Spanish Cooperation project in Southern Tunisia:
PV-RO desalination unit in the village of Ksar Ghilène
(Fernando Castellano)
Summary

- KSAR GHILÈNE: Needs and solutions
- Partners
- ITC: previous experiences
- Project description
  - Objectives
  - Phases
  - Technical solution
  - Success of the project
Ksar Ghilène. Location

Location: Ksar Ghilène, Kebili

Situation: Southern Tunisia
Characteristics of the village

- **Population**: 51 families (~300 inhabitants)
- **Facilities**: school, mosque, National Guard, community clinic
- **Activity**: agriculture and cattle raising
Characteristics of the village

- Solar lighting street lamps
- Electrification by Solar Home Systems
- Solar thermal heating in the community bathrooms
- No possibility of connection to electrical grid (nearest point 150 km)
- Hydraulic grid for general water supply (50 m³ storage tank)
- Water supply: brackish water well inside the oasis
Water supply: Needs and solution

- Needs of water for agriculture, animals and services
- Nearest drinking water well: 60 km (Bir Soltane)

Solution:
- Reverse Osmosis (RO) desalination plant
- Supply of energy by a Solar Photovoltaic (PV) power plant

Project co-financed by Spanish International Cooperation.
Partners of the Project

- **Spanish International Cooperation Agency**: Spanish Ministry of External Affairs and International Cooperation (Azahar Program)

- **Agence Nationale de Maîtrise de l'Énergie (ANME)**: Attached to the Tunisia Ministry of Environment and Country Planning

- **Commissariat Régional au Développement Agricole de Kèbili (CRDA)**: Attached to the Tunisia Ministry of Agriculture, Environment et Hydraulic resources

- **Regional Government of the Canary Islands**: General Directorate of Relations with Africa
  - **Canary Islands Institute of Technology (ITC)**: Public company of the Canarian Government, attached to the Regional Ministry of Industry, Trade and New Technologies
Canary Islands Institute of Technology (ITC)

- **Main goals**: to promote the industrial development of the Region, fostering Research, Development and Innovation in emerging technological fields, in close collaboration with companies and research institutions.

- **Fields of activities**:
  - Energy (renewable energies, energy management, …)
  - Water Technologies (desalination, waste water treatment, …)
  - Environmental Technologies
  - Biotechnology
  - Medical Engineering
  - IT Systems…
Canary Islands Institute of Technology

**REs & Water. R&D Lines**

- Electricity production, penetration of REs in weak electrical grids, development of small-medium size wind energy systems
- Fresh water production, development and evaluation of desalination and water treatment systems (RO, ED, solar MD)
- Hydrogen production
- Cold and ice production
- Application in buildings and agriculture
- Testing of solar thermal collectors
- Sustainable energy and water management…
ITC previous experiences

Renewable Energies & Water Technologies:
Drinking water supply with stand alone systems

- **DESSOL** - Reverse osmosis desalination plant driven by a stand alone photovoltaic system
- **DESALPARQ** - Modular reverse osmosis desalination plant driven by an off-grid wind farm
- **AEROGEDESA** - Sea water desalination plant directly driven by a wind turbine
- **CONTEDES** - Water desalination container (stand alone, grid connection not necessary)
ITC previous experiences (I)

Renewable Energies & Water Technologies: Electricity supply to isolated areas

- **MORENA** - Container with hybrid system (wind-photovoltaic-diesel) for electricity supply in small rural villages

- **HYBRID SYSTEMS** - Hybrid systems for electricity supply (wind-photovoltaic-diesel) to isolated villages

- **PUNTA JANDIA** – Wind–Diesel System for the production of electricity, water, cold and ice in remote village
Cooperation with Greek, Macaronesian islands and African countries (Morocco, Mauritania, Senegal, Cape Verde, Tunisia)

- Feasibility study for the electrification and water supply (using renewable energy systems) of 32 villages in Morocco
- Installation of a hybrid PV-wind-diesel system for the electrification in the village of Ouassen (Morocco)
- Elaboration of the wind atlas of Northern Mauritania
- Thematic Parc on RES, Desalination and Drip Irrigation at the Faculty of Sciences and Technology of the University of Nouakchott, Mauritania
- 4 RO desalination plants at the National Parc Banc d’Arguin (Mauritania). Supply of the 4 plants with RES (2 phase)
Ksar Ghilène: Project objectives

1. Supply of drinking water to the population
2. Installation of a desalination unit supplied by a solar PV system
3. Dissemination of the results
4. Management of the produced water
Phases of the project

1. Design of the desalination unit and the solar PV generator
2. Study of infrastructures and hydraulic works
3. Civil engineering works
4. Acquisition of equipments
5. Elaboration of operation and maintenance manuals
6. Equipment transportation to the village
7. Installation and execution
8. Practical training of local technicians
9. Follow-up and evaluation of the project
Project description

- **Design parameters:**
  - Daily water consumption: 15 m³/day (SUMMER)
  - Solar Irradiation (annual avg.): 5600 kWh/m²
  - Ambient temperature (annual avg.): 26 ºC (0 – 45)

- **Technical solution:**
  - Well brackish water source. Hydraulic conduction
  - Building (passive cooling architectural solution)
  - Reverse Osmosis Desalination plant
  - PV solar generator
Source of water

- Artesian well (brackish water)
- Located inside the oasis
- Distance from village: 2 km
- Uses: irrigation of palms, crops and tourist services.

Water characteristics:
- Concentration: 3500 mg/L
- SDI > 3
- Temperature: 35 ºC
Building

- General distribution
Building

- Passive cooling: Semi-buried construction
PV solar generator

Electric scheme

PV GENERATOR
Total Power: 10 kWp

PV1
3.3 kWp

PV2
3.3 kWp

PV3
3.3 kWp

CHARGE REGULATOR
120V/100A

INVERTER
120V / 10kVA / 400V

BATTERIES
(600 Ah, C10)

LOADS

HIGH PRESSURE PUMP
3 kW / 400V / 50Hz

FEED PUMP
1 kW / 400V / 50Hz

DESSINFECTION
200 W

CONTROL, VALVES
50 W

LIGHTING
250 W

FUERZA
**RO desalination unit**

- **Flow diagram**

  - **FEED WATER PUMP**
    - 3 bar, 3 m³/h
    - 1 kW
  - **HIGH PRESSURE PUMP**
    - <15 bar, 3 m³/h
    - 3 kW
  - **ARTESIAN WELL**
    - Brackish water
  - **Filtration**
    - sand & cartridge
  - **Recovery: 70%**
  - **Product Water**
    - <500 ppm, 2.1 m³/h
    - 15 m³/day (8h)
  - **Brine discharge**

  **Note:** Specific consumption: 2 kWh/m³

ADU-RES. September 2005
Success of the project

- Follow-up and evaluation of the project: 9 months
- Practical training of local technicians:
  - ITC facilities
  - During the start-up of the system
- Management of the produced water
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THANK YOU FOR YOUR ATTENTION