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**ECONOMIC AND SOCIAL COUNCIL**

**Economic and Social Commission for Western Asia (ESCWA)**

Expert Group Meeting on "Adopting the Sustainable Livelihoods Approach for Promoting Rural Development in the ESCWA Region"
Beirut, 21-22 December 2009

# IMPROVING RURAL LIVELIHOODS THROUGH PHOTOVOLTAIC ELECTRIFICATION: THE ESCWA PILOT IN KAAWA, YEMEN

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UN-ESCWA

# Improving Rural Livelihood through Solar PV Electrification: ESCWA Pilot Project- Ka'awa Village - Yemen

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**Expert Group Meeting on Adopting the Sustainable Livelihoods Approach for Promoting Rural Development in the ESCWA Region, 21-22 December 2009, Beirut**

UN-ESCWA

## Contents

# 1-Millennium Development Goals (MDGs)

**Goal (1):** Eradicate extreme poverty and hunger

**Goal (2):** Achieve Universal primary education

**Goal (3):** Promote Gender Equality and Empower Women

**Goal (4):** Reduce child Mortality

**Goal (5):** Improve maternal Health

**Goal (6):** Combat HN/AIDS, Malaria and other Diseases

**Goal (7):** Ensure Environment of Sustainability

**Goal (8):** Develop a global partnership for development

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## 2-How to Contribute to the Millennium Development Goals (MDGs)?

- The Supply of the conventional energy services to many of the rural areas is difficult especially electricity:
  - Usually the national electric grid is difficult to be extended
  - The supply of fuel is difficult and complicated
  - To have Qualified Technicians in site for O&M is a problem
- RE resources (Solar, Wind) are available in each of our Countries
- RE can be a solution for the rural energy problem for ESCWA region
- The case of rural areas in Yemen was identified and solar PV systems can effectively contribute to :
  - Poverty Alleviation
  - Improve the quality of Life
    - Education
    - Maternal Health
    - Combat diseases
    - Child Mortality Reduction

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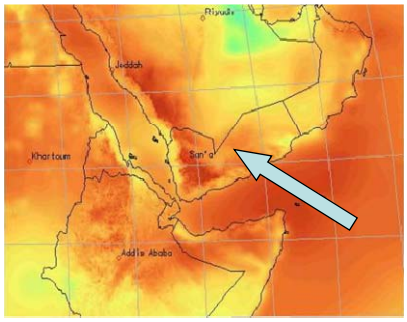
# 3-General Information about Ka'awa Village

1. At the end of the year 2008, the percentage of population supplied with electricity was only 47% in Yemen. A lot of villages in Yemen are small in size and are situated far away from main roads, and are not supplied with infrastructure.
2. After consultation with the Yemeni Government Ka'awa village was chosen for implementing the pilot project. The village population is over 300 people living in 80 houses.
3. The main activity of the inhabitants is fishing.




4. Education level is low, 85% of the males and 95% of the females are illiterate
5. The existing health center can't provide vaccination services because no electricity to operate a refrigerator to store the vaccines
6. TV, Radio and Telephone services are not available

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## Ka’awa Village

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**Villagers welcoming ESCWA team at arrival**

**11/12/2009**

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# The Weather Conditions

| Month | Horizontal Radiation (kWh/m2/d) | Wind speed ( m/s ) @ 10m | Temperature (°C) |
|---|---|---|---|
| Jan | 5.63 | 5.95 | 23 |
| Feb | 6.17 | 5.37 | 23.7 |
| Mar | 6.92 | 4.51 | 25.1 |
| Apr | 7.06 | 3.27 | 26.9 |
| May | 7.43 | 3.69 | 28.9 |
| Jun | 6.98 | 7.1 | 30.5 |
| Jul | 6.56 | 8.75 | 29.8 |
| Aug | 6.83 | 8.32 | 29.2 |
| Sep | 6.96 | 5.38 | 29.3 |
| Oct | 6.95 | 3.67 | 27.3 |
| Nov | 6.45 | 5 | 25 |
| Dec | 5.75 | 5.73 | 23.6 |
| Year | 6.64 | 5.56 | 26.9 |

Table-1

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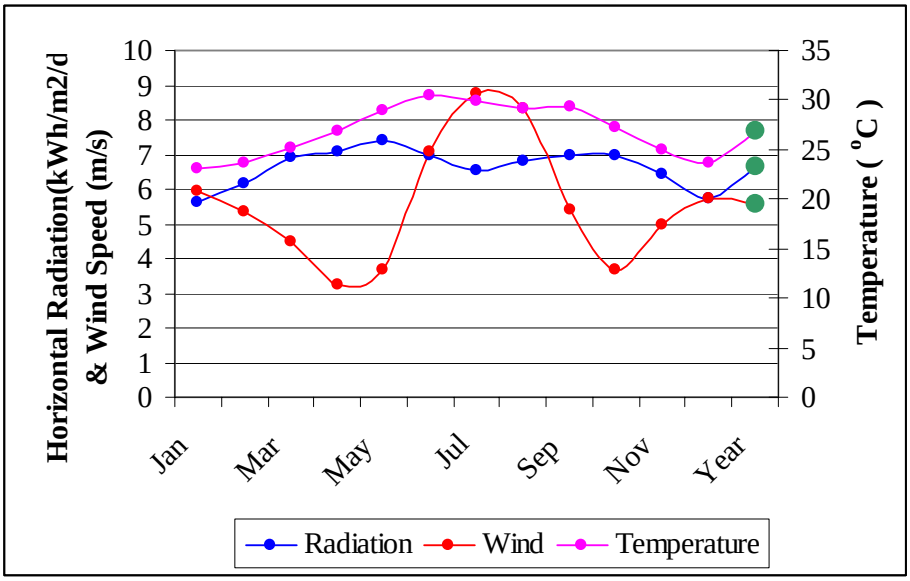


## 4-Ka'awa Village – Project Description

Solar photovoltaic stand-alone system is one of the most cost effective means to provide small amounts of electricity in areas without a grid.

Solar home systems (SHS) are small systems designed to meet the basic electricity demand of a single household, consists of one or more photovoltaic (PV) modules, a battery, and a load consisting of lights, and one or more sockets for radio, television or other appliances.

A battery charge regulator is usually added to control charging and discharging of the battery.

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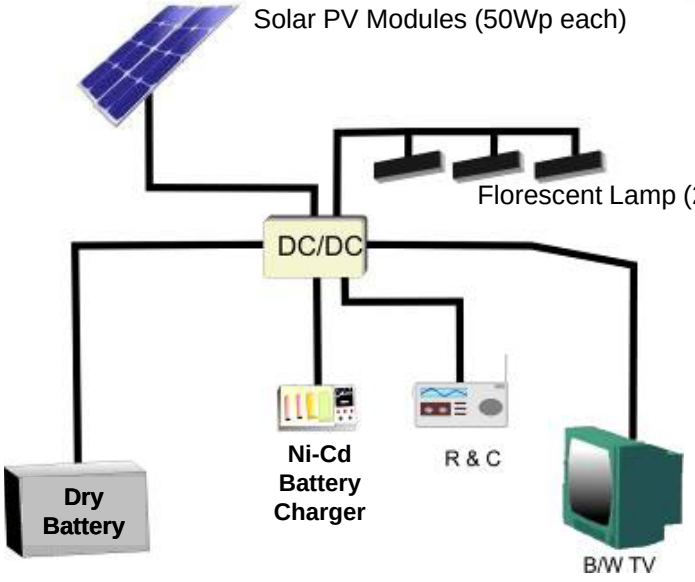
# PV System Design

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# Ka'awa Village Photovoltaic Electrification Pilot Project

**Funding Body**

United Nations Economic and Social Commission for Western Asia (ESCWA) Supported by OPEC Fund for International Development (OFID)

**Project Outline**

1. Supply and Installation of stand-alone photovoltaic systems for basic domestic needs, street lighting, health center, mosque and school
2. Training technicians and beneficiaries

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# The PV Project

- The contract for the project has been signed on 15 January 2009.
- The project's end date was originally planned for July 2009, but due to some difficulties reported by the contractor during implementation, and to the difficulty in coordination with the village local authority the contract has been extended until the first week of January 2009.
- After ESCWA's team visit to Ka'awa, and its intervention in addressing the delays in implementation, a local social and development association has been established in December 2009. The association is comprised of 50 members from the Ka'awa village residents. This association would aim at following-up on the current project's operation and maintenance in order to benefit from the installed equipment, and at following-up on upcoming future projects on the subject.

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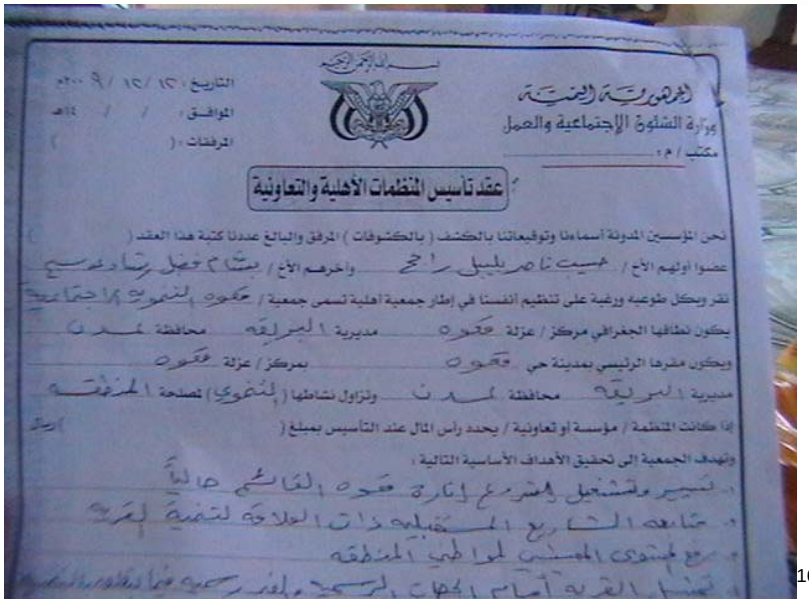


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# 5-Summary of needs in the Village

| | No. of systems | Lighting @ 20W | B/W TV | R & C | Ni-Cd Charger | Others |
|---|---|---|---|---|---|---|
| Group1 | 40 | 2 | 1 | 1 | 1 | × |
| Group2 | 20 | 3 | 1 | 1 | 1 | × |
| Group3 | 10 | 5 | 1 | 1 | 1 | × |
| Under Construction | 10 | 3 | 1 | 1 | 1 | × |
| Street | 10 | 2 | × | × | × | × |
| Health | 1 | 4 | × | 1 | 1 | Refrigerator |
| Mosque | 1 | 5 | × | × | × | Loud Speaker |
| School | 1 | 4 | 1 | 1 | 1 | × |
| **Total** | **93** | **253** | **81** | **82** | **82** | **X** |

-Group 1: Number of Rooms = 2/House

-Group 2: Number of Rooms = 3/House

-Group 3: Number of Rooms = 5/House

-Under Construction = Number of Rooms =3/House

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# 6-Summary of loads in the village (in Watts)

| | Number of units | lighting/ Unit | TV/Unit | R&C/Unit | Ni-Cd charger/ Unit | Others/Unit | Total |
|---|---|---|---|---|---|---|---|
| group 1 | 40 | 40 | 20 | 6 | 2 | - | 40*68=2720 |
| group 2 | 20 | 60 | 20 | 6 | 2 | - | 20*88=1760 |
| group 3 | 10 | 100 | 20 | 6 | 2 | - | 10*128 =1280 |
| Under Construction | 10 | 60 | 20 | 6 | 2 | - | 10*88=880 |
| Street | 10 | 40 | - | - | | - | 10*40=400 |
| Health Center | 1 | 80 | - | 6 | 2 | Refrigerator 60 | 148 |
| Mosque | 1 | 100 | - | - | - | Loud Speaker 20 | 120 |
| School | 1 | 80 | 20 | 6 | 2 | - | 108 |
| Total | 93 | 5060 | 1620 | 492 | 164 | 80 | 7416 |

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# 7-System Design Criteria

- Autonomy based on local climate conditions=3 days
- The system shall be able to provide at least 95% of the daily load in the month of January (Winter)
- Optimum tilt angle=15 degrees
- Orientation= Facing South
- Operation power is
  - TV 7-8 Hrs/day
  - R&C 10 Hrs/day
  - Lighting 4-12 Hrs/day
  - Battery Charger 10 Hrs/day
  - Refrigerator 24Hrs/day
  - Loud Speaker 1 Hr/day

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# 8-Daily Estimated Energy Consumption per day Wh/d

| Group 1 | 40 | Houses | | | |
|---|---|---|---|---|---|
| Daily Load: | Watt | Qty | hrs | L. F. | Wh/d |
| Lighting | 20 | 2 | 6 | 0.7 | 168 |
| TV | 20 | 1 | 7 | 1 | 140 |
| R & Cassette | 6 | 1 | 10 | 1 | 60 |
| Ni-Cd Charger | 2 | 1 | 10 | 1 | 20 |
| Total Daily Load (Wh/d) | | | | | 388 |

| Health Center | | 1 | Unit | | |
|---|---|---|---|---|---|
| Total Daily Load | Watt | Qty | hrs | L. F. | Wh/d |
| Lighting | 20 | 4 | 4 | 0.5 | 160 |
| Vaccine Refregerator | 60 | 1 | 24 | 0.5 | 720 |
| R & Cassette | 6 | 1 | 10 | 1 | 60 |
| Ni-Cd Charger | 2 | 1 | 10 | 1 | 20 |
| Total Daily Load | | | | | 960 |

| Group 2 | 20 | Houses | | | |
|---|---|---|---|---|---|
| Daily Load | Watt | Qty | hrs | L. F. | Wh/d |
| Lighting | 20 | 3 | 7 | 0.7 | 294 |
| TV | 20 | 1 | 7 | 1 | 140 |
| R & Cassette | 6 | 1 | 10 | 1 | 60 |
| Ni-Cd Charger | 2 | 1 | 10 | 1 | 20 |
| Total Daily Load | | | | | 514 |

| School | 1 | Unit | | | |
|---|---|---|---|---|---|
| Total Daily Load | Watt | Qty | hrs | L. F. | Wh/d |
| Lighting | 20 | 4 | 6 | 0.7 | 336 |
| TV | 20 | 1 | 8 | 1 | 160 |
| R & Cassette | 6 | 1 | 10 | 1 | 60 |
| Total Daily Load | | | | | 556 |

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## 8-Daily Estimated Energy Consumption per day Wh/d

| Group 3 | 10 | Houses | | | |
|---|---|---|---|---|---|
| Daily Load: | Watt | Qty | hrs | L. F. | Wh/d |
| Lighting | 20 | 5 | 7 | 0.7 | 490 |
| TV | 20 | 1 | 7 | 1 | 140 |
| R & Cassette | 6 | 1 | 10 | 1 | 60 |
| Ni-Cd Charger | 2 | 1 | 10 | 1 | 20 |
| | | | | Total Daily Load: | 710 |

| Street Lighting | | 10 | Units | | |
|---|---|---|---|---|---|
| Total Daily Load | Watt | Qty | hrs | L. F. | Wh/d |
| Lighting | 20 | 1 | 12 | 1 | 240 |
| Lighting | 20 | 1 | 6 | 1 | 120 |
| | | | | Total Daily Load= | 360 |

| Under Construction | 10 | Houses | | | |
|---|---|---|---|---|---|
| Daily Load | Watt | Qty | hrs | L. F. | Wh/d |
| Lighting | 20 | 3 | 7 | 0.7 | 294 |
| TV | 20 | 1 | 7 | 1 | 140 |
| R & Cassette | 6 | 1 | 10 | 1 | 60 |
| Ni-Cd Charger | 2 | 1 | 10 | 1 | 20 |
| | | | | Total Daily Load | 514 |

| Mosque | 1 | Unit | | | |
|---|---|---|---|---|---|
| Total Daily Load | Watt | Qty | hrs | L. F. | Wh/d |
| Lighting | 20 | 5 | 5 | 1 | 500 |
| Loud Speaker | 20 | 1 | 1 | 1 | 20 |
| | | | | Total Daily Load | 520 |

**Total Estimated energy consumption per day = 41436 Wh (# 42KWh)** [21]

## General Layout of PV – Installation Options

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## Criteria for Components

**Modules:**

- It is preferable to buildup the PV panel from small capacity PV modules (40~60Wp), the choice was for 50Wp.
- The photovoltaic modules shall have an approximate useful life of 20 years.

**Batteries**

- Maintenance-free value-regulated lead-acid (VRLA) batteries dedicated for solar, the choice was for 80&110 AH capacity

**Systems**

- It should be safe, with automatic operation except for turning the loads ON or OFF, and of simple maintenance.

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## 9-Customer Education and Training


- As with other systems, it is essential that the homeowner be given a simple user manual clarifying benefits of the PV system and make sure that he clearly understands his responsibilities.

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## Technical training

- One of the attractive attributes of PV system is the lack of maintenance due to the fact that the backbone of the system is the solar cell which is a semi-conductor product with no moving parts. However, electrical systems need to be maintained from time to time.

- An on-the job training has been conducted from 12 to 16 December 2009 for 11 participants representing the Yemeni Ministry of Electricity (3 participants), Sana'a University (3 participants) and Ka'awa villagers (5 participants). This training aimed at raising the capacity of participants on PV systems installation, maintenance and identification of malfunction.

- An end-users training has been conducted on 11 December 2009 for 70 Ka'awa villagers. It aimed at training villagers on running the installed PV systems.

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## On the Job Training

**Technicians and Locals during Solar PV assembly**

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## On the Job Training

Solar PV Arrays assembled by the trainees

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## On the Job Training

Trainees testing the Solar PV arrays

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## Training of End Users

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## Training of End Users

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# 10-Bill of Quantities

| | No. of systems | Modules (50Wp each) | Support* Structure | | Batteries** (@100Ah) *** | | Controller (200W/12V) | Lighting & Ballast (20W/12V) | Ni-Ca Battery Charger Charger | Vaccine Refrigerator (60W/12V) |
|---|---|---|---|---|---|---|---|---|---|---|
| G1 | 40 | 80 | 20 | 20 | ~ 1 | 40 | 40 | 80 | 40 | × |
| G2 | 20 | 60 | 10 | 10 | ~2 | 40 | 20 | 60 | 20 | × |
| G3 | 10 | 40 | 5 | 5 | ~2 | 20 | 10 | 50 | 10 | × |
| Under C | 10 | 30 | 5 | 5 | ~1 | 10 | 10 | 30 | 10 | × |
| Street | 10 | 20 | 0 | 10 | ~1 | 10 | 10 | 20 | 0 | × |
| Health | 1 | 6 | 1 | 0 | ~3 | 3 | 1 | 4 | 1 | 1 |
| Mosque | 1 | 3 | 1 | 0 | ~2 | 2 | 1 | 5 | 0 | × |
| School | 1 | 3 | 1 | 0 | ~2 | 2 | 1 | 4 | 0 | × |
| Sum | 93 | 242 | 43 | 50 | | 127 | 93 | 253 | 81 | 1 |
| | | | | | | | | | | |
| **Spare Parts** | | 12 | × | × | | 5 | 10 | 20 | 5 | × |
| | | | | | | | | | | |
| **TOTAL** | | 254 | 43 | 50 | | 132 | 103 | 273 | 86 | 1 |

* Pole support structure on 50 ×50×50 cm concrete base.

** No. of batteries required for each system is rounded to the nearest integer. Using capacity smaller than 100Ah is recommended to accommodate the various required capacities. Battery cabinets of suitable structure and size are required for each system

*** During tendering formalities it was decided 47*80AH and 88*110 AH (135 Batteries)

**Total Cost DDU: 192,463 USD**

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# 11-Conclusion

**Impact of the Implementation of the Project**
**The villagers quality of life will be improved through:**

- Raising the health level by the replacement of kerosene lamps for lighting with electric lamps,
- Enhancing the health center to provide vaccination and more services,
- Connecting the villagers with the outside world through the TV & Radio
- Demonstrating the benefits of using natural and clean resources (Solar Energy)
- Cooperation between villagers and concerned stakeholders, and the creation of a villagers' association.

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# Thank You

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