# VOL.I CHAPTER 3
# BASE SURVEY

# *CHAPTER 3 BASE SURVEY*

## 3.1 Natural Conditions in the Study Area and Need for Decentralized Electrification

Haouz Region extends to the south of Marrakech city, and measures 160 km east~west and 60 km north~south. Land area of the Haouz Province is 6,231 km² with population in 1994 of 434,810 persons comprising 67,444 households. The provincial government office is located in Tahanaout.

The target of the subject Study is in principal 120 unelectrified villages which are not candidates for connection to the existing grid. These villages have a population of 45,556 comprising 7,272 households. The Haut Atlas range with 3,000 m class peaks (highest peak is Toubkal at 4,167 m) runs along the southern periphery of the area. Moving northward, the topography of the area alters to piedmont and hills, ultimately opening up on the Haouz Plain (500~600 m). The target Study villages are scattered in this area of varying topography.

The Amizmiz, Rheraya, N'fis, Ourika, Zat rivers, etc. flow northward from their headwaters in the Haut Atlas to join the Tensift river, which empties into the Atlantic Ocean. The majority of the Study villages are scattered along these tributaries, which are the site as well of the micro-hydropower sites selected under the Study. Rainfall in the Study area is highest at 600~800 mm in the mountainous region in the south, and gradually decreases moving northward (300~400 mm in the plain region).

As topography becomes more rugged, access to villages deteriorates to only foot paths and distance from the existing grid increases making decentralized electrification necessary.

In the target villages, television use rate is 52% (powered by car battery) and illumination rate by butane gas is 56%. The above described topographical conditions render battery recharge and fuel supply an extremely laborious effort. Also, in order to obtain fuel wood for energy, villagers engage in unmanaged tree felling which poser the danger of natural environment degradation.

In this Report, the "Haouz Region" is used to designate the area in terms of development concept, while "Haouz Province" indicates the administrative unit pertaining to the area.

## 3.2 Survey of Natural Conditions

### 3.2.1 Meteorology as Indicated by Existing Data

In the basin of the main tributaries there exits some meteorological synoptic posts. Since the whereabouts of their data record could not be accounted for, the data obtained from Meteorological Station in Marrakech, which has relatively long-term observation records, was used as base data to comprehend the general meteorological conditions of the Study area. This was supplemented by rainfall data collected at selected appropriate observation points. (see Table 3.2-1)

(1) Climate of the Study Area

The rolling plain between the Haut Atlas and the Atlantic Ocean lies in the Mediterranean Climatic Zone: with hot and dry summer and mild winter with much precipitation. Marrakech is situated further inland and exhibits a continental climate with Mediterranean undertone. Mean daily temperature ranges from 11.8 °C in January to 29.2 °C in July, maximum temperature from 18.4 °C (January) to 37.7 °C in July, minimum temperature from 5.3 °C (January) to 20.8 °C (July), relative humidity from 40.9% (July) to 58.5% (January), sunlight hours from 197.8 hr (February) to 324.6 hr (June), and rainfall from 1.8mm (June) to 52.7mm (March). Fog occurs predominantly in the winter, while lightning occurs most in March~April and July~October. (Table 3.2.1 and Figure 3.2.2 indicate general meteorological characteristics of Marrakech.)

Although Marrakech is located in relatively low piedmont of the Atlas range, the Study area is almost all higher mountain terrain. Accordingly, meteorological conditions are more severe than that of Marrakech, particularly with regard to low temperatures and heavy snow in the winter.

(2) Precipitation

Daily rainfall record and isohyetal map were collected to study flood discharge and spatial characteristics of precipitation. Daily rainfall data for 15 years (1980/81 - 1994/95) were collected for 5 observation stations in the Study area. As evident from the data the hydrological year of the study area is from September to August of the following year. Annual precipitation values are summarized in the table below. Average annual rainfall in the study area for the 5 observation stations ranges from 192 to 489 mm. These values are somewhat lower than those of the isohyetal map (Figure 3.2-3). Except for Aghbalou which generally agrees with the foregoing, all of the posts lie within the 400-500 isohyetal belt on the isohyetal map.

About 70-80% of the precipitation happens during the period from November to April. The dry period from June to September receive only 7-9% of rainfall.

*Annual Rainfall of the Main Basins*

*Unit:(mm)*

| Station | Taferiat | Aghbalou | Tahanaout | Ignir N'Kouris | Imin El Hammam |
|---|---|---|---|---|---|
| 1980/81 | 273 | 408 | 395 | 191 | 271 |
| 1981/82 | 405 | 582 | 411 | 189 | -- |
| 1982/83 | -- | 315 | -- | 115 | -- |
| 1983/84 | 277 | 376 | 312 | 157 | 288 |
| 1984/85 | 388 | 552 | 396 | 281 | 379 |
| 1985/86 | -- | 468 | 647 | 123 | -- |
| 1986/87 | -- | 314 | 280 | 140 | 230 |
| 1987/88 | -- | 595 | 365 | 304 | 470 |
| 1988/89 | -- | 681 | 545 | -- | 365 |
| 1989/90 | 286 | 438 | -- | -- | 296 |
| 1990/91 | 474 | 829 | 462 | 177 | 373 |
| 1991/92 | 292 | 487 | 361 | 340 | 398 |
| 1992/93 | 238 | 277 | 193 | 84 | 226 |
| 1993/94 | -- | 648 | -- | -- | -- |
| 1994/95 | 396 | 359 | -- | 208 | 310 |
| Average | 337 | 489 | 397 | 192 | 328 |

-- Month with missing data (observation months per year extend from September to August of the following year)

The tables below exhibit the exceedance (for flood prevention) and non-exceedance (for water resource planning) probability analysis of annual rainfall for 5-100 years return period.

*Exceedance Probability Analysis*

*Unit:(mm)*

| Return Period | 5yrs | 10yrs | 30yrs | 50yrs | 100yrs |
|---|---|---|---|---|---|
| Taferiat | 399 | 447 | 517 | 548 | 591 |
| Aghbalou | 705 | 845 | 1067 | 1172 | 1321 |
| Tahanaout | 481 | 544 | 631 | 669 | 718 |
| Ignir N'kouris | 244 | 285 | 347 | 375 | 412 |
| Imin El Hammam | 426 | 483 | 564 | 599 | 646 |

*Non-exceedance Probability Analysis*

*Unit.(mm)*

| Return Period | 5yrs | 10yrs | 30yrs | 50yrs | 100yrs |
|---|---|---|---|---|---|
| Taferiat | 269 | 245 | 220 | 211 | 201 |
| Aghbalou | 377 | 327 | 277 | 260 | 242 |
| Tahanaout | 290 | 250 | 206 | 189 | 170 |
| Ignir N'kouris | 129 | 108 | 85 | 77 | 68 |
| Imin El Hammam | 261 | 228 | 192 | 179 | 164 |

Figure 3.2-4 shows the chart for mean monthly precipitation of the gauging stations.

### 3.2.2 Temperature and Rainfall Estimates

The meteorological observation stations on the northern slope of the Haut Atlas range to the south of Marrakech are almost all located below 2,000 m elevation, have only sparse data, and carry out no observations other than for rainfall and temperature. The records for these stations showed numerous time gaps, were low in reliability and included no data on snowfall. They were subsequently deemed inappropriate for planning under the Study. Although snowfall does occur at elevations around 1,000 m, villages which become snowbound as a result of snowfall over several months are located above 2,000 m elevation.

No existing data is available for the target micro-hydropower scheme areas. To address this, average temperatures and rainfall amounts for the Project area was estimated by extrapolating from records available at the Marrakech observation station. This was done by applying the trend that temperatures gradually drop and rainfall conversely is greater as elevation increases.

(1) Temperature

Due to the fact that data is sparse for observation stations at elevations corresponding to that of the Project area, mean monthly temperatures were estimated according the formula below for 5 existing gauging stations and 7 micro-hydropower scheme areas (of which 3 were the subject of survey at the Pre-Feasibility Study stage). Results of this estimation are shown in Figure 3.2-5 and 3.2-6).

Assuming temperature drop rate to be -0.6 °C / 100 m, $T = -0.6 \times (H-HM)/100 + TM$, where H = target site elevation, TM = temperature at Marrakech and HM = elevation at Marrakech.

Since the 5 existing gauging stations are at higher elevation than Marrakech, mean monthly temperatures are lower. The target 7 micro-hydropower sites are located at even higher elevation than the foregoing 5 existing stations. With the exception of Inzaine, temperatures in January drop below 0° C.

(2) Precipitation

Since the micro-hydropower scheme sites are at points of high elevation of the Haut Atlas piedmont, observation data is almost non-existent as in the case of other general meteorological data. Assuming that a straight line proportional relation exists between rainfall and elevation up to a certain altitude, rainfall amount was calculated according to the formula $R = aH + b$. In order to calculate proportional coefficients a and b, annual rainfall and elevation data for 4 existing gauging stations was applied. Data for Iguir N'kouris was eliminated due to poor correlation with that of the other stations. Also, data at the Asni, Ait Ourir an Tlat N'Yacoub gauging stations was eliminated due to poor reliability. The periods covered by the data from these were extremely limited, and showed poor correlation with that of the other stations.

Study was made for 4 cases of hydrological years 1980~81, 1983~84, 1990~91 and annual mean rainfall. The hydrological years were selected on the basis of the fact that each of the 4 gauging stations had complete records for these years. As shown in Figure 3.2-7, the data for the said existing stations indicates a straight line proportional relationship between rainfall and elevation, with $R^2 = 0.79 \sim 0.98$.

Applying the proportional relationship calculated as per above, annual mean rainfall at each micro-hydropower site was computed (Table 3.2-2). With the exception of the 3 sites (Id Ssiar, Alla Oumzri and Adardour) located in the Amizmiz and N'fis catchments, the annual mean rainfall amounts calculated according to formula (4) in the table show relatively good correspondence with the isohyetal map, with estimated values being around 1.0~1.2 fold that of the map. In the case of the Amizmiz and N'fis catchments, estimated values are around 1.4~1.8 fold that of the map. It can be seen from the isohyetal map as well that the rainfall impact due to the mountain topography of the basins is different than that for the other catchments.

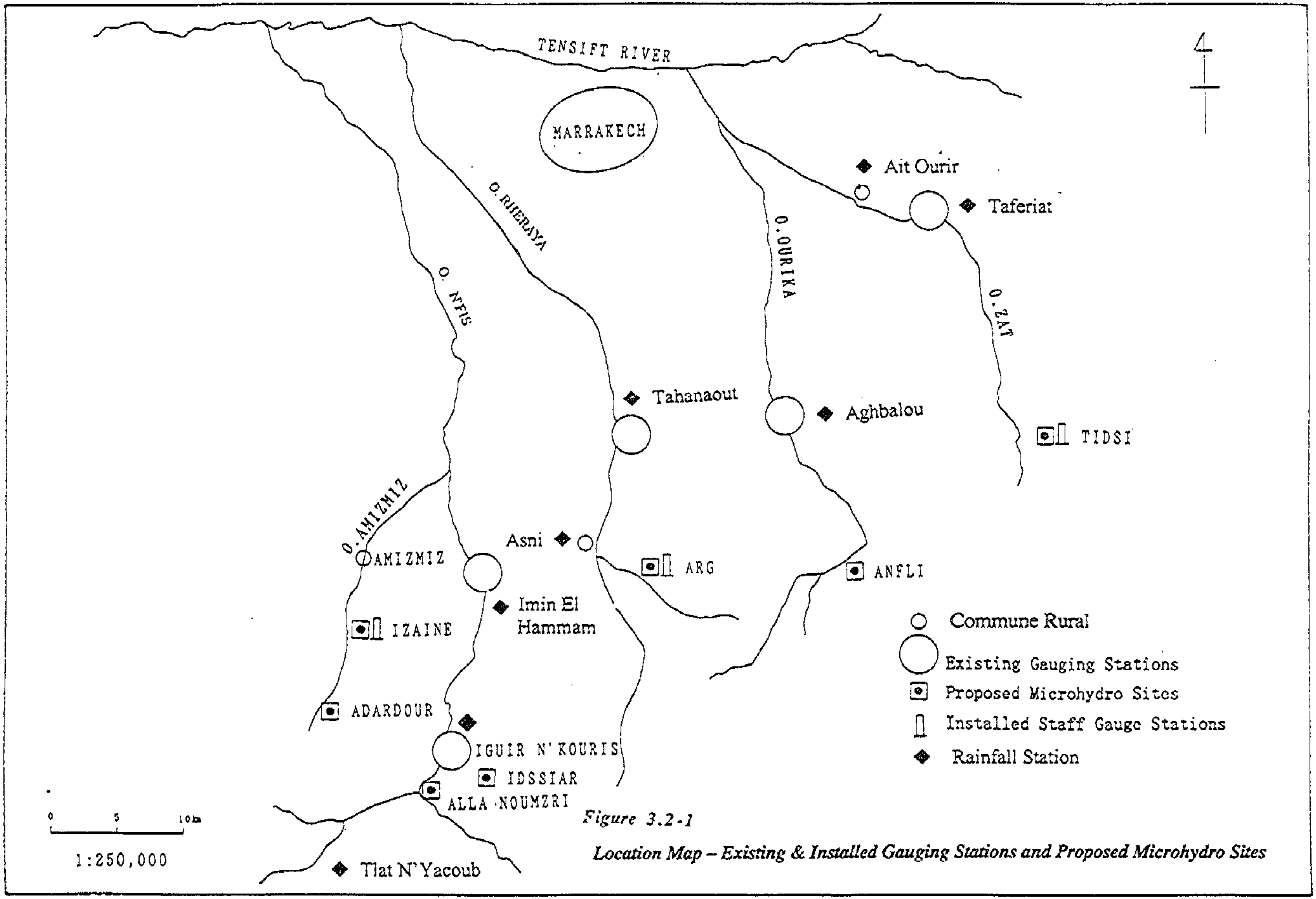



*Figure 3.2-1*

***Location Map – Existing & Installed Gauging Stations and Proposed Microhydro Sites***

*Table 3.2-1* ***Meteorological Data – Marrakech 1984-1991***

a)Mean monthly temperature, humidity, sunshine and precipitation - Marrakech (08° 02'W, 31° 37'N, 463.53m)

| Month | Temperature ℃ | | | | | Humidity (%) | Sunshine hour | Precipitation | |
|---|---|---|---|---|---|---|---|---|---|
| | Maximum | | Minimum | | Mean | | | (mm) | days |
| | Mean max | Extreme | Mean min | Extreme | | | | | |
| Jan | 18.4 | 23.4 | 5.3 | 1.4 | 11.8 | 58.5 | 228.8 | 32.3 | 5.8 |
| Feb | 20.1 | 27.7 | 7.7 | 3.4 | 13.9 | 57.9 | 197.8 | 33.8 | 6.4 |
| Mar | 22.6 | 30.0 | 9.6 | 5.7 | 16.1 | 52.5 | 254.6 | 52.7 | 5.6 |
| Apr | 24.5 | 32.2 | 11.3 | 7.2 | 17.9 | 51.6 | 275.7 | 15.5 | 5.3 |
| May | 27.4 | 36.0 | 13.8 | 10.2 | 20.6 | 48.4 | 297.6 | 9.5 | 3.1 |
| Jun | 32.2 | 38.8 | 16.4 | 13.3 | 24.3 | 48.0 | 324.6 | 6.0 | 0.9 |
| Jul | 37.7 | 43.9 | 20.8 | 16.3 | 29.2 | 40.9 | 318.5 | 1.8 | 1.6 |
| Aug | 37.2 | 43.9 | 21.0 | 16.7 | 29.1 | 40.9 | 308.3 | 3.8 | 1.3 |
| Sep | 33.7 | 41.5 | 19.3 | 15.2 | 26.5 | 43.1 | 253.6 | 5.6 | 1.9 |
| Oct | 27.3 | 33.4 | 14.9 | 11.1 | 21.1 | 50.9 | 250.6 | 14.0 | 3.8 |
| Nov | 22.6 | 29.7 | 11.2 | 5.6 | 16.9 | 55.5 | 229.4 | 37.3 | 6.8 |
| Dec | 19.7 | 25.7 | 7.4 | 2.5 | 13.6 | 57.0 | 223.1 | 16.9 | 4.8 |
| Total | | | | | | | 3162.7 | 229.3 | 47.0 |
| Average | 26.9 | | 13.2 | | 20.1 | 50.4 | 263.6 | | |
| Maximum | | 43.9 | | | | 58.5 | 324.6 | 52.7 | 6.8 |
| Minimum | | | | 1.4 | | 40.9 | 197.8 | 1.8 | 0.9 |

