

Expert Group Meeting on “Enhancing capacity building addressing Water and Energy interlinkages for Sustainable Development in the Arab Region” UN – House, Beirut –
Lebanon, 25 – 26 June 2019



The role of desalination in Water-energy-food nexus: An opportunity for Algeria



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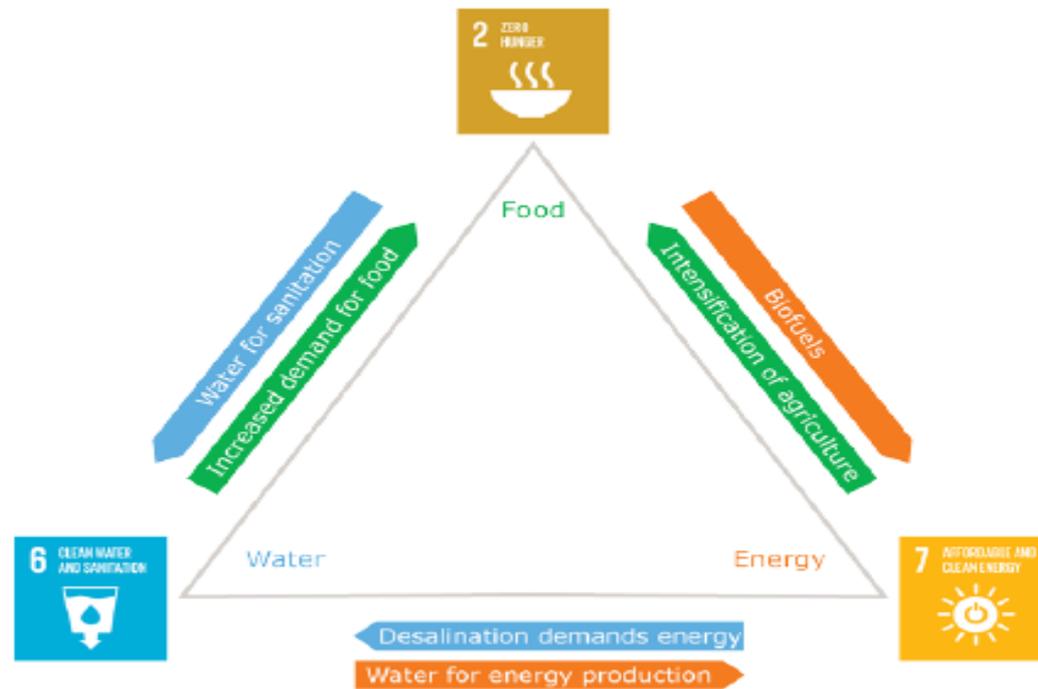
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Outlines

- **The Water-Energy-Food Nexus Concept**
- **WEF Nexus in Algeria**
- **Policy recommendations**
- **Nexus in practice: Cases studies from Algeria**
- **Conclusions**



The Water-Energy-Food Nexus



water security

sustainable energy

food security

The interactions and potential synergies between water, food and energy,

• *Source:* Reinhard, Stijn, Jan Verhagen, Wouter Wolters and Ruerd Ruben, 2017. *Water-food-energy nexus; A quick scan.*

Motivation

- Fast growing population and demands.
- Environmental degradation.
- Impacts of climate change, resource scarcities, and human insecurities.
- Increasing dependence on other regions (trade); among largest wheat importer.



Opportunities

- Renewable Energy Desalination can play an important role in the **Water-Energy-Food nexus** by exploiting synergies between energy generation, water treatment and agriculture
- Improving resource use efficiencies (207 Mm³ of treated wastewater in 2016 and 136 WWTP in operation, ONA 2018). (Groundwater 7.5 billion m³/year, MRE, 216)
- Reducing environmental stress and promoting development.
- Building on energy: renewables and others Building on diversity -> opportunities for sharing of knowledge, technologies, best practices etc..



