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XIX WORLD WATER CONGRESS
International Water Resources Association (IWRA)
Marrakech, Morocco | 1-5 December 2025

Kingdom of Morocco



Ministry of
Equipment and Water

Emerging solutions to face water crisis in the MENA region: Comparative analysis of three leading countries (Morocco, Saudi Arabia, Egypt)

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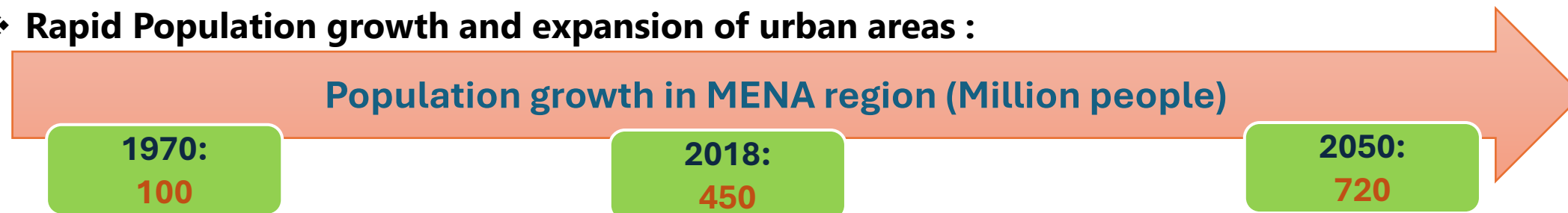
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Context of water scarcity in MENA region

❖ Rapid Population growth and expansion of urban areas :



❖ **Arid to semi-arid climate is dominating in the region**, limitation of renewable water resources (MENA is holding only 1% of the global freshwater but contains nearly 6% of the global population (World bank, 2023) ;

❖ **The average annual per capita water resource availability across MENA will fall below 500 m³/hab/y** (the absolute water scarcity threshold). Some countries experience extreme water shortages with per capita available water below 100 m³/hab/y);

❖ **12 of the world's 17 most water-stressed countries are in the MENA region.**

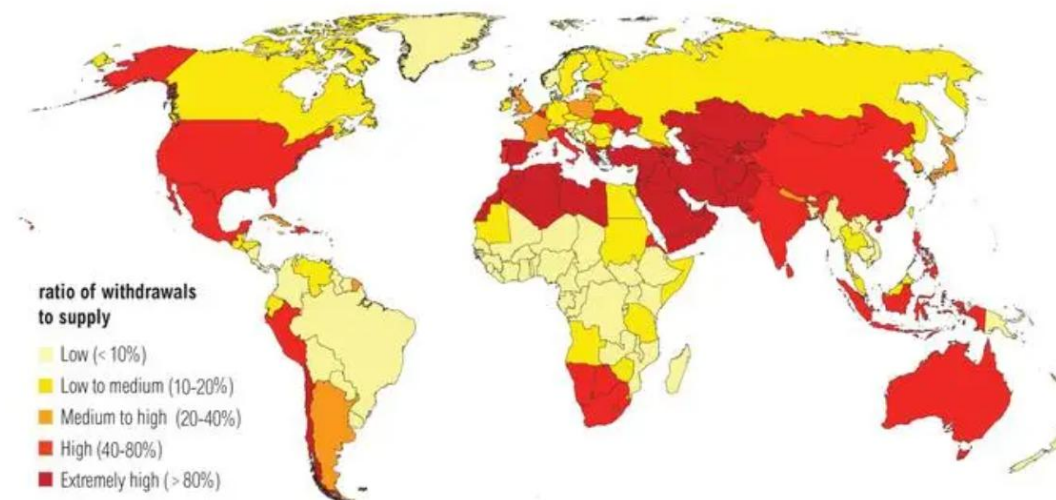




Context of water scarcity in MENA region

- ❖ **Water withdrawals for agriculture in MENA (around 85%) are higher than the world average (70 %)**, reflecting the critical role of irrigation in such an arid region. This is combined with low irrigation efficiency (waste of water in irrigation could attain 60%)
- ❖ **Groundwater overuse:** overexploitation of nonrenewable groundwater: example of SAU's fossil aquifers being drained in an excessive rate to support agricultural exports of wheat (World Bank, 2022)
- ❖ **Climate change exacerbate the water stress in the region:** with temperature rise, droughts being more and more frequent and with large duration and high intensity. This would lead to water resources depletion and conflicts between users would make the water stress even harsher (10-20% reduction of rainfall is expected by the mid-century according to the IPCC).

Water Stress by Country: 2040



NOTE: Projections are based on a business-as-usual scenario using SSP2 and RCP8.5.

For more: ow.ly/RiWop

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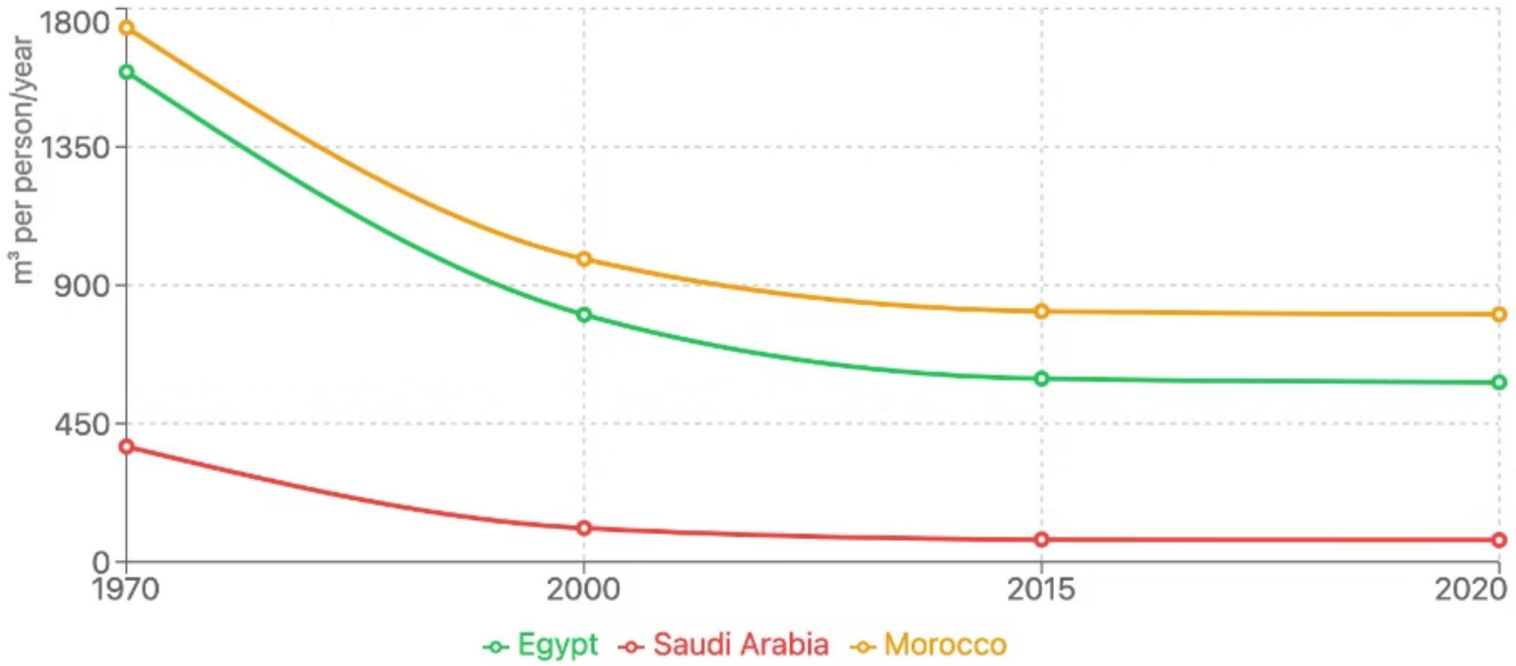
Water crisis in Saudi Arabia, Egypt and Morocco



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Saudi Arabia faces some of the most severe water scarcity challenges in the world

Per Capita Renewable Water Resources (m³/year)



Water crisis in Saudi Arabia, Egypt and Morocco



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Saudi Arabia faces some of the most severe water scarcity scarcity challenges in the world

- Saudi Arabia faces some of the most severe water scarcity challenges in the world, driven by its arid climate, limited renewable water resources, and historically unsustainable consumption patterns—particularly in agriculture.
- In 2015, 84% of the Kingdom's total water demand (24.8 billion m³) was consumed by the agricultural sector, **with over 90% sourced from non-renewable groundwater**.
- This unsustainable reliance has led to rapid depletion of fossil aquifers, increased salinity, and deterioration in water quality.
- Additionally, **inefficiencies in the urban water sector such as high non-revenue water (up to 30–40%)** and limited wastewater reuse (only 17% in 2015) have compounded the crisis.