Note: Temperature averaged over 1984-1991

**Average occurrence of thunderstorm, mist/fog and hail – Marrakech(1986-1995)**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Thunderstorm | 0.1 | 0.7 | 1.8 | 1.6 | 0.5 | 0.7 | 2.5 | 1.7 | 1.3 | 1.5 | 0.4 | 0.3 | 13.1 |
| Mist / fog | 1.5 | 1.6 | 1.8 | 0.5 | 0.6 | 0.2 | 0.0 | 0.1 | 0.3 | 0.8 | 1.6 | 1.9 | 10.9 |
| Hail | 0.0 | 0.0 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.1 | 0.4 |

Mean monthly temperature, humidity, sunshine and precipitation
(08° 02'W, 31° 37'N, 463.53m)

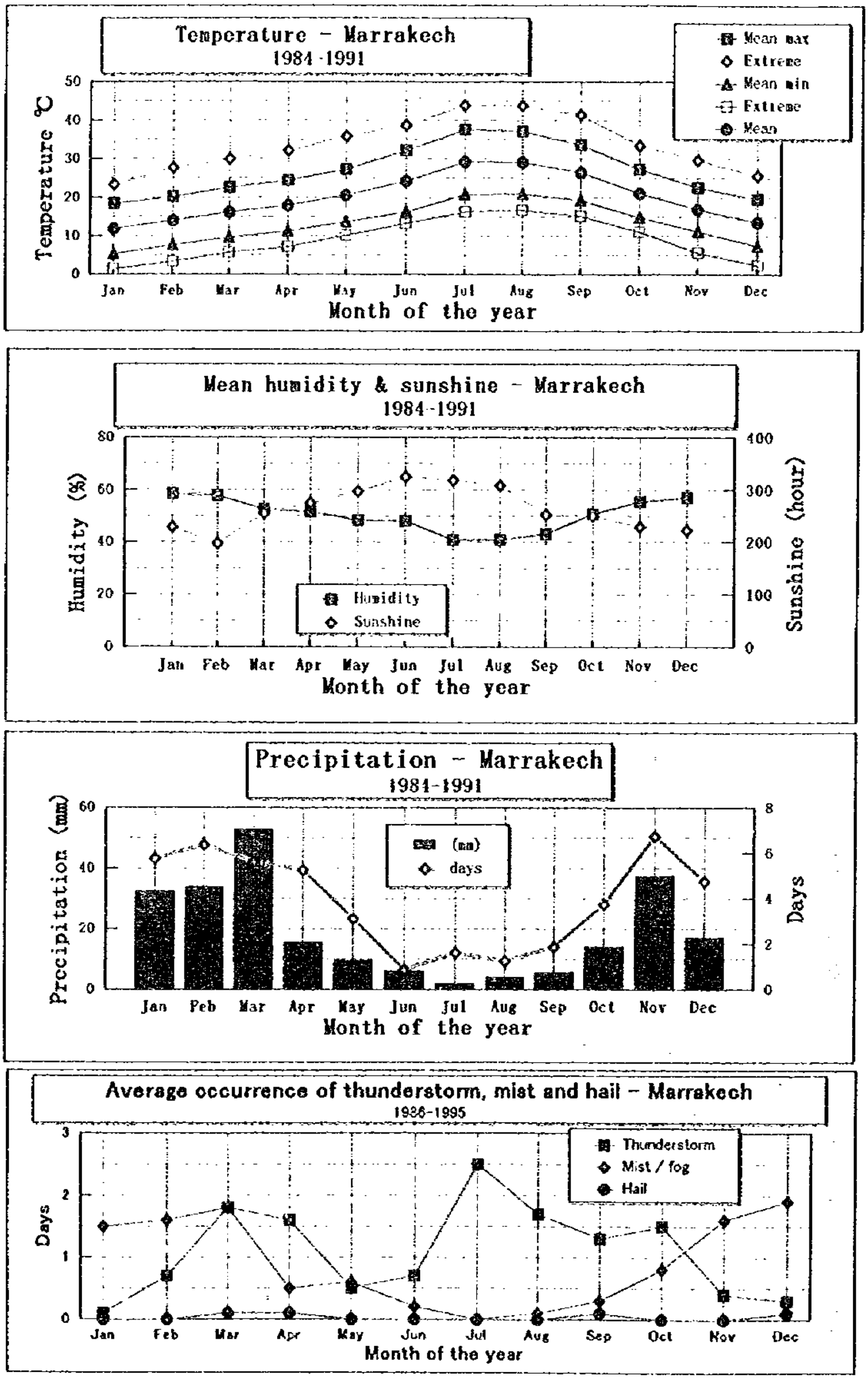



*Figure 3.2-2 Meteorological Chart – Marrakech*

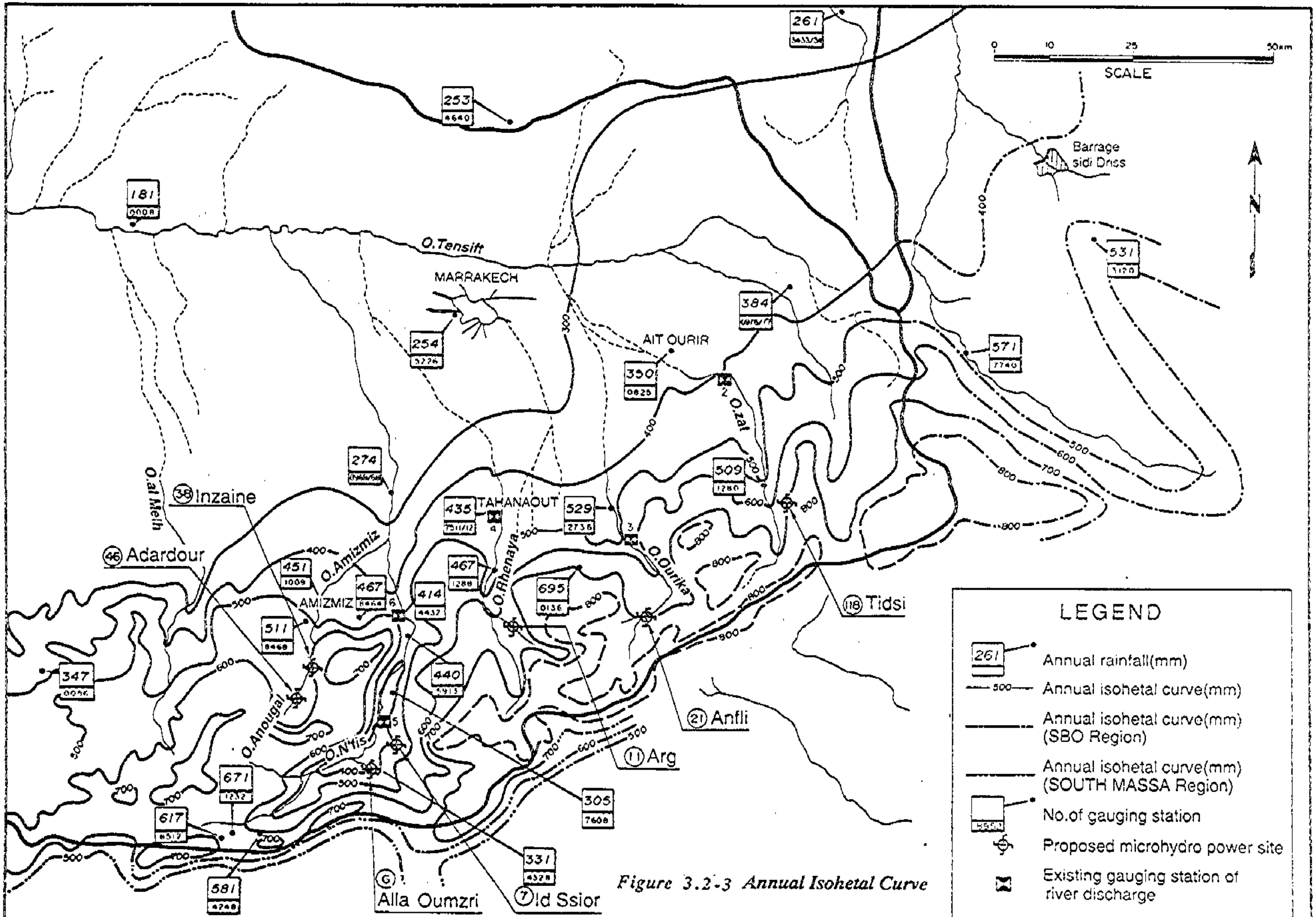
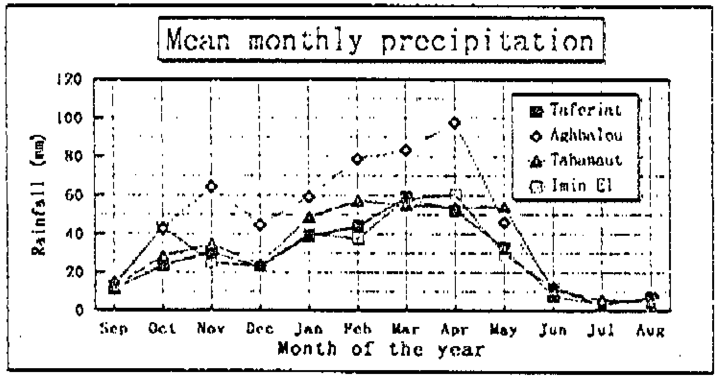



*Figure 3.2-3 Annual Isohetal Curve*

Source:CLIMATOLOGIE PLUVIOMETRIE ISOYETES ANNUELLES(1935/36 à 1984/85)/ADMINISTRATION DE L'HYDRAUTIQUE

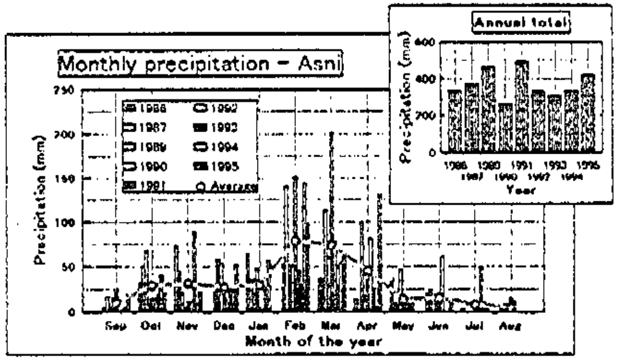
Mean monthly precipitation at gauging station




Monthly precipitation – Asni 31° 5'N 008° 0'W 1200 m

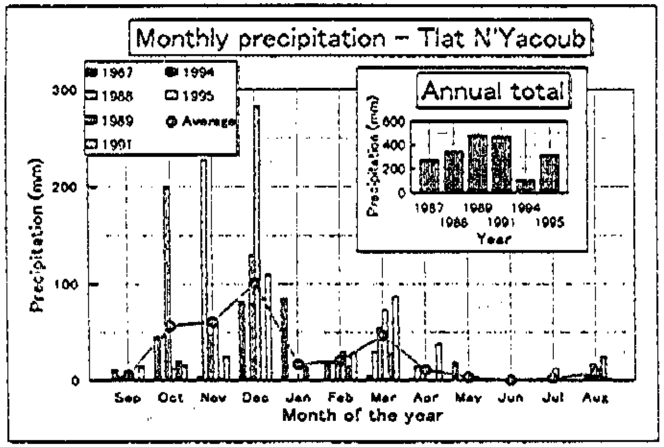
Unit (mm)

| | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1986 | 5.0 | 32.0 | 72.3 | 0.0 | 65.0 | 53.0 | 37.0 | 14.0 | 38.5 | 19.5 | 3.5 | 0.0 | 327.8 |
| 1987 | 17.0 | 50.4 | 44.5 | 21.7 | 33.8 | 140.0 | 30.0 | 0.0 | 10.0 | 23.5 | 0.0 | 4.7 | 375.1 |
| 1989 | 4.0 | 68.0 | 21.0 | 58.0 | 35.5 | 51.7 | 113.5 | 98.0 | 3.0 | 0.0 | 0.0 | 8.0 | 402.6 |
| 1990 | 16.0 | 0.0 | 4.5 | 54.0 | 48.0 | 0.0 | 60.1 | 16.7 | 46.5 | 19.0 | 0.0 | 0.0 | 264.8 |
| 1991 | 25.2 | 14.5 | 11.7 | 22.0 | 1.0 | 151.5 | 201.8 | 35.8 | 4.0 | 8.0 | 0.0 | 18.0 | 491.5 |
| 1992 | 0.0 | 14.5 | 11.0 | 12.5 | 0.0 | 45.5 | 78.2 | 80.8 | 10.7 | 60.5 | 8.0 | 12.0 | 333.7 |
| 1993 | 2.0 | 19.5 | 89.0 | 28.5 | 27.0 | 29.6 | 30.7 | 25.5 | 8.5 | 0.0 | 48.5 | 0.0 | 307.3 |
| 1994 | 5.0 | 40.1 | 8.5 | 0.0 | 56.8 | 143.7 | 54.4 | 5.0 | 9.5 | 0.0 | 10.0 | 0.0 | 333.1 |
| 1995 | 18.8 | 21.2 | 22.5 | 52.3 | 0.0 | 99.6 | 81.0 | 130.0 | 0.0 | 13.0 | 3.7 | 0.0 | 422.2 |
| Average | 10.3 | 28.9 | 31.7 | 27.4 | 29.7 | 79.4 | 74.0 | 45.4 | 14.3 | 15.9 | 8.2 | 4.5 | 388.8 |