In **Algeria**, there are about **42 million** people who need water, food, and energy

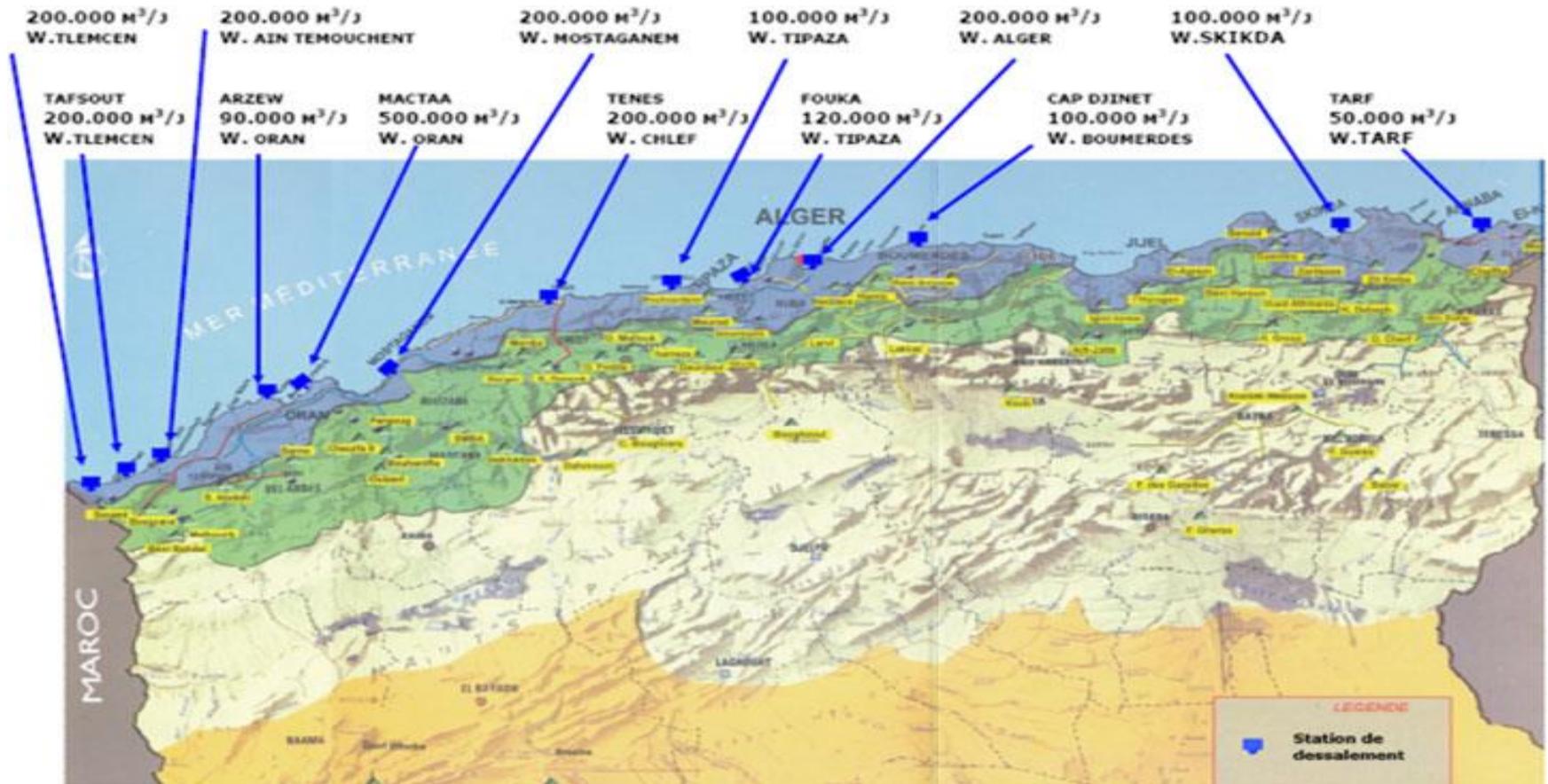
The most critical drivers destabilizing the existing balance between the water demand and supply are:

- The natural water scarcity (**Among 33 Water-Stressed Countries: 2040**)
- Drought due to climate changes (average annual rainfall has decreased by over **30%** in recent decades (Algeria INDC, 2015).
- The increasing population (**1.67%**)
The situation will get worse over the few next years!!!!

WATER ENERGY NEXUS

- For humans to be able to utilize the available water resources, energy from some sources is needed to extract groundwater, feeding desalination plants, producing freshwater, distribution and use, and collecting wastewater,
- Sometimes water is a direct input to the **energy generation process**: cooling, hydropower, geothermal, exploration and refining. Much more often it plays a role at various intermediate phases of electricity generation.
- Water cycle demands at least **15%** of national electricity consumption. In 2030, the water sector is expected to rise to **16,090** GWh.

