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Regional capacity building workshop on "Water - Energy Nexus Operational Toolkit: Renewable Energy"

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Water and Energy Nexus: Case Studies and Initiatives from Jordan

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ENERGY IN JORDAN

IMPORTANT FIGURES, 2015

Primary Energy Consumption	8.944 Mtoe
Crude Oil	6.331 Mtons
Imported Natural Gas	1.94 mcm
Consumed Electricity	16163 GWh
Cost of Imported Energy	2.532 bn JD
Imported Energy Bill	9.5% of GDP
Per Capita Primary Energy Consumption	1373 kgoe
Per Capita Electricity Consumption	2483 KWh
Energy Intensity (kgoe/1000 JD)	207

Current and Evolving Policies

- Tax and customs exemptions granted to RE and EE, 2008
- Renewable Energy & Energy Efficiency Law, 2012
- The Reference Price List which includes the indicative prices for each type of Renewable Source
- Sale of Electrical Energy generated from Small RE Systems (Net Metering – Roof Tops)
- Cost of Connecting RE Facility to Distribution Grid
- Electric Power Wheeling Directives
- Jordan Renewable and Energy Efficiency FUND (JREEEF) designed to mobilize and provide financial and technical support
- Energy Efficiency By-Law
- Energy Efficiency Code
- Solar Energy Code
- Insulation Code
- Green Building Manual

Solar Water Pumping Project-2017

- This project is funded by the EU and being implemented by RSS/NERC jointly with Ministry of Environment and Jordan Valley Authority.
- The Total Budget is around 7,000,0000 Euros.
- The Project aims at replacing 200 – old pumping stations (using grid electricity or Diesel) by new solar pumping station in the Jordan Valley and another 100 pumping stations in the High Lands in Jordan.
- The project has been started with a detailed assessment of the existing pumping stations (age of the pump, efficiency, annual consumption, available area for solar panels, cost sharing by the owners…)
- The estimated saving in electricity is more than 5 GWh/year.

SWEDEN

MINARET

The MENA Region Initiative as a Model of NEXUS Approach and Renewable Energy Technologies Project (MINARET)

FUTURE PIONEERS
Empowering Communities

IUCN

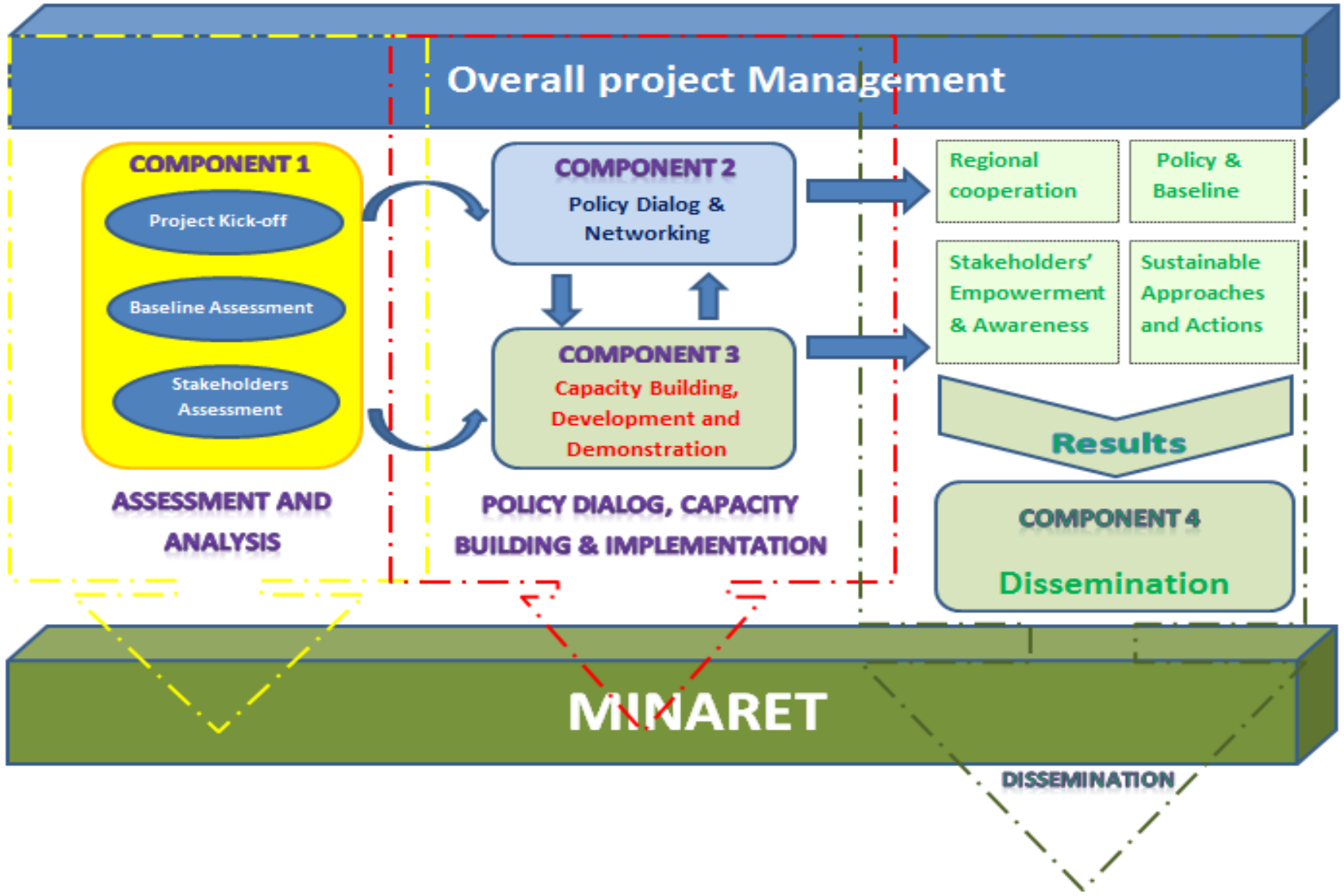
Amman Jordan 1970
Royal Scientific Society