Monthly precipitation – Tlat N'Yacoub 31° 0'N 008° 2'W 1400 m

| | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1987 | 11 | 45 | 4 | 82 | 85 | 19 | 5 | 2 | 18 | 0 | 0 | 0 | 271 |
| 1988 | 4 | 45 | 228 | 2 | 0 | 18 | 29 | 14 | 0 | 0 | 0 | 4 | 344 |
| 1989 | 0 | 201 | 47 | 131 | 0 | 16 | 55 | 14 | 0 | 0 | 2 | 17 | 482 |
| 1991 | 3 | 12 | 60 | 283 | 0 | 29 | 73 | 0 | 0 | 0 | 12 | 0 | 472 |
| 1994 | 0 | 20 | 2 | 0 | 14 | 14 | 27 | 0 | 0 | 0 | 0 | 24 | 100 |
| 1995 | 14 | 15 | 24 | 110 | 0 | 28 | 87 | 37 | 0 | 0 | 0 | 1 | 316 |
| Average | 5.3 | 56.3 | 60.8 | 101.2 | 16.4 | 20.6 | 45.9 | 11.1 | 3.0 | 0.0 | 2.3 | 7.7 | 330.6 |




Monthly precipitation – Ait Ourir

Unit (mm)

| | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1986 | 0.3 | 31 | 52 | 0 | 62 | 37 | 32 | 11 | 31 | 63 | 6.7 | 0 | 326 |
| 1987 | 2.5 | 25 | 35 | 38 | 26 | 64 | 26 | 3.9 | 0 | 4.8 | 0 | 0 | 226 |
| 1990 | 8.4 | 2.8 | 4.9 | 36 | 29 | 0 | 62 | 9.6 | 26 | 3.8 | 2.7 | 0 | 185 |
| Average | 4 | 20 | 30 | 25 | 39 | 34 | 40 | 8 | 19 | 24 | 3 | 0 | 246 |

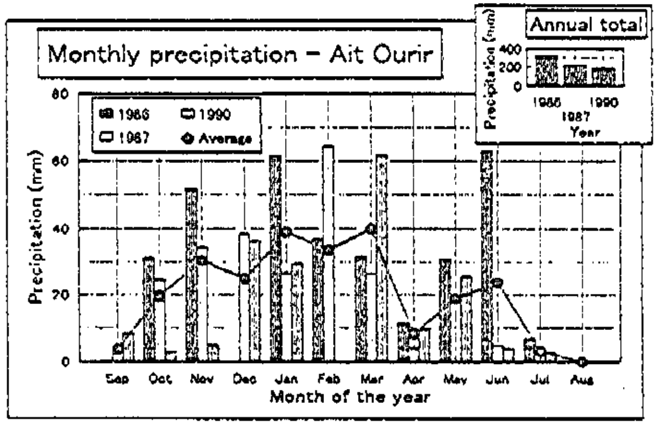



*Figure 3.2-4 Mean Monthly Precipitation of the Gauging Stations*

Estimated Temperature - Existing Hydrological Stations

| Station | Marrakech | Taferiat | Aghbalou | Tahanaout | Ignir N'Kouris | Imin El Hammam |
|---|---|---|---|---|---|---|
| Altitude (m) | 463.53 | 760 | 1,070 | 925 | 1,100 | 770 |
| Month | Mean Maximum Temperature | | | | | |
| Jan | 18.4 | 16.6 | 14.7 | 15.6 | 14.5 | 16.5 |
| Feb | 20.1 | 18.4 | 16.5 | 17.4 | 16.3 | 18.3 |
| Mar | 22.6 | 20.9 | 19.0 | 19.9 | 18.8 | 20.8 |
| Apr | 24.5 | 22.7 | 20.9 | 21.7 | 20.7 | 22.7 |
| May | 27.4 | 25.6 | 23.7 | 24.6 | 23.6 | 25.5 |
| Jun | 32.2 | 30.4 | 28.6 | 29.4 | 28.4 | 30.4 |
| Jul | 37.7 | 35.9 | 34.0 | 34.9 | 33.8 | 35.8 |
| Aug | 37.2 | 35.4 | 33.6 | 34.5 | 33.4 | 35.4 |
| Sep | 33.7 | 31.9 | 30.0 | 30.9 | 29.9 | 31.8 |
| Oct | 27.3 | 25.5 | 23.7 | 24.5 | 23.5 | 25.5 |
| Nov | 22.6 | 20.8 | 19.0 | 19.8 | 18.8 | 20.8 |
| Dec | 19.7 | 17.9 | 16.0 | 16.9 | 15.9 | 17.8 |
| Month | Mean Minimum Temperature | | | | | |
| Jan | 5.3 | 3.5 | 1.7 | 2.6 | 1.5 | 3.5 |
| Feb | 7.7 | 5.9 | 4.1 | 4.9 | 3.9 | 5.9 |
| Mar | 9.6 | 7.8 | 6.0 | 6.9 | 5.8 | 7.8 |
| Apr | 11.3 | 9.5 | 7.7 | 8.5 | 7.5 | 9.5 |
| May | 13.8 | 12.0 | 10.1 | 11.0 | 9.9 | 11.9 |
| Jun | 16.4 | 14.6 | 12.7 | 13.6 | 12.5 | 14.5 |
| Jul | 20.8 | 19.0 | 17.2 | 18.0 | 17.0 | 19.0 |
| Aug | 21.0 | 19.2 | 17.3 | 18.2 | 17.1 | 19.1 |
| Sep | 19.3 | 17.5 | 15.7 | 16.6 | 15.5 | 17.5 |
| Oct | 14.9 | 13.1 | 11.2 | 12.1 | 11.1 | 13.0 |
| Nov | 11.2 | 9.4 | 7.5 | 8.4 | 7.4 | 9.3 |
| Dec | 7.4 | 5.6 | 3.8 | 4.7 | 3.6 | 5.6 |
| Month | Mean Temperature | | | | | |
| Jan | 11.8 | 10.1 | 8.2 | 9.1 | 8.0 | 10.0 |
| Feb | 13.9 | 12.1 | 10.3 | 11.1 | 10.1 | 12.1 |
| Mar | 16.1 | 14.4 | 12.5 | 13.4 | 12.3 | 14.3 |
| Apr | 17.9 | 16.1 | 14.3 | 15.1 | 14.1 | 16.1 |
| May | 20.6 | 18.8 | 16.9 | 17.8 | 16.7 | 18.7 |
| Jun | 24.3 | 22.5 | 20.6 | 21.5 | 20.5 | 22.4 |
| Jul | 29.2 | 27.5 | 25.6 | 26.5 | 25.4 | 27.4 |
| Aug | 29.1 | 27.3 | 25.5 | 26.3 | 25.3 | 27.3 |
| Sep | 26.5 | 24.7 | 22.9 | 23.7 | 22.7 | 24.7 |
| Oct | 21.1 | 19.3 | 17.5 | 18.3 | 17.3 | 19.3 |
| Nov | 16.9 | 15.1 | 13.2 | 14.1 | 13.1 | 15.0 |
| Dec | 13.6 | 11.8 | 9.9 | 10.8 | 9.7 | 11.7 |

Note: Temperature gradation is taken to be 0.6 °C/100m
Temperature of existing hydrological stations were estimated with data of Marrakech

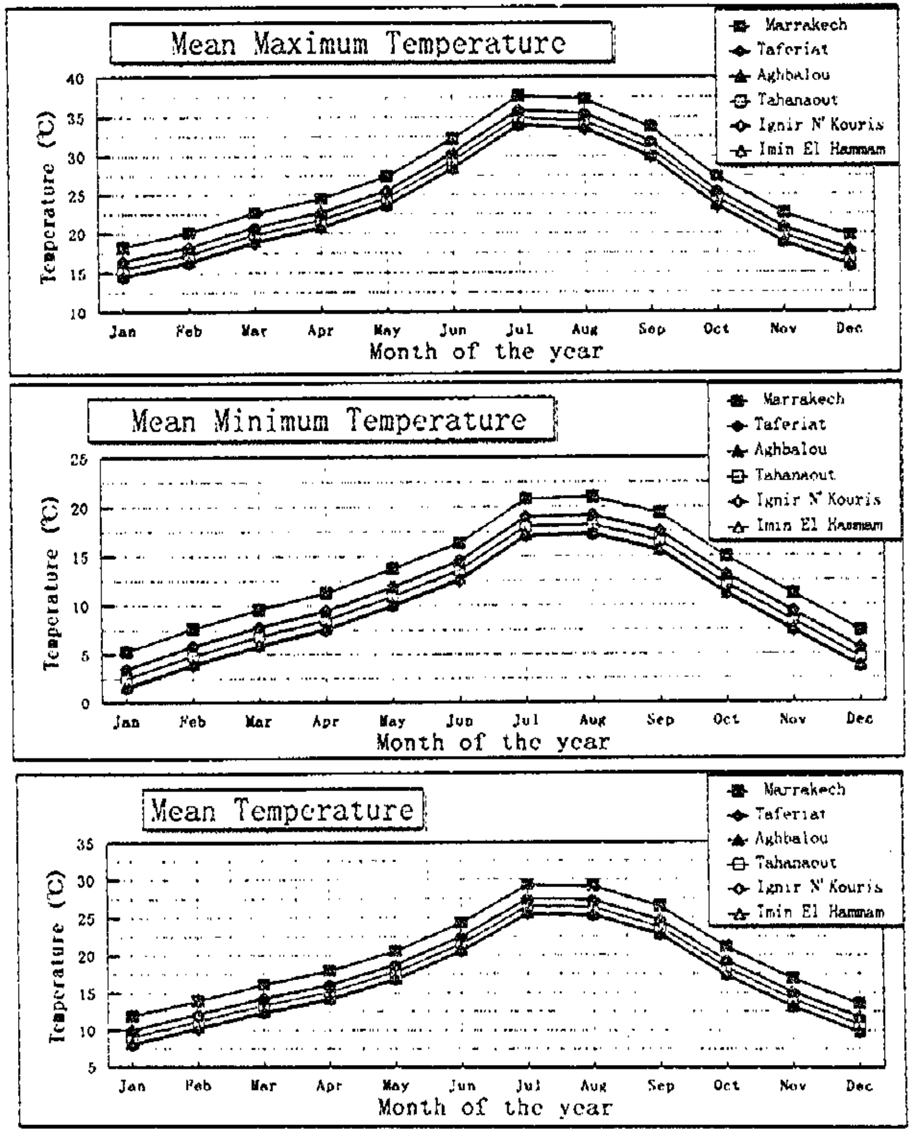
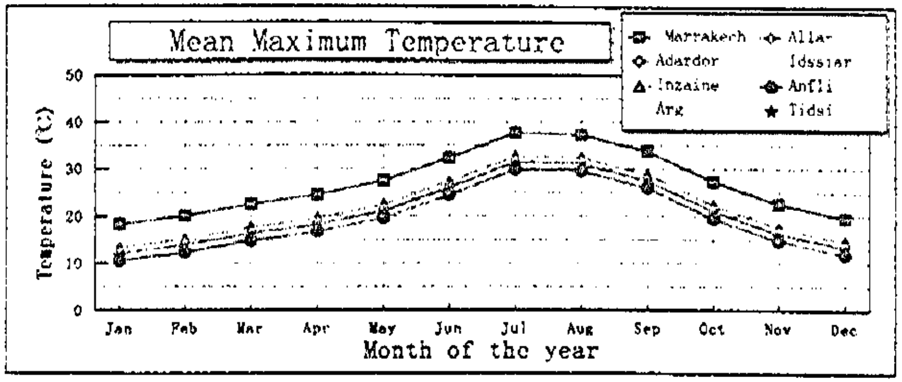


