

INTERNATIONAL  
CONFERENCE ON  
DESALINATION AND  
SUSTAINABILITY

1 - 2 March 2012



الجمعية المغربية للمياه و تحلية المياه



in cooperation with



supported by



CASABLANCA 2012

MOROCCO

**DESALINATION IN MOROCCO:  
« CHALLENGES AND PROSPECTS »**

**Mr Khalid Tahri**

MOR12-007

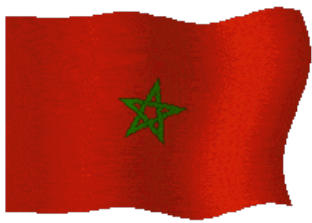
# Outline

- 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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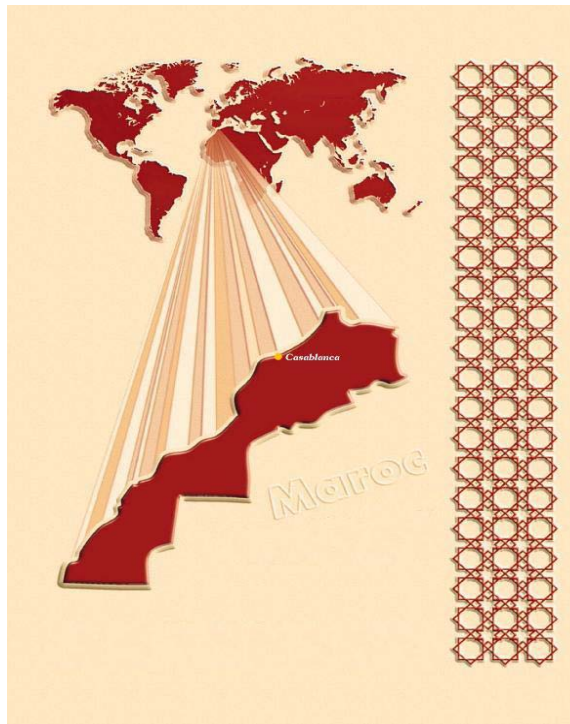
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# Morocco, in brief

- Position: North Africa, 14 km from Europe
- Area: 710 850 km<sup>2</sup>
- 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**



**Highway Oujda-Fez**

**Morocco is an  
attractive  
platform for  
investment**



**Seaside resort Saidia**



**Industrial free zone Rabat**



**Agro pole Meknes**



**Future Marina Casablanca**

# ENERGY IN MOROCCO

- Nowadays, energy consumption is about 25 000 GWh
- Total installed capacity about 6000 MW.
- An important dependency to thermal energy of which 95% imported.

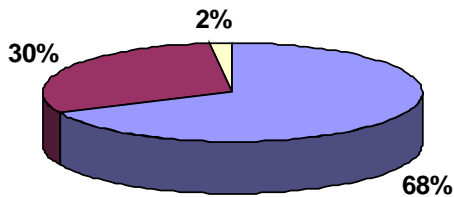


**Energy bill is a real burden for the national economy**



Energy allocation 2008

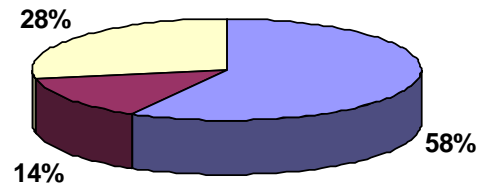
**6000 MW**



■ Thermal energy ■ Hydraulic energy □ Renewable energy

Energy allocation 2020

**14000 MW**



■ Thermal energy ■ Hydraulic energy □ Renewable energy

# Integrated Moroccan Wind Energy Project

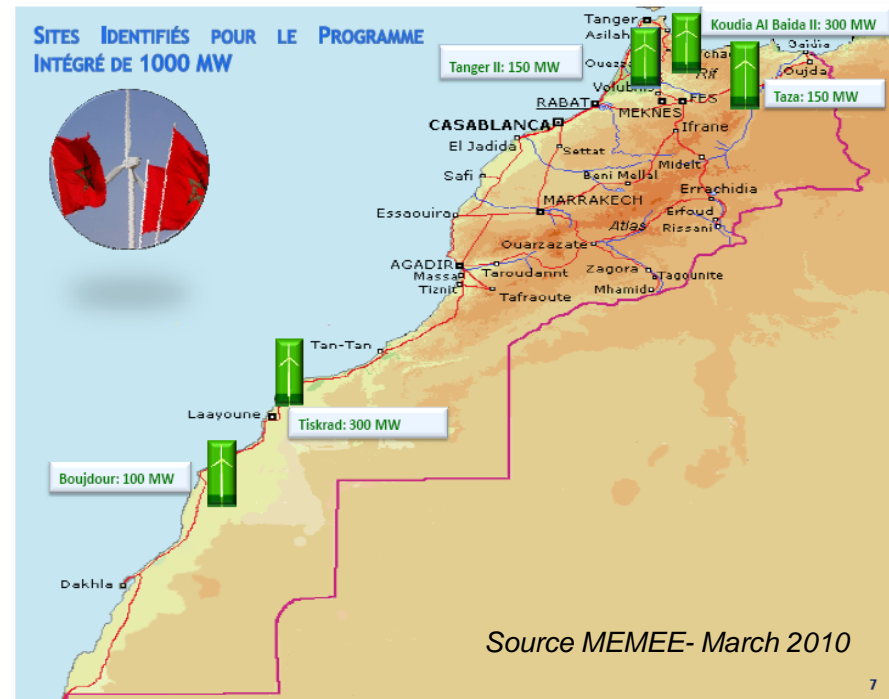
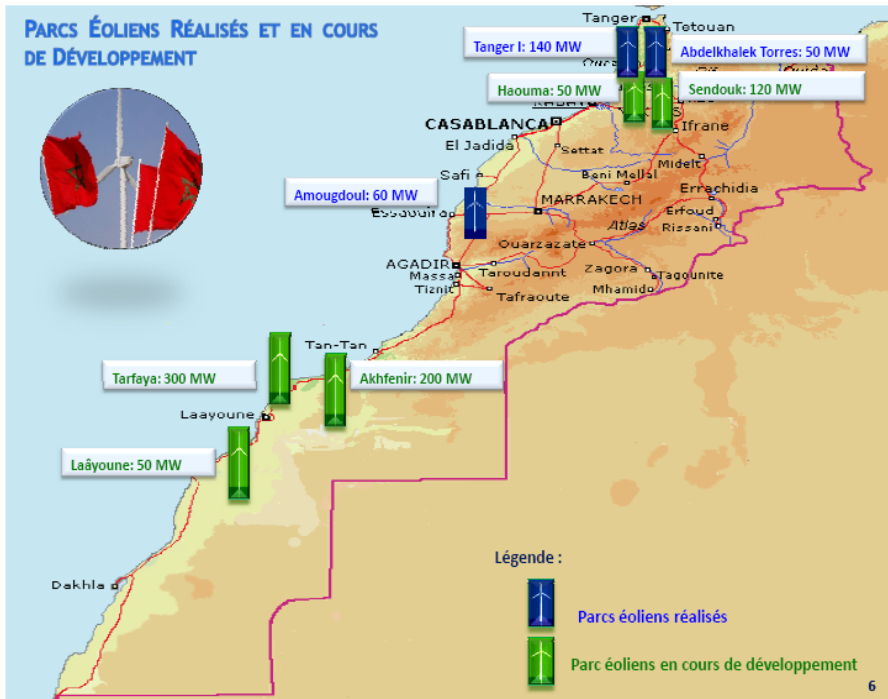
## 2000 MW



