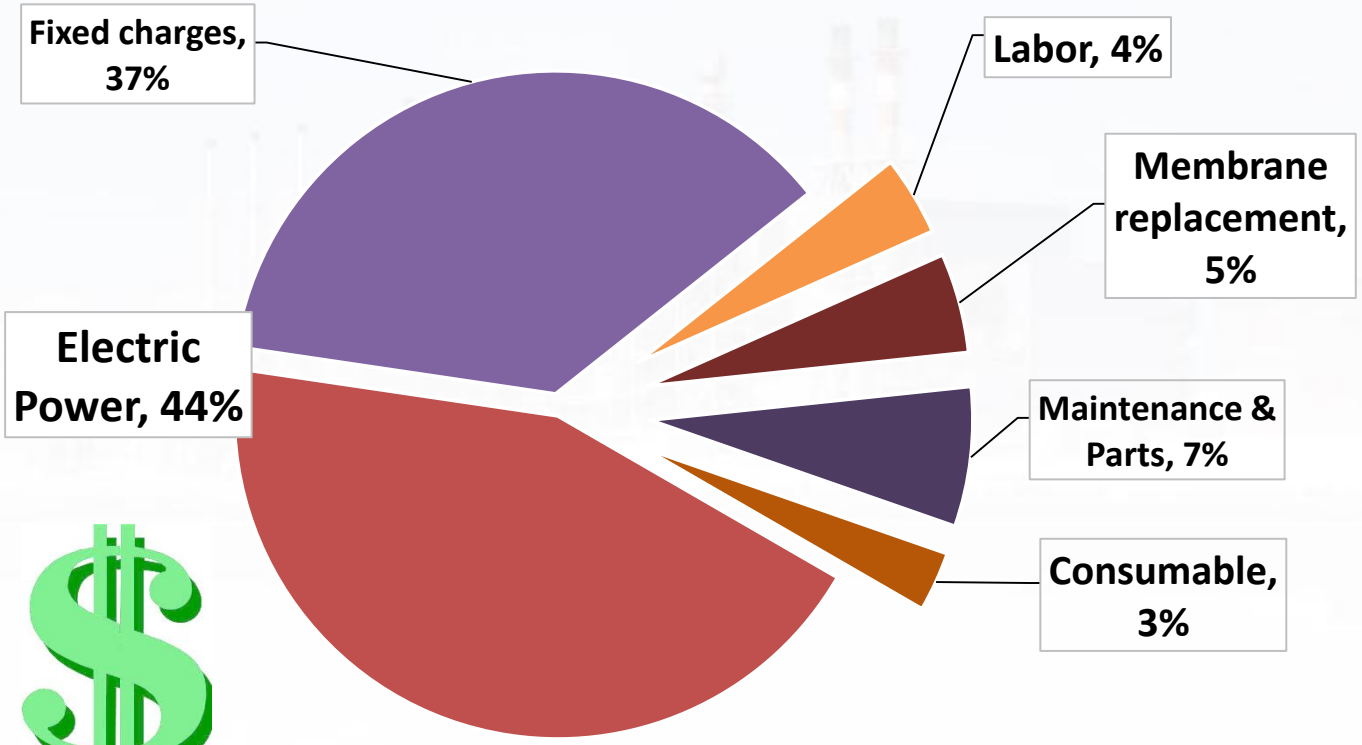
Reverse Osmosis (RO)

- **Background & Principles:**



Reverse Osmosis (RO)