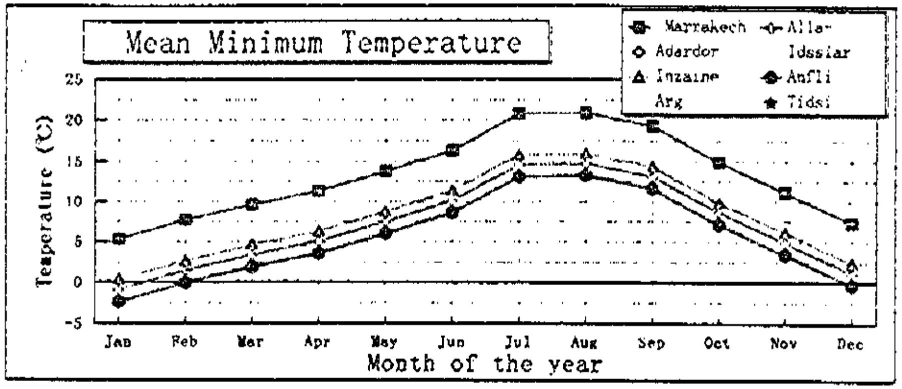

*Figure 3.2-5 Estimated Temperature – Existing Hydrological Stations*

Estimated Temperature - Microhydro Potential Sites

| Station | Marrakech | Adardour | Inzaine | Arg | Alla-Youmzri | Idssiar | Anfli | Tidsi |
|---|---|---|---|---|---|---|---|---|
| Altitude(m) | 463.53 | 1,770 | 1,300 | 1,525 | 1,500 | 1,700 | 1,750 | 1,725 |
| Month | Mean Maximum Temperature | | | | | | | |
| Jan | 18.4 | 10.5 | 13.3 | 12.0 | 12.1 | 10.9 | 10.6 | 10.8 |
| Feb | 20.1 | 12.3 | 15.1 | 13.8 | 13.9 | 12.7 | 12.4 | 12.6 |
| Mar | 22.6 | 14.8 | 17.6 | 16.3 | 16.4 | 15.2 | 14.9 | 15.1 |
| Apr | 24.5 | 16.7 | 19.5 | 18.1 | 18.3 | 17.1 | 16.8 | 16.9 |
| May | 27.4 | 19.5 | 22.4 | 21.0 | 21.2 | 20.0 | 19.7 | 19.8 |
| Jun | 32.2 | 24.4 | 27.2 | 25.8 | 26.0 | 24.8 | 24.5 | 24.6 |
| Jul | 37.7 | 29.8 | 32.6 | 31.3 | 31.4 | 30.2 | 29.9 | 30.1 |
| Aug | 37.2 | 29.4 | 32.2 | 30.9 | 31.0 | 29.8 | 29.5 | 29.7 |
| Sep | 33.7 | 25.8 | 28.7 | 27.3 | 27.5 | 26.3 | 26.0 | 26.1 |
| Oct | 27.3 | 19.5 | 22.3 | 20.9 | 21.1 | 19.9 | 19.6 | 19.7 |
| Nov | 22.6 | 14.8 | 17.6 | 16.2 | 16.4 | 15.2 | 14.9 | 15.0 |
| Dec | 19.7 | 11.8 | 14.7 | 13.3 | 13.5 | 12.3 | 12.0 | 12.1 |
| Month | Mean Minimum Temperature | | | | | | | |
| Jan | 5.3 | -2.5 | 0.3 | -1.0 | -0.9 | -2.1 | -2.4 | -2.2 |
| Feb | 7.7 | -0.1 | 2.7 | 1.3 | 1.5 | 0.3 | -0.0 | 0.1 |
| Mar | 9.6 | 1.8 | 4.6 | 3.3 | 3.4 | 2.2 | 1.9 | 2.1 |
| Apr | 11.3 | 3.5 | 6.3 | 4.9 | 5.1 | 3.9 | 3.6 | 3.7 |
| May | 13.8 | 5.9 | 8.7 | 7.4 | 7.5 | 6.3 | 6.0 | 6.2 |
| Jun | 16.4 | 8.5 | 11.3 | 10.0 | 10.1 | 8.9 | 8.6 | 8.8 |
| Jul | 20.8 | 13.0 | 15.8 | 14.4 | 14.6 | 13.4 | 13.1 | 13.2 |
| Aug | 21.0 | 13.1 | 15.9 | 14.6 | 14.7 | 13.5 | 13.2 | 13.4 |
| Sep | 19.3 | 11.5 | 14.3 | 13.0 | 13.1 | 11.9 | 11.6 | 11.8 |
| Oct | 14.9 | 7.0 | 9.9 | 8.5 | 8.7 | 7.5 | 7.2 | 7.3 |
| Nov | 11.2 | 3.3 | 6.2 | 4.8 | 5.0 | 3.8 | 3.5 | 3.6 |
| Dec | 7.4 | -0.4 | 2.4 | 1.1 | 1.2 | 0.0 | -0.3 | -0.1 |
| Month | Mean Temperature | | | | | | | |
| Jan | 11.8 | 4.0 | 6.8 | 5.5 | 5.6 | 4.4 | 4.1 | 4.3 |
| Feb | 13.9 | 6.1 | 8.9 | 7.5 | 7.7 | 6.5 | 6.2 | 6.3 |
| Mar | 16.1 | 8.3 | 11.1 | 9.8 | 9.9 | 8.7 | 8.4 | 8.6 |
| Apr | 17.9 | 10.1 | 12.9 | 11.5 | 11.7 | 10.5 | 10.2 | 10.3 |
| May | 20.6 | 12.7 | 15.5 | 14.2 | 14.3 | 13.1 | 12.8 | 13.0 |
| Jun | 24.3 | 16.4 | 19.3 | 17.9 | 18.1 | 16.9 | 16.6 | 16.7 |
| Jul | 29.2 | 21.4 | 24.2 | 22.9 | 23.0 | 21.8 | 21.5 | 21.7 |
| Aug | 29.1 | 21.3 | 24.1 | 22.7 | 22.9 | 21.7 | 21.4 | 21.5 |
| Sep | 26.5 | 18.7 | 21.5 | 20.1 | 20.3 | 19.1 | 18.8 | 18.9 |
| Oct | 21.1 | 13.3 | 16.1 | 14.7 | 14.9 | 13.7 | 13.4 | 13.5 |
| Nov | 16.9 | 9.0 | 11.9 | 10.5 | 10.7 | 9.5 | 9.2 | 9.3 |
| Dec | 13.6 | 5.7 | 8.5 | 7.2 | 7.3 | 6.1 | 5.8 | 6.0 |

Note: Temperature gradation is taken to be 0.6 ℃/100m
Temperature of potential micro-hydro sites were estimated with data of Marrakech



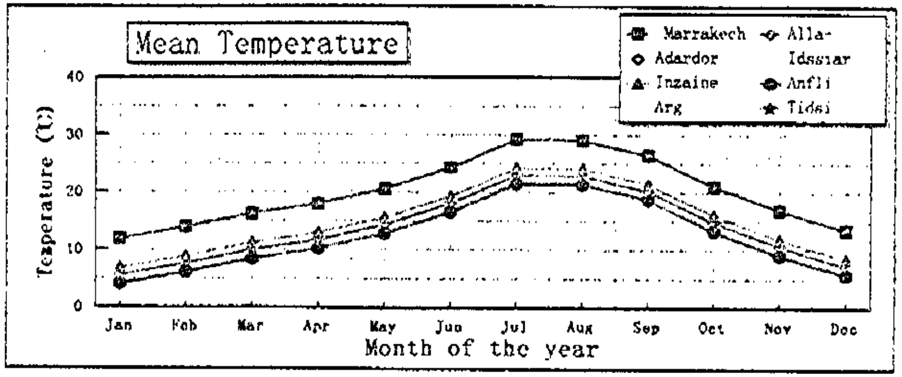




*Figure 3.2-6 Estimated Temperature – Microhydro Potential Sites*

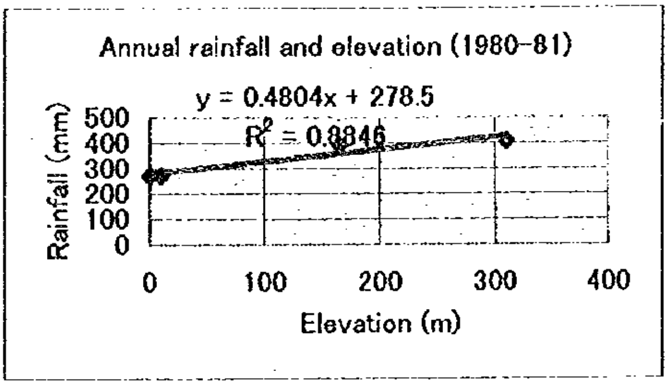
Annual rainfall and elevation

| Station | Elevation | Ref. height |
|---|---|---|
| Taferiat | 760 | 0 |
| Aghbalou | 1070 | 310 |
| Tahanaout | 925 | 165 |
| Imin El Hammam | 770 | 10 |

Note: Iguir N'Kouris was omitted due to exceptionally low correlation with altitude. The observed rainfall data for upstream reaches of N'fis are lower than expected, possibly a result of topographic conditions. This trend can also be seen in isohyetal map.

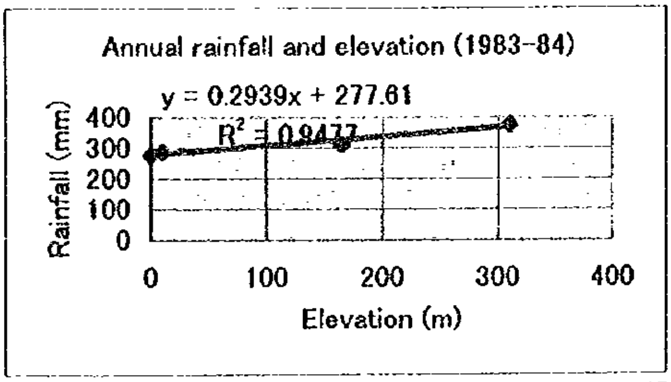
1980-81

| Elevation | Rainfall |
|---|---|
| 0 | 273 |
| 310 | 408 |
| 165 | 395 |
| 10 | 271 |



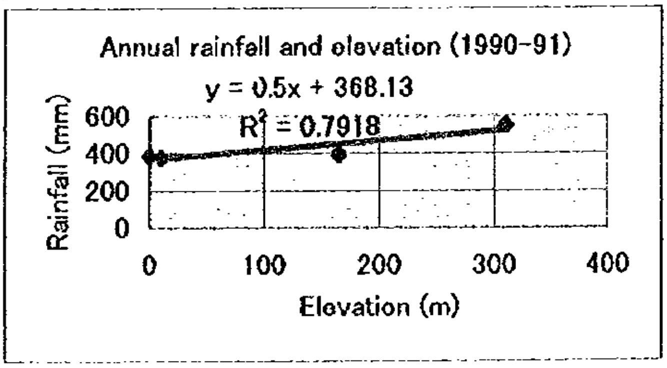

1983-84

| Elevation | Rainfall |
|---|---|
| 0 | 277 |
| 310 | 376 |
| 165 | 312 |
| 10 | 288 |




1990-91

| Elevation | Rainfall |
|---|---|
| 0 | 388 |
| 310 | 552 |
| 165 | 396 |
| 10 | 379 |




Mean annual

| Elevation | Rainfall |
|---|---|
| 0 | 337 |
| 310 | 489 |
| 165 | 397 |
| 10 | 328 |

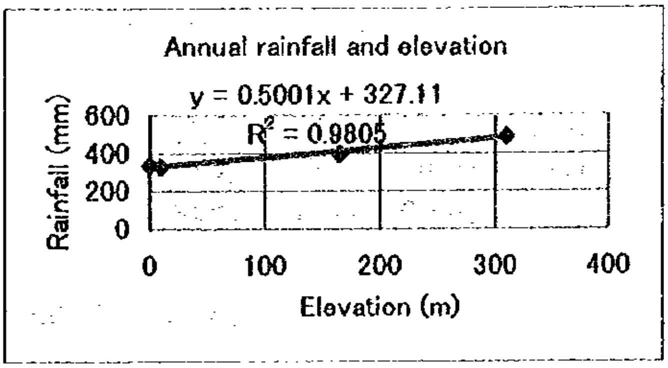



***Figure 3.2-7 Linear Relationship between Annual Rainfall and Elevation***

*Table 3.2-2 Estimated Annual Rainfall -- Microhydro Potential Sites*

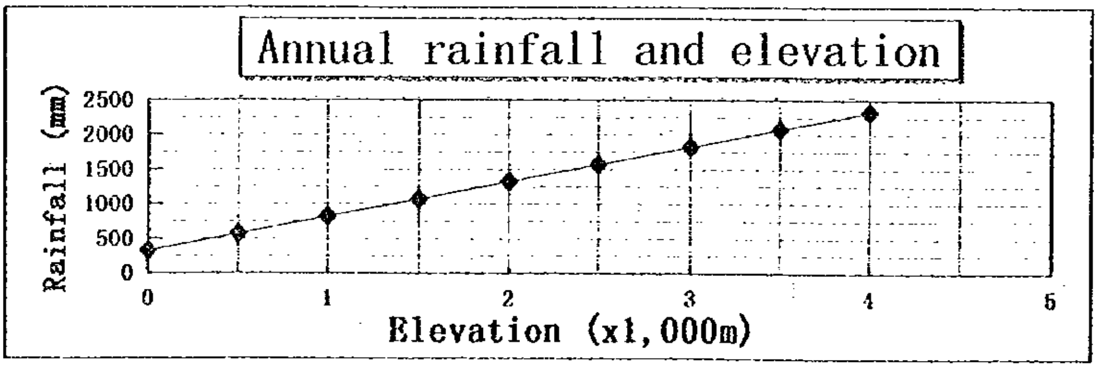
| No. | Scheme | Elevation (m) | Adjusted height (m) | Estimated mean annual rainfall Eq(1) (mm) | Eq(2) (mm) | Eq(3) (mm) | Eq(4) ① (mm) | Isohyetal ② (mm) | ①/② |
|---|---|---|---|---|---|---|---|---|---|
| 46 | Adardour | 1,770 | 1,010 | 763.7 | 574.4 | 873.1 | 832.2 | 600 | 1.4 |
| 38 | Inzaine | 1,300 | 540 | 537.9 | 436.3 | 638.1 | 597.2 | 600 | 1.0 |
| 11 | Arg | 1,525 | 765 | 646.0 | 502.4 | 750.6 | 709.7 | 650 | 1.1 |
| 6 | Alla-Noumzri | 1,500 | 740 | 634.0 | 495.1 | 738.1 | 697.2 | 480 | 1.5 |
| 7 | Idssiar | 1,700 | 940 | 730.1 | 553.9 | 838.1 | 797.2 | 450 | 1.8 |
| 21 | Anfli | 1,750 | 990 | 754.1 | 568.6 | 863.1 | 822.2 | 700 | 1.2 |
| 118 | Tidsi | 1,725 | 965 | 742.1 | 561.2 | 850.6 | 809.7 | 700 | 1.2 |

Reference height (Taferiat): 760 m

| Year | Equation | a | b |
|---|---|---|---|
| 1980-81 | Eq(1) | 0.48 | 278.5 |
| 1983-84 | Eq(2) | 0.29 | 277.6 |
| 1990-91 | Eq(3) | 0.50 | 368.1 |
| Mean | Eq(4) | 0.50 | 327.1 |

Note: Rainfall (y) is estimated with the respective linear equation
Eq(1)～Eq(4). The values for Isohyetal were obtained from
SOUS-MISSION III B, CLIMATOLOGIE-PLUVIOMETRIE
ISOYETES ANNUELLES (1935/36 a 1984/85)
Rainfall of micro-hydro potential sites were estimated with observed data of the existing gauging stations located in the downstream reaches.
A linear relationship between rainfall and altitude is normally assumed.
Linear equation $y=ax+b$ $x$ = Adjusted height (m)

Values by Eq(4), in general, are slightly larger than those of Isohyetal map. The values for Idssiar, Alla-Noumzri and Adardour are much larger than those of Isohyetal map, 1.4～1.8 times, a trend as expected since rainfall in the upstream reaches of N'Fis shows poor correlation with altitude, as evident from isohyetal map.
Rainfall in the upstream of N'Fis could be affected strongly by local topography.



### 3.2.3 Hydrological Survey

(1) Hydrological Data Collection

In order to survey the generation potentiality of the potential microhydro sites, the existing gauging stations in the Study area were surveyed. As a result five (5) existing gauging stations were identified (Figure 3.2-1), though these are not necessarily very close to the target sites. Nevertheless, these data were adopted as they are useful for planning and no other better data exist in the Study area. Although observations at each of the said stations have been carried out over a long period of time, there are many instances of missing data for hydrological analysis, and as a result record analysis centered on daily discharge data for the last 10 years.