### By 2020

**Achieved and on going Program**  
**1000 MW**

**Integrated Program**  
**1000 MW**

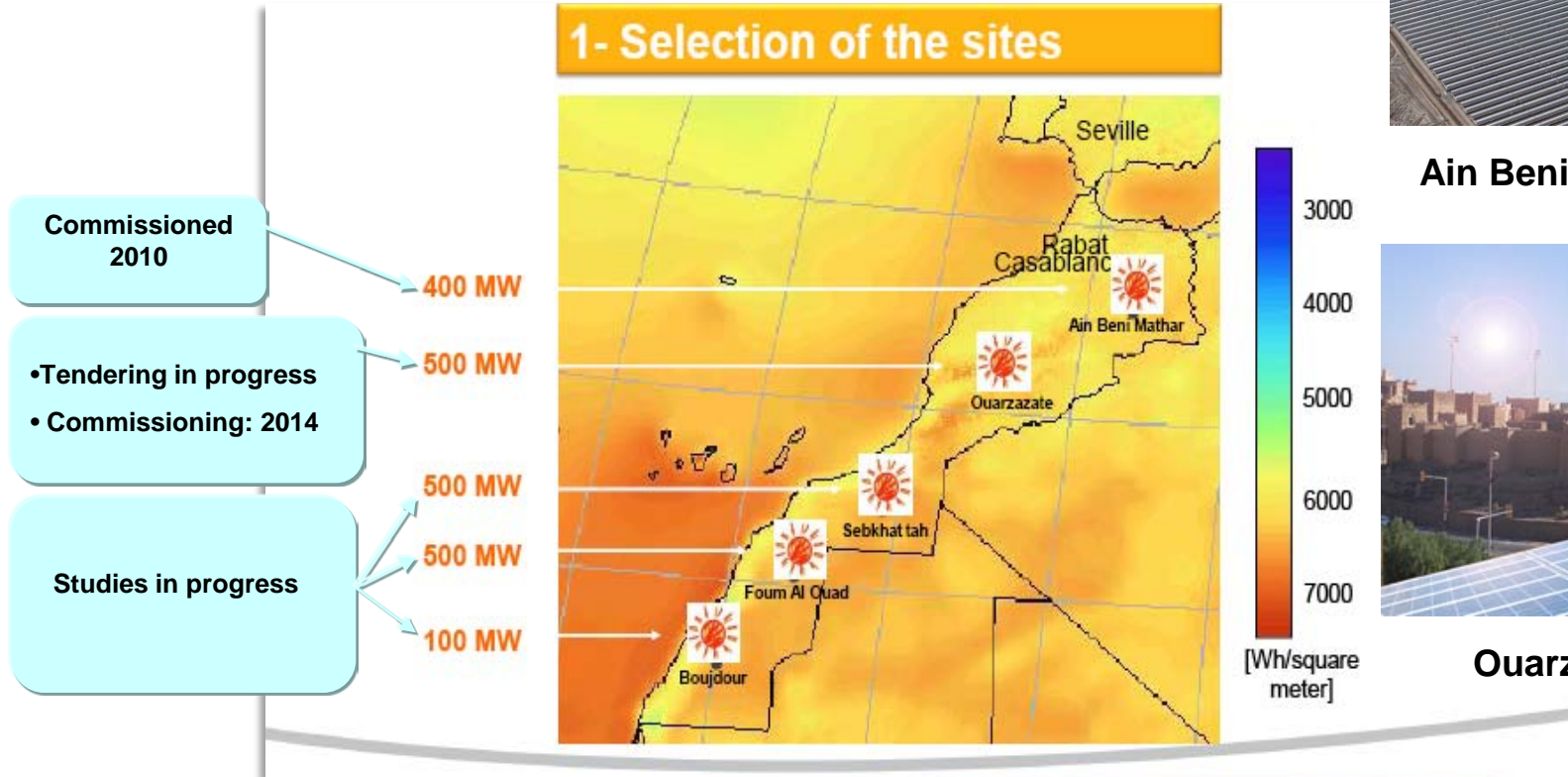




# Integrated Moroccan Solar Energy Project

## 2000 MW

### By 2020



**Ain Beni Mathar project**



**Ouarzazate project**

Source : MASEN - oct. 2010

# Morocco, Main Plans



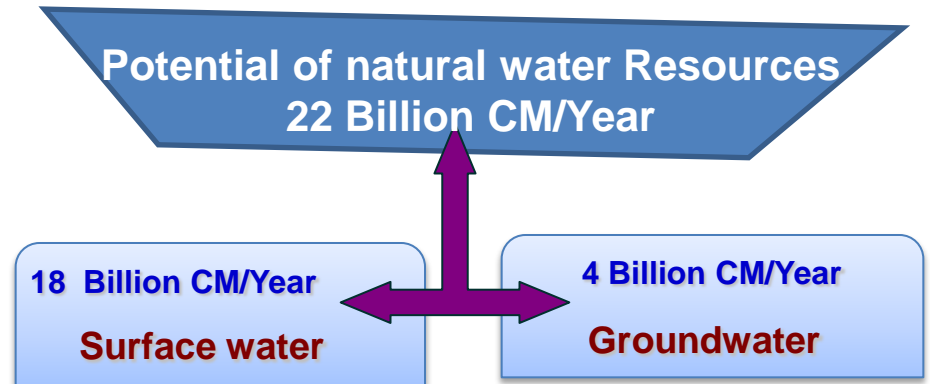
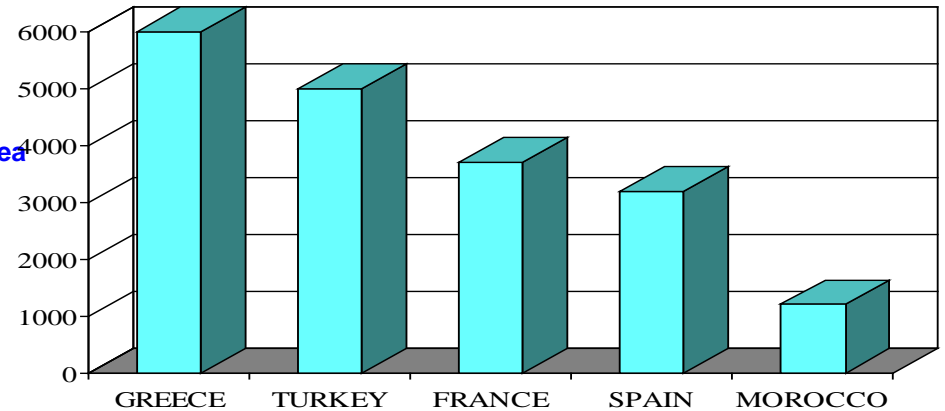
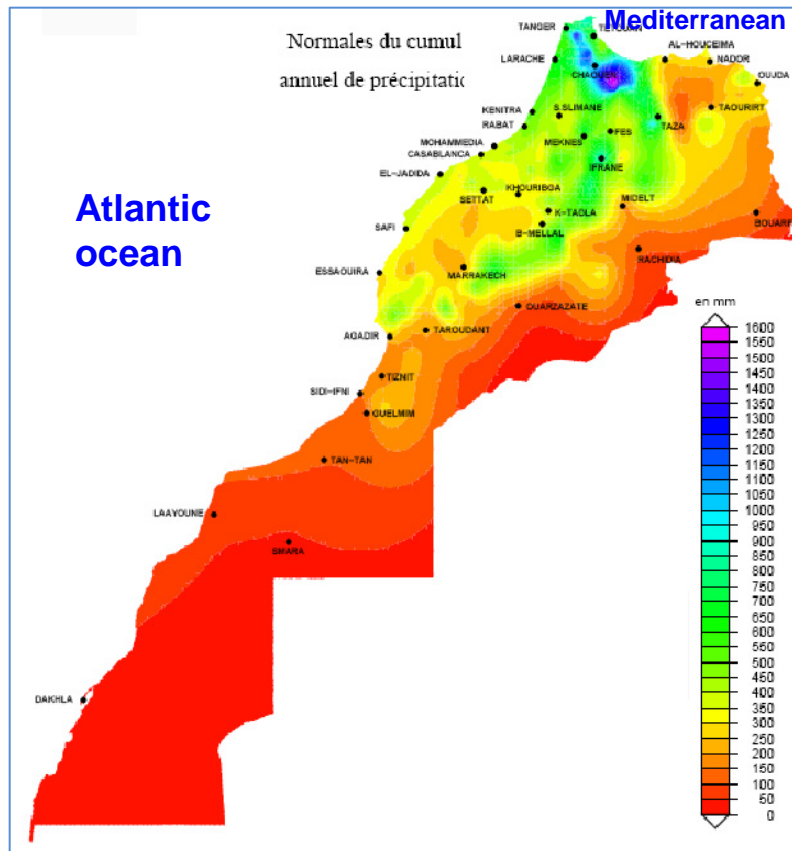
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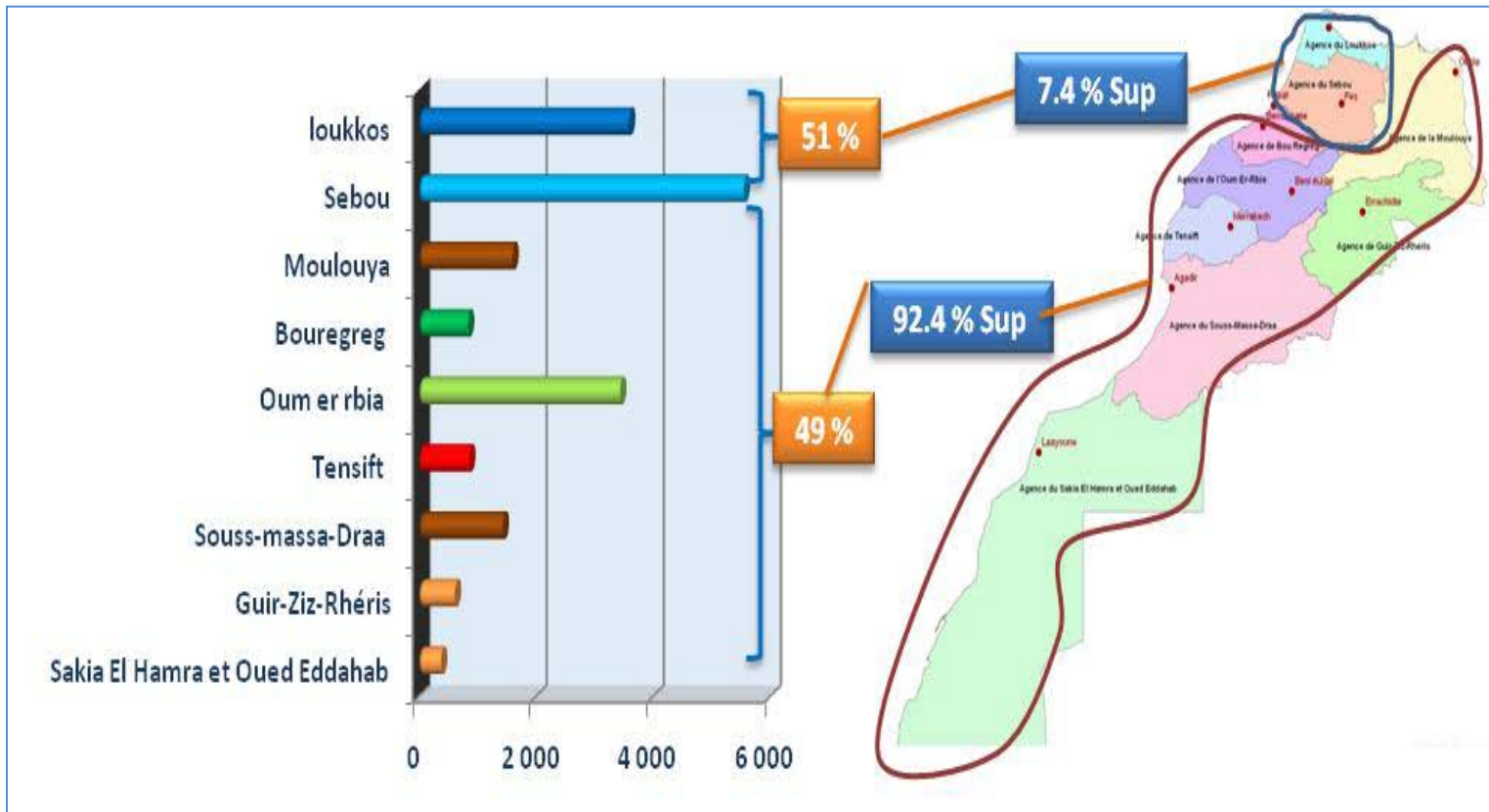