NERC
National Energy Research Center

Project's Main Objective

The overall goal of the proposed project is to "Strengthen regional cooperation within the MENA region through implementing the NEXUS approach (energy/water/food) integrated with renewable energy technologies at the municipality level, to mitigate climate change impacts and combat poverty".

Project Structure and Methodology



As-Samra wastewater treatment plant (WWTP)

- It is the largest wastewater treatment facility in Jordan.
- Construction of the As-Samra WWTP was undertaken between 2003 and August 2008, at a cost of $169m.
- The facility treats an average flow of 267,000m^3 of wastewater on a daily basis, serving a population of 2.2 million living in the Greater Amman and Zarqa areas.
- The WWTP receives 80% of its electricity needs through the combination of hydraulic turbines and gas turbines powered by digestion biogas (**Total Installed Electrical Power 14 MW**).
  - ✓ Inlet Pelton turbines / 1.7 MW
  - ✓ Outlet Francis turbines / 2.5 MW
  - ✓ Biogas power generator / 9.5 MW
- The remaining 20% comes from the national grid.
- As-Samra WWTP consists of:
  - ✓ a primary settling tank
  - ✓ eight aeration tanks and eight secondary settling tanks
  - ✓ four anaerobic sludge digesters
  - ✓ Biogas and hydro-powered generators, and
  - ✓ Odor control system.
- The digested Sludge flows to the digested sludge storage tank where it is pumped to 25 solar evaporation basins where it is dried to about 30% dry solids.

Sources: SUEZ's degremont® water handbook
http://www.water-technology.net/projects/as-samra-wastewater-treatment-plant-jordan

Solar Desalination in Jordan

- **Conventional RO- diesel generator experimental plant was erected in Qatar Village to study the technical characteristics of the RO systems**
- **The Aqaba project:**
  16kWp , 140 modules, Kyocera.

Performance Specifications :

- Feed Water TDS (mg/L): 4000
- Feed Water Temperature(˚C) :25
- Production (GPM): 15
- Permeate TDS(mg/L): 100
- Recovery(%):60
- Feed Water Max. Silt Density: 5.0
- Feed Water Max. Turbidity (NTU): 1.0
- Feed Water chlorine Tolerance(mg/l): 0.1
- Concentrate LSI: 1.5
- Min. LinePressure Required: 20
- 3rd Year R.O. Feed Pressure (psi): 230
- 3rd year concentrate pressure(psi): 185

Qatar Village & Aqaba solar powered Desalination system using RO Technology

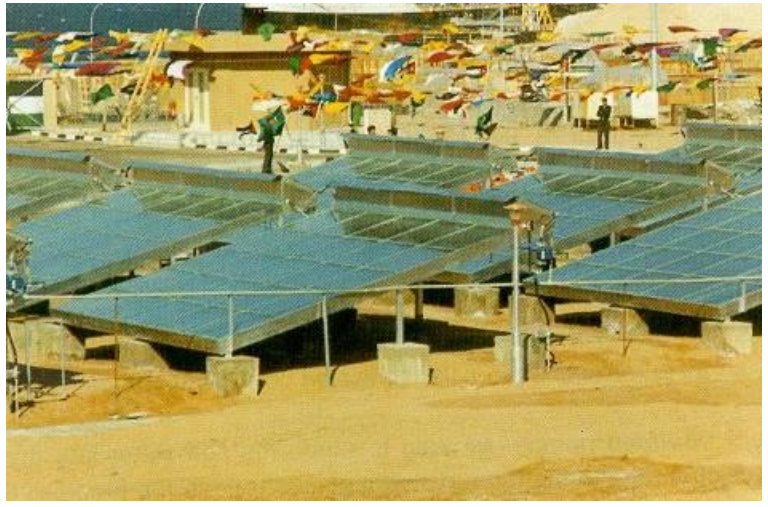
The first largest Water Desalination plant in Jordan

- Opened in March 2017
- The desalination project was implemented by KEMAPCO. on the principle of build-operate-transfer (BOT).
- Plant capacity is 500 m3/hour
- Payback is around 7 years.
- The plant will provide the same amount of water as the Disi project.
- The project, which would meet Aqaba's water needs until the year 2035, is to be fully supplied with renewable energy sources, with the methane gas emitted by the plant and solar energy to generate electricity for the entire project.

