**MOROCCAN STRATEGY OF RENEWABLE ENERGY**

Solar Power as an appropriate means of rural electrification

Beirut, November 27th
SUMMARY

1. MOROCCAN ELECTRICITY FIGURES

2. DEVELOPMENT PERSPECTIVES IN RENEWABLE ENERGY

3. USE OF SOLAR POWER IN RURAL ELECTRIFICATION
### Office National d’Electricité IN FIGURES

<table>
<thead>
<tr>
<th>Category</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Workforces</strong></td>
<td>8,680 employees</td>
</tr>
<tr>
<td><strong>Customers</strong></td>
<td>More than 4.5 million customers</td>
</tr>
<tr>
<td><strong>Turnover</strong></td>
<td>2.1 billion of €</td>
</tr>
</tbody>
</table>
| **Supply-Demand** | - installed Capacity: 6,377 MW  
                    - Demand: 28,752 GWh  
                    - Growth rate of demand: 8.4% in 2011 |
| **Investment**    | 550 million of € |
Balance of Supply-Demand in 2011

ONE Generation
- Capacity: 4,626 MW
- Generation: 11,237 GWh (39%)

IPP Generation
- Capacity: 1,750 MW
- Generation: 12,620 GWh (44%)

Interconnections
- 4,607 GWh (16%)

Auto-generation
- 217 GWh (<1%)

ONE
Single Buyer
Total Demand: 28,7 TWh

Distribution MV/LV
(40%)
10,297 GWh

VHV/HV Direct Customers
(17%)
4,444 GWh

Public and private utilities
(43%)

MV/LV Customers
10,893 GWh
About 6,8% demand average increase.

Resulting from sustained economic and social growth in Morocco:

- Widespread access to electricity (in rural and urban areas);
- Development of major projects across the Kingdom (infrastructures, industry, etc.);
- Improved population standard of living (in particular due to INDH: The National Initiative for Human Development), etc.
Growth of Installed Capacity by 50% highlighting particularly the introduction of natural gas and renewable energy.

<table>
<thead>
<tr>
<th>Energy Type</th>
<th>MW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal Steam Coal</td>
<td>1785</td>
</tr>
<tr>
<td>Thermal Steam Oil</td>
<td>600</td>
</tr>
<tr>
<td>Combined Cycle (Tahaddart)</td>
<td>384</td>
</tr>
<tr>
<td>Solar thermal &amp; Combined Cycle Ain Béni Mathar</td>
<td>470</td>
</tr>
<tr>
<td>Gaz Turbines</td>
<td>1118</td>
</tr>
<tr>
<td>Hydraulic</td>
<td>1306</td>
</tr>
<tr>
<td>Wind</td>
<td>250</td>
</tr>
<tr>
<td>Pump-Turbine</td>
<td>464</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>6377</td>
</tr>
</tbody>
</table>

**Tangier Wind farm**

**Ain Beni Mathar thermo solar power plant**
Transmission Network total length: 20,877 km
- 400 kV: 1,413 km
- 225 kV: 7,920 km
- 150 kV: 147 km
- 60 kV: 11,397 km
Morocco has become a regional crossroads for power exchange between north and south.
MOROCCAN ENERGY STRATEGY

GOALS

1. SECURITY OF SUPPLY
2. WIDESPREAD ACCESS TO ELECTRICITY
3. DEMAND SIDE MANAGEMENT
4. ENVIRONMENTAL PROTECTION ISSUES

STRATEGIC ORIENTATIONS

1. A mix diversified and optimized around a choice of reliable and competitive technologies;
2. Taking advantage of national energy resources by increasing the share of Renewable Energies in the energy mix;
3. Energy efficiency as a national priority;
4. Regional integration.
MOROCCAN SOLAR ENERGY GENERATION PROJECT

- Installed capacity/2020:
  - 2000 MW
  - The Commercial Operation Date of the first solar plant (160 MW CSP): 2015