# Climate and water resources

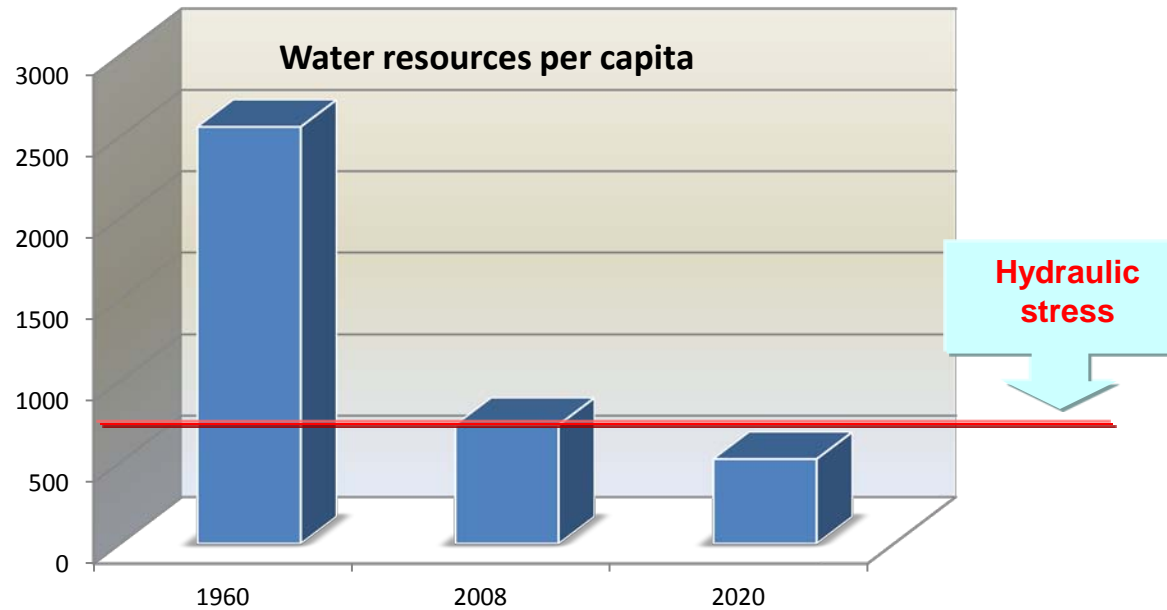
rainfall



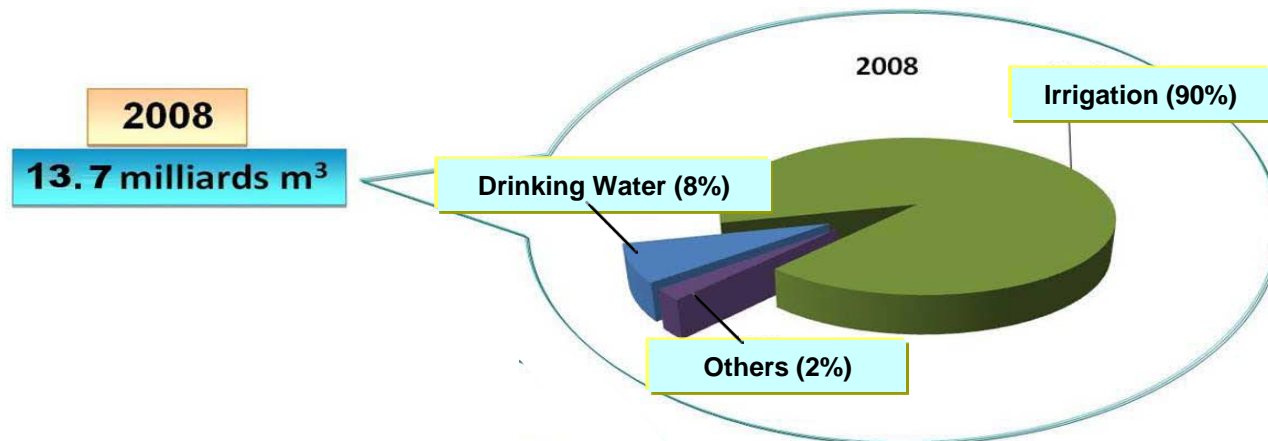
# Spatial distribution of Water resources



# Water resources regarding offer



# Water resources regarding demand





# 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

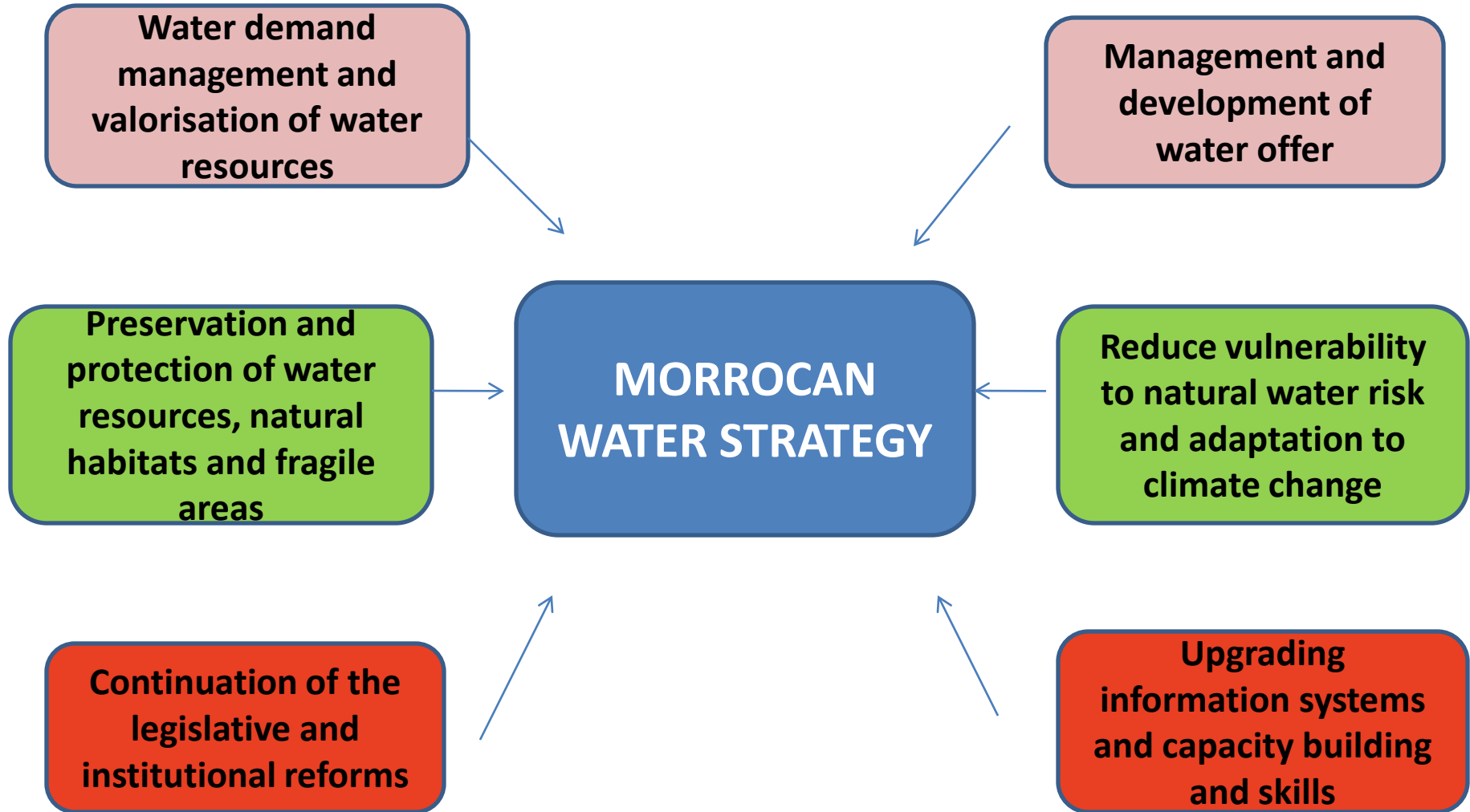
## ***Protection:***

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

## ***Financial:***

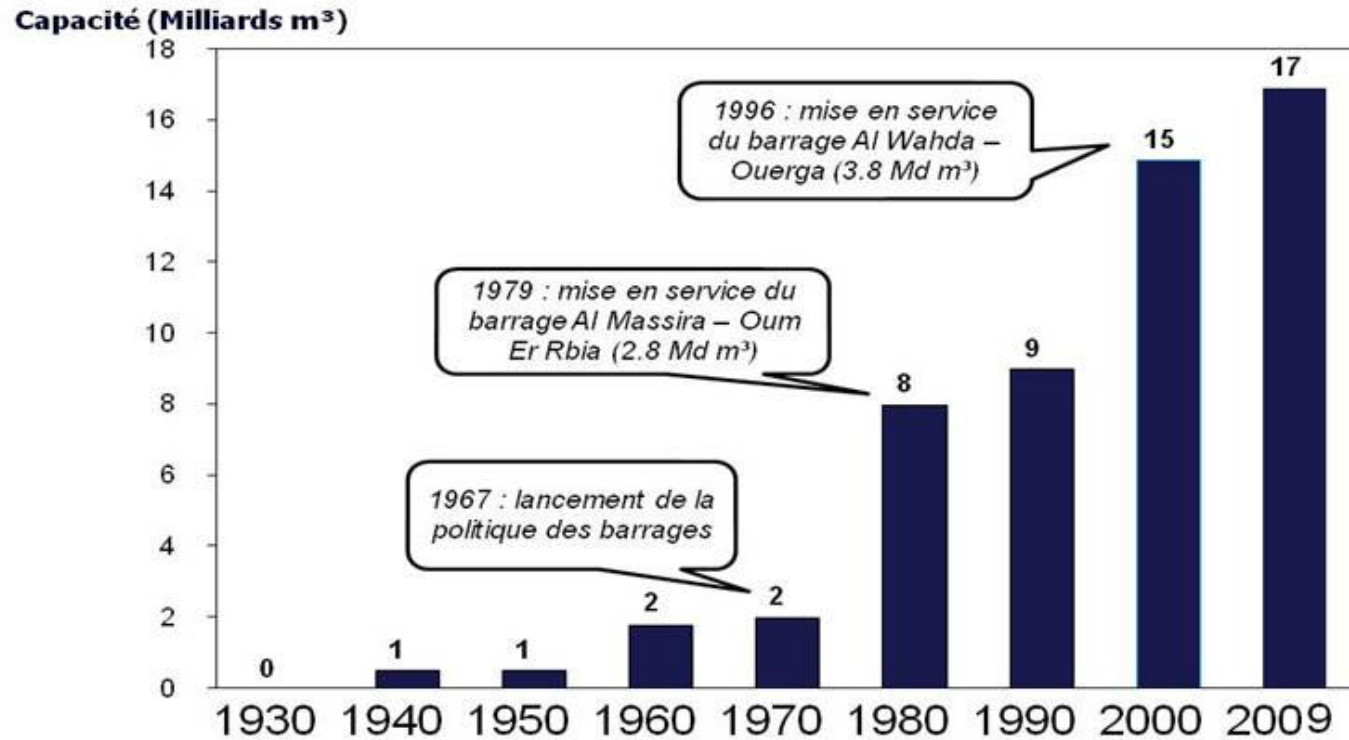
- Introduction of the principle sampler-pays and polluter-pays