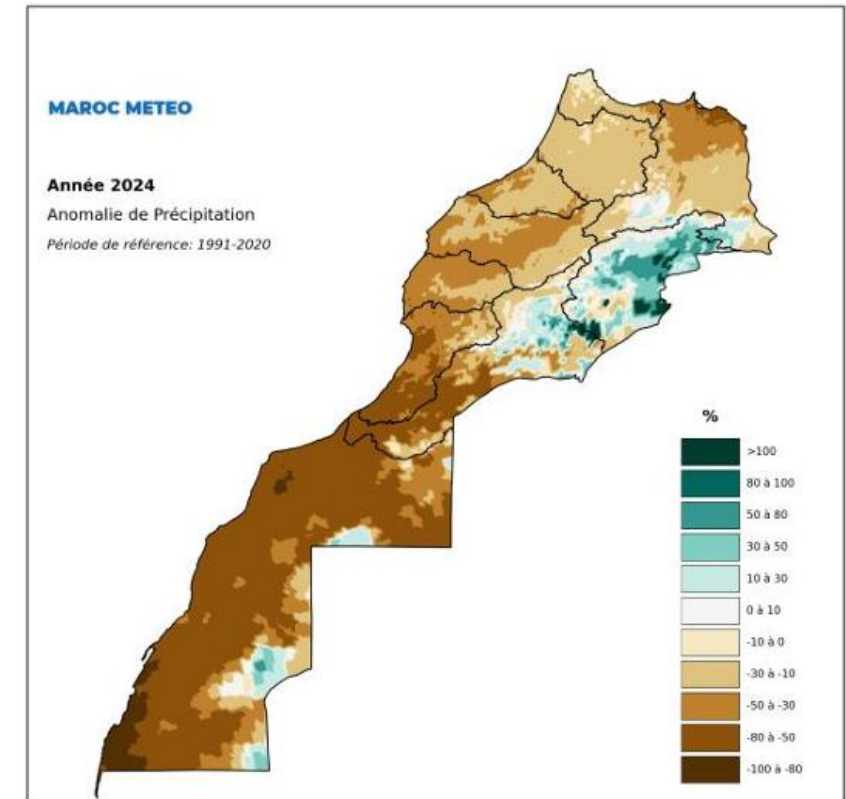
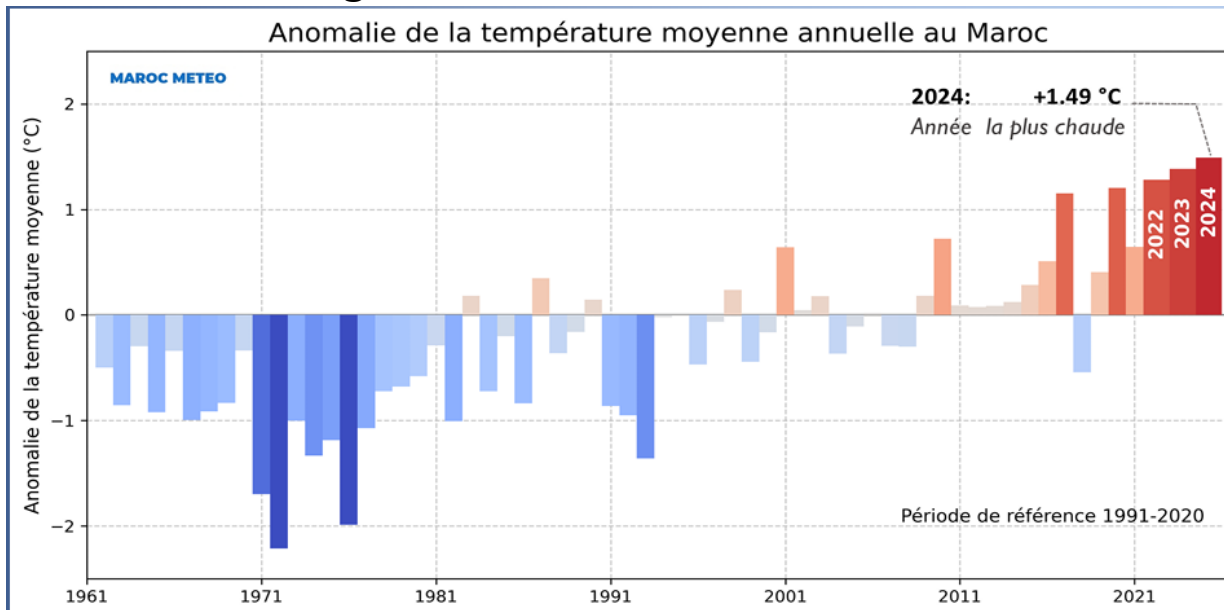
Water crisis in Saudi Arabia, Egypt and Morocco



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Morocco faces its 8th consecutive dry year

- **The challenge in Morocco in the last years consisted in securing the different water users**, especially the public water supply while lessening the negative impact on agriculture.
- **Precipitation is exposed to large reductions in the last two decades** (around 30% according to the (World Bank, 2021))



SOURCE: DGM, 2025



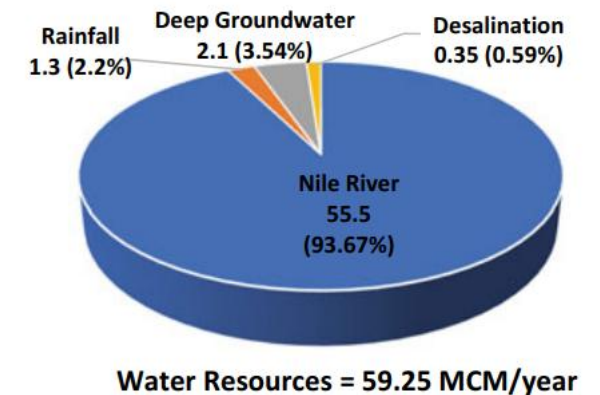
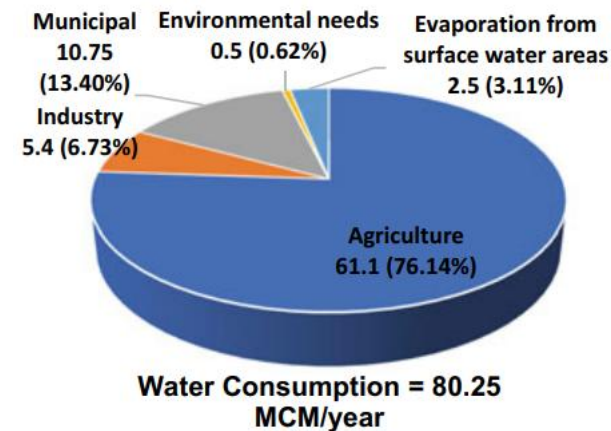
Water crisis in Saudi Arabia, Egypt and Morocco



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Egypt faces the challenge of securing its agriculture relying on The Nile on The Nile River which is a shared resource with neighbor countries

- **97% of water resources of Egypt comes from The Nile River** (55.5 Billions cubic meter per year)
- **The remaining supply is provided by groundwater, residential wastewater, desalinated water and finally rainfall** (which is already scarce across the country).
- Hence, **facing climate change impacts on water availability requires developing agreements with the other countries linked to the Nile river.**



SOURCE: MWRI (2017)





I. Main actions In the national water policy

Saudi Arabia

In response to the challenging situation of water scarcity, **Saudi Arabia launched its National Water Strategy 2030 (NWS 2030)**, a unifying framework aligned with Vision 2030 to ensure water security, sustainability, and economic efficiency. This strategy is based on **Five Strategic Objectives**

1

Ensuring continuous and secure water supply for all users

2

Improving demand-side management across all sectors

3

Delivering high-quality water and sanitation services at reasonable costs

4

Protecting and preserving water resources and the environment

5

Enhancing the sector's competitiveness, governance, and private sector participation





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I. Main actions In the national water policy

Saudi Arabia: Transformative initiatives



Agricultural Water Reform

Key initiatives target agricultural water reform, including phasing out alfalfa cultivation (79% of agricultural water use) and use) **and improving irrigation efficiency from 50% to 75% with modern technologies.**



Water Supply and Service Quality

The Water Supply and Service Quality Program aims to reduce network losses to below 15%, expand smart metering, and metering, and automate distribution systems. **The Wastewater Wastewater Reuse Program seeks to increase treated effluent effluent reuse to 70% by 2030**, significantly boosting non-conventional water supply.