- Generation:
  - ≈ 4500 Gwh per year

- Estimated investment cost:
  - 9 billions of US$

- Fuel annual save:
  - 1 million of TOE per year

- CO₂ emission avoided:
  - 3.7 millions Tons per year

- MASEN as a lead in the implementation of the solar Project
- ONE as off taker and Transmission System Operator (TSO)
INTEGRATED WIND ENERGY GENERATION PROGRAM

- **Installed capacity/2020**
  - 2000 MW
  - Taza: The first Wind farm (150 MW) under operation in 2014

- **Generation**
  - ≈ 6600 Gwh per year

- **Estimated investment cost**
  - 3.5 billions of US$

- **Fuel annual save**
  - 1,5 million of TOE per year

- **CO₂ emission avoided**
  - 5.6 millions Tons per year

- **ONE as a lead in the implementation of the wind Program**
- Private producers under the RE Law « 13-09 »
- Current Installed Capacity of Wind: 280 MW
ENERGY MIX

2020’s target:

- 42% of installed capacity in renewables;
- Natural gas to mitigate the RE intermittency.

PPP’s as a development model of RE and natural gas projects

<table>
<thead>
<tr>
<th>Source</th>
<th>2010</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal</td>
<td>48%</td>
<td>27%</td>
</tr>
<tr>
<td>Gas</td>
<td>23%</td>
<td>14%</td>
</tr>
<tr>
<td>Fioul-oil</td>
<td>9%</td>
<td>14%</td>
</tr>
<tr>
<td>Fioul</td>
<td>20%</td>
<td>16%</td>
</tr>
<tr>
<td>Hydro</td>
<td>16%</td>
<td>14%</td>
</tr>
<tr>
<td>Wind</td>
<td>3%</td>
<td>14%</td>
</tr>
</tbody>
</table>

2000 MW Wind
2000 MW Hydraulic
2000 MW Solar
12 million citizens have benefited from this program;
Investing more than 20 billion of MAD;
Creating of 100,000 jobs
# Realization planning of the PERG: Location of the villages/MV Network

<table>
<thead>
<tr>
<th>Geographical location</th>
<th>Electrification option</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grouped village located near the MV network</td>
<td>Grid connection</td>
</tr>
<tr>
<td>Dispersed village regardless of the location / MV network</td>
<td>Stand alone PV Kits</td>
</tr>
<tr>
<td>Isolated grouped village, but far from the MV network</td>
<td>Decentralised Grid</td>
</tr>
<tr>
<td>Distant villages with grouped habitat</td>
<td>Grid connection</td>
</tr>
</tbody>
</table>
Homes grouped are connected through the extension of the national grid.

Close grouped homes are directly connected to the distribution network with no extension.

Scattered homes require PV.

Homes grouped but located in far areas require decentralized networks (PVs, …).
THE PROGRAM’S SCHEDULE

- Rural electrification via the power grid should cover 38,200 homes by 2014 according to the following schedule:
  - 1996-2002: Step 1 and Step 2 (Cost/Home <= 10 000 DH) RER*: 55%
  - 2002-2004: Step 3 (Cost/Home <= 14 000 DH) RER: 72%
  - 2004-2006: Step 4-1st part (Cost/Home <= 20 000 DH) RER: 87%
  - 2006-2014: Step 4-2nd part (Cost/Home <= 27 000 DH) RER: 99%

- Rural electrification via PV has enabled us to electrify 3,663 homes so far.

*: RER stands for Rural Electrification Rate
**Decentralised rural electrification**

- The decentralized Electrification concerns villages with dispersed habitats which connection cost is high.

- **Used Techniques:**
  - Photovoltaic systems (stand alone PV systems);
  - Micro hydro-electric power stations;
  - Diesel engine.

- **150,000 households in 6000 villages** are eligible to be Electrified by PV systems, practically **7% of rural households**.
The current achievements for photovoltaic option are mainly based on a Fee For Service approach:

- **Objectives of FFS approach:**
  - Accelerate the achievements;
  - Ensure a sustainable service, adapted and with lower cost;
  - Involvement of the private sector.