# NATIONAL STRATEGY FOR WATER SECTOR DEVELOPMENT



# Water 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: 1 100 km and 210 m<sup>3</sup>/s



# Water strategy

## Mobilization of non conventional water

- *Desalination program*



- *Wastewater treatment and re-use program*



- *Rainfall capture*



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# WATER SECTOR ORGANISATION

Consultative Authority

Higher Council of Water & Climate

Planning authorities

M. Agriculture

MEMWE (HBA)

M. Energy

M. Interior

M. Health

ONEP

Water Utilities and Users

ORMVA (Agriculture)

Drinking Water Sector

<i>Producers :</i> ONEP Private Agencies Communes	<i>Distributors:</i> ONEP Private Agencies Communes
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Producers Energy  
. ONE  
. Private



Ben Ahmed



## Main missions

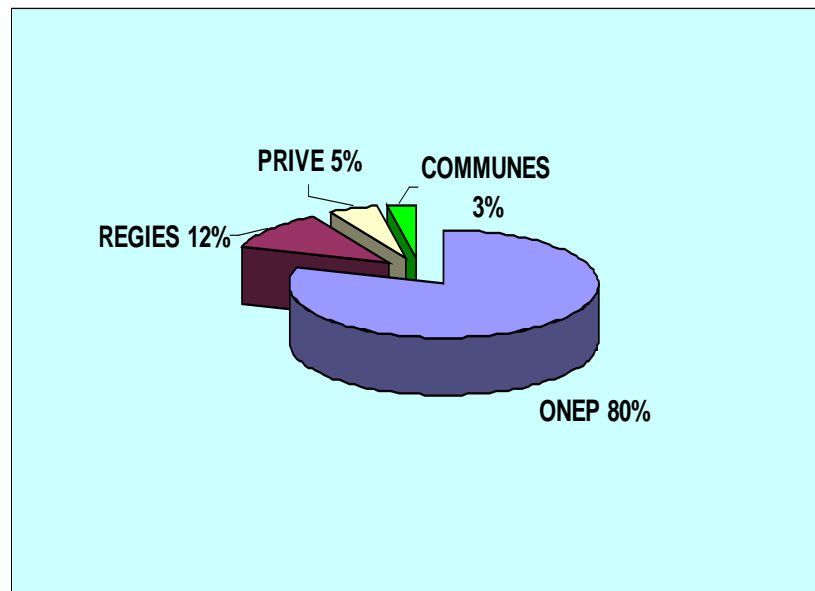
- ◆ Planning
- ◆ Implementing drinking water projects
- ◆ Managing Water installations
- ◆ Controlling water quality (55 laboratories)

## 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 m<sup>3</sup>
- **SALES** : 766 Million m<sup>3</sup>
- **ACCESS RATE** : 96 %
- **CUSTOMERS (Potable Water)** : 1.5 Million
- **TREATMENT VOLUME OF WASTE WATER** : 166.000 m<sup>3</sup>/d
- **STAFF** : 7300





# **ONEP INVESTMENT PROGRAM**

## **2011-2015**

In Billion US\$

Activity	Realizations 2001 – 2009	Projections 2011 – 2015	Objectives
<b>Potable water :</b> <b>a- Urban areas</b> <b>b- Rural areas</b>	<b>1,36</b> <b>0,87</b>	<b>1,36</b> <b>0,60</b>	<i>-The equipped flow by the end of 2009 has reached 51 m<sup>3</sup>/sec and will be carried to more than 65 m<sup>3</sup> /s</i> <i>-Access rate in rural areas will increase from 89 % at the end of 2009 up to 95 %</i>
<b>Sanitation</b>	<b>0,45</b>	<b>0,68</b>	<i>The flow of treated wastewater will increase from 121.000 m<sup>3</sup> / d to more than 320.000 m<sup>3</sup> / d by 2015, for a beneficiary population of about 4,6 M</i>
<b>Total</b>	<b>2,68</b>	<b>2,64</b>	

# Projections 2011-2015

## 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 m<sup>3</sup>/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 m<sup>3</sup>/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 m<sup>3</sup>/d** and a cost of **0,25 billion US\$** ;
- ❑ The Reinforcement of the potable water supply of **Agadir** city from seawater desalination, for **100000 m<sup>3</sup>/d** and a cost of **0,12 billion US\$**.



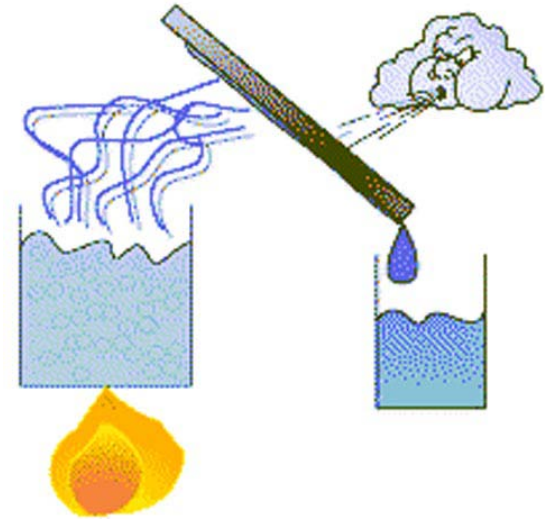
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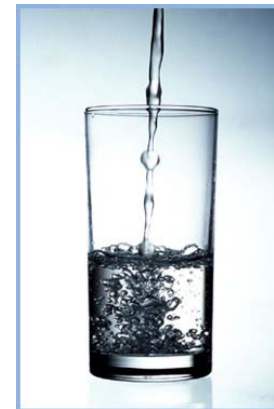
# *Desalination process*

Distillation process based on changing phase **Water-Vapor**,

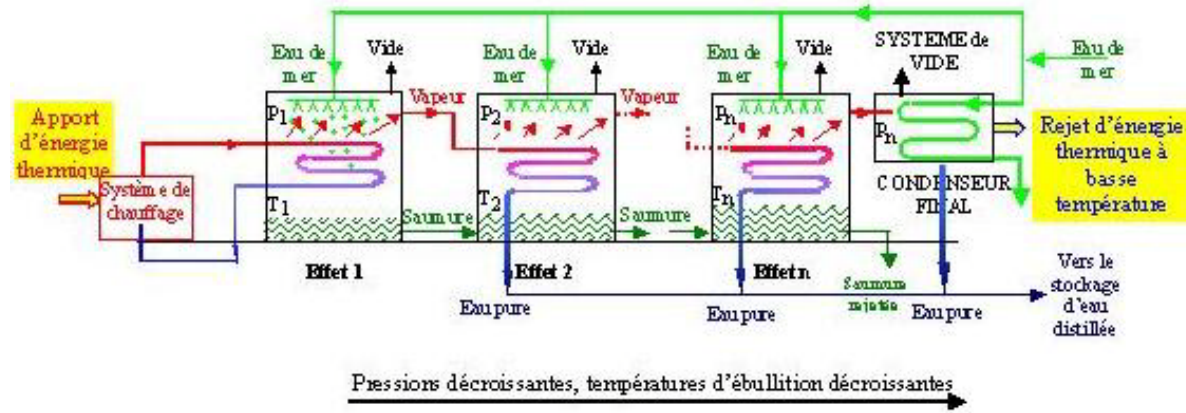
Membrane process based on **Salt-Water** separation using semi permeable membranes.



*Copy of nature*



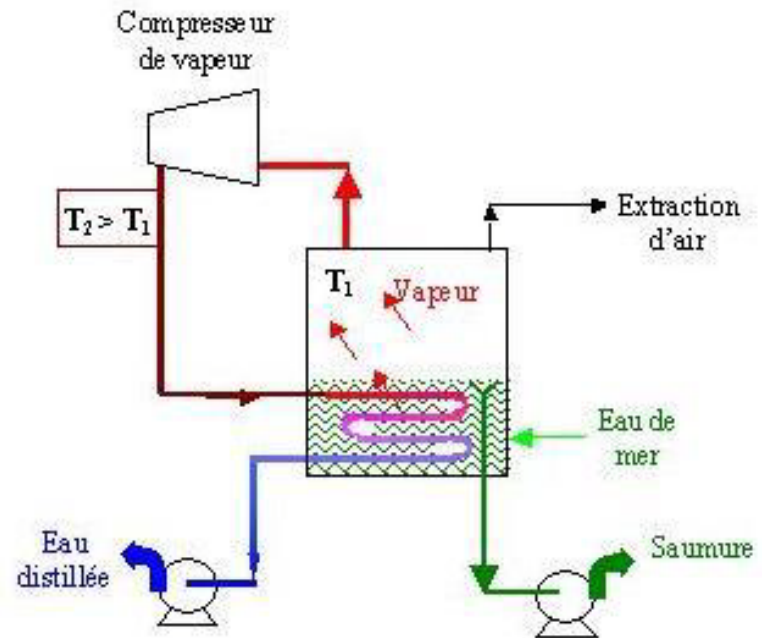
# Distillation Technologies



## Mechanical Compression of vapor (MCV)

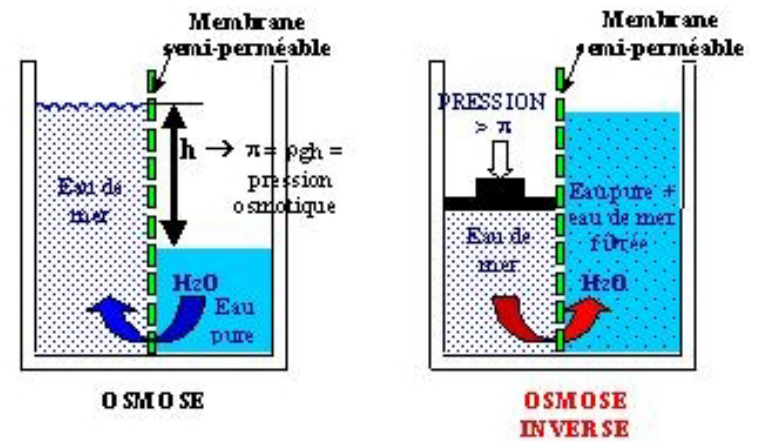
### Distillation Multi-Effect (MED)