Desalination and Renewable Energy

The desalination sector, **supplying over 60% of municipal water**, will be restructured through **Privatization and Institutional Reform Programs**. SWCC Programs. SWCC is undergoing restructuring to encourage private investment, **and the strategy aims to aims to increase renewable energy in desalination to desalination to 25%**,

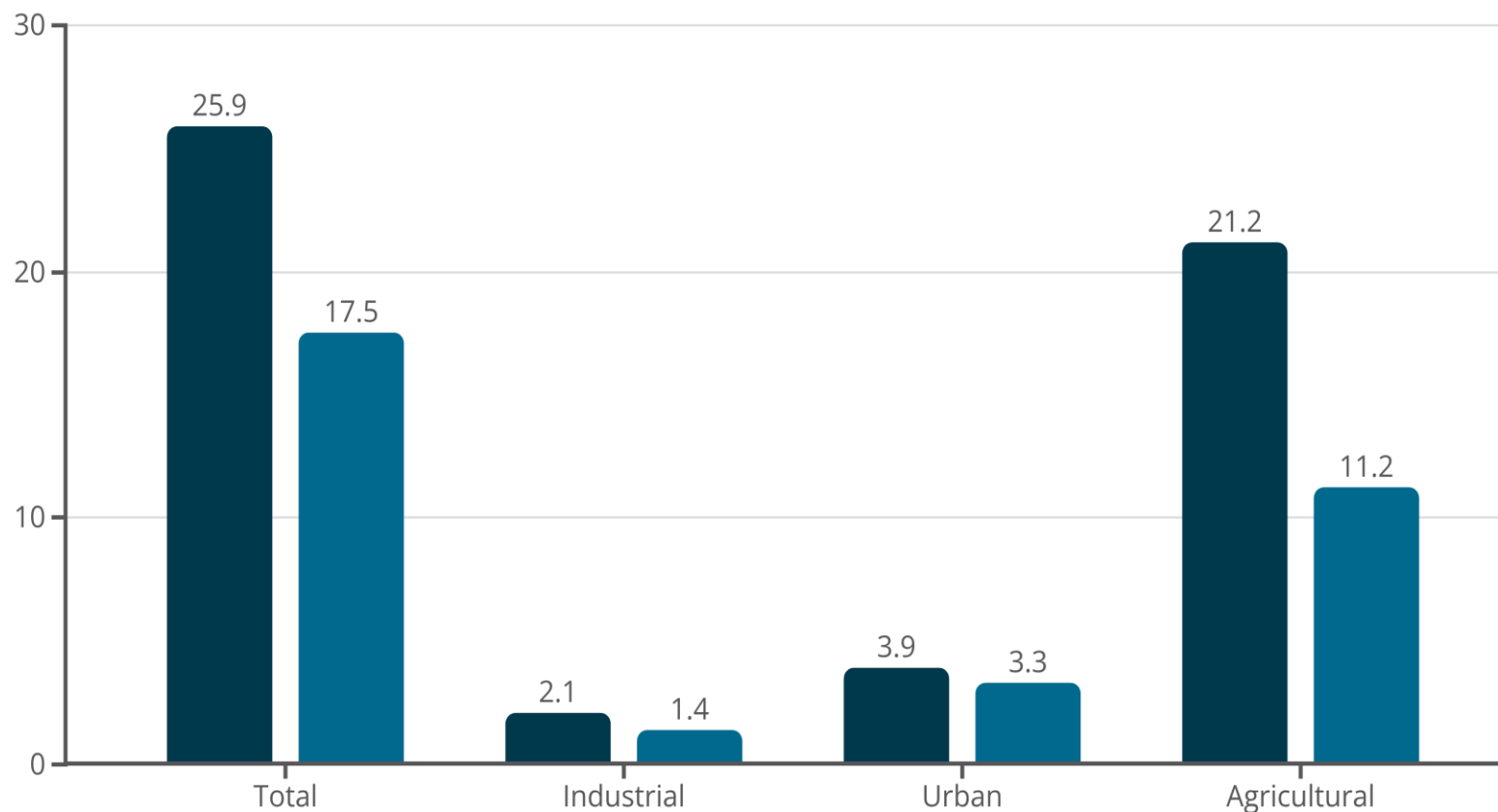




I. Main actions In the national water policy

Saudi Arabia: Transformative initiatives

Total Water Supply by Sector (2016 vs 2030) (in billion cubic meters)

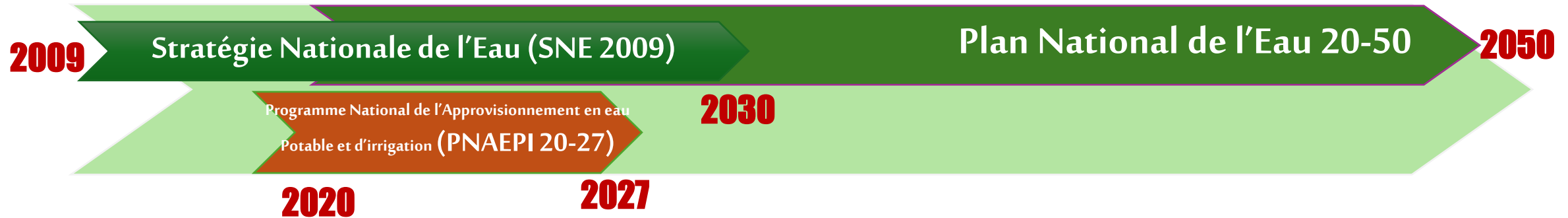




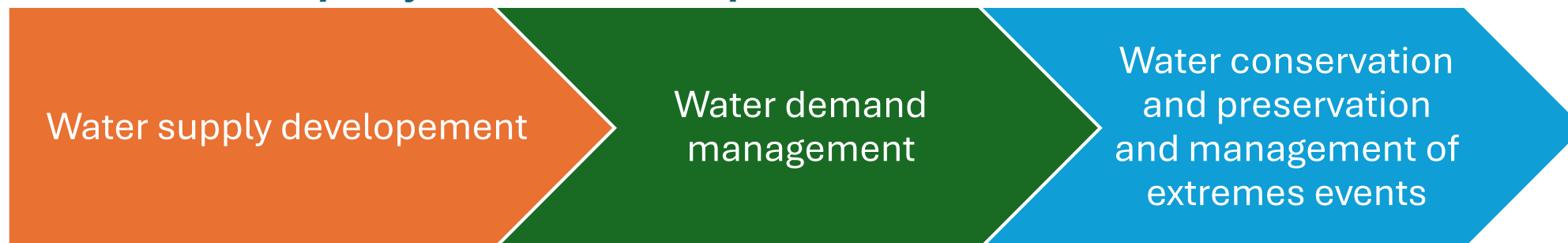
I. Main actions in the national water policy

Morocco

- ❖ **An anticipative and proactive approach** has been adopted since decades in Morocco in terms of long-term water planning.



- ❖ **The current water policy relies on 3 main pillars:**



I. Main actions In the national water policy



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Morocco

Four Major Shifts to face Water Crisis

1. From Water Supply Development to Demand Management

From: Supply Development

- Conventional water resources
- Non-conventional water resources

To: Demand Management

- Improved water supply network efficiency
- Enhanced irrigation canal performance
- Hydraulic efficiency programs
- Aquifer management contracts

2. From Conventional Resources to Combined Conventional & nonconventional WR

From: Conventional Resources

- Development of conventional water resources mainly dams and water transfers

To: Combined supply development

Development of both conventional and non-conventional resources:

- Seawater desalination: 1,700 Mm³ by 2030
- Treated wastewater reuse: 100 MCM/y by 2027 and 300 MCM by 2050
- Artificial aquifer recharge



I. Main actions In the national water policy



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Morocco

Four Major Shifts to face Water Crisis

3. From Short-term Management to Long-term Planning

From: Short-term Management

- Based on available water resources and overexploitation
- Current state of water supply and irrigation networks
- Real-time water resource management

To: Long-term Management

- Water resource development within PDAIRE and PNE frameworks
- Accounting for demand management and climate change
- Development of Water-Energy Nexus

4. From Rural-Urban Solidarity to Urban-Rural Solidarity

From: Rural → Urban

Exploitation of water resources from interior basins and mountains by cities (dams and groundwater)