*Existing Gauging Stations and Data Collected*

| Station No. | | Station name | Date established | Data collected | |
|---|---|---|---|---|---|
| 2 | 1562/53 | Taferiat | 1962.2. 9 | 1980.9 ` 1993.8 | 1) |
| 3 | 2089/53 | Aghbalou | 1969.4. 4 | 1981.9 ` 1994.8 | 2) |
| 4 | 1565/53 | Tahanaout | 1962.3. 8 | 1983.9 ` 1993.8 | 3) |
| 5 | 510/62 | Iguir N'kouris | 1974.3.20 | 1984.9 ` 1994.8 | 3) |
| 6 | 1566/53 | Imin El Hamman | 1966.7.14 | 1983.9 ` 1992.8 | |

Note: 1) 1986~1989 missing data
2) 1985~1987, 1989 missing data
3) 1987 missing data

(2) Study of Hydrological Data

1) Basin Hydrological Characteristics

Table 3.2-3 indicates the discharge coefficients for each basin of the Study area. These values express the correlation between annual discharge and rainfall as observed at the existing stations. Results of plotting of average discharge coefficients by area and elevation indicate the generally expected trends that the average discharge coefficient decreases as catchment area increases, and conversely increases with greater elevation.

The specific discharges for the above existing stations, as well as discharge coefficients and specific discharges taken from other data sources (Bassin Versant du Tensift Caracteristiques de l'Ecoulement) are shown in Table3.2.-4.

The results of the survey under this Study shows good correlation with the data taken from other sources. Specifically with regard to discharge coefficients for Zat, Ourika and Amizmiz catchments, estimated values under the Study and those from other data show vary little variance. In the case of the Rheraya and N'fis rivers, the estimated values under the Study are somewhat larger.

2) Average Discharge

The daily discharge data were used to estimate mean monthly and yearly discharge for the hydrological years of the gauging stations (Table 3.2-5).

The results show that mean daily discharge fluctuates throughout a year: From November to June much flow is observed but from July to October the flow is reduced to mere trickles. Discharge in late fall and winter comes mainly from the direct runoff of rainfall. In late winter and spring, most of the discharge comes from runoff of melting snow, resulting from rainfall and solar warmth. This trend is obvious at Iguir N'kouris and Imin El Hammam in the basin of N'fis (Figure 3.2-8).

3) Design Discharge

Daily discharge data of each hydrological year for the stations were sequenced in ordinal magnitude to obtain the design discharge, $Q_{max}$-$Q_{365}$.

The table below shows the design discharge $Q_{185}$ & $Q_{275}$ and unit area values ($km^2$).

***Specific Discharge of $Q_{185}$, $Q_{275}$***

*Unit: ($m^3/s$, $l/s/km^2$)*

| Station | Area (km²) | Ratio | Q185 (m3/s) | Q275 (m3/s) | Q185 (l/s/km²) | Q275 (l/s/km²) |
|---|---|---|---|---|---|---|
| Taferiat | 515 | 2.3 | 1.4 | 0.5 | 2.72 | 0.97 |
| Aghbalou | 503 | 2.2 | 2.7 | 1.4 | 5.37 | 2.78 |
| Tahanaout | 226 | 1.0 | 1.1 | 0.7 | 4.89 | 3.11 |
| Ignir N'kouris | 848 | 3.8 | 3.7 | 0.6 | 4.36 | 0.7 |
| Imin El Hammam | 1236 | 5.7 | 5.1 | 1.2 | 3.95 | 0.93 |

Note: When taking catchment of Tahanaout as 1, the catchment ratio of other catchment ranges from 2.2 `5.7.

The specific value of $Q_{185}$ and $Q_{275}$ ranges from 5.37-2.72l/s/km² and 3.11-0.7l/s/km², respectively, indicating that discharge characteristics differ from basin to basin.

## *Table 3.2-3* *Runoff ratio – Existing Gauging Stations*

Taferiat/Zat Catchment area = 515 km2 Mean= 0.44 Max= 0.65 Min= 0.32

| year | | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1990 | 1991 | 1992 | 1993 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| (a) Annual | (m3/s) | 883.3 | 1,039.9 | 203.9 | 573.1 | 975.8 | 753.4 | 1,068.1 | 1,128.0 | 448.6 | 1,564.1 |
| discharge | (x1,000m3) | 76,321 | 89,843 | 17,615 | 49,520 | 84,313 | 65,092 | 92,282 | 97,463 | 38,756 | 135,136 |
| | (mm) | 148.2 | 174.5 | 34.2 | 96.2 | 163.7 | 126.4 | 179.2 | 189.2 | 75.3 | 262.4 |
| (b) Rainfall | (mm) | 273 | 405 | - | 277 | 388 | - | 474 | 292 | 238 | - |
| Runoff ratio | (a)/(b) | 0.54 | 0.43 | | 0.35 | 0.42 | | 0.38 | 0.65 | 0.32 | |

Aghbalou/Ourika Catchment area = 503 km2 Mean= 0.46 Max= 0.88 Min= 0.12

| year | | 1981 | 1982 | 1983 | 1984 | 1988 | 1990 | 1991 | 1992 | 1993 | 1994 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| (a) Annual | (m3/s) | 1,253.6 | 217.2 | 464.7 | 1,396.0 | 1,690.9 | 5,574.5 | 7,187.7 | 1,000.5 | 3,322.2 | 1,266.1 |
| discharge | (x1,000m3) | 108,312 | 18,766 | 40,150 | 120,612 | 146,096 | 481,635 | 621,015 | 86,444 | 287,036 | 109,394 |
| | (mm) | 215.3 | 37.3 | 79.8 | 239.8 | 290.5 | 957.5 | 1234.6 | 171.9 | 570.6 | 217.5 |
| (b) Rainfall | (mm) | 582 | 315 | 376 | 552 | 681 | 859 | 487 | 277 | 648 | 359 |
| Runoff ratio | (a)/(b) | 0.37 | 0.12 | 0.21 | 0.43 | 0.43 | 1.11 | 2.54 | 0.62 | 0.88 | 0.61 |

Tahanaout/Rerava Catchment area = 226 km2 Mean= 0.52 Max= 0.72 Min= 0.17

| year | | 1983 | 1984 | 1985 | 1986 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| (a) Annual | (m3/s) | 234.7 | 606.3 | 282.3 | 466.4 | 1,020.8 | 1,045.2 | 709.8 | 1,351.6 | 326.8 | 753.1 |
| discharge | (x1,000m3) | 20,275 | 52,382 | 24,394 | 40,294 | 88,197 | 90,303 | 61,329 | 116,776 | 28,236 | 65,071 |
| | (mm) | 89.7 | 231.8 | 107.9 | 178.3 | 390.3 | 399.6 | 271.4 | 516.7 | 124.9 | 287.9 |
| (b) Rainfall | (mm) | 312 | 396 | 647 | 280 | 545 | - | 462 | 361 | 193 | - |
| Runoff ratio | (a)/(b) | 0.29 | 0.59 | 0.17 | 0.64 | 0.72 | | 0.59 | 1.43 | 0.65 | |

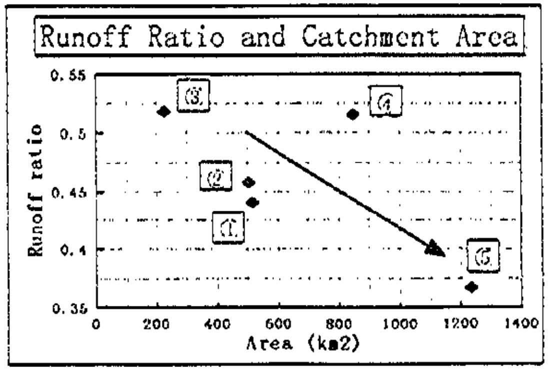
Iguir N'Kouris Catchment area = 848 km2 Mean= 0.52 Max= 0.88 Min= 0.25

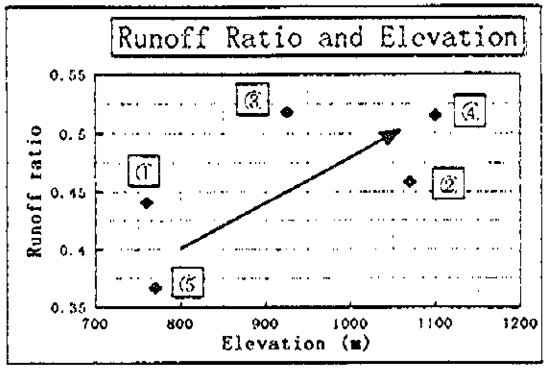
| year | | 1984 | 1985 | 1986 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| (a) Annual | (m3/s) | 1,050.0 | 476.7 | 340.4 | 2,917.6 | 4,834.7 | 945.6 | 2,942.5 | 589.8 | 1,510.1 | 904.8 |
| discharge | (x1,000m3) | 90,718 | 41,185 | 29,412 | 252,084 | 417,722 | 81,697 | 254,232 | 50,955 | 130,476 | 78,173 |
| | (mm) | 107.0 | 48.6 | 34.7 | 297.3 | 492.6 | 96.3 | 299.8 | 60.1 | 153.9 | 92.2 |
| (b) Rainfall | (mm) | 281 | 123 | 140 | - | - | 177 | 340 | 84 | - | 208 |
| Runoff ratio | (a)/(b) | 0.38 | 0.39 | 0.25 | | | 0.54 | 0.88 | 0.72 | | 0.44 |

Imin El Hammam Catchment area = 1,236 km2 Mean= 0.37 Max= 0.95 Min= 0.21

| year | | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| (a) Annual | (m3/s) | 1,152.5 | 1,538.0 | 719.7 | 703.8 | 7,714.7 | 5,689.8 | 6,836.3 | 1,375.4 | 5,411.2 | 704.2 |
| discharge | (x1,000m3) | 99,577 | 132,880 | 62,180 | 60,810 | 666,554 | 491,601 | 590,660 | 118,837 | 467,530 | 60,847 |
| | (mm) | 80.6 | 107.5 | 50.3 | 49.2 | 539.3 | 397.7 | 477.9 | 96.1 | 378.3 | 49.2 |
| (b) Rainfall | (mm) | 288 | 379 | - | 230 | 470 | 365 | 296 | 373 | 398 | 226 |
| Runoff ratio | (a)/(b) | 0.28 | 0.28 | | 0.21 | 1.15 | 1.09 | 1.61 | 0.26 | 0.95 | 0.22 |

Note: Rainfall observed at the existing gauging stations were taken to represent rainfall of the basin.
Runoff ratio >= 1.0 were omitted in obtaining mean, max and min values, and could be attributed to runoff resulting from snowfall or errors in rainfall and discharge data.
The frequency of rainfall occurring in few mm is often high. In semi-arid region these rainfall are often lost into the atmosphere as evapotranspiration and thus not contributing to runoff, resulting in lower runoff ratio.




① Taferiat
② Aghbalou
③ Tahanaout
④ Iguir N'Kouris
⑤ Imin El Hammam

*Table 3.2-4* ***Specific Discharge – Existing Gauging Stations***

| Oued | | Zat | Ourika | Reraya | N'Fis | | Amizmiz |
|---|---|---|---|---|---|---|---|
| Station | Name | Taferiat | Aghbalou | Tahanaout | Iguir N'Kouris | Imin El Hamam | Sidi Hssain |
| | Type | Simplifiee | Principale | Principale | Principale | Principale | Simplifiee |
| | No. IRE | 1562/53 | 2089/53 | 1565/53 | 510/62 | 1566/53 | 2431/53 |
| Catchment (km2) | | 515 | 503 | 226 | 848 | 1236 | 115 |
| Altitude (m) | | 760 | 1070 | 925 | 1100 | 770 | |
| Data of operation | | 09/02/62 | 01/04/69 | 08/03/62 | 20/03/74 | 14/07/66 | 16/12/87 |
| Mean runoff | | 4.37 | 5.12 | 1.73 | 3.80 | 4.84 | 0.42 |
| Specific discharge(l/s/km2) | | *8.49* | *10.18* | *7.65* | *4.48* | *3.92* | *3.63* |
| Data used in this study | From | 1980 | 1981 | 1983 | 1985 | 1983 | #2 |
| | To | 1993 | 1994 | 1993 | 1994 | 1992 | #2 |
| Data omitted | (19xx) #1 | 86～89, 91 | 85～87, 89 | 87, 91 | 95 | 93, 91 | #2 |

Note: Water/hydrological year: September to August of following year
#1 Data omitted in this study due to missing data or interrupted observation
#2 Sidi Hssain Station (Amezmiz, a tributary of N'Fis) was omitted as no data was available.
These values were quoted from "TABLEAU DES STATIONS HYDROLOGIQUES"

**Runoff ratio and specific discharge of basins in the study area**

| Oued | Catchment area (km2) ① | Annual Runoff (mm) ② | Annual Rainfall (mm) ③ | Deficit (mm) ④=③-② | Runoff ratio (%) ⑤=②/③ | Specific discharge (l/s/km2) ⑥=②*10^6/(86400*365) | Remarks |
|---|---|---|---|---|---|---|---|
| Zat | 525 | 260 | 541 | 281 | 48 | *8.2* | |
| Ourika | 503 | 323 | 673 | 350 | 48 | *10.2* | |
| Reraya | 225 | 244 | 609 | 365 | 40 | *7.7* | |
| N'Fis | 1,686 | 102 | 579 | 477 | 18 | *3.2* | |
| Amezmiz | 115 | 186 | 546 | 360 | 34 | *5.9* | |

Note: Source of data unknown. The above values were quoted from tables collected from Department of Hydrology, Public works. "BASSIN VERSANT DU TENSIFT CARACTERISTIQUES DE L'ECOULEMENT"