### Distillation Multi-Stage Flash (MSF)

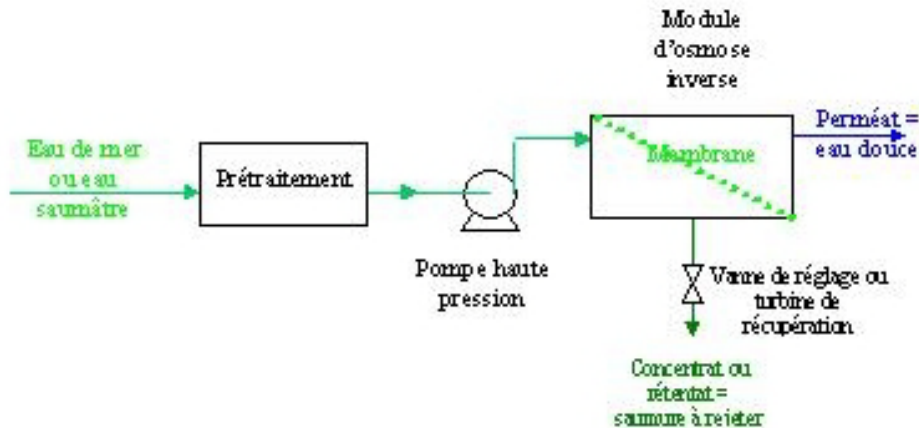
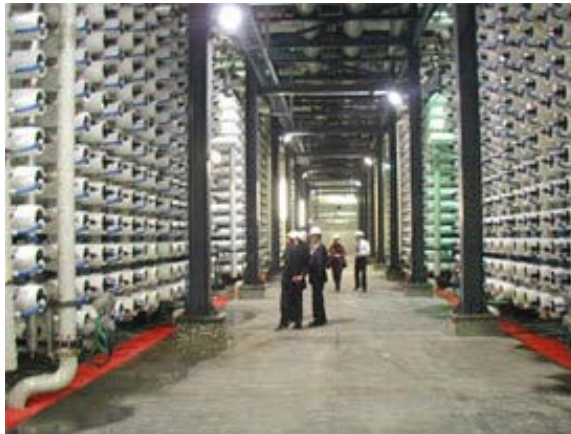




# Membrane Techniques



## Reverse Osmosis



# DESALINATION WORLDWIDE

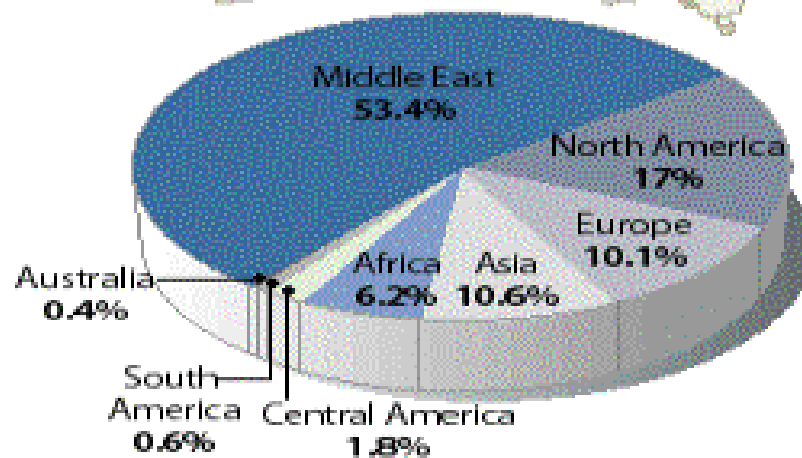
## MAJOR DESALINATION PLANTS WORLDWIDE

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

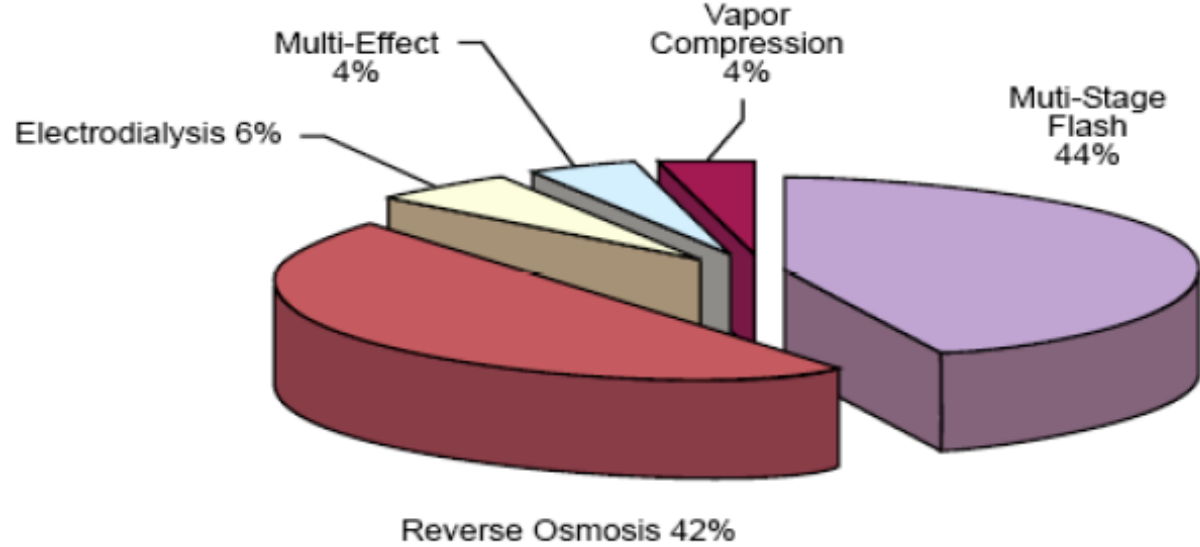
A breakdown of where desalination technology is used on seawater, salty underground water and in other water treatments around the world.



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

SCOTT HIBSTAND/ORLANDO SENTINEL

## Cost analysis

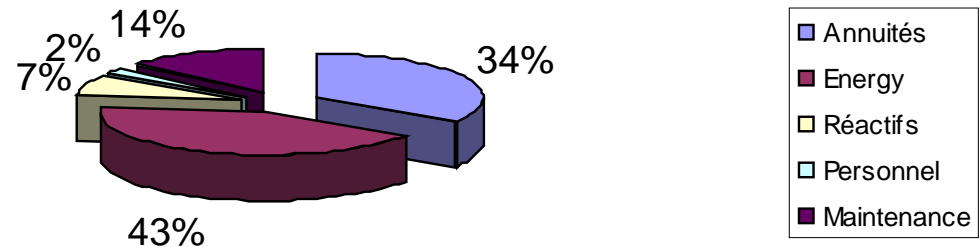


✚ In general, all desalination process need a high CAPEX with a light advantage for RO.

✚ OPEX analysis shows that desalination process are energy consumers.

✚ Total cost of produced water could reach 0,5 US\$/m<sup>3</sup> however it's affected with many factors.

### Décomposition du prix de production d'eau dessalée TDS=20g/l



# Desalination Plants: Main achievements

**Total Installed capacity: 35 000 m<sup>3</sup>/d**



**Khenifra**  
In progress  
30000 m<sup>3</sup>/d



**Laayoune**  
1st phase  
1995  
7000 m<sup>3</sup>/d



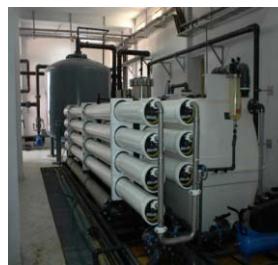
**Tarfaya**  
2001  
860 m<sup>3</sup>/d