To: Urban → Rural

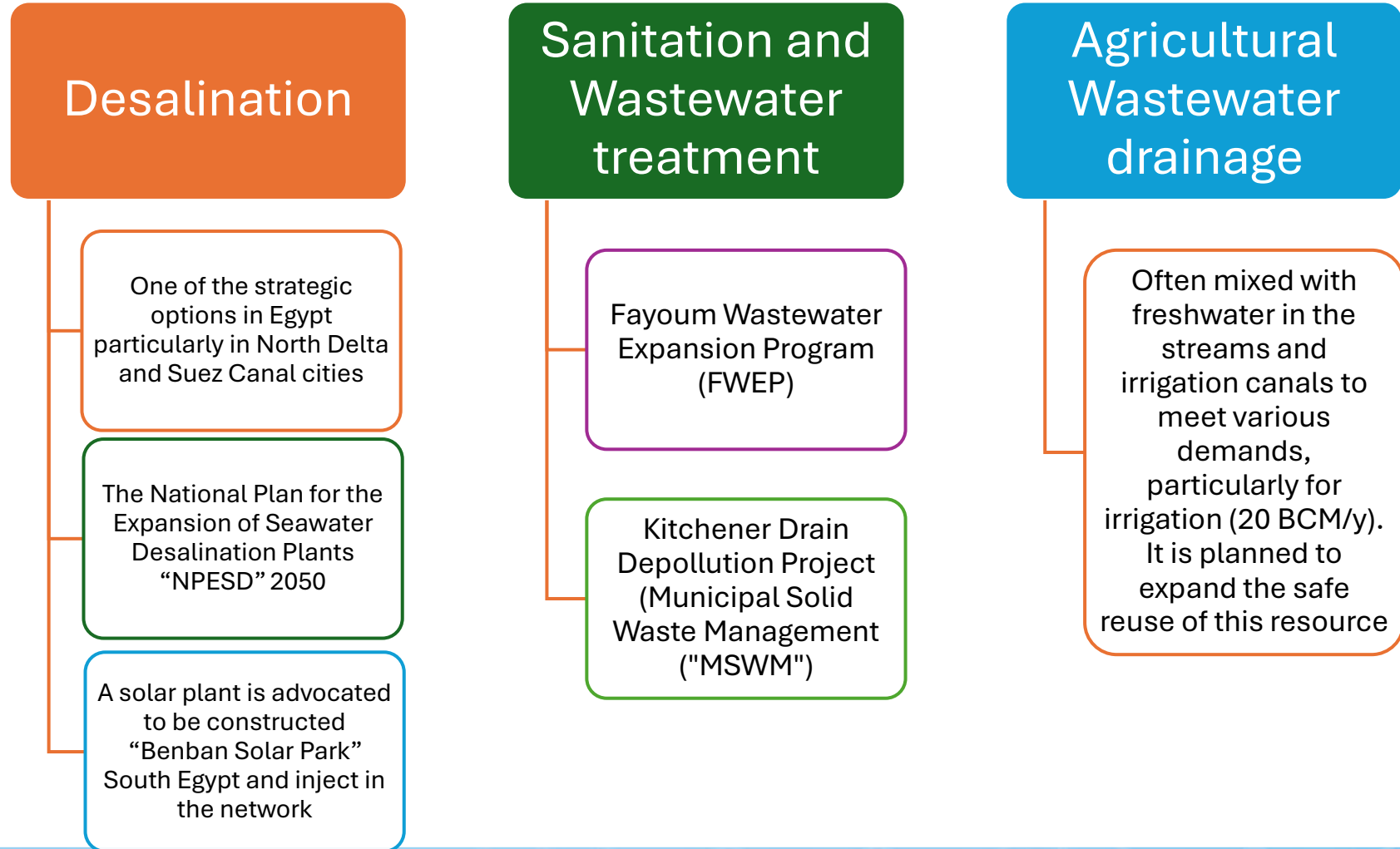
- Seawater desalination for coastal cities
- Treated wastewater reuse for green spaces
- Preserve conventional water for rural and mountain areas





I. Main actions In the national water policy

Egypt



II.Desalination: a growing market in the 3 countries



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Saudi Arabia: a global leader in desalination

Water Supply Chain

وزارة البيئة والمياه والزراعة
Ministry of Environment Water & Agriculture



الهيئة السعودية للمياه
Saudi Water Authority



the Saline Water Conversion Corporation (SWCC)

الشركة السعودية لشراكات المياه
Saudi Water Partnership Company
Main Offtaker

region



II. Desalination: a growing market in the 3 countries

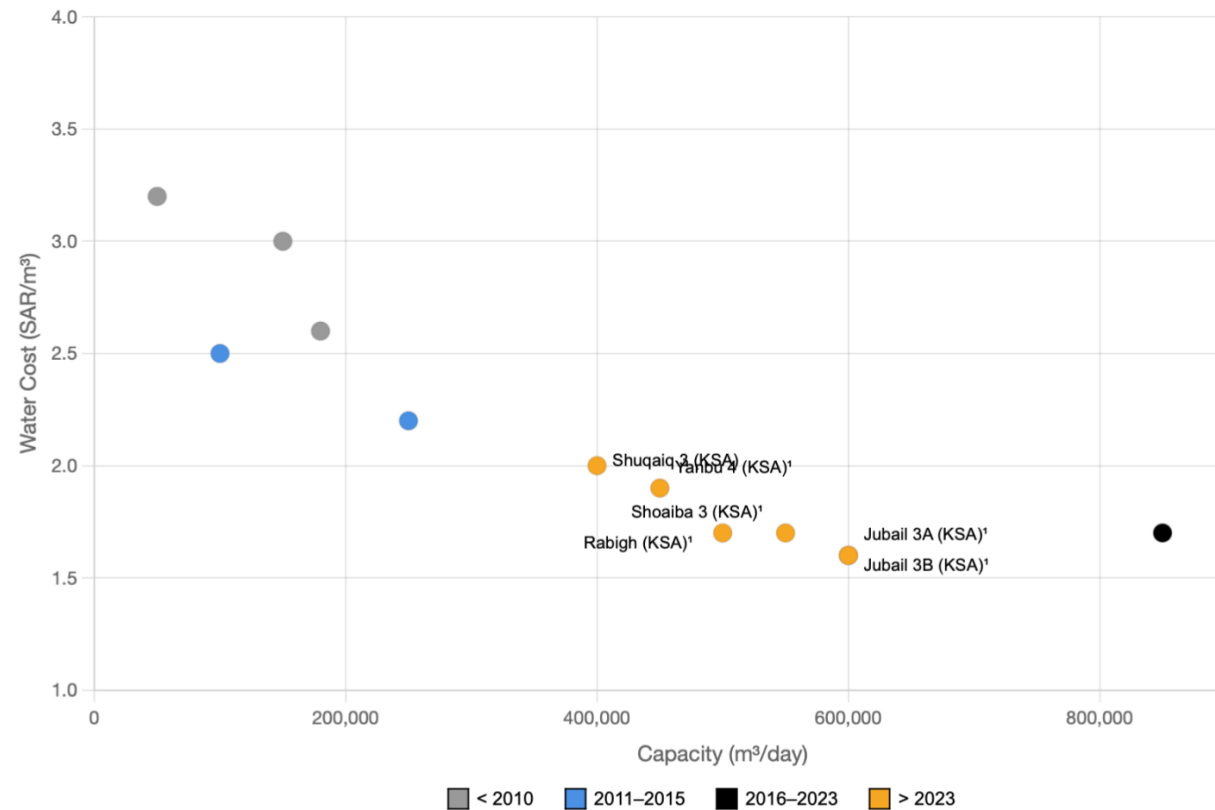
Saudi Arabia

The chart illustrates the relationship between the cost of water (CoW) production and the capacity of desalination plants across different commissioning periods. It shows a clear trend of decreasing production costs as plant capacity increases, highlighting the economies of scale in desalination. Older plants commissioned before 2010 generally exhibit higher production costs, often exceeding 2.5 SAR/m³, while newer plants developed after 2023—such as Yanbu 4 (KSA)¹, Shuqaiq 3 (KSA), Jubail (KSA), Jubail 3A (KSA)¹, and Shoaba 3 (KSA)¹—demonstrate significantly lower costs, with several achieving or approaching the benchmark of 1.7 SAR/m³.



Water Production Cost (CoW) vs Capacity for SWRO Plants

Analyzed plants from < 2010 to > 2023 | Cost ranges from 1 to 3 SAR/m³



II.Desalination: a growing market in the 3 countries



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Saudi Arabia: Sustainable Agriculture with Desalinated Seawater



- The Ministry of Environment, Water and Agriculture (MEWA) in Saudi Arabia has undertaken a comprehensive study on using desalinated seawater (DSW) for agricultural irrigation. This strategic initiative diversifies water sources, reduces reliance on non-renewable groundwater, and aligns with Vision 2030's national goals.
- **The study confirmed DSW's viability for high-value crops like cherry tomatoes, blueberries, and grapes in the southwestern region, particularly when combined with renewable energy and treated sewage effluent.** This approach not only boosts food security but also promotes innovation and private sector engagement in the water-agriculture sector.