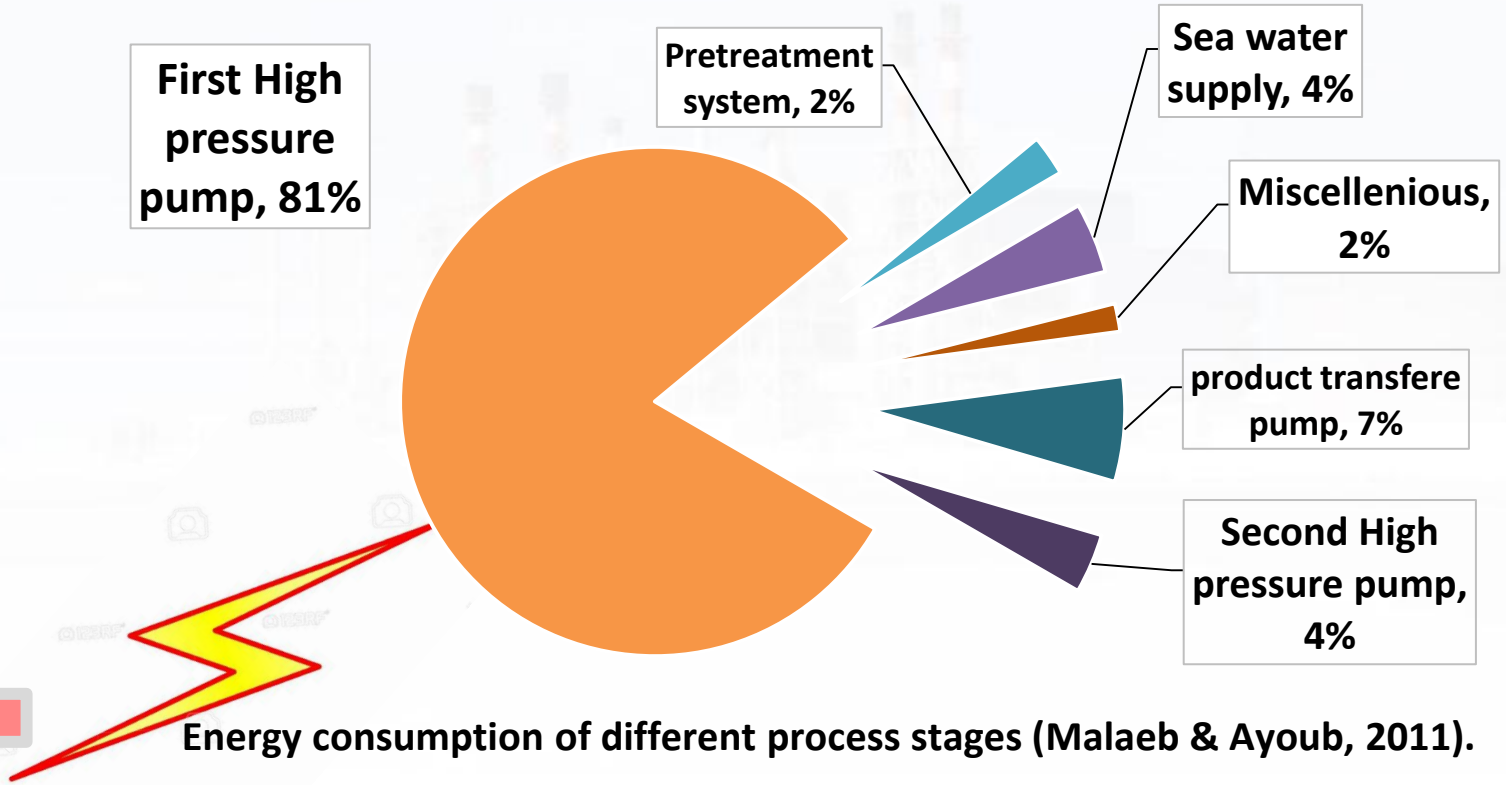
- **Energy Consumption & Cost:**



Total water cost distribution. Source: (Wilf, 2004)

Reverse Osmosis (RO)