**Laayoune**  
3rd phase  
2010  
13000 m<sup>3</sup>/d



**Tan Tan**  
2003  
1700 m<sup>3</sup>/d



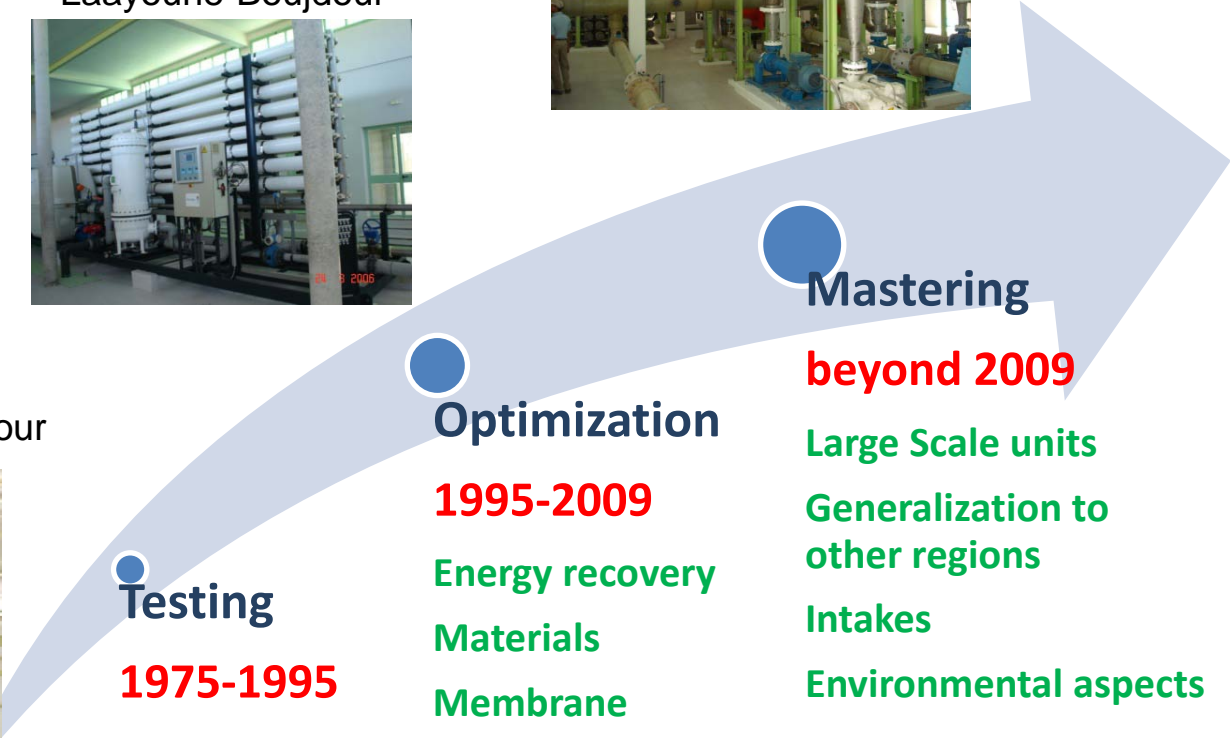
# Desalination Know-How advancement

Laayoune-Boujdour



Laayoune-Khenifra-Khouribga-Tan Tan-Agadir

Tarfaya-Smara-Boujdour



**Testing**

**1975-1995**

ED-MCV-RO

South regions

**Optimization**

**1995-2009**

Energy recovery

Materials

Membrane

Automatism

**Mastering**

**beyond 2009**

Large Scale units

Generalization to other regions

Intakes

Environmental aspects

**35 years experience**

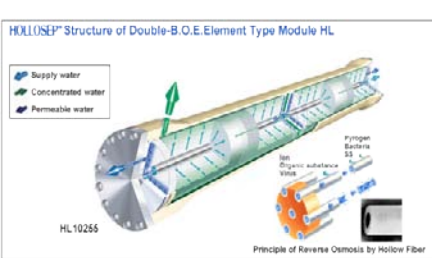




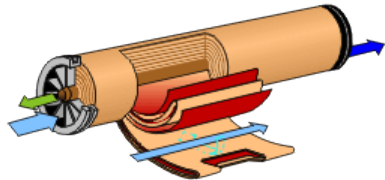
# DESALINATION KNOW-HOW ADVANCEMENT

## Membrane technology

- Hollow fiber membranes



- Spiral wound membranes



## Energy recovery

- Pelton turbines



- PEX



- DWEER

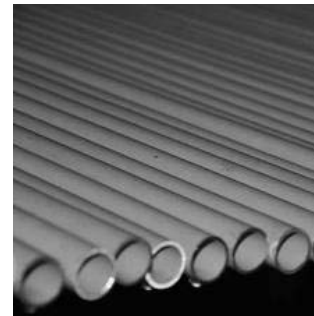


## Stainless steel Material

- 316 L



- Duplex



## Automatism

- Regulation valve

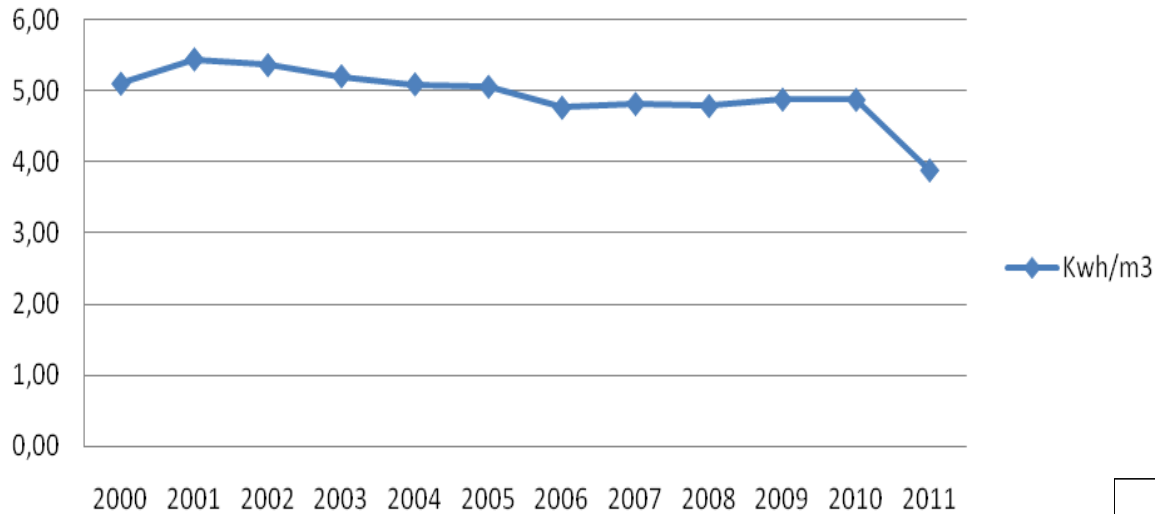


- Frequency variator

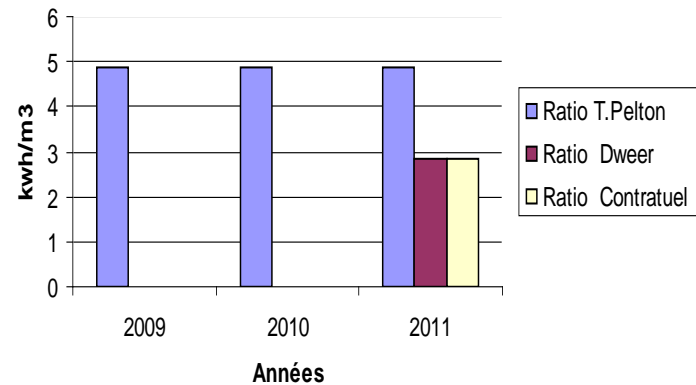


# IMPACT ON CAPEX

Evolution du ratio Kwh/m<sup>3</sup> pour la station de dessalement de Lâayoune



Evolution du ratio kwh/m<sup>3</sup>



# FUTUR DESALINATION PROJECTS

## Touristic Projects

**Guelmim  
(Plage Blanche)**  
6.000 m<sup>3</sup>/d

**Dakhla**  
8.600 m<sup>3</sup>/d

**Al Hoceima  
(Cal Iris)**  
8.600 m<sup>3</sup>/d

## Cities

**Agadir  
(1<sup>st</sup> phase)**  
100.000 m<sup>3</sup>/d

**Khenifra**  
30.000 m<sup>3</sup>/d