## *Table 3.2-5 Mean Monthly and Annual Discharge – Existing gauging Stations*

unit: m3/s

QUED ZAT/TAFERIAT No. IRE 1562/53 Catchment=515km2 Altitude=760m

| Year | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1990 | 1991 | 1992 | 1993 | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Sept | 0.44 | 0.15 | 0.13 | 0.01 | 0.03 | 0.02 | 0.69 | 0.35 | 0.12 | 0.08 | 0.20 |
| Oct | 2.33 | 0.19 | 0.41 | 2.95 | 0.03 | 0.03 | 0.31 | 0.90 | 0.16 | 1.21 | 0.85 |
| Nov | 3.92 | 0.23 | 0.80 | 0.89 | 0.67 | 0.37 | 0.25 | 0.33 | 0.51 | 3.88 | 1.18 |
| Dec | 1.31 | 0.24 | 0.97 | 0.46 | 0.88 | 0.66 | 1.45 | 10.19 | 0.72 | 2.80 | 1.97 |
| Jan | 0.75 | 0.88 | 0.44 | 0.22 | 10.38 | 2.42 | 0.39 | 1.05 | 1.20 | 3.06 | 2.08 |
| Feb | 3.95 | 2.40 | 1.12 | 0.18 | 4.66 | 3.93 | 3.07 | 1.10 | 1.68 | 9.96 | 3.22 |
| Mar | 4.89 | 1.67 | 1.11 | 0.95 | 3.03 | 6.17 | 12.53 | 3.73 | 4.81 | 16.06 | 5.50 |
| Apr | 6.50 | 12.14 | 0.78 | 1.01 | 3.40 | 3.03 | 10.45 | 9.74 | 2.58 | 7.64 | 5.73 |
| May | 3.31 | 9.00 | 0.53 | 11.36 | 7.48 | 2.58 | 3.12 | 6.08 | 1.65 | 4.84 | 5.00 |
| Jun | 1.03 | 1.97 | 0.19 | 0.39 | 1.25 | 2.20 | 1.52 | 2.33 | 0.91 | 1.93 | 1.37 |
| Jul | 0.39 | 0.37 | 0.18 | 0.08 | 0.22 | 1.87 | 1.22 | 0.49 | 0.32 | 0.22 | 0.54 |
| Aug | 0.44 | 4.10 | 0.10 | 0.01 | 0.07 | 1.59 | 0.16 | 0.57 | 0.08 | 0.18 | 0.73 |
| Annual | 2.42 | 2.85 | 0.56 | 1.57 | 2.67 | 2.06 | 2.93 | 3.08 | 1.23 | 4.29 | 2.36 |

QUED OURIKA/AGHBALOU No. IRE 2089/53 Catchment=503km2 Altitude=1,070m

| Year | 1981 | 1982 | 1983 | 1984 | 1988 | 1990 | 1991 | 1992 | 1993 | 1994 | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Sept | 0.10 | 0.39 | 0.05 | 0.17 | 0.75 | 9.70 | 2.12 | 0.81 | 0.19 | 0.35 | 1.46 |
| Oct | 0.83 | 0.41 | 0.76 | 0.11 | 2.21 | 2.16 | 2.67 | 1.09 | 1.20 | 0.82 | 1.23 |
| Nov | 1.33 | 0.49 | 2.54 | 0.99 | 8.13 | 0.69 | 1.08 | 0.90 | 5.63 | 1.06 | 2.28 |
| Dec | 0.74 | 0.54 | 0.76 | 1.75 | 2.67 | 2.42 | 37.54 | 1.37 | 4.74 | 0.67 | 5.32 |
| Jan | 1.20 | 0.41 | 0.51 | 5.86 | 2.54 | 0.73 | 5.07 | 1.55 | 5.61 | 0.39 | 2.39 |
| Feb | 2.11 | 0.69 | 0.39 | 6.10 | 2.94 | 11.93 | 4.26 | 1.83 | 11.48 | 1.53 | 4.29 |
| Mar | 3.30 | 1.01 | 1.12 | 5.10 | 4.90 | 75.39 | 29.69 | 10.27 | 37.69 | 3.46 | 16.69 |
| Apr | 11.65 | 1.18 | 2.78 | 8.52 | 7.53 | 60.84 | 70.88 | 9.88 | 25.50 | 16.00 | 21.47 |
| May | 15.60 | 1.67 | 5.30 | 12.58 | 5.62 | 13.31 | 61.98 | 3.89 | 17.18 | 8.38 | 14.55 |
| Jun | 2.93 | 0.26 | 0.86 | 3.32 | 3.17 | 2.04 | 12.23 | 0.80 | 3.72 | 1.65 | 3.10 |
| Jul | 0.81 | 0.08 | 0.12 | 1.17 | 14.05 | 1.61 | 2.22 | 0.28 | 0.87 | 0.89 | 2.21 |
| Aug | 0.56 | 0.04 | 0.03 | 0.37 | 0.96 | 2.53 | 5.18 | 0.19 | 0.60 | 6.41 | 1.60 |
| Annual | 3.43 | 0.60 | 1.27 | 3.82 | 4.63 | 15.27 | 19.64 | 2.74 | 9.10 | 3.47 | 6.39 |

QUED RERAYA/TAHANAOUT No. IRE 1565/53 Catchment=225km2 Altitude=925m

| Year | 1983 | 1984 | 1985 | 1986 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Sept | 0.16 | 0.17 | 0.12 | 0.11 | 0.41 | 0.77 | 1.08 | 0.35 | 0.28 | 0.11 | 0.35 |
| Oct | 0.31 | 0.04 | 0.71 | 0.36 | 1.39 | 5.71 | 0.37 | 0.54 | 0.22 | 0.07 | 0.97 |
| Nov | 0.40 | 0.21 | 0.54 | 0.89 | 4.79 | 2.29 | 0.36 | 0.16 | 0.26 | 1.21 | 1.11 |
| Dec | 0.43 | 0.30 | 0.64 | 0.50 | 2.07 | 2.93 | 0.49 | 4.41 | 0.32 | 0.90 | 1.39 |
| Jan | 0.43 | 2.33 | 0.68 | 0.71 | 1.32 | 3.15 | 0.37 | 0.23 | 0.45 | 0.91 | 1.09 |
| Feb | 0.29 | 1.49 | 0.76 | 5.22 | 1.27 | 2.72 | 0.95 | 0.30 | 0.45 | 1.80 | 1.49 |
| Mar | 0.51 | 1.10 | 1.18 | 1.88 | 2.41 | 5.67 | 6.02 | 1.02 | 1.32 | 6.05 | 2.71 |
| Apr | 0.90 | 3.71 | 1.01 | 2.40 | 5.86 | 2.59 | 7.08 | 13.08 | 2.16 | 6.54 | 4.54 |
| May | 3.16 | 7.43 | 2.21 | 2.36 | 6.30 | 4.65 | 3.42 | 15.19 | 2.31 | 5.45 | 5.25 |
| Jun | 0.71 | 2.52 | 0.97 | 0.79 | 4.76 | 2.41 | 1.83 | 7.26 | 1.74 | 1.14 | 2.41 |
| Jul | 0.26 | 0.42 | 0.32 | 0.34 | 2.06 | 0.72 | 0.91 | 0.98 | 1.01 | 0.22 | 0.73 |
| Aug | 0.09 | 0.19 | 0.11 | 0.13 | 0.91 | 0.32 | 0.44 | 0.76 | 0.22 | 0.38 | 0.35 |
| Annual | 0.64 | 1.66 | 0.77 | 1.28 | 2.80 | 2.86 | 1.94 | 3.69 | 0.90 | 2.06 | 1.86 |

QUED N'FIS/IGUIR NKOURIS No. IRE 510/62 Catchment=818km2 Altitude=1,100m

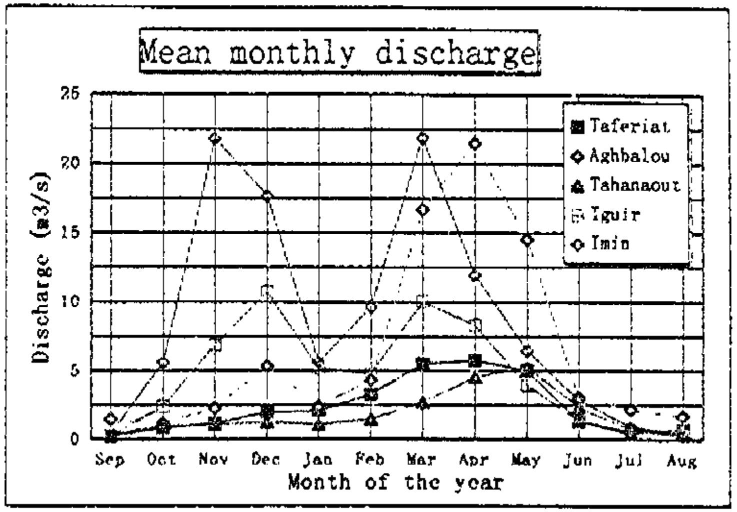
| Year | 1984 | 1985 | 1986 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Sept | 0.00 | 0.00 | 0.14 | 0.49 | 0.35 | 1.32 | 0.16 | 0.24 | 0.10 | 0.12 | 0.29 |
| Oct | 0.00 | 0.12 | 0.00 | 4.57 | 10.01 | 1.21 | 0.68 | 0.32 | 6.39 | 0.61 | 2.38 |
| Nov | 1.70 | 0.29 | 0.25 | 46.95 | 7.11 | 0.72 | 0.86 | 0.63 | 9.35 | 0.80 | 6.87 |
| Dec | 2.25 | 0.51 | 0.38 | 9.48 | 47.56 | 1.35 | 34.48 | 2.23 | 4.63 | 4.24 | 10.71 |
| Jan | 5.16 | 0.85 | 3.64 | 5.95 | 22.65 | 0.95 | 7.92 | 1.69 | 2.85 | 0.36 | 5.14 |
| Feb | 7.28 | 0.58 | 4.40 | 4.59 | 9.55 | 1.61 | 8.49 | 3.56 | 3.13 | 1.20 | 4.79 |
| Mar | 6.71 | 7.61 | 1.85 | 5.66 | 27.83 | 9.85 | 14.81 | 5.92 | 10.72 | 9.40 | 10.01 |
| Apr | 4.83 | 3.85 | 0.62 | 10.37 | 19.15 | 9.21 | 11.42 | 2.93 | 7.50 | 9.97 | 8.28 |
| May | 5.35 | 1.43 | 0.73 | 4.80 | 8.43 | 2.98 | 9.08 | 1.30 | 2.89 | 2.35 | 3.93 |
| Jun | 1.44 | 0.30 | 0.01 | 2.10 | 3.88 | 0.91 | 3.66 | 0.49 | 0.68 | 0.38 | 1.39 |
| Jul | 0.08 | 0.00 | 0.00 | 1.11 | 0.98 | 0.15 | 0.92 | 0.10 | 0.17 | 0.14 | 0.40 |
| Aug | 0.02 | 0.02 | 0.00 | 0.43 | 0.35 | 0.42 | 0.62 | 0.10 | 1.26 | 0.10 | 0.33 |
| Annual | 2.88 | 1.31 | 0.93 | 7.99 | 13.25 | 2.59 | 8.04 | 1.62 | 4.14 | 2.48 | 4.55 |

QUED N'FIS/IMIN EL HAMAN No. IRE 1566/53 Catchment=1,290km2 Altitude=770m

| Year | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Sept | 0.00 | 0.00 | 0.01 | 0.11 | 0.00 | 0.52 | 0.73 | 1.88 | 0.19 | 0.73 | 0.42 |
| Oct | 2.91 | 0.00 | 0.10 | 0.72 | 7.97 | 7.38 | 32.87 | 1.31 | 1.02 | 1.53 | 5.58 |
| Nov | 24.78 | 4.16 | 0.35 | 4.31 | 33.68 | 106.43 | 40.88 | 0.74 | 1.07 | 1.66 | 21.81 |
| Dec | 3.98 | 3.25 | 0.69 | 0.63 | 38.81 | 13.74 | 49.01 | 1.48 | 62.90 | 2.50 | 17.70 |
| Jan | 1.32 | 9.10 | 1.10 | 5.71 | 1.57 | 6.15 | 18.41 | 1.32 | 8.78 | 2.60 | 5.61 |
| Feb | 0.55 | 9.58 | 1.17 | 7.82 | 33.61 | 6.91 | 8.37 | 2.29 | 17.25 | 3.12 | 9.64 |
| Mar | 1.31 | 7.02 | 12.87 | 1.88 | 93.63 | 11.76 | 35.96 | 15.00 | 31.66 | 4.68 | 21.68 |
| Apr | 0.86 | 6.69 | 1.65 | 0.61 | 25.86 | 20.00 | 16.07 | 12.97 | 29.18 | 2.72 | 11.96 |
| May | 2.10 | 9.20 | 1.98 | 0.72 | 10.89 | 8.50 | 11.83 | 4.91 | 12.43 | 1.86 | 6.44 |
| Jun | 0.22 | 1.69 | 0.50 | 1.10 | 5.30 | 4.62 | 6.07 | 1.88 | 6.32 | 0.95 | 2.86 |
| Jul | 0.02 | 0.22 | 0.06 | 0.01 | 1.37 | 1.46 | 2.71 | 0.67 | 2.14 | 0.71 | 0.94 |
| Aug | 0.00 | 0.03 | 0.03 | 0.00 | 0.43 | 1.00 | 0.45 | 0.70 | 0.91 | 0.11 | 0.37 |
| Annual | 3.15 | 4.21 | 1.97 | 1.93 | 21.08 | 15.59 | 18.73 | 3.77 | 11.78 | 1.93 | 8.76 |

## Mean monthly discharge

| | Taferiat | Aghbalou | Tahanaout | Iguir Nkouris | Imin El Hamam |
|---|---|---|---|---|---|
| No. IRE | 1562/53 | 2089/53 | 1565/53 | 510/62 | 1566/53 |
| Period | 1980-93 | 1981-94 | 1983-93 | 1984-94 | 1983-92 |
| Catchment (km2) | 515 | 503 | 225 | 848 | 1290 |
| Elevation (m) | 760 | 1070 | 925 | 1100 | 770 |
| Sep | 0.20 | 1.46 | 0.35 | 0.29 | 0.42 |
| Oct | 0.85 | 1.23 | 0.97 | 2.38 | 5.58 |
| Nov | 1.18 | 2.28 | 1.11 | 6.87 | 21.81 |
| Dec | 1.97 | 5.32 | 1.30 | 10.71 | 17.70 |
| Jan | 2.08 | 2.39 | 1.09 | 5.14 | 5.61 |
| Feb | 3.22 | 4.29 | 1.49 | 4.79 | 9.64 |
| Mar | 5.50 | 16.69 | 2.71 | 10.04 | 21.88 |
| Apr | 5.73 | 21.47 | 4.54 | 8.28 | 11.96 |
| May | 5.00 | 14.55 | 5.25 | 3.93 | 6.44 |
| Jun | 1.37 | 3.10 | 2.41 | 1.39 | 2.86 |
| Jul | 0.54 | 2.21 | 0.73 | 0.40 | 0.94 |
| Aug | 0.73 | 1.69 | 0.35 | 0.33 | 0.37 |




Note:

For Imin El Hamam and Iguir Nkouris two discharge peaks exit: the 1st is due to rainfall while the 2nd melting snow. As evident from the difference in catchment size, the discharge at Imim El Hamam is, on the whole, larger than that at Iguir Nkouris.

Imin El Hamam and Iguir Nkouris are in the same catchment, the later being higher in altitude.

Though small in magitude, the 1st discharge peak is also evident at Aghbalou.

For the above three stations, the decline in discharge in Dec and Jan is probably due to precipitation occurring in the from of snow. Precipitation in earlier months probably occurs as rainfall.