- **Energy Consumption & Cost:**

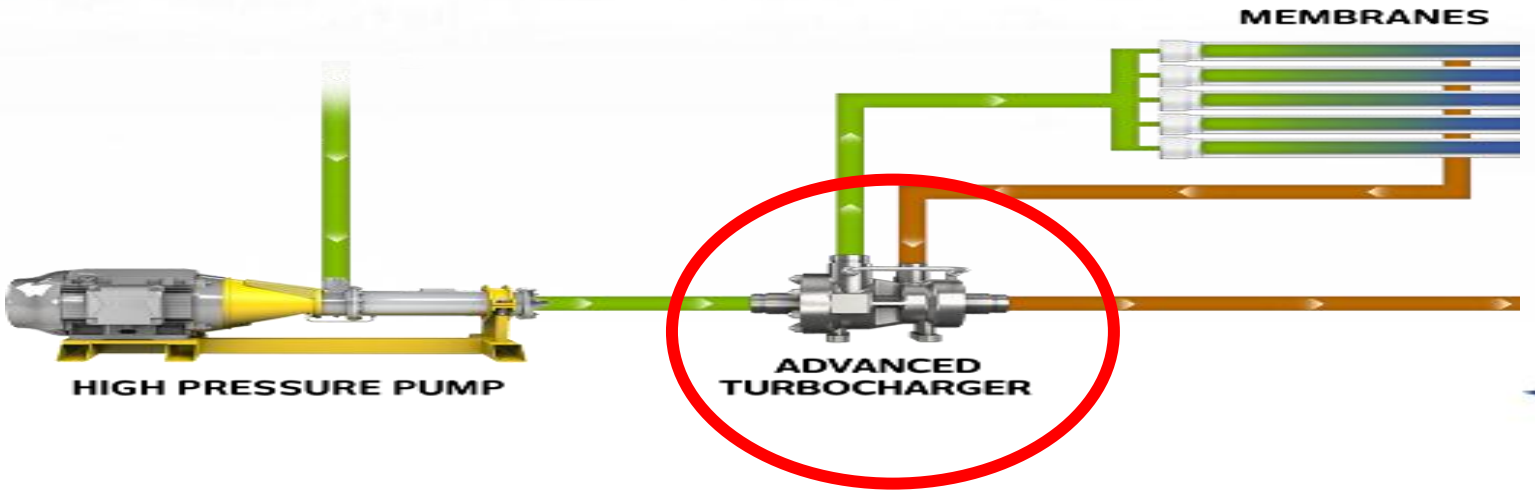


Energy consumption of different process stages (Malaeb & Ayoub, 2011).

Reverse Osmosis (RO)

- **<u>Energy Consumption & Cost:</u>**
- Cost Reduction pathways:

1. High flux membranes. (Fouling resistant membranes)
2. More efficient Energy recovery devices.



Reverse Osmosis (RO)

- **Recent Developments :**

Areas of Developments and future researches include:

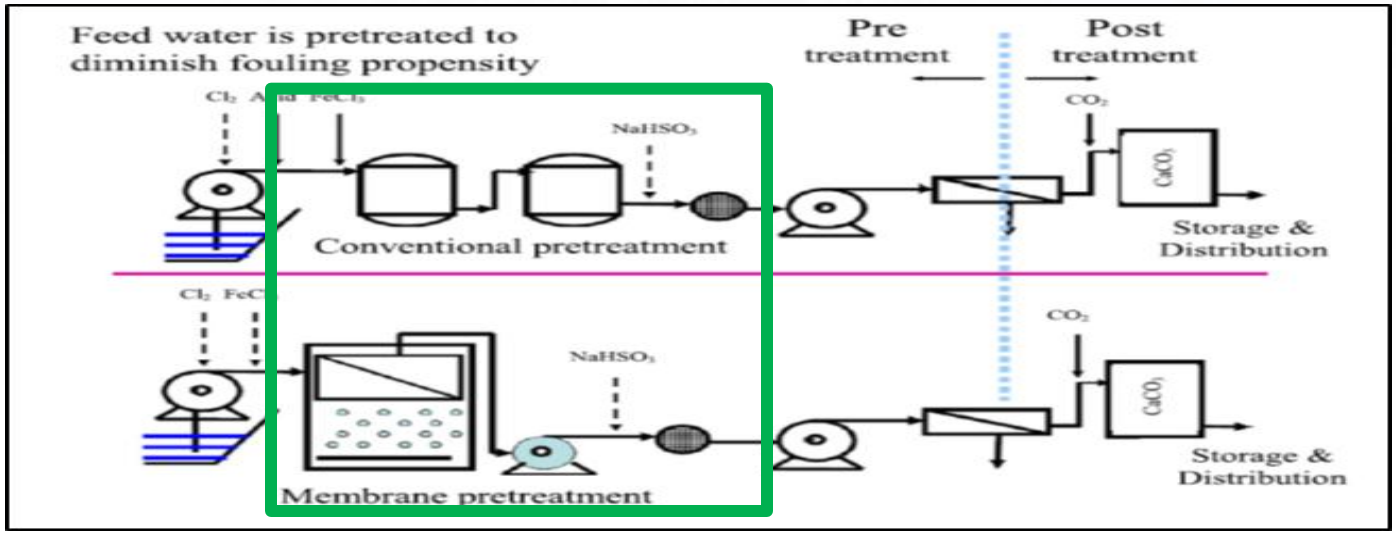
- Cost Reduction Methodologies.
- Development of high flux membranes.
- Studies in Cost Estimation and Performance Evaluation.