**Khouribga**  
26.000 m<sup>3</sup>/d

**Nador**  
43.000 m<sup>3</sup>/d

**Essaouira**  
50.000 m<sup>3</sup>/d

**Sidi Ifni**  
13.000 m<sup>3</sup>/d

**Laâyoune**  
26.000 m<sup>3</sup>/d

**Boujdour**  
8.600 m<sup>3</sup>/d

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# MAIN CHALLENGES



## RAW WATER QUALITY

- Dakhla case



## CAPEX: FINANCIAL DEAL

- Agadir case



## OPEX: ENERGY BILL

- Tan Tan case

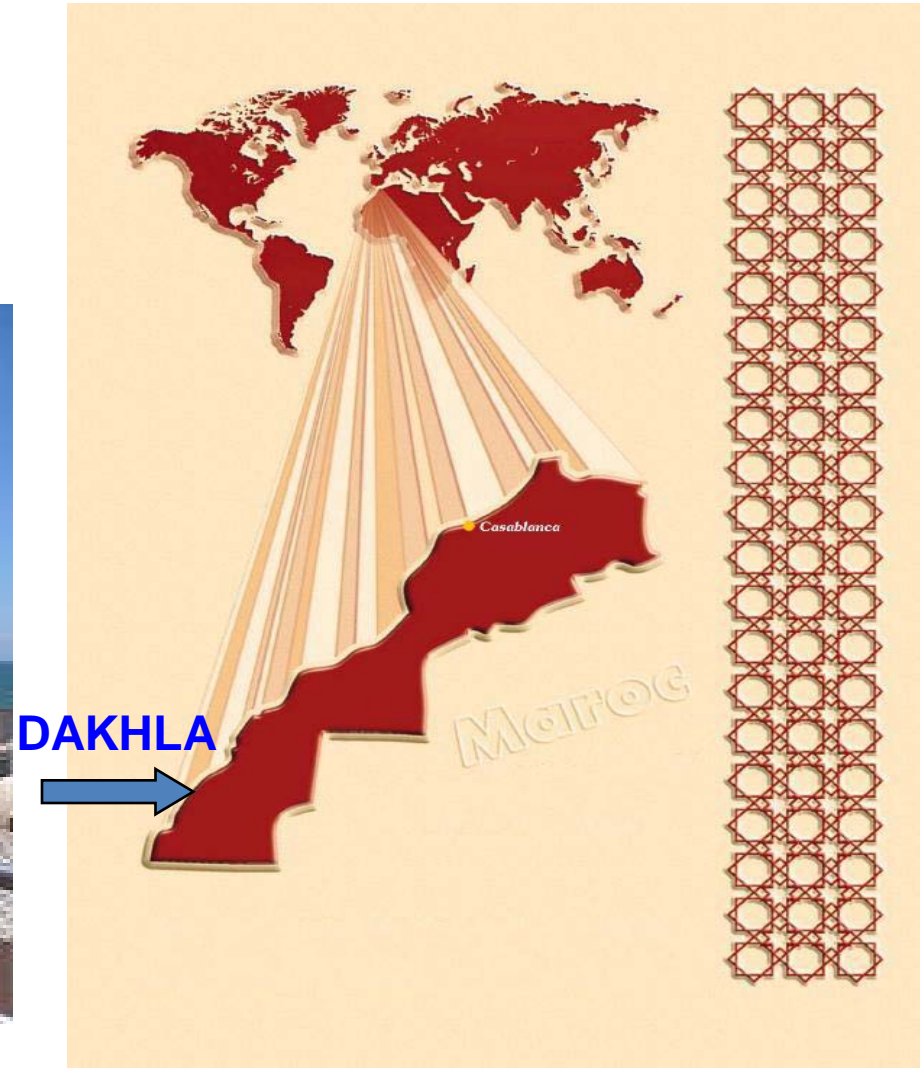


# DAKHLA CASE

**Population: 100 000 inhab**

**Main activities:**

**(Breeding, Fishing, Nautical sports)**



# DAKHLA CASE

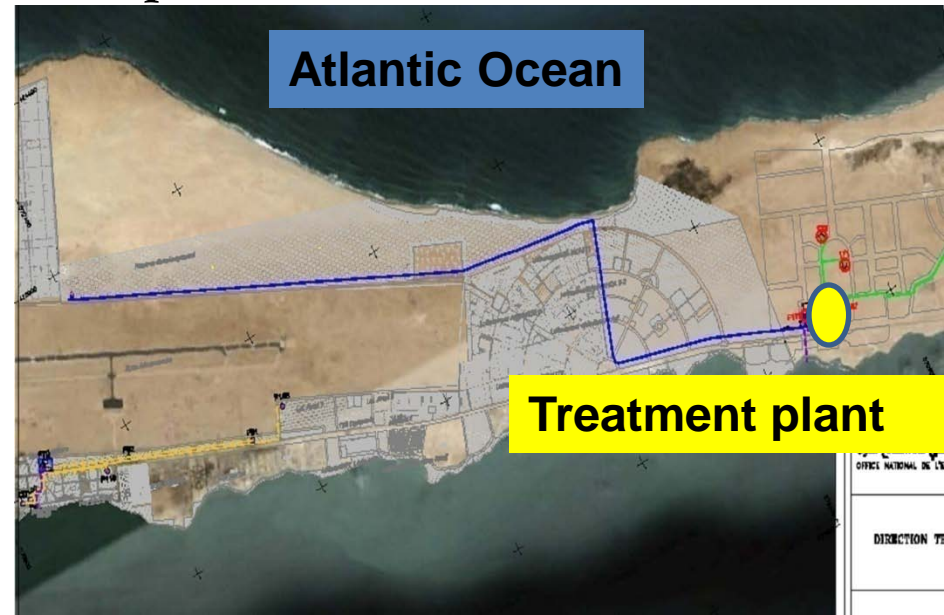
## Main constraint

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

**$H_2S$ ,  $NH_4$ , Fe, TDS,  $T^\circ$**

# DAKHLA Technical Sheet

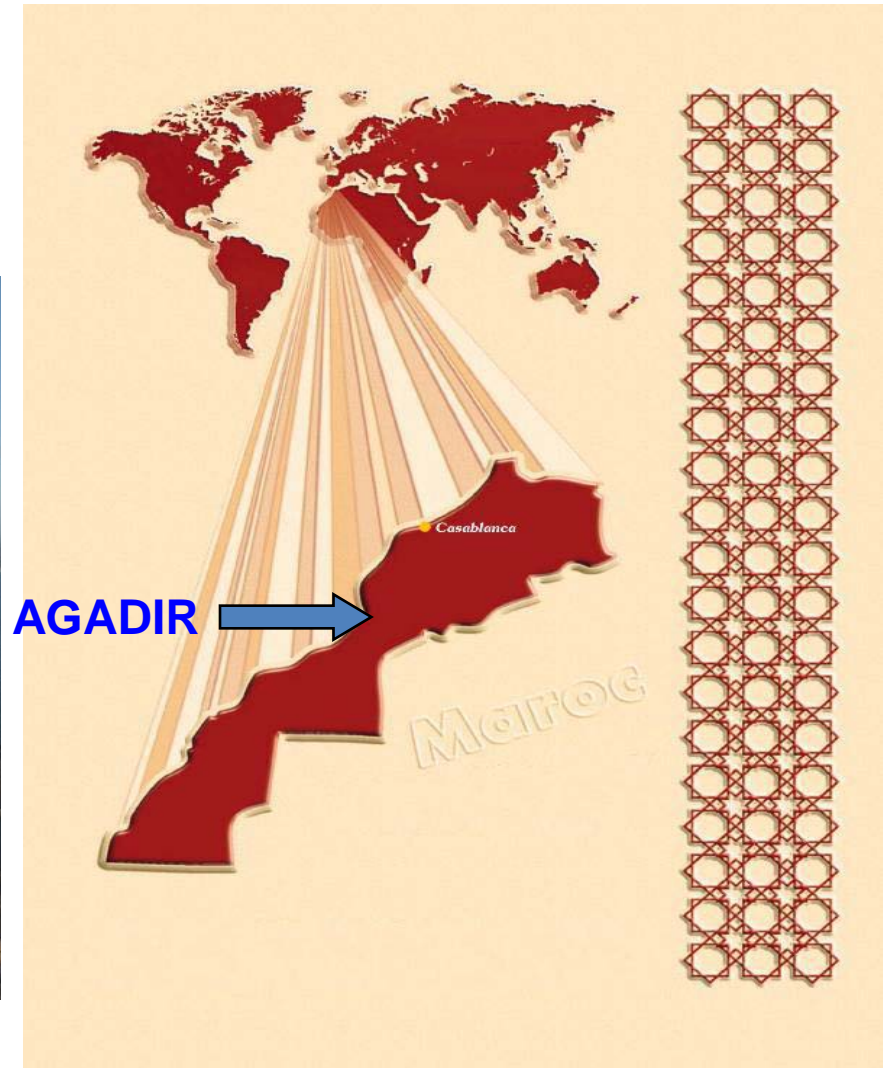
- Capacity (1<sup>st</sup> phase) : 17 300 m<sup>3</sup>/d  
(60% to be desalted)
- Process : Reverse Osmosis
- Intake : Boreholes
- TDS : 2,5 g/l
- Investment cost : 10 Millions US\$
- Current Stage : Construction Start up
- Commissioning date : 2013



# AGADIR CASE

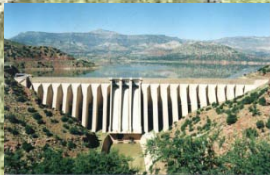
Population: 800 000 inhab

2<sup>nd</sup> economical pole:  
(Agriculture, Fishing, Tourism)

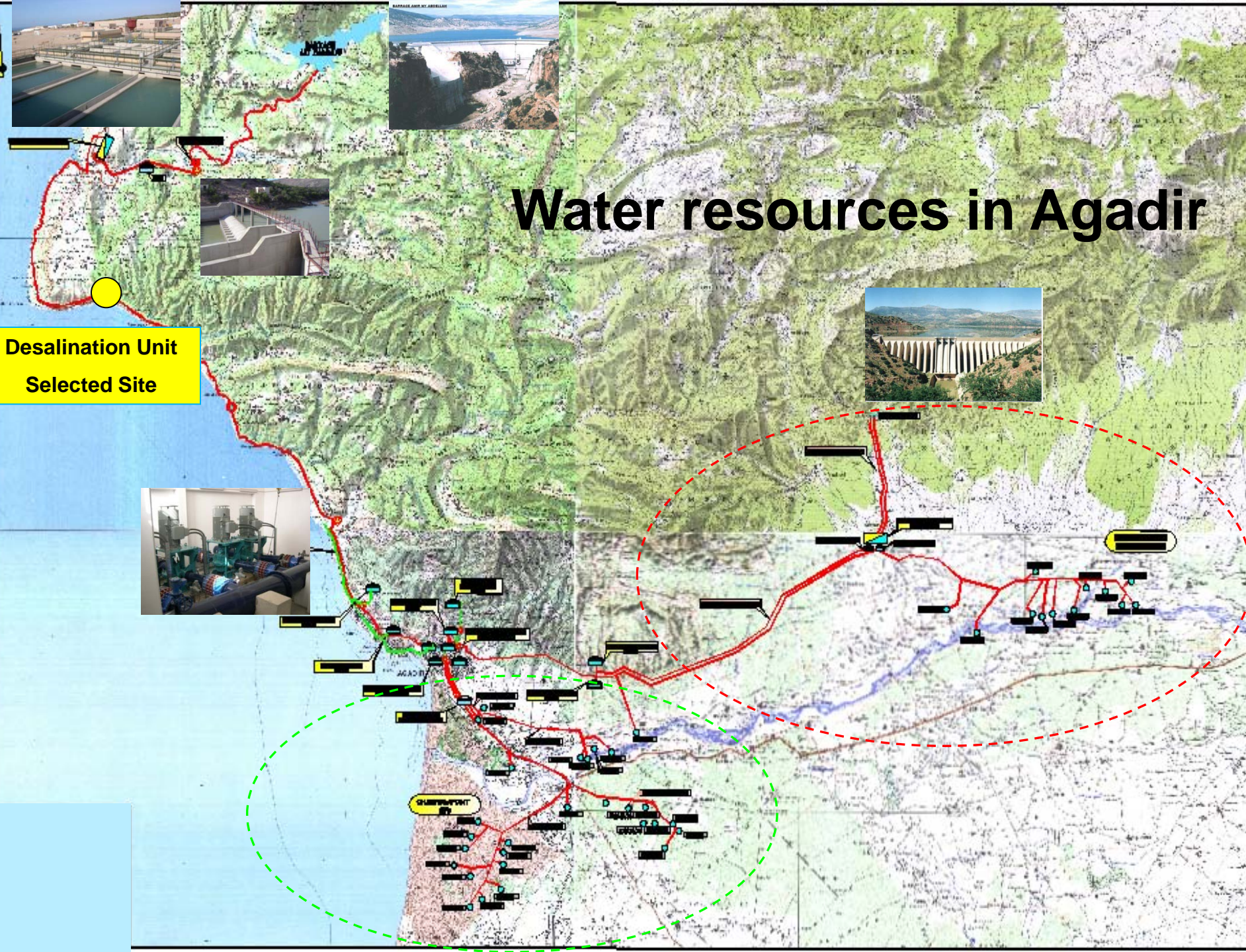




# Water resources in Agadir



**Desalination Unit  
Selected Site**





# AGADIR Technical Sheet

- Capacity (1<sup>st</sup> phase) : 100 000 m<sup>3</sup>/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.*