For all the stations, the 2nd peaks are similar or larger than the 1st peak.

For Imin El Hamam and Iguir Nkouris the 2nd peak occurs in March, for Tahanaout in May, for Aghbalou in April and for Taferiat in April.

*Figure 3.2-8 Mean Monthly and Annual Discharge – Existing gauging Stations*

### 3.2.4 Sunshine Intensity in Mountain Region

The Study area in Haouz Province is located on the southern side of the Haut Atlas range at elevations ranging 500~2,300 m. Terrain comprises both mountain slope and plain. Figure 3.2-9 indicates the daylight intensity distribution in Morocco. In the case of the PV generating module, sunshine intensity is computed applying 1 kW/m²/h as the base sunshine volume, and multiplying this by the average number of sunshine hours. As shown in the figure below, the Study area exhibits an average 5.3~5.6 kWh/m²/day, placing its sunshine intensity value within the 5.3~5.6 kWh/m²/day range.

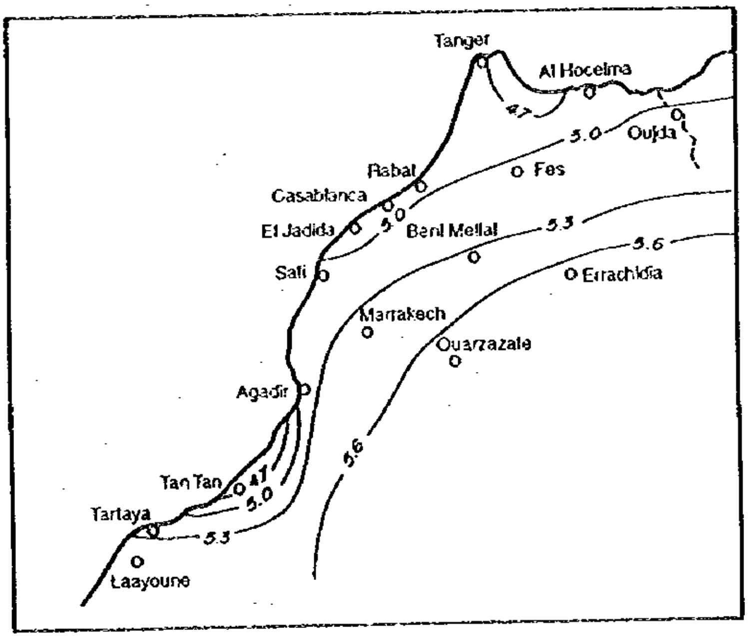



***Figure 3.2-9 Distribution of Daylight Intensity in Morocco***

In the case of adopting PV generation systems in the mountainous areas of Haouz region, there will be numerous instances where the subject villages are located in valleys. Accordingly, sights where confirmed during field survey so as not to be subject to reduction of effective sunlight hours available due to blockage of sunlight by mountain mass.

On the other hand, it is anticipated that there will be some differentiation between plain and mountain areas in terms of frequency of cloud cover and rainfall. Although it would be best to install sunshine meters in the target mountain villages for precise collection of data on sunshine hours, due to the constraints under the Study it was instead decided to request a record of weather conditions to be taken at the time of water level gauging at the discharge observation stations. This was utilized as a basis of estimating the percentage rate for fair weather. Such weather observations were performed twice each day (once in the morning and once in the afternoon). Results are as follows.

| | Month: | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May |
|---|---|---|---|---|---|---|---|---|---|
| Arg | Morning | 81 | 87 | 42 | 32 | 83 | 74 | 43 | 87 |
| | Afternoon | 65 | 67 | 35 | 29 | 72 | 74 | 33 | 87 |
| Tidsi | Morning | 81 | 80 | 58 | 61 | 76 | 87 | 53 | 77 |
| | Afternoon | 81 | 60 | 45 | 32 | 72 | 52 | 27 | 53 |

Although precise evaluation is difficult to a lack of comparative data for plain region, it is assumed that fair weather rate is poor for December, January and April.

Sunshine hour ratio in Marrakech for each month compared to the month of maximum sunshine hours (July) is shown in the following table.

| Month | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ratio | 72 | 64 | 62 | 64 | 67 | 72 | 76 | 84 | 95 | 100 | 94 | 82 |

Comparing with the above table, it is concluded that there is potential for insufficient sunshine volume in mountain areas in December, January and April. Nevertheless, it must be borne in mind that the observation data for the said mountain area represents one time only, and therefore is lacking in preciseness. Under the subject Master Plan, capacity of PV generating modules for systems in mountain villages which meet the criteria below is to be 1.5 times that of systems targeted at plain region in order to achieve design power supply.

① Villages located at elevations over 1,500 m

② Villages where rainfall is in excess of 600 mm per year

Table 3.2-6 indicates the 17 villages which meet the above criteria.

## *Table 3.2-6 Villages Concluded to Experience Low Sunshine Intensity*

| No. | Douar | Map No. | Alti-tude m | • | * | Power source |
|---|---|---|---|---|---|---|
| (1) | Tizi Oussem | 11 | 1,800 | • | * | PV |
| (2) | Id Aissa | 11 | 1,740 | • | * | PV |
| (3) | Tassa Ouirgane | 7 | 1,190 | | * | PV |
| (4) | Igrem | 7 | 1,750 | • | * | PV |
| 6 | Alla Oumzri | 8 | 1,440 | | * | H |
| 7 | Id Ssior | 7 | 1,650 | • | | H |
| (8) | Aghella | 3 | 2,050 | • | * | PV |
| (9) | Ikiss | 4 | 1,700 | • | * | PV |
| 10 | Amsakrou | 11 | 1,850 | • | * | H |
| 11 | Arg | 11 | 1,580 | • | * | H |
| (12) | Tinerhouhrine | 11 | 2,000 | • | * | PV |
| 13 1 | El Bour | 11 | 1,400 | | * | D |
| 13 2 | Imskar | 11 | 1,380 | | * | G |
| 15 | Ikiss | 11 | 1,850 | • | * | H |
| (17) | Tacheddirt | 11 | 2,180 | • | * | PV |
| 18 | Sqour | 14 | 1,200 | | | |
| 19 | Amagdour | 14 | 1,150 | | | |
| (20) | Tamaterte | 18 | 1,800 | • | * | PV |
| 21 | Antli | 18 | 1,750 | • | * | H |
| 22 | Timichi | 11 | 2,000 | • | * | H |
| 23 | Agouns | 11 | 2,300 | • | * | D |
| 24 | Oulad Mansour | 6 | 630 | | | |
| 25 1 | Oulad Lahjar | 6 | 700 | | | |
| 25 2 | Oumnas | 6 | 700 | | | |
| 26 1 | Awin Mazouz | 5 | 500 | | | |
| 26 2 | Bouchiha Bon Om | 5 | 500 | | | |
| 27 | Del El Ain | 6 | 580 | | | |
| 30 | Bel Abbas | 10 | 660 | | | |
| 32 | Derb Chem's | 10 | 900 | | | |
| 33 | Sour Tedrara | 10 | 940 | | | |
| 34 | Tlat Tedrara | 10 | 970 | | | |
| 35 | Imin Tala | 3 | 1,480 | | | |
| 36 | Addouz | 3 | 1,460 | | | |
| 37 | Ain Ghad | 3 | 1,450 | | | |
| 38 | Inzaine | 3 | 1,420 | | | |
| 39 | Imi N'isly | 3 | 1,350 | | | |
| 40 | Dou Anamer | 3 | 1,320 | | | |
| 41 | Igoundem | 3 | 1,350 | | | |
| 42 | Toug Lkheif | 3 | 1,200 | | | |
| 43 | Ait Ouzkri | 7 | 1,100 | | | |
| 44 | Ait Hmad | 7 | 1,400 | | | |
| 45 | Tizgui | 3 | 1,180 | | | |
| 46 | Adardour | 3 | 1,800 | • | | H |
| 47 | Lemdinat | 3 | 1,840 | • | * | D |
| 48 | Tnirt | 3 | 1,750 | • | | D |
| (49) | Anemi | 3 | 1,700 | • | | PV |
| 50 | Ansmrou | 3 | 1,780 | • | * | D |
| (51) | Talat Ait Ihla | 3 | 1,760 | • | * | PV |
| 52 | Toulkine | 3 | 1,710 | • | | D |
| (53) | Adghouss | 3 | 1,770 | • | | PV |
| 54 | Douzrou | 3 | 1,820 | • | | D |
| 55 | Ait Outmane | 3 | 1,450 | | | |
| (56) | Tagadirt | 3 | 1,610 | • | | PV |
| (57) | Tifirt | 3 | 1,580 | • | | PV |
| (58) | Anfrioune | 3 | 1,720 | • | | PV |
| 59 | Ait Smil | 2 | 1,040 | | | |
| 60 | Tifratine | 2 | 810 | | | |
| 61 | Aguenze | 2 | 820 | | | |
| 62 | Ifit Baragha | 3 | 850 | | | |
| 63 | Agadir Baragha | 3 | 1,070 | | | |
| 65 | Adar Baragha | 3 | 1,070 | | | |
| 66 | Tadchert | 3 | 1,100 | | | |
| 67 | Tamsoult | 3 | 960 | | | |
| 68 | Dar Jamaa Ait Ali | 3 | 970 | | | |
| 69 | Agadir Ait Brahim | 3 | 930 | | | |
| 70 | Iouraghan | 3 | 950 | | | |
| 71 | Imiki | 2 | 880 | | | |
| 72 | Ifit Ait Alla | 2 | 900 | | | |
| 73 | Boukhelf | 3 | 950 | | | |
| 74 | Addar Ait Ali | 3 | 1,030 | | | |
| 76 | Ait Bourd | 3 | 1,040 | | | |
| 77 | Ait M'Barek | 3 | 1,060 | | | |
| 78 | Agadir Ait Bourd | 3 | 1,190 | | | |
| 79 | Afella Ouassif | 3 | 1,110 | | | |
| 81 | Afella Ighil | 7 | 1,033 | | | |
| 83 1 | Anfeg | 7 | 1,020 | | | |
| 83 2 | Aguersouak | 7 | 970 | | | |
| 84 | Ait Bouzid | 7 | 950 | | | |
| 85 1 | Oumast | 7 | 940 | | | |
| 85 2 | Ait Zitoun | 7 | 1,000 | | | |
| 86 | Tagadirt | 7 | 1,150 | | | |
| 87 1 | Zaouit | 7 | 1,160 | | | |
| 87 2 | Izalaghan | 7 | 1,020 | | | |
| 88 | Tigouder | 7 | 1,240 | | | |
| 89 | Amezi | 7 | 1,180 | | | |
| 90 | Agouni | 7 | 1,100 | | | |
| 91 | Chasbat Tarik | 6 | 830 | | | |
| 92 | Ighil Sdidene | 7 | 900 | | | |
| 93 | Tizi | 7 | 930 | | | |
| 94 | Aghbalou | 7 | 850 | | | |
| 95 | Ait Hsain | 7 | 1,080 | | | |
| 96 | Ait Boubker | 7 | 1,160 | | | |
| 97 | Tazatourt | 7 | 1,050 | | | |
| 98 | Tamsoulte | 7 | 1,050 | | | |
| 99 | Tizgui | 7 | 1,220 | | | |
| 100 | Ait Tirghit | 7 | 1,480 | | | |
| 101 | Tachbibt Kabli | 6 | 850 | | | |
| 102 | Tachbibt Echatoui | 6 | 850 | | | |
| 103 | Asgoune | 6 | 820 | | | |
| 104 | Ait Aamara Loued | 6 | 750 | | | |
| 105 | Igouder | 6 | 835 | | | |
| 106 | Lakaama | 3 | 930 | | | |
| 107 | Ait Aamar El Bour | 6 | 860 | | | |
| 109 | Chouirige | 6 | 720 | | | |
| 112 | Lamhamid | 6 | 870 | | | |
| 113 1 | Tarast | 17 | 1,210 | | | |
| 113 2 | Assaka | 17 | 1,200 | | | |
| 114 | Abadou | 15 | 1,110 | | | |
| 115 | Quriz | 16 | 1,550 | • | * | G |
| 116 | Tabant Ighi | 16 | 1,500 | • | * | G |
| (117) | Ansa | 14 | 1,880 | • | * | PV |
| 118 | Tidsi | 16 | 1,750 | • | * | H |
| 119 | Ait Atmane | 16 | 1,550 | • | * | D |
| (120) | Ezzaouite | 14 | 1,690 | • | * | PV |

1)O; villages with low daylight intensity
2)•; villages located at elevations over 1500m
3)*; villages where rainfall exceeds 600m per year

4) Electrification method
PV Photovoltaic generation
H Micro-hydropower generation
D Diesel generation
G Transmission line extension

### 3.3 Base Data Study for Project Formulation

#### 3.3.1 Villager Aspirations regarding Electrification, and Affordability to Pay Electricity Tariffs

Villager aspirations regarding electrification, and affordability to pay electricity fees as identified through questionnaire survey are as follows:

① 98% of villagers desire electrification to power lighting, radio and television appliances. Those desiring electrification solely for lighting, or solely for television and radio use comprise only 2%.

② 21% of villagers also desire electrification for other electrical appliances such as refrigerator, etc.

③ Village chiefs and average villagers indicate an average capacity for initial investment of DH 1,990 and DH 1,050, respectively.

④ Village chiefs and average villagers indicate an average affordability for monthly electricity fees of around DH 140 and DH 70, respectively.

⑤ Annual village household income is over DH 29,000, of which DH 15,000 is saved.

Under PERG projects, beneficiaries pay 25% of investment. Where this is paid on an installment basis, the amount is DH 40 per month over a 7 year period; when paid in a single lump sum the amount is DH 2,252. (In the case of a 50 W PV kit, cost is DH 9,000, 25% of which is DH 2,250.)

#### 3.3.2 Possibility of Electrification by Extension of Existing Transmission Lines

Table 3.3-1 indicates the distance from existing 22 kV transmission line to target villages. Villages marked "A" are located at 5 km or more from existing lines; while those marked "B" are either located at over 10 km distance, or power line routes would be over very rugged terrain. In both cases "A" and "B", electrification by either PV generation or micro-hydropower would be advantageous compared to extension of the existing transmission line. A preliminary study was carried out to determine the appropriate method of electrification for each village.