- The shortage of fresh water resources in Algeria triggered the **use of desalination**, mainly based on **Reverse Osmosis (RO)**. The implemented desalination plants **increased the overall energy consumption**.
- As energy production is based on fossil-fuels, a finite source, it is obvious that **promoting renewable energies** to power desalination plants is needed.
- Special attention should be paid to **renewable safe energy sources**, of which the most important is solar, which can have enormous potential as **Algeria** holds one of the **highest** solar potential in the **world** which is estimated at **13.9 TWh per year** .



Large scale seawater desalination plants' location

WATER FOOD NEXUS

- Water and Food in Algeria are strongly inter-linked and highly interdependent.
- Algeria is facing a water scarcity challenge, where agriculture is its predominant consumer. Water withdrawal for irrigation, livestock and aquaculture purposes accounts for approximately **4,000 MCM/yr**, or **64%** of global water withdrawals today , and is forecast to grow at an annual rate of 6.8%.
- In addition to the increase in water scarcity, the agricultural sector faces an enormous challenge of producing almost **50%** more food by **2030** and doubling production by **2050**.

Policy recommendations for Mainstreaming WEF

Based on the landscape analysis of the water, energy and food security nexus in Algeria the following recommendations could allow decision makers to develop the right strategies and plans that contribute to the achievement of **sustainable development** of each of these three sectors:

- 1) The development of a national strategy for planning and implementing projects utilizing the nexus approach to promote coordination and collaboration across sectors,
- 2) Adopting a nexus knowledge platform to enable information sharing.
- 3) The implementation of a national nexus steering committee comprised of policy makers, researchers, and civil society organizations to join management strategy to promote projects in these three sectors.
- 4) Promote energy efficiency and improved wastewater management.

Algerian government actions

In spite of the fact that water- energy -food nexus is a new concept, some promising actions are done by Algerian government.

- **40 %** of national energy consumption must be from renewable energy and especially solar energy by **2030**
- Construction of low-capacity dams
- Subsidy of farmers
- Introduction of sophisticated economic irrigation techniques toward water conserving food production (drip irrigation, solar pumped irrigation.....)
- **22,000 MW** of renewable energy capacity by **2035-2040**, of which **12,000 MW** will be meant for domestic consumption and the rest for export.

Case studies

- Disinfection of Treated Wastewater and its Reuse in the Irrigation of vine – Corso Boumerdes
- The treated wastewater of Boumerdes plant has a good physico-chemical quality and it contains important nutrients.
- The quality of TWW is conform with national reuse standards (bacteriological aspect).

The cultures applied are table grapes (40 ha), orange (20 ha), sorghum (15 ha) and alfalfa (5 ha).

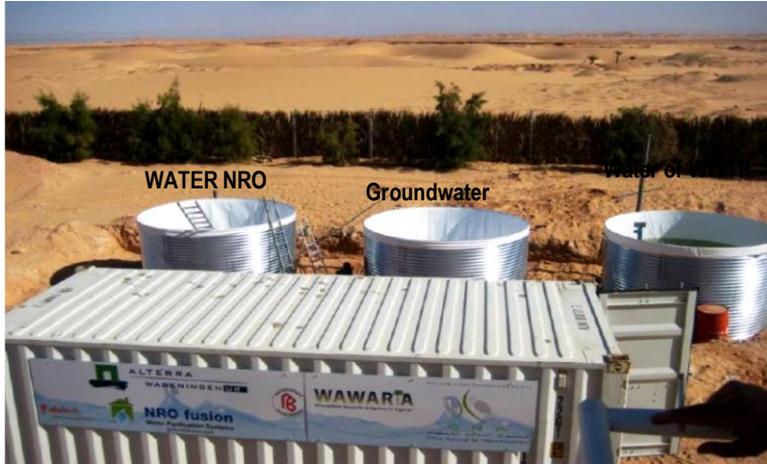


- The farm has an area of **80** hectares, located 5 kilometers from the WWTP. It has two storage ponds of water with a total capacity of **11 000 m³**, the adduction of treated water to storage basins is performed by a pipe of 5000 m the water discharge is provided by three electric pumps of **80 m³ /h** each one, placed at the downstream of the chlorination step. The water in storage ponds pass stays up for at least 72 hours to ensure proper clarification and evaporate the residual chlorine.