Solar Desalination in Jordan

- **Solar desalination of Sea water using heat pipe principle (**1977-1981)

Distilled quantities achieved during summer were 5 liters/m2 /day and 2.5 to 3.0 liters/m2 /day in winter. The seawater salinity is 41400 ppm where the product water has a quality of 35ppm



Parabolic trough desalination plant in Aqaba

24 m long parabolic trough with a sun tracking system. Multistage evaporator – 6 effects

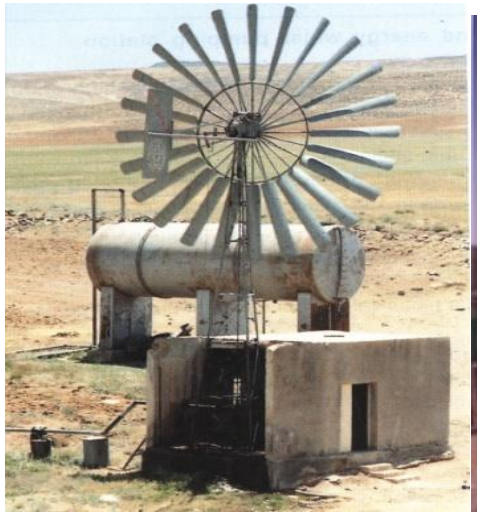
This unit was producing 1m^3 /day at solar radiation of 5.6 kWhr/m^2/day.

Geothermal Energy Applications

Many of the geothermal sources are currently being used on a small scale either for recreation, heating greenhouses or on several fish- breeding farms run by the Arab Fish Company.

Wind energy for water pumping

- Mudawara wind pumping station - 1983
- Jurf wind pumping station - 1986
- Twana wind pumping station - 1987
- Elaka wind water pumping station - 1992
- Athaghra wind water pumping station - 2001
- Hamad 2 wind water pumping station - 2002



Solar Pumping

PV Water Pump at Tafila - 2017

- This project aims to replace the diesel generator with Photovoltaic system to power water pumps in remote areas .
- The size of the pump is 23 kW and the PV System size is 30 kWp.
- The energy production is 150 kWh/Day, the water yield is $70m^3$/Day and the annual CO2 emissions reduction is 30,000 kg.

Solar Pumping

Al- Hazeem PVP-system

- Location: 150 km east of Amman.
- Installed in 1987
- 110 m3/day
- System1: peak power of **1.759** kW
- System 2: peak power of **1.656** kW
- Two water storage tanks each 55 m^3 capacity.

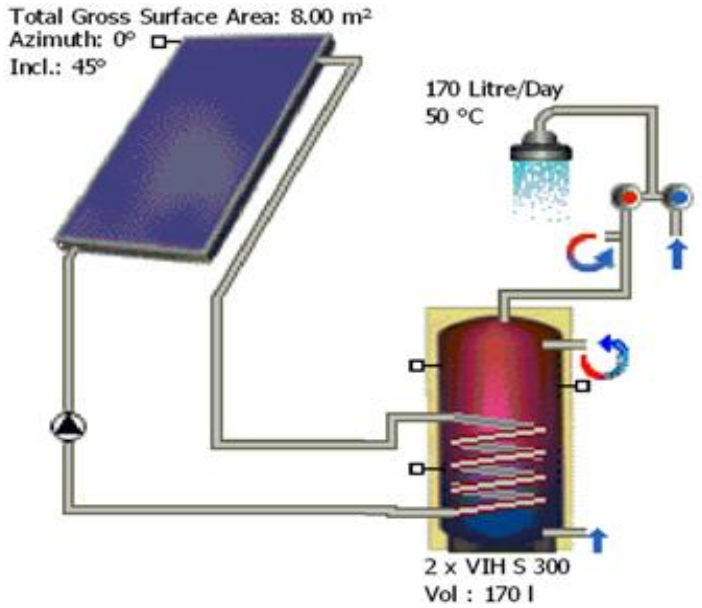
Umari PVP system

- This photovoltaic pumping system was installed in June 1985.
- 40 m^3 / day of water
- Consists of an array of 42 polycrystalline PV modules.
- Total peak power of 1.613 KW, with DC/AC inverter
- 55 m3 water storage tank.

Wadi El-Ritem

Bio-Gas System/Dair yousef farm

- Digester size about 16 m^3 included the dome.
- Operation of electrical mixer using the photovoltaic panels.
- Utilization of solar water heaters to produce hot water to be used for domestic requirements and in the Digester



- The farm is used to grow cows for milk production (around 12 cows) in the northern part of Jordan.
- The monthly gas production is around 5 m3 /day equals to 150 m3/month.
- System Cost: JD 4000
- Payback: 4 Years

Thank you