### *Table 3.3-1 Distance between Villages and Existing Transmission Line (1/2)*

| No. | Douar Name | Households | Population | Distance from transmission | (km) | Line volt (kV) | Remarks |
|---|---|---|---|---|---|---|---|
| 1 | Tizi Oussem | 72 | 444 | B | 10.5 | 22 | via [2]. through the mountain |
| 2 | Id Aissa | 44 | 180 | B | 8.5 | 22 | |
| 3 | Tassa Ouirgane | 55 | 375 | A | 5.0 | 22 | |
| 4 | Igrem | 27 | 130 | B | | | |
| 6 | Alla Oumzri | 40 | 280 | | 3.0 | 22 | |
| 7 | Id Ssior | 66 | 500 | A | 6.0 | 22 | |
| 8 | Aghella | 64 | 394 | B | | | |
| 9 | Ikiss | 68 | 389 | B | | | |
| 10 | Amsakrou | 55 | 420 | A | 7.5 | 22 | via [11]. 2.5km from [11] |
| 11 | Arg | 75 | 1,020 | A | 5.0 | 22 | |
| 12 | Tinerhouhrine | 30 | 250 | B | 10.1 | 22 | via [15]. 1.3km from [15] |
| 13 1 | El Bour | 65 | 510 | | 2.0 | 22 | |
| 13 2 | Imskar | 40 | 280 | | 2.0 | 22 | |
| 15 | Ikiss | 65 | 500 | A | 8.8 | 22 | via [10]. 1.3km from [10] |
| 17 | Tacheddirt | 60 | 360 | B | 13.9 | 22 | via [12]. 3.8km from [12] |
| 18 | Sqour | 45 | 360 | | 4.5 | 22 | |
| 19 | Amagdour | 22 | 150 | A | 5.5 | 22 | |
| 20 | Tamaterte | 40 | 240 | A | 5.0 | 22 | |
| 21 | Anfli | 63 | 378 | A | 8.0 | 22 | via [20]. 3.0km from [20] |
| 22 | Timichi | 60 | 370 | B | 8.6 | 22 | via [23]. 2.6km from [23] |
| 23 | Agouns | 105 | 630 | B | 6.0 | 22 | through the mountain |
| 24 | Oulad Mansour | 70 | 500 | A | 1.5 | 60 | |
| 25 1 | Oulad Lahjar | 100 | 600 | | 0.3 | 22 | |
| 25 2 | Oumnas | 150 | 800 | | 1.0 | 60 | |
| 26 1 | Awin Mazouz | 67 | 420 | B | 6.3 | 22 | |
| 26 2 | Bouchiha Bon Omar | 66 | 400 | | 4.5 | 22 | |
| 27 | Del El Ain | 110 | 600 | | 0.7 | 60 | |
| 30 | Bel Abbas | 140 | 900 | | 4.0 | 22 | |
| 32 | Derb Chem's | 60 | 369 | | 2.2 | 22 | |
| 33 | Sour Tedrara | 110 | 677 | | 2.0 | 22 | |
| 34 | Tlat Tedrara | 80 | 490 | | 1.0 | 22 | |
| 35 | Imin Tala | 70 | 460 | B | | | along the Anougal River |
| 36 | Addouz | 50 | 300 | B | | | along the Anougal River |
| 37 | Ain Ghad | 43 | 206 | B | | | along the Anougal River |
| 38 | Inzaine | 70 | 420 | B | | | along the Anougal River |
| 39 | Imi N'isly | 86 | 450 | A | 9.0 | | along the Anougal River |
| 40 | Dou Anamer | 35 | 220 | A | 9.0 | | along the Anougal River |
| 41 | Igoundem | 13 | 100 | A | 8.0 | | along the Anougal River |
| 42 | Toug Lkheif | 40 | 250 | A | 7.0 | | along the Anougal River |
| 43 | Ait Ouzkri | 40 | 250 | | 4.5 | | along the Anougal River |
| 44 | Ait Hmad | 50 | 300 | A | 6.0 | | along the Anougal River |
| 45 | Tizgui | 60 | 250 | A | 5.5 | | along the Anougal River |
| 46 | Adardour | 160 | 700 | B | | | along the Anougal River |
| 47 | Lemdinat | 160 | 985 | A | 6.5 | 22 | via [51]. 1.0km from [51] |
| 48 | Tnirt | 230 | 1,416 | | 4.0 | 22 | in the case via [49]. 1.5km from [49] |
| 49 | Anermi | 90 | 540 | | 4.0 | 22 | |
| 50 | Ansmrou | 160 | 985 | A | 8.0 | 22 | via [51]. 2.5km from [51] |
| 51 | Talat Ait Ihla | 70 | 210 | A | 5.5 | 22 | |
| 52 | Toulkine | 190 | 1,400 | | 3.0 | 22 | |
| 53 | Adghouss | 50 | 200 | A | 6.0 | 22 | via [52]. 3.0km from [52] |
| 54 | Douzrou | 220 | 1,500 | A | 8.5 | 22 | via [52]. 5.5km from [52] |
| 55 | Ait Outmane | 150 | 600 | B | 9.6 | 22 | via [54]. 1.1km from [54] |
| 56 | Tagadirt | 50 | 140 | B | | | |
| 57 | Tifirt | 90 | 150 | B | | | |
| 58 | Anfrioune | 60 | 120 | A | 8.0 | 22 | via [52]. 5.0km from [52] |
| 59 | Ait Smil | 150 | 1,400 | | 4.0 | 22 | via [63]. 1.0km from [63] |
| 60 | Tifratine | 80 | 600 | A | 7.5 | 22 | via [62]. 2.0km from [62] |
| 61 | Aguenze | 20 | 200 | A | 8.5 | 22 | |
| 62 | Ifit Baragha | 35 | 250 | A | 5.5 | 22 | |

## *Table 3.3-1 Distance between Villages and Existing Transmission Line (2/2)*

| No. | Douar Name | Households | Population | Distance from transmission | (km) | Line volt (kV) | Remarks |
|---|---|---|---|---|---|---|---|
| 63 | Agadir Baragha | 40 | 300 | | 3.0 | 22 | |
| 65 | Adar Baragha | 11 | 60 | A | 5.5 | 22 | via [66]. 1.5km from [66] |
| 66 | Tadchert | 30 | 200 | | 4.0 | 22 | via [63]. 1.0km from [63] |
| 67 | Tamsoult | 5 | 37 | | 3.5 | 22 | via [63]. 0.5km from [63] |
| 68 | Dar Jamaa Ait Ali | 60 | 220 | A | 6.5 | 22 | |
| 69 | Agadir Ait Brahim | 28 | 120 | A | 7.0 | 22 | via [68]. 0.5km from [68] |
| 70 | Iouraghan | 18 | 80 | A | 7.0 | 22 | via [68]. 0.5km from [68] |
| 71 | Imiki | 50 | 500 | A | 8.0 | 22 | |
| 72 | Ifit Ait Alla | 22 | 200 | A | 9.5 | 22 | |
| 73 | Boukhelf | 85 | 425 | A | 9.0 | 22 | via [74]. 1.5km from [74] |
| 74 | Addar Ait Ali | 22 | 150 | A | 7.5 | 22 | via [70]. 0.5km from [70] |
| 76 | Ait Bourd | 100 | 700 | B | 10.0 | 22 | via [69]. 3.0km from [69] |
| 77 | Ait M'Barek | 30 | 120 | A | 9.5 | 22 | via [69]. 2.5km from [69] |
| 78 | Agadir Ait Bourd | 60 | 400 | B | 11.0 | 22 | via [76]. 1.0km from [76] |
| 79 | Afella Ouassif | 25 | 120 | B | 10.7 | 22 | via [76]. 0.7km from [76] |
| 81 | Afella Ighil | 10 | 70 | | 1.0 | 22 | via [80]. 1.0km from [80] |
| 83 1 | Anfeg | 15 | 95 | | 1.2 | 22 | via [80]. 1.2km from [80] |
| 83 2 | Aguersouak | 20 | 100 | | 1.0 | 22 | via [80]. 1.0km from [80] |
| 84 | Ait Bouzid | 119 | 733 | | 3.2 | 22 | via [80]. 3.2km from [80] |
| 85 1 | Oumast | 35 | 180 | | 1.8 | 22 | via [80]. 1.8km from [80] |
| 85 2 | Ait Zitoun | 35 | 180 | | 1.5 | 22 | via [80]. 1.5km from [80] |
| 86 | Tagadirt | 28 | 137 | A | 7.1 | 22 | via [94]. 2.5km from [94] |
| 87 1 | Zaouit | 9 | 60 | | 3.0 | 22 | via [90]. 1.0km from [90] |
| 87 2 | Izalaghan | 12 | 62 | | 3.2 | 22 | via [90]. 1.2km from [90] |
| 88 | Tigouder | 24 | 130 | | 4.0 | 22 | via [90]. 2.0km from [90] |
| 89 | Amezi | 36 | 181 | | 2.6 | 22 | via [90]. 2.6km from [90] |
| 90 | Agouni | 30 | 172 | | 2.0 | 22 | via [80]. 2.0km from [80] |
| 91 | Chaabat Tarik | 53 | 254 | A | 5.3 | 22 | via [92]. 1.8km from [92] |
| 92 | Ighil Sdidene | 14 | 54 | | 3.5 | 22 | via [80]. 3.5km from [80] |
| 93 | Tizi | 59 | 284 | | 3.0 | 22 | via [80]. 3.0km from [80] |
| 94 | Aghbalou | 90 | 472 | | 4.6 | 22 | via [80]. 4.6km from [80] |
| 95 | Ait Hsain | 13 | 75 | | 3.4 | 22 | via [98]. 0.5km from [98] |
| 96 | Ait Boubker | 14 | 80 | | 3.9 | 22 | via [95]. 0.5km from [95] |
| 97 | Tazatourt | 33 | 152 | | 4.7 | 22 | via [98]. 1.8km from [98] |
| 98 | Tamsoulte | 33 | 320 | | 2.9 | 22 | via [83-2]. 1.9km from [83-2] |
| 99 | Tizgui | 50 | 360 | | 3.1 | 22 | via [83-1]. 1.9km from [83-1] |
| 100 | Ait Tirghit | 50 | 600 | | 4.9 | 22 | via [99].1.8km from [99] |
| 101 | Tachbibt Kabli | 30 | 220 | | 3.0 | 22 | via [102]. 0.5km from [102] |
| 102 | Tachbibt Echatoui | 30 | 150 | | 2.5 | 22 | via [107] |
| 103 | Asgoune | 30 | 270 | | 3.5 | 22 | in the case via [102].2.0km from[102] |
| 104 | Ait Aamara Loued | 80 | 420 | | 4.5 | 22 | in the case via [103].2.5km from[103] |
| 105 | Igouder | 120 | 680 | | 0.5 | 22 | |
| 106 | Lakaarna | 30 | 185 | | 1.0 | 22 | near from[111]. 0.4km from [111] |
| 107 | Ait Aamar El Bour | 70 | 492 | | 0.4 | 22 | |
| 109 | Chouirige | 120 | 800 | | 1.4 | 22 | |
| 112 | Lamhamid | 30 | 150 | | 0.3 | 22 | |
| 113 1 | Tarast | 45 | 417 | B | 17.0 | 22 | |
| 113 2 | Assaka | 45 | 387 | B | 20.0 | 22 | |
| 114 | Abadou | 110 | 800 | B | 6.0 | 22 | along the road |
| 115 | Quriz | 22 | 280 | | 0.2 | 22 | from the on going line |
| 116 | Tabant Ighi | 287 | 1,767 | A | 8.0 | 22 | |
| 117 | Ansa | 59 | 300 | B | | 22 | |
| 118 | Tidsi | 40 | 316 | B | 5.0 | 22 | |
| 119 | Ait Atmane | 104 | 900 | B | 8.0 | 22 | through the mountain |
| 120 | Ezzaouite | 16 | 121 | A | 8.0 | 22 | through the mountain |
| Total | 114 | 7,272 | 45,556 | | | | |

(Notes A: more than 5.0km
B: more than 10.0km or steep route

### 3.3.3 Village Household Number, Population and Residential Area

Table 3.3-2 indicates village household number and population for the years 1996 and 2010, as well as the present dimensions east~west and north~south for area occupied by homes. Household number and population for the year 2010 provide the basis for the power forecast for the design target year (2010).

## *Table 3.3-2 Nos. of Households and Residential Area Size of Villages (1/2)*

| Administrative Location | | Douar | | Village in 1996 | | Village in 2010 | | Residensial Area in 1996 (identfied by) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cercle | Commue R. | No. | Name | House holds | Popula-tion | House holds | Popula-tion | Frag-ments | E - W (m) | N - S (m) | Map/ | Survey |
| Asni | Ouirgane | 1 | Tizi Oussem | 72 | 444 | 86 | 537 | 1 | 200 | 150 | * | |
| | | 2 | Id Aissa | 44 | 180 | 52 | 218 | 1 | 250 | 200 | * | |
| | | 3 | Tassa Ouirgane | 55 | 375 | 65 | 454 | 1 | 800 | 500 | | * |
| | Imgdal | 4 | Igrem | 27 | 130 | 32 | 157 | 1 | 500 | 150 | | * |
| | Talat N'Yacoub | 6 | Alla Oumzri | 40 | 280 | 48 | 339 | 1 | 150 | 150 | | * |
| | Ijoukak | 7 | Id Ssior | 66 | 500 | 78 | 605 | 1 | 500 | 300 | | * |
| | Ighil | 8 | Aghella | 64 | 394 | 76 | 477 | 1 | 600 | 250 | * | |
| | Aghbar | 9 | Ikiss | 68 | 389 | 81 | 471 | 1 | 1,000 | 900 | | * |
| | Asni | 10 | Amsakrou | 55 | 420 | 65 | 508 | 1 | 300 | 200 | * | |
| | | 11 | Arg | 75 | 1,020 | 89 | 1,234 | 4 | 400 | 1,000 | * | |
| | | 12 | Tinerhouhrine | 30 | 250 | 36 | 302 | 1 | 150 | 150 | * | |
| | | 13 1 | El Bour | 65 | 510 | 77 | 617 | 1 | 300 | 300 | | * |
| | | 13 2 | Imskar | 40 | 280 | 48 | 339 | 1 | 200 | 150 | * | |
| | | 15 | Ikiss | 65 | 500 | 77 | 605 | 1 | 250 | 250 | | * |
| | | 17 | Tacheddirt | 60 | 360 | 71 | 436 | 1 | 250 | 250 | | * |
| Tahanaout | Ourika | 18 | Sqour | 45 | 360 | 53 | 436 | 1 | 120 | 300 | | * |
| | | 19 | Amagdour | 22 | 150 | 26 | 181 | 1 | 900 | 900 | | * |
| | | 20 | Tamaterte | 40 | 240 | 48 | 290 | 1 | 200 | 150 | * | |
| | Setitfadma | 21 | Anfli | 63 | 378 | 75 | 457 | 1 | 150 | 300 | | * |
| | | 22 | Timichi | 60 | 370 | 71 | 448 | 1 | 600 | 400 | | * |
| | Oukaimeden | 23 | Agouns | 105 | 630 | 125