WAWARIA - WasteWater Reuse for Irrigation in Arid Region

- The pilot project Wastewater Reuse for Irrigation in Algeria (**WAWARIA**) was to demonstrate the potential to safely valorize wastewater treated and polished with membrane based filtration for irrigation purposes.
- The project consisted of installing three irrigation plot for tomatoes, potatoes and cucumber that were irrigated with 3 water quality:
 - i) Traditional water for irrigation (groundwater),
 - ii) Treated wastewater,
 - iii) Tertiary polished water with membrane (NF).
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Irrigation management system of WAWARIA project



Large scale

- The Kahrama venture between AEC (20%) and Kansas-based Black & Veatch (80%) has the country's first independent water desalination and power project (IWPP) in Arzew close to the GL2Z gas liquefaction complex. This has a \$400m power plant of **314 MW** and **88,000 m³/d** plant built by a Japanese partnership of Itochu and Ishikawajima-Harima Heavy Industries under a \$260m EPC contract signed at the end of 2002. These plants became operational in April 2005.

Kahraba Plant



Projet Kahraba 01/10/2009

Magtaa Desalination Plant

- Construction of the plant started in October 2008, and was completed to begin operations in November 2014. The plant features the world's biggest ultra-filtration membranes with a capacity to desalinate **500,000** cubic meters of sea water a day.
- The off-takers are Sonatrach and ADE.

Maqtaa Desalination Plant



Client: Algeria Energy Company

Location: Algeria

Project: Design, develop, build, operate and maintain on 25-year concession

Capacity: 500,000 m³/day

Awards: Highly Commended - Desalination Plant of the Year, Global Water Awards 2015

Highly Commended - Desalination Deal of the Year, Global Water Awards 2010

Integrated Solar Combined-Cycle (ISCC) A concentrating solar power (CSP)

- It combines the benefits of solar energy with the benefits of a combined cycle. The solar resource partially substitutes the fossil fuel. The project consists of a **150 MW** hybrid power plant composed of a combined cycle and a **20 MW** solar thermal plant.

Hybrid solar power plant Hassi R'Mel



Solar Field: 1.94 million sq. ft.

Status: in operation

Owner: NEAL

Operator: Abengoa Solar and NEAL

Solar powered RO desalination project at CRTSE

- the application is primarily pilot and demonstration systems.
- The PV-RO – NF system consists of a photovoltaic field that supplies electricity to the desalination unit through a DC/ AC converter and a RO or NF membrane for the water softening in the Enhanced Oil Recovery (EOR) application.
- Investment costs are relatively high, as is the case with most RE-desalination technologies, resulting in specific cost of drinking water in the range of 3.5–7 €/m³ for brackish RO unit.
- **The project started on 1st March 2019.**



BW30-4040

Active area: 7.2 m²

Salt rejection: 99.5%

NF 90-4040

Active area: 11.5 m²

Salt rejection: 98 %

Solar PV systems need:

PV panels

Inverters (DC/AC)

Batteries

Charge controllers

- It aims to support the market development for RE-desalination
- Making the general public aware of the technology
- Its application in the Enhanced Oil Recovery (EOR) application,



Pilot unit Hybrid process involving Ion exchange resin coupled with NF or RO

- Two configurations are possible:
- Stand alone PV-RO plants
 - Grid connected PV-RO plants

Ions	TFT 611 (ppm)	TFT 611* (ppm) – Stage 1
Na	1294	732
K	64	1.51
Ca	331	7.68
Mg	181	2.56
SO ₄	1723	34.4
CO ₃	0.85	0.05
CO ₂	3.39	3.27
HCO ₃	126	38.13
Cl	2198	1104
TDS	6162	1920
pH	7.60	7.21

Groundwater water quality of Tin Fouyé Tabankort

CONCLUSIONS

- The strong interaction between energy and water will demand an equally strong policy.
- Public policy should be tailored to account for water use as a metric related to overall **sustainability** of a particular energy system, or an energy resource roadmap.
- Similarly, better data on current water use, in all sectors of the economy, as well as energy, is necessary in order to better educate the public about their use of water and allow stakeholders to make better informed decisions regarding this resource.

- The nexus approach presents an opportunity for Algeria to make strides in three sectors without comprising its natural or social environment.
- Effective governance in the water, energy and food security sectors and the use of holistic approaches will set the stage for Algeria to continue making strides towards economic growth.
- The nexus must prevail at all levels, based on inclusiveness for all sectors of the economy including: policy makers, stakeholders, academic, civil society and private sector.

Thank you for your attention