Reverse Osmosis (RO)

- **<u>Future Challenges :</u>**
- Handling of RO rejected waste.
- Direct and Indirect costs for brine discharge.
- Reduction of Membrane Fouling.
- Evaluation of RO process in pharmaceuticals removal.
- Studying DBPs removal using RO technology.

Hybrid Systems (HS)

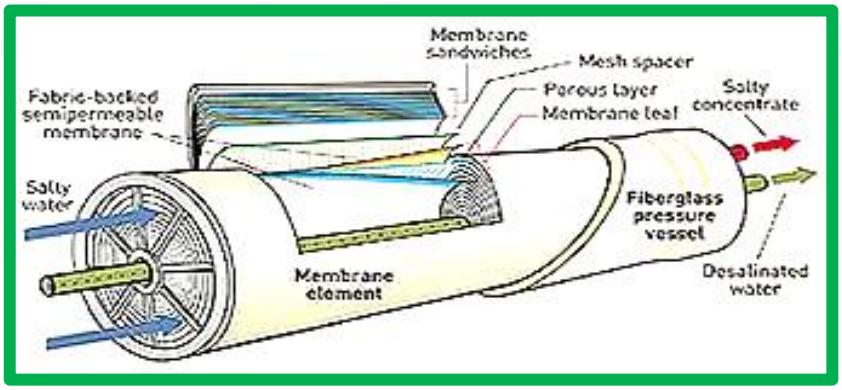
- Background & Principles.
- Energy Consumption & Cost.
- Recent Developments.
- Future Challenges.



Hybrid Systems (HS)

- **Background & Principles:**

Membrane Desalination



+

- **Adsorption**
- **Coagulation**
- **Ion Exchange**
- **Nano Filtration**
- **Forward Osmosis**
- **Other Techniques**

Hybrid Systems (HS)

- **<u>Energy consumption and Cost:</u>**
- Energy and cost is very dependent on the design and components of the hybrid system.
- No adequate information on the cost estimate of Hybrid systems.
- Developing membranes, energy reduction and recovery devices will subsequently improve the performance of integrated systems.

Hybrid Systems (HS)

- **<u>Developments and Future challenges:</u>**
- Economic and Environmental feasibility of different hybrid systems is still unclear.
- An integrated study for different hybrid systems is crucially needed.
- Feed water oriented system design should be studied in deep with reference to the financial dimension.

Recommendations, Remarks & Conclusions

- More research efforts are needed on draw solutes to push FO applications.
- The main two drawbacks regarding RO technology is membrane fouling and Energy consumption.
- New research efforts have added a lot to the development of high flux membranes and cost moderation in RO Systems.

Recommendations, Remarks & Conclusions

- Developments have been accomplished in Cost estimation and Performance Evaluation of desalination systems.
- Technical, Economic and Ecological Data analysis programs have introduced a perfect help for decision makers to choose the most suitable system for each case.
- There is still an information gap in terms of the economic and environmental feasibility of hybrid membrane systems.

Recommendations, Remarks & Conclusions

- Resources, Needs, and Quality of feed water should be taken into consideration during Hybrid systems designing.
- Hybrid Systems represent the cure for different obstacles faced desalination using conventional methods if used in the right way.


Thank
You