II.Desalination: a growing market in the 3 countries

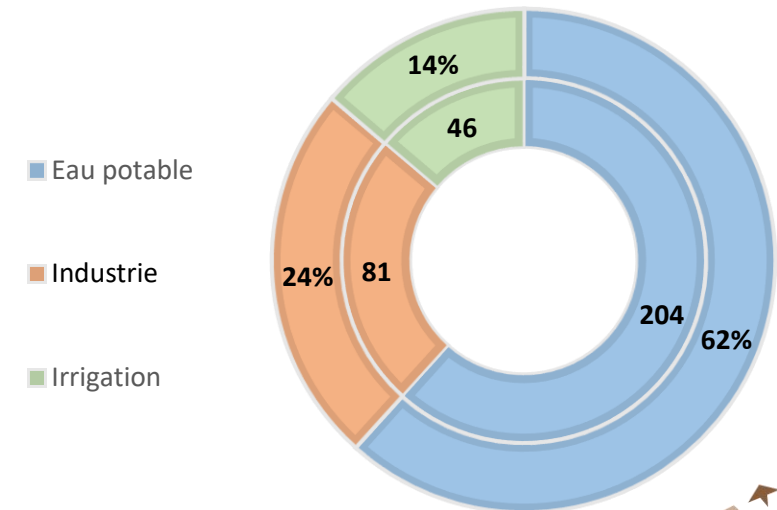


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Morocco: for securing drinking water supply

- Desalination's current volume is around **331 MCM/y** fulfilling water needs **for the three fundamental uses: domestic supply, industry and irrigation** (executed by 4 main actors: ONEE, OCP, Ministry of Agriculture, Ministry of Interior).
- **13 desalination are under preparation** and would permit to reach around **1.7 Billion cubic meter of desalinated water by 2030** (with Large-scale stations such as: **Casablanca 300 MCM/y, Rabat 300 MCM/y, Souss Massa 350 MCM/y, Tangier 150 MCM/y, Oriental 300 MCM/y**)
- **Morocco-UAE's strategic agreement for desalination powered by RE (TAQA Morocco-NAREVA-ONEE)**: so as to make the desalinated water cost more affordable: **900 MCM/y** planned in this sense, with a cost around **4.5 MAD/m³**.

58 existing Desalination plant(dont 41 monoblocs)



II.Desalination: a growing market in the 3 countries

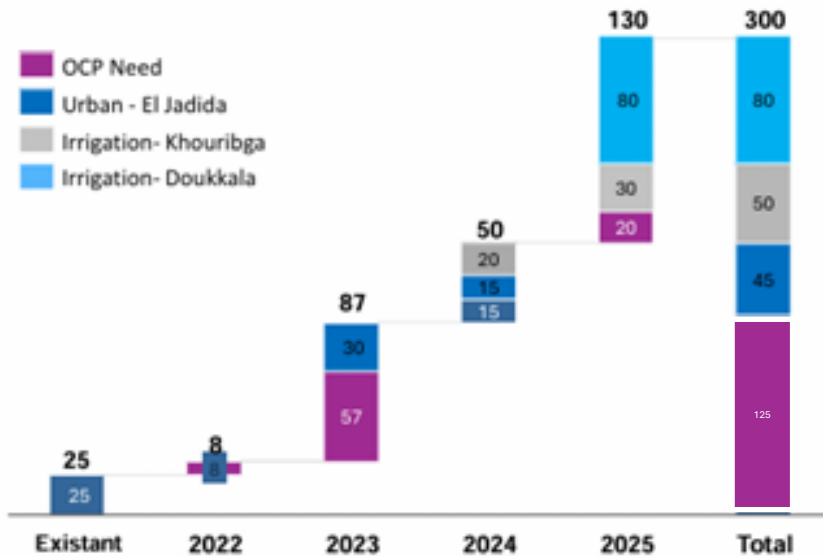


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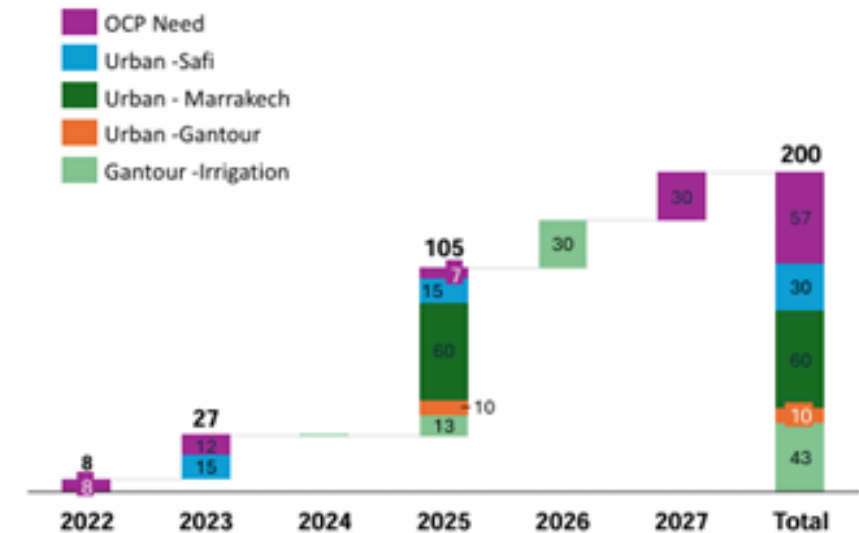
Morocco: Ambitious Desalination program of OCP (500 MCM/y)

OCP intends to secure its industrial water needs through desalination and REUSE. **Desalination plants of OCP contribute also to securing strategic urban centres** (El Jadida, Safi, South Casablanca, Khouribga and Marrakech soon)

Plan de dessalement d'eau de l'Axe Nord
Mm³



Plan de dessalement d'eau de l'Axe Centre
Mm³

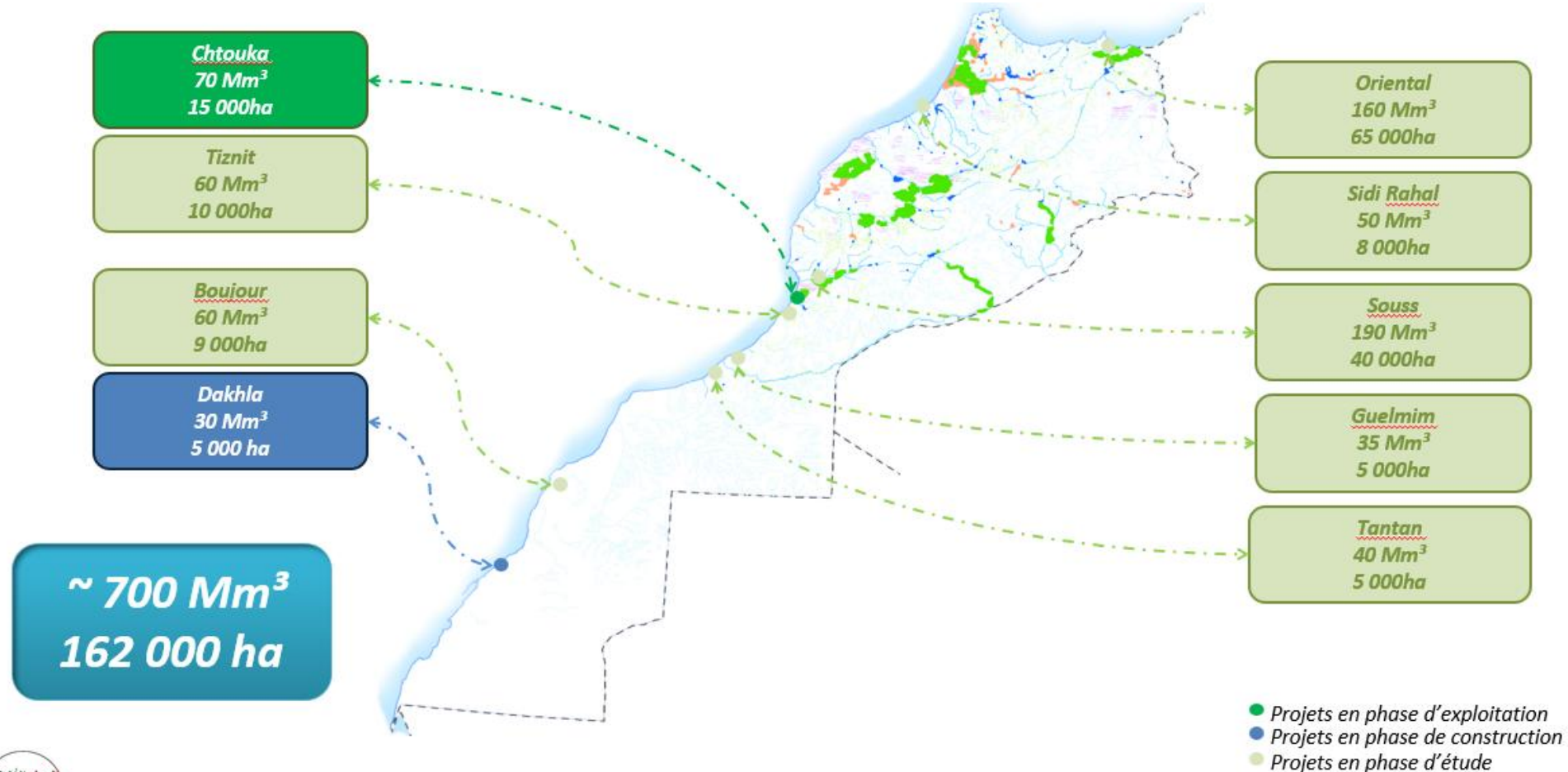


II.Desalination: a growing market in the 3 countries



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Morocco: Desalination at the service of high revenue crops



