Trends in Desalination

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Our Blue Planet …

We have the responsibility to preserve these blue “satellites” of our Blue Planet.

… and the Water

71% of Earth Surface is Water

97.4% Sea Water
2.6% Fresh Water

68.6% is Frozen
30.1% is Ground Water
(0.783 % Earth Water)
1.3% is Surface Water

21% Lakes & Rivers
(0.0071 % Earth Water)
2018 Desalination in Figures

Around **20 000** Desalination Plants Worldwide (>100 m$^3$/day) in **150** Countries

**100 000 000** cubic meters per day is the Desalination Capacity built until 2018.

Over **300** Millions people in the World can drink water supplied by Desalination plants.

<table>
<thead>
<tr>
<th>Plants</th>
<th>Desalination Plants - 30th Inventory</th>
<th>Capacity - m$^3$/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>19 744 Total Plants</td>
<td></td>
<td>99,728,694</td>
</tr>
<tr>
<td>3 793 Off Line</td>
<td></td>
<td>6,889,086</td>
</tr>
<tr>
<td>15 598 In Operation</td>
<td></td>
<td>83,786,165</td>
</tr>
<tr>
<td>353 Under Construction</td>
<td></td>
<td>9,053,443</td>
</tr>
<tr>
<td>15 951 Under Construction + Operation</td>
<td></td>
<td>92,839,608</td>
</tr>
</tbody>
</table>

Average growth = 8% / year

Future growth: 5-6%

**200 Mill. M$^3$/day** in 2030/2032

Growing Areas:
Middle East, Africa
USA, Latin America
India, China
Sea water is confirmed as main source

... and the solution is RO

Sea water is growing faster than other sources. Going to 65%

Both, Municipal and Industrial Markets, are growing at the same rate.

Industry mainly in:
- O&G
- Mining
- Power

Higher size in Municipal
Average Municipal Plant: 8 600 m³/day
Average Industrial Plant: 3 600 m³/day

Membranes are actually prevailing in the Market: > 95%
Even in Middle East!
Desalination Plants are becoming not linked to a Power Plant Contract and Evaporation become marginal
Procurement Method: Large Plants Mainly in DBFO or DBO 
.... and Plant size is increasing

XL Plants in DBFO or DBO
O&M > 20 years
IWWP → IWP (mainly RO)
In 2018-2019 DBFO > 50%
Market
DBFO not only in ME, also in Africa, USA, LatAm …

Annual Contracted Capacity with Private Sector Involvement, after year

<table>
<thead>
<tr>
<th>Total Plants</th>
<th>Procurement</th>
<th>2000 m3/day</th>
<th>%</th>
<th>Average m3/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>296</td>
<td>BOT / IWP / DBO</td>
<td>23 003 309</td>
<td>24.5%</td>
<td>77 714</td>
</tr>
<tr>
<td>18 159</td>
<td>DB / EPC</td>
<td>70 837 124</td>
<td>75.5%</td>
<td>3 901</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SW Plants</th>
<th>Procurement</th>
<th>m3/day</th>
<th>%</th>
<th>Average m3/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>220</td>
<td>BOT / IWP / DBO</td>
<td>20 391 982</td>
<td>35.7%</td>
<td>92 687</td>
</tr>
<tr>
<td>5 757</td>
<td>DB / EPC</td>
<td>36 668 377</td>
<td>64.3%</td>
<td>6 369</td>
</tr>
</tbody>
</table>

Going to MegaTon concept

Taweelah, 910,000 m³/day
Al Jubail, 1,200,000 m³/day
Desalination Trends: Energy and OPEX Optimization

OPEX drives the Market: 2/3 OPEX, 1/3 CAPEX

- SWRO: potential reduction of 0.2-0.3 kW.h/m³
- More performant/robust membranes, pumps and ERD
- Biofouling Control
- Minimize chemicals
- Ensure Plant Availability (spares, DAF, …)
- UF or DMF: case by case, CAPEX + OPEX
- Delivery time and planning
- Respect the Environment

Taking profit of Renewable Energy:
- Minimize “Carbon footprint”
- Reduce Energy costs (RE: 2 to 8 € cents/kW.h)
- Direct coupling for small or remote plants

OPEX: Energy still the key
Incremental and marginal phase
Membranes for the Future

Polyamide (PA)

Graphene oxide (GO)

Carbon Nanotube (CNT)

Nanoporous Graphene (NF)

Aquaporin (AQP)
Future Trend in Technologies: Brine as Source

- **Brine discharge**
  - 50

- **Treated Waste Water or Fresh water**
  - 50

**Brine Treatment**

**POST TREATMENT**

- 50

**Compatable with Existing Facilities**

**Increase Water Production**

(+ Recover Salts)

(+ Produce Energy)

(+ WW Reuse)

**Salinity Gradient Power**
Thank you for your attention

Miguel Angel SANZ