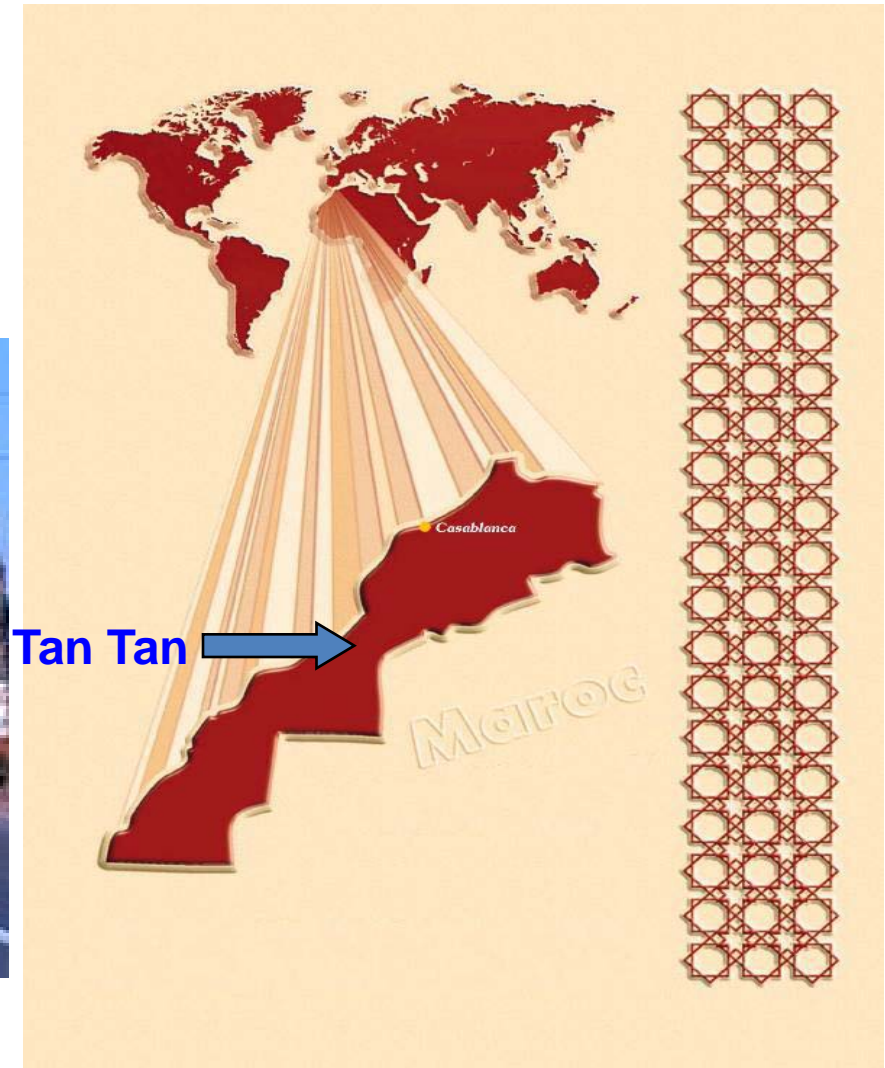


# TAN TAN CASE

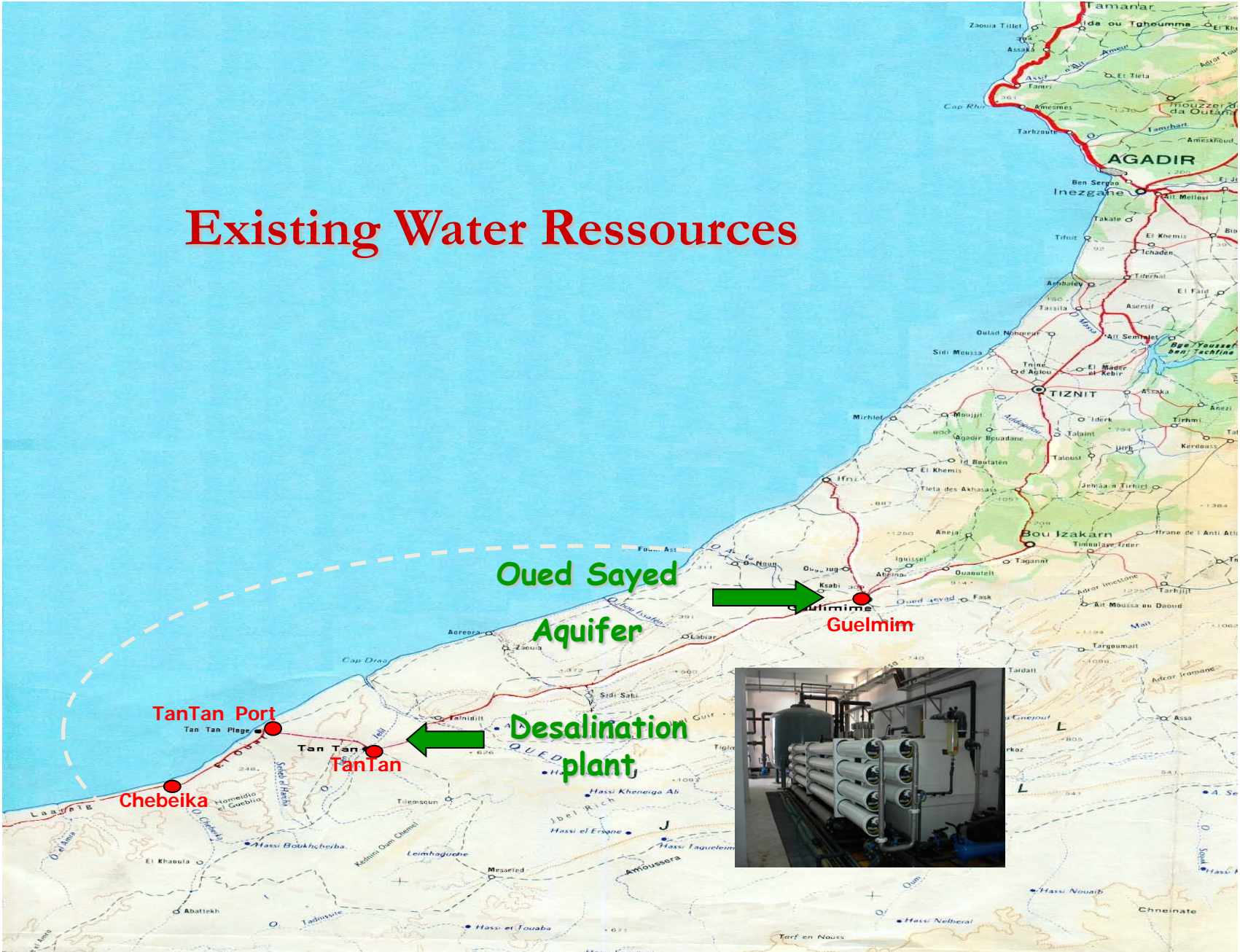
**Population: 70 000 inhab**

**Activities:**

**Breeding , Fishing, Potential tourism**



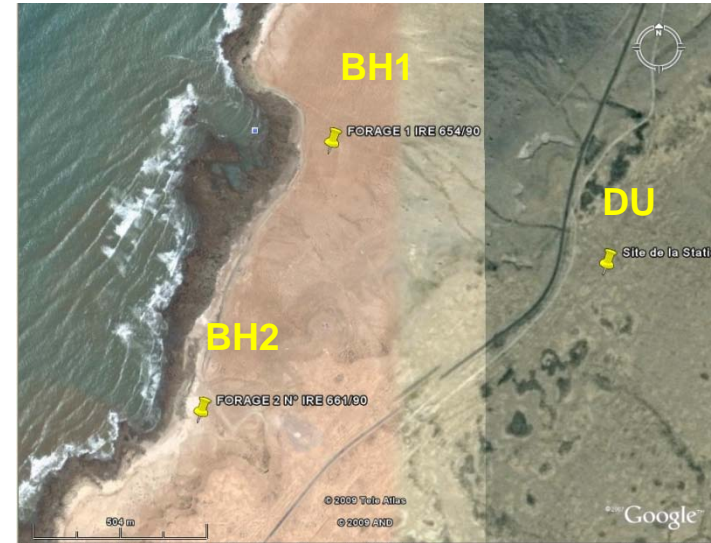
# Existing Water Resources





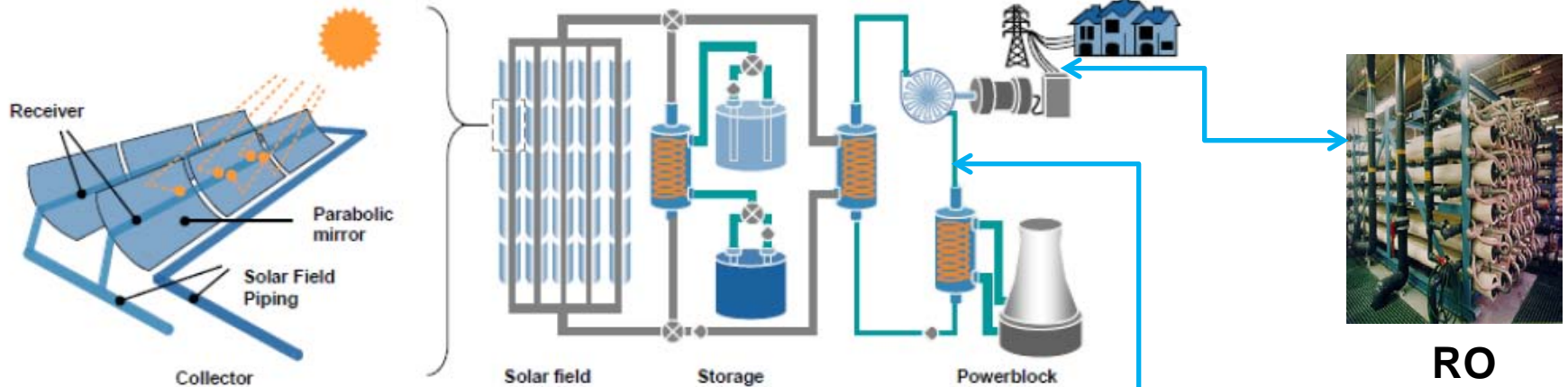
# Tan Tan Technical sheet

- Capacity (1<sup>st</sup> phase) : 9 000 m<sup>3</sup>/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 1<sup>st</sup> phase.



*Renewable energy could be the solution?*

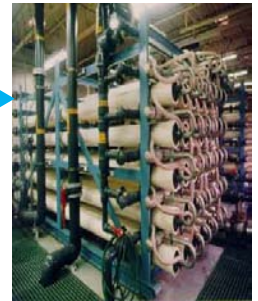
# DESALINATION COUPLED TO RENEWABLE ENERGY



- 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.



RO



MED

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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 m<sup>3</sup>/d) ONEP- RABAT

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[www.onep.ma](http://www.onep.ma)