II. Desalination: a growing market in the 3 countries



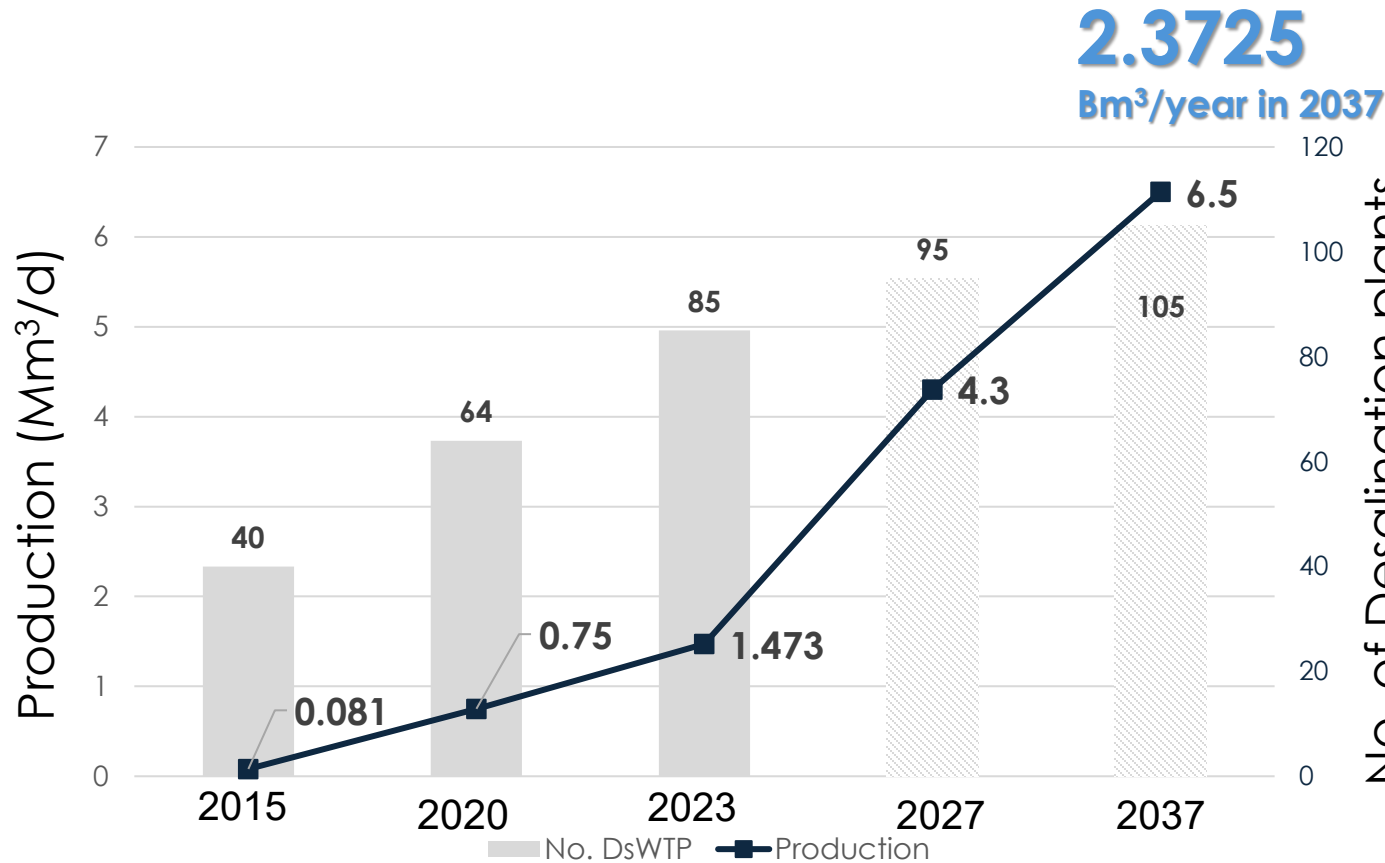
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Egypt

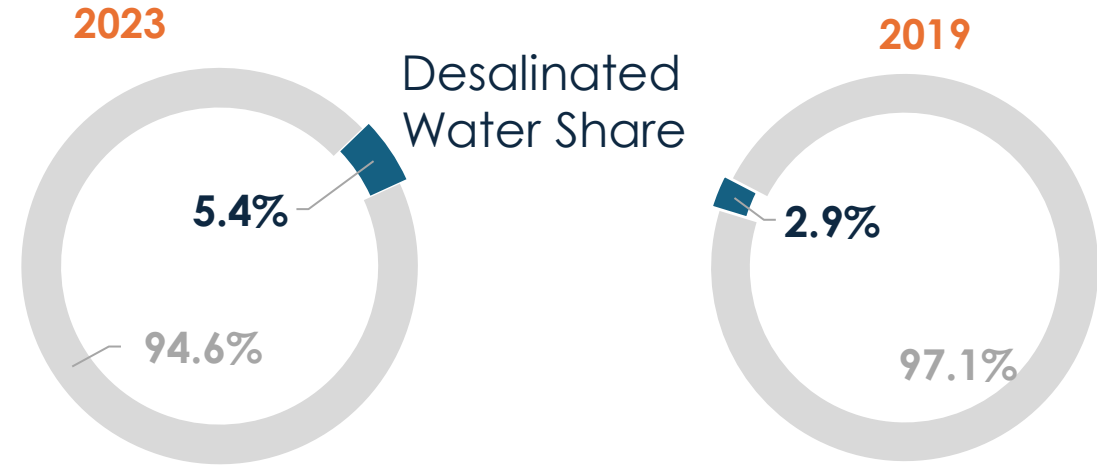


0.54

Bm³/year in 2023



No. of Desalination plants



Operated by HCWW

Operated by Other water Suppliers
(Public and Private sector)



II. Desalination: a growing market in the 3 countries



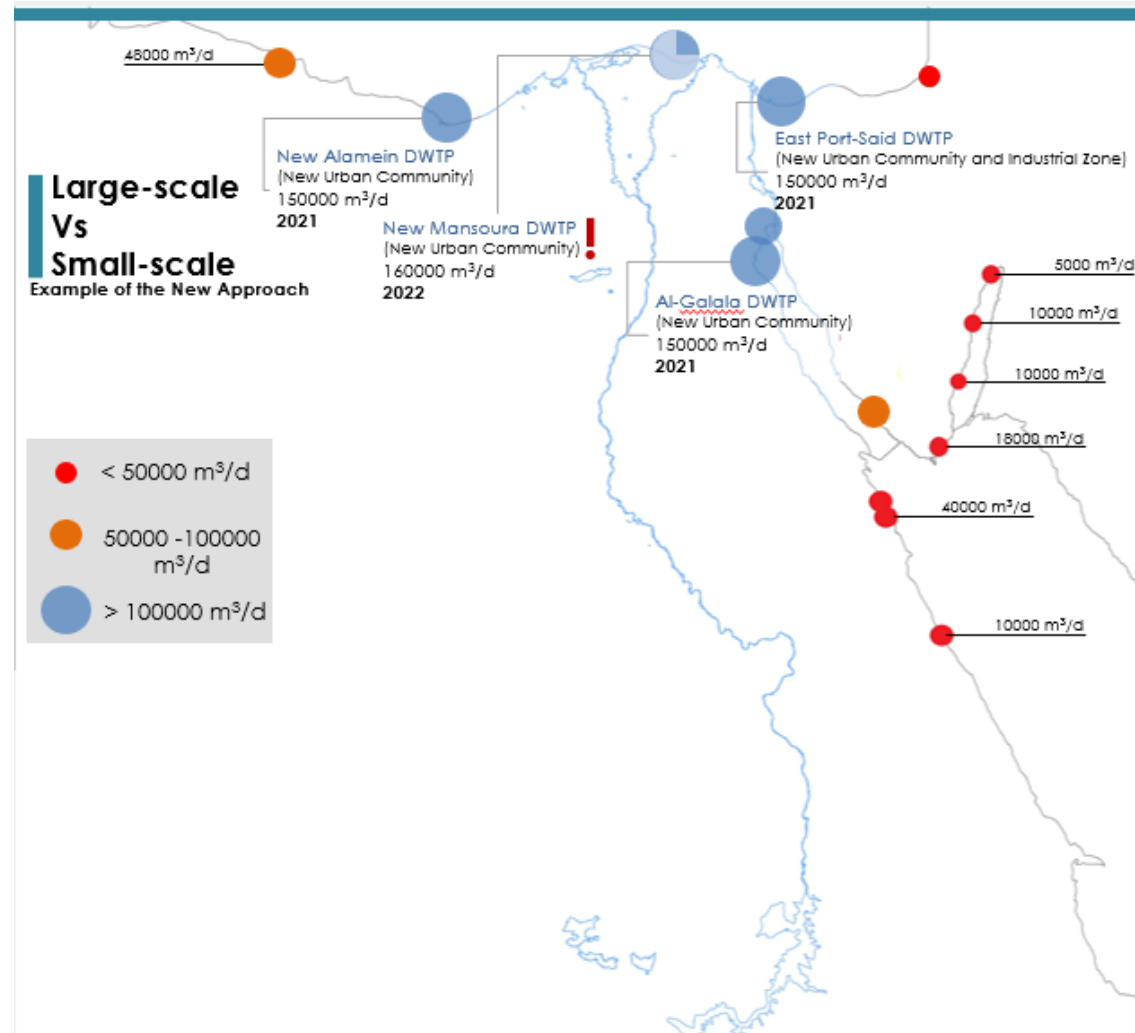
Egypt



Embark of construction of **large-scale** Desalination plants ($> 100000 \text{ m}^3/\text{d}$) instead of **small-scale** plants ($2000 - 10000 \text{ m}^3/\text{d}$).



To decrease the **Initial Coast** of the construction.



IV. Comparative analysis of Desalination in the 3 countries



Technical

- **RO is dominating in the 3 countries due to its specific energy consumption's attractiveness**
- **Large scale Desal Plants are a trend in the 3 countries to reduce the cost of produced water.**
- **Morocco is the only country having used Desalination for irrigation supply among the 3 countries**

Financial and institutional

- **Morocco has set up Desal Plants through PPPs recently (Chtouka, Casablanca, Dakhla)**
- **SAU and Egypt intend to boost the private sector investment in Desalination development**
- **Renwable enregy is gaining of interest in terms of cobination with desalination plants as its cost development is tending to reduce**

Environment al

- **Brine is a common challenge to the three countries**



V. Challenges of Desalination in the 3 countries



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- **RO is the dominating technology in MENA region, which is often linked with membrane fouling problems** (organic, colloidal, biofouling, mineral)
- **Consistent energy needs** (around 3.57 Kwh/m³, and 2.54 only for RO) which is **often generated from fossil fuels** and contributes to **greenhouse gas emissions**.
- **Disruption of marine species:**
 - Salinity of the brine: 1.6-2 times higher than the feed seawater.
 - Temperature
 - Chemicals: employed in pretreatment and membrane cleaning (including copper, ferrous, nickel, molybdenum, and chromium (Al-Addous et al., 2024))
- **Bron removal:** rejection rates from 40% to 60% that are enhanced by some methods such as the double-pass RO system (Al-Addous et al., 2024)



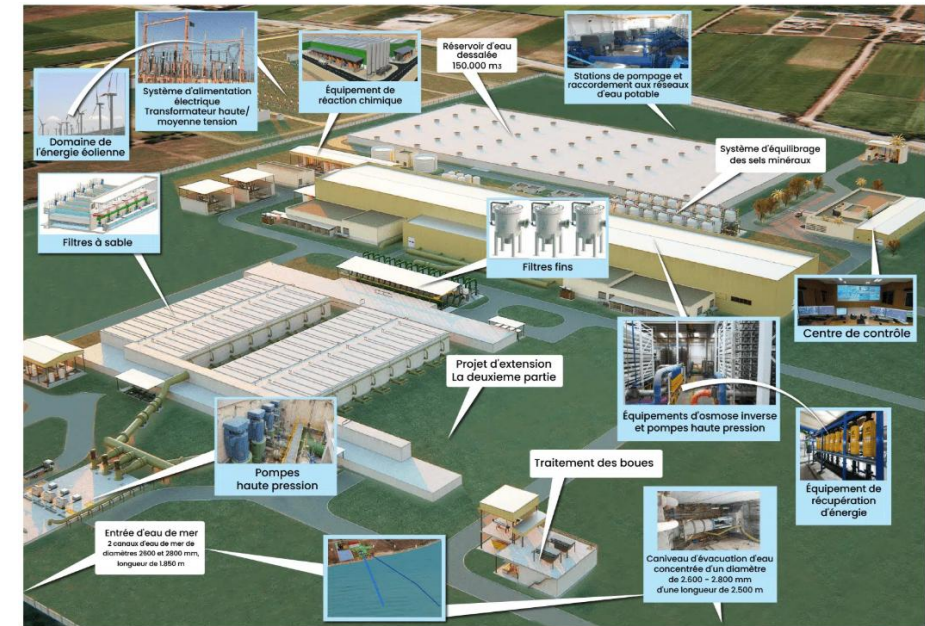
VI. Opportunities for Desalination development in the 3 countries



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Renewable energy based-desalination to reduce their carbon footprint

- Many studies have tested a wide range of renewable energies as a source for desalination plants in the MENA region, mainly at the experimental and small scale, either for thermal options (MSF and MED) or membrane treatment (Reverse Osmosis) since the 1980s (Taha Sayed, 2023).
- It reduces reliance on fossil energy and significantly minimize greenhouse emissions (up to 94%) (Khan et al., 2024).
- RO would be more economically attractive when combined to renewable energy, especially at the large scale:
 - The large station of Casablanca (300 MCM/y) under construction through a PPP would afford desalinated water with a cost around 4.48 MAD/m³ due to combination of a Wind energy park of 360 MW (Source: ONEE, 2024)



VI. Opportunities for Desalination development in the 3 countries

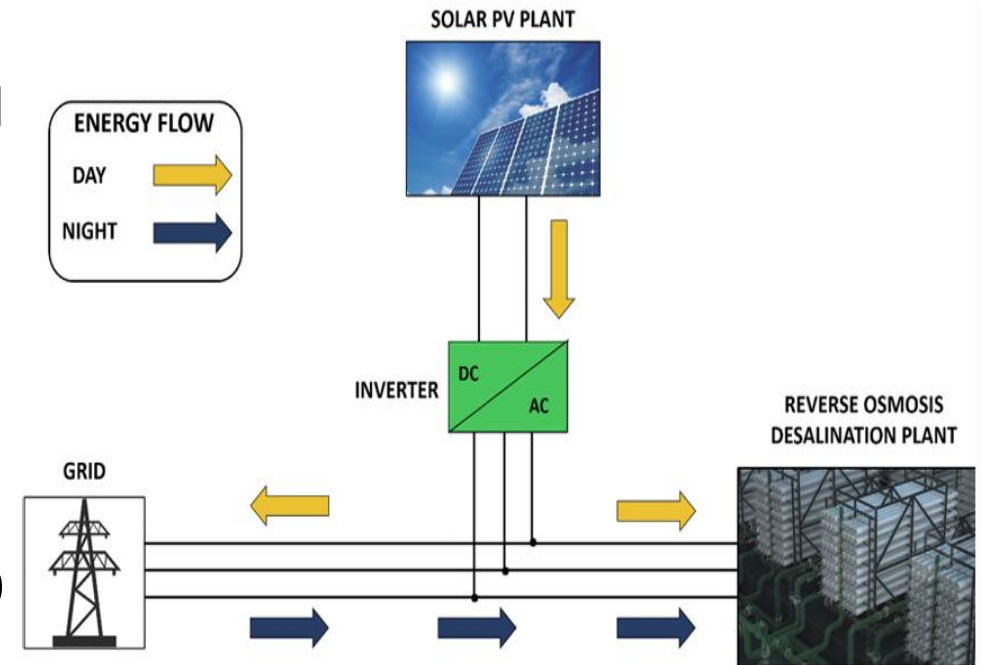


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Renewable energy based-desalination : Example of the largest Solar-PV desalination plant from KSA

Solar-PV was shown very suitable, cost-effective and compatible with RO-plants, such was the large-scale Al Khafji solar PV-SWR desalination plant in KSA (2018):

- Production capacity: 60 000 m³/d
- Solar PV system: 20 MW over an area of 900 000 m²
- Use: sufficient freshwater supply of a city of 150 000 people.
- Cost: \$130 Million



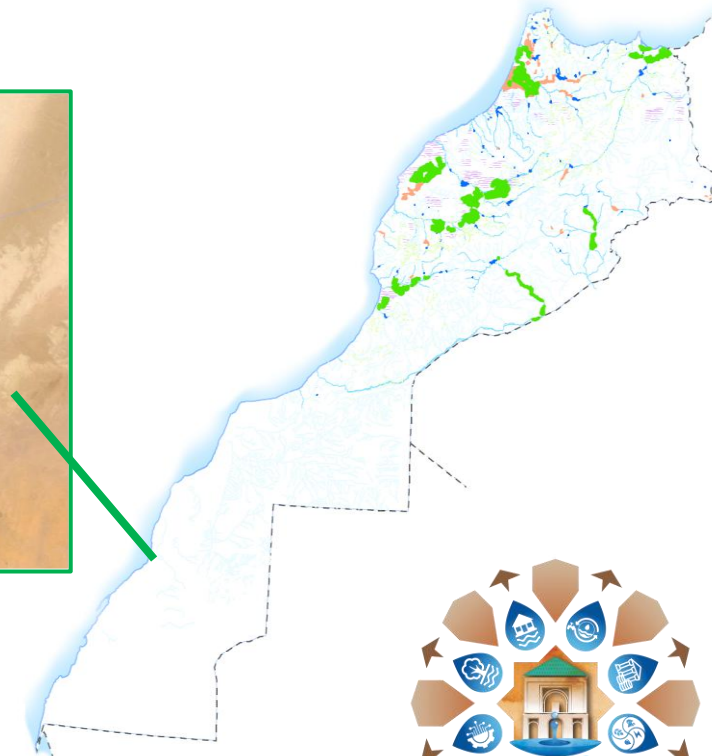
VI. Opportunities for Desalination development in the 3 countries



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Renewable energy based-desalination : Example of Dakhla desalination plan from Morocco (Wind energy)

- **Wind-RO plants were also tested (Algeria, UAE, Morocco) at different levels of capacity production.**
- **Dakhla Project:**
 - **Production capacity (37 MCM/y)**
 - **Use: PWS and irrigation (5000 ha : 30.1 MCM/y)**
 - **Wind park: 40 MW initially and would move to 60 MW**
 - **Construction beginning: mid 2022**



VI. Opportunities for Desalination development in the 3 countries

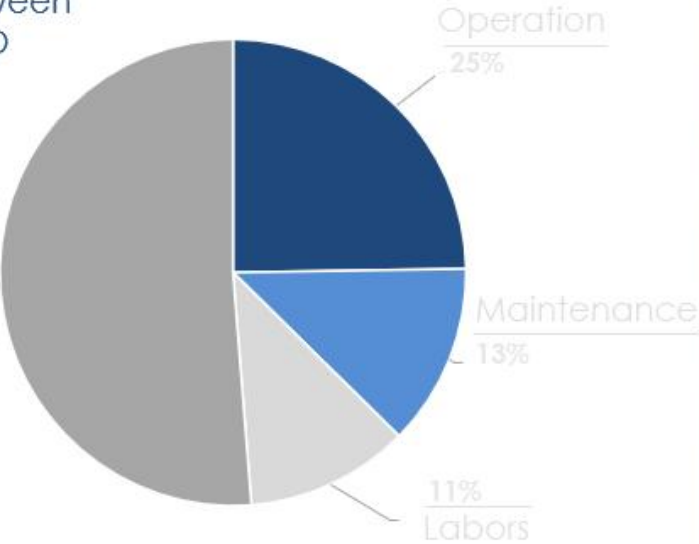


Renewable energy based-desalination : Egypt

The Running Cost.....

Range between 0.4 – 0.6 USD

There are cost reduction plans



Benban Solar Park

Located in Aswan (South)
4th largest solar park worldwide.

Electricity 51%

Energy consumption ratio (3.5 – 4 Kw/m³)

Energy Price

Optimization (To less than 3 Kw/m³)

Encourage the renewable energy instead of traditional energy



VI. Opportunities for Desalination development in the 3 countries



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Disposal of Brine linked to desalination plants

- **Careful engineering technics and studies are required including diffusion in brine discharge disposal locations and 3D simulations.**
- **Alternative pretreatment to reduce chemicals: such as Ultrafiltration;**
- **Heat recovery in thermal desalination to limit the temperature change in receiving seawater;**
- **Minimal and zero-liquid discharge (MLD and ZLD):** aim to recover high-quality freshwater with the near complete elimination of liquid waste from desalination plants, achieving water recovery rates of more than 95%. The compressed solid waste generated can be disposed of in an eco-friendly manner or repurposed as high-value-added compounds (Al-Addous et al., 2024; Abualtayef et al., 2016; Xiong et al., 2017)



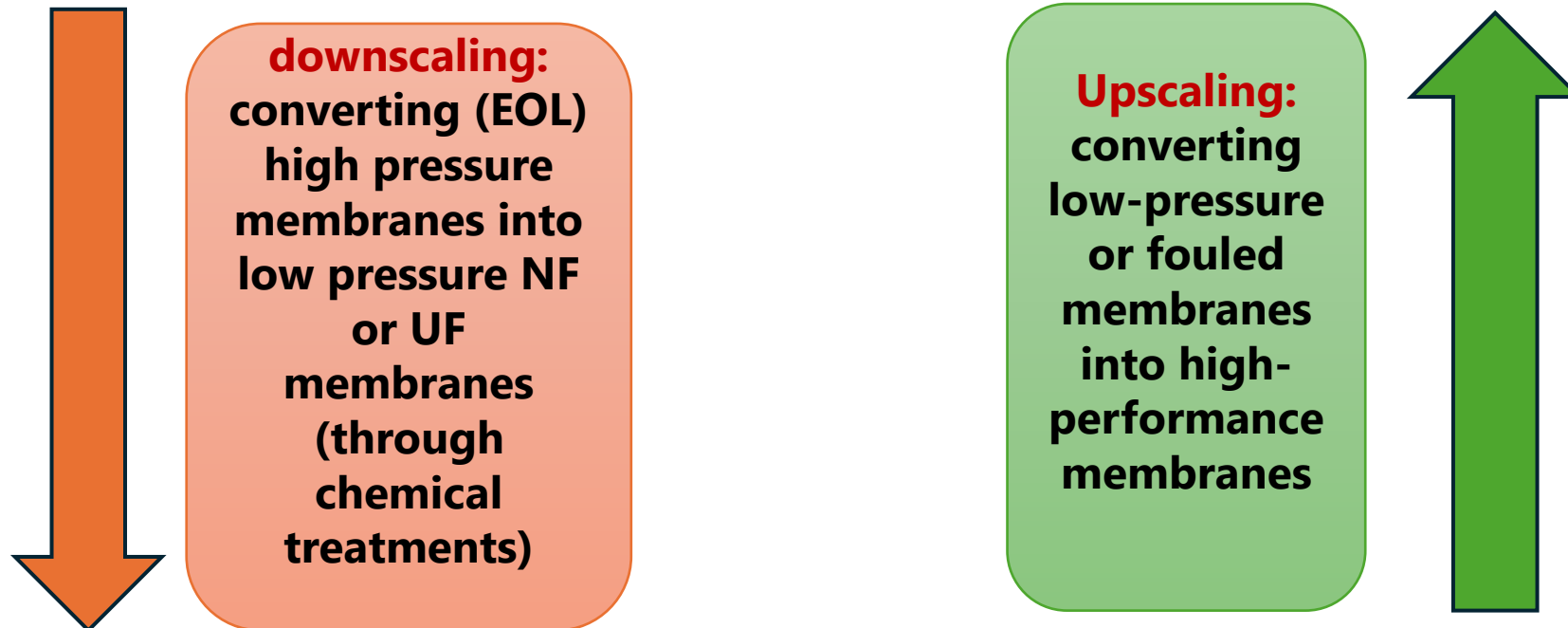
VI. Opportunities for Desalination development in the 3 countries



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Reuse of old membranes/End Of Life membranes of reverse osmosis

Investigations are being made by researchers to reuse/restore membranes efficiency: combining chemical agents and physical agitation (e.g. ultrasound-assisted cleaning)(Somani et al., 2025)



Conclusions



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- In the context of water scarcity in the three analyzed countries, and taking into account the potential of renewable energies in the MENA region, **renewable powered desalination plants is to be reinforced as a major solution and cost-effective one in terms of dealing with the water stress context.**
- Advancements in technology (membranes), increased use of solar energy, and energy, and greater private sector participation would enhance the cost of cost of desalinated water
- Investing in large-scale, modern desalination facilities is an effective strategy for strategy for improving cost-efficiency and ensuring sustainable water supply in the supply in the region.



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