- **Services provider ensures:**
  - Identification and sensitization of the potential customers;
  - Supply and installation of all equipment;
  - After sale service and renewal of the material under guarantee during 10 years;
  - Advances and monthly payments collect during 10 years;
  - Intervention in less than 48 hours in case of breakdown;
  - Recycling of the batteries.

- **ONE is the owner of equipment during 10 years**

- **Environmental aspect:** Collection and recycling of batteries are the responsibility of the service provider.
**Fee For Service Contract**

**ONE** ➔ Grants subsidies + Monitors

**Customer** ➔ Cash advance + monthly payments/ 10 years

- From a technical standpoint, two systems are proposed to the customer:
  - 75 Wc for lighting and audiovisual applications;
  - 200 Wc for lighting, audiovisual applications and refrigeration.

- The financial package for Fee For Service includes participation by ONE according to the system installed (75 or 200 Wc), payable to the service provider after completion and commissioning of the installation.

- The beneficiary household participates by payment to the services provider of an advance upon taking out of a subscription and monthly payments over a period of 10 years.


<table>
<thead>
<tr>
<th>Transaction – 1 –</th>
<th>Sizes available</th>
<th>Customer’s part (US$)</th>
<th>ONE’s subsidy (US$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓ 16,000 units;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>✓ Start up in 2002;</td>
<td>- 50 Wc,</td>
<td>- 82+ 7,5/month</td>
<td>635</td>
</tr>
<tr>
<td></td>
<td>- 75 Wc,</td>
<td>- 212 + 11/month</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- 100 Wc.</td>
<td>- 365+15/month</td>
<td></td>
</tr>
<tr>
<td></td>
<td>82+ 7.5/month</td>
<td>- 212 + 11/month</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- 365+15/month</td>
<td>- 365+15/month</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Transaction – 2 –</th>
<th>Sizes available</th>
<th>Customer’s part (US$)</th>
<th>ONE’s subsidy (US$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓ 12,000 units;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>✓ Start up in 2003;</td>
<td>- 50 Wc,</td>
<td>- 82+ 7,5/month</td>
<td>425 to 1725 depending upon the system</td>
</tr>
<tr>
<td></td>
<td>- 75 Wc,</td>
<td>- 212 + 11/month</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- 200 Wc.</td>
<td>- 590 +27/month</td>
<td></td>
</tr>
<tr>
<td></td>
<td>82+ 7.5/month</td>
<td>- 212 + 11/month</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- 590 +27/month</td>
<td>- 590 +27/month</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Transaction – 3 –</th>
<th>Sizes available</th>
<th>Customer’s part (US$)</th>
<th>ONE’s subsidy (US$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓ 37,000 units;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>✓ Start up in 2004;</td>
<td>-75 Wc,</td>
<td>- 106+ 7,5/month</td>
<td>645</td>
</tr>
<tr>
<td></td>
<td>- 200 Wc.</td>
<td>- 470+ 18/month</td>
<td>1290</td>
</tr>
<tr>
<td></td>
<td>106+ 7.5/month</td>
<td>- 470+ 18/month</td>
<td></td>
</tr>
<tr>
<td></td>
<td>470+ 18/month</td>
<td>- 470+ 18/month</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Transaction – 4 –</th>
<th>Sizes available</th>
<th>Customer’s part (US$)</th>
<th>ONE’s subsidy (US$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓ 40,000 units;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>✓ Start up in 2005;</td>
<td>-75 Wc,</td>
<td>- 106+ 7,5/month</td>
<td>645</td>
</tr>
<tr>
<td></td>
<td>- 200 Wc.</td>
<td>- 470+ 18/month</td>
<td>1290</td>
</tr>
<tr>
<td></td>
<td>106+ 7.5/month</td>
<td>- 470+ 18/month</td>
<td></td>
</tr>
<tr>
<td></td>
<td>470+ 18/month</td>
<td>- 470+ 18/month</td>
<td></td>
</tr>
</tbody>
</table>

51,559 homes have been provided with PV under “Fee For Service” contracts
Thank you for your attention