DESALINATION IN MOROCCO:
« CHALLENGES AND PROSPECTS »

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MOR12-007
Outline

• Morocco, a country in Motion for a sustainable development
• Water strategy in Morocco
• ONEP, as a main operator
• Desalination, an option for water supply
• Challenges & Prospects
• Conclusion
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Morocco, in brief

- Position: North Africa, 14 km from Europe
- Area: 710 850 km²
- Population: 31 millions
- Climate: Mediterranean
- Parliamentary, democratic and social constitutional monarchy
- GDP: 2000 Euro/capita
- Growth: 5 % per year

Rabat (capital)

Casablanca

Marrakech

Fez

Tangier
Morocco strategy for Sustainable development

The last decade was marked by two major steps:

1- To Improve the quality of life for all population, to compensate for the delay regarding social development.

2- To work in-depth on sustainable development and protecting the environment while taking advantage of Morocco’s natural resources.

The vision is to realign man and nature in the context of sustainable, responsible and clean development.
Mega projects in Morocco

Wind farm Essaouira

Future High Speed train Tangier- Casablanca

Tangier MED Harbour

Morocco is an attractive platform for investment

Highway Oujda-Fez

Seaside resort Saidia

Industrial free zone Rabat

Agro pole Meknes

Future Marina Casablanca
Nowadays, energy consumption is about 25,000 GWh. Total installed capacity is about 6,000 MW. An important dependency to thermal energy, of which 95% is imported.

Energy bill is a real burden for the national economy.

### Energy Allocation

#### 2008
- Thermal energy: 6000 MW (30%)
- Hydraulic energy: 120 MW (2%)
- Renewable energy: 1800 MW (30%)

#### 2020
- Thermal energy: 6800 MW (28%)
- Hydraulic energy: 4000 MW (14%)
- Renewable energy: 10000 MW (58%)
Integrated Moroccan Wind Energy Project
2000 MW

By 2020

Achieved and on going Program
1000 MW

Integrated Program
1000 MW

Source: MEMEE - March 2010
Integrated Moroccan Solar Energy Project
2000 MW
By 2020

1- Selection of the sites

- Commissioned 2010
- Tendering in progress
- Commissioning: 2014
- Studies in progress

Source: MASEN - oct. 2010
Morocco, Main Plans

**INDH**
Social development

**Energy**
Solar Plan, Wind Plan

**Infrastructures**
ports, airports, highways, HST

**Fishing**
Halieutis Plan

**Tourism**
Azur Plan

**Agriculture**
Maroc vert Plan

**Industry**
Emergence Plan

**Housing**
Sustainable Cities

**Environment**
Environmental Charter

**Water Strategy**

(main vector for Sustainable development)
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Climate and water resources

Rainfall

4 Billion CM/Year

Groundwater

18 Billion CM/Year

Surface water

Potential of natural water Resources

22 Billion CM/Year

Atlantic ocean

Mediterranean sea

Potential of natural water Resources

22 Billion CM/Year

18 Billion CM/Year

Surface water

4 Billion CM/Year

Groundwater
Spatial distribution of Water resources
Water resources regarding offer

Water resources per capita

Hydraulic stress

Water resources regarding demand

2008
13.7 milliards m³

2008
Irrigation (90%)

Drinking Water (8%)

Others (2%)
Water Law 10-95

**Institutional**
- Institutionalization of the Supreme Council for Water and Climate
- Creation of river-basins agencies throughout the national territory
- Creation of provincial and prefectural committees of the Water

**Planning**
- National Plan for Water
- Plan on Integrated Management of Water Resources at the regional level

**Protection:**
- Quantity: perimeter of protection and prohibition of groundwater
- Quality: protection against pollution

**Financial:**
- Introduction of the principle sampler-pays and polluter-pays
NATIONAL STRATEGY FOR WATER SECTOR DEVELOPMENT

- Water demand management and valorisation of water resources
- Preservation and protection of water resources, natural habitats and fragile areas
- Continuation of the legislative and institutional reforms
- Management and development of water offer
- Reduce vulnerability to natural water risk and adaptation to climate change
- Upgrading information systems and capacity building and skills
Water strategy
Mobilization of conventional water

- 130 large dams with a total capacity of nearly 18 billion CM
- Thousands of boreholes and wells
- 13 systems of water transfer: 1100 km and 210 m³/s
Water strategy
Mobilization of non conventional water

• Desalination program

• Wastewater treatment and re-use program

• Rainfall capture
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Main missions
- Planning
- Implementing drinking water projects
- Managing Water installations
- Controlling water quality (55 laboratories)

Strategic axis
- Perpetuating the existing installations
- Generalizing water access, mainly for rural area
- Intervening in sewerage service to control the water cycle.
ONEP KEY FIGURES 2010

- TURNOVER : 331 Million US$
- INVESTEMENT : 362 Million US$
- PRODUCTION : 901 Million m³
- SALES : 766 Million m³
- ACCESS RATE : 96 %
- CUSTOMERS (Potable Water) : 1.5 Million
- TREATMENT VOLUME OF WASTE WATER : 166,000 m³/d
- STAFF : 7300
## ONEP INVESTMENT PROGRAM
### 2011-2015

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<thead>
<tr>
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<tbody>
<tr>
<td>Potable water:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a- Urban areas</td>
<td>1.36</td>
<td>1.36</td>
<td>- The equipped flow by the end of 2009 has reached 51 m³/sec and will be carried to more than 65 m³/s</td>
</tr>
<tr>
<td></td>
<td>0.87</td>
<td>0.60</td>
<td>- Access rate in rural areas will increase from 89 % at the end of 2009 up to 95 %</td>
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<tr>
<td>b- Rural areas</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sanitation</td>
<td>0.45</td>
<td>0.68</td>
<td>The flow of treated wastewater will increase from 121,000 m³/d to more than 320,000 m³/d by 2015, for a beneficiary population of about 4.6 M</td>
</tr>
<tr>
<td>Total</td>
<td>2.68</td>
<td>2.64</td>
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Large Scale Potable Water Projects

- The Reinforcement of the potable water supply of Rabat/Casablanca coastal zone from Sidi Mohamed Ben Abdellah dam, for 430000 m³/d and a cost of 0,3 billion US$;

- The Reinforcement of the potable water supply of the cities of Fes and Meknes from Driss 1st Dam, for 170000 m³/d and a cost of 0,15 billion US$;

- The Reinforcement of the potable water supply of Marrakech city from Al Massira Dam, for 215000 m³/d and a cost of 0,25 billion US$;

- The Reinforcement of the potable water supply of Agadir city from seawater desalination, for 100000 m³/d and a cost of 0,12 billion US$. 
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Desalination process

Distillation process based on changing phase Water-Vapor,

Membrane process based on Salt-Water separation using semi permeable membranes.
Distillation Technologies

Mechanical Compression of vapor (MCV)

Distillation Multi-Effect (MED)

Distillation Multi-Stage Flash (MSF)
Membrane Techniques

Reverse Osmosis
MAJOR DESALINATION PLANTS WORLDWIDE

The United States has 2 major municipal seawater-desalination plants — 1 under construction in Tampa and another inactive plant in Santa Barbara, Calif. Other countries with 1 or more major plants are marked with red dots.

Capacity by region
A breakdown of where desalination technology is used on seawater, salty underground water and in other water treatments around the world.

SOURCES: Engineering News-Record; Aqua Resources International Corp.; International Desalination Association

SCOTT HESTAND/ ORLANDO SENTINEL
In general, all desalination process need a high CAPEX with a light advantage for RO.

OPEX analysis shows that desalination process are energy consumers.

Total cost of produced water could reach 0.5 US$/m³ however it’s affected with many factors.
Desalination Plants: Main achievements

Total Installed capacity: 35 000 m³/d

- **Laayoune 1st phase**
  - 1995
  - 7000 m³/d

- **Laayoune 3rd phase**
  - 2010
  - 13000 m³/d

- **Khenifra**
  - In progress
  - 30000 m³/d

- **Tarfaya**
  - 2001
  - 860 m³/d

- **Tan Tan**
  - 2003
  - 1700 m³/d

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[Map showing locations and capacities]
Desalination Know-How advancement

-testing 1975-1995
ED-MCV-RO
South regions

Optimization 1995-2009
Energy recovery
Materials
Membrane
Automatism

Laayoune-Boujdour

Mastering beyond 2009
Large Scale units
Generalization to other regions
Intakes
Environmental aspects

Laayoune-Khenifra-Khouribga-Tan Tan-Agadir

Testing 1975-1995
ED-MCV-RO
South regions

Tarfaya-Smara-Boujdour

35 years experience
DESALINATION KNOW-HOW ADVANCEMENT

Membrane technology

- Hollow fiber membranes
- Spiral wound membranes

Energy recovery

- Pelton turbines
- PEX
- DWEER

Stainless steel Material

- 316 L
- Duplex

Automatism

- Regulation valve
- Frequency variator
IMPACT ON CAPEX

Evolution du ratio Kwh/m3 pour la station de dessalement de Lâayoune

- Ratio T. Pelton
- Ratio Dweer
- Ratio Contratuel


Kwh/m3
FUTUR DESALINATION PROJECTS

Touristic Projects
- Guelmim (Plage Blanche) 6,000 m³/d
- Dakhla 8,600 m³/d
- Al Hoceima (Cal Iris) 8,600 m³/d

Cities
- Agadir (1st phase) 100,000 m³/d
- Khenifra 30,000 m³/d
- Khouribga 26,000 m³/d
- Nador 43,000 m³/d
- Essaouira 50,000 m³/d
- Sidi Ifni 13,000 m³/d
- Laâyoune 26,000 m³/d
- Boujdour 8,600 m³/d
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MAIN CHALLENGES

RAW WATER QUALITY
- Dakhla case

CAPEX: FINANCIAL DEAL
- Agadir case

OPEX: ENERGY BILL
- Tan Tan case
DAKHLA CASE

Population: 100 000 inhab

Main activities:
(Breading, Fishing, Nautical sports)
DAKHLA CASE
Main constraint

A Complex raw water quality with many parameters exceeding drinkable water standards

$\text{H}_2\text{S}, \text{NH}_4, \text{Fe}, \text{TDS, T}^\circ$
DAKHLA Technical Sheet

- Capacity (1st phase) : 17 300 m³/d
  (60% to be desalted)
- Process : Reverse Osmosis
- Intake : Boreholes
- TDS : 2.5 g/l
- Investment cost : 10 Millions US$
- Current Stage : Construction Start up
- Commissioning date : 2013
AGADIR CASE

Population: 800 000 inhab

2nd economical pole:
(Agriculture, Fishing, Tourism)
Water resources in Agadir

Desalination Unit
Selected Site
AGADIR Technical Sheet

- Capacity (1st phase): 100 000 m³/d
- Process: Reverse Osmosis
- Intake: Direct
- TDS: 36 g/l
- Required Power: 20 MW
- Electrical supply: National grid
- Current Stage: Tendering in progress
- Commissioning date: 2015
- Contract form: BOT

A new management mode and financial deal that could contribute to reduce CAPEX and OPEX.
TAN TAN CASE

Population: 70,000 inhab

Activities:

Breading, Fishing, Potential tourism
Existing Water Resources

Oued Sayed Aquifer

Guelmim

TanTan Port

Chebeika

Desalination plant
**Tan Tan Technical sheet**

- **Capacity (1st phase)**: 9 000 m³/d.
- **Process**: Reverse Osmosis.
- **Intake**: Beach boreholes.
- **TDS**: 15 to 20 g/l.
- **Required Power**: 5 MW.
- **Current Stage**: Works in progress.
- **CAPEX**: 20 millions US$.
- **Commissioning date**: 2013.
- **Electrical supply**: National grid as a 1st phase.

*Renewable energy could be the solution?*
Morocco enjoys an important potential of renewable energies.

Desalination coupled to RE is feasible (feasibility study already done for MENA regions).

For economical reasons, this technique should be used for cogeneration of: Drinking Water, Electricity and Heat.
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CONCLUSION

- Morocco is an attractive platform for investment in MENA regions.
- Morocco has developed a complete strategy to enhance water and sanitation sectors for sustainable development.
- To reduce the impact of the energy bill on the Moroccan economy, the use of Renewable energy is the key.
- ONEP acquired a noticeable know-how in desalination that will be beneficial for his future desalination program development.
- R&D is highly recommended to face increasing complex raw water quality.
- Desalination coupled to renewable energy might be a potential axis for cooperation.
- PPP could be a win-win option to develop water desalination program of Morocco.
Thank you for your attention

Bouregreg treatment plant (800 000 m³/d) ONEP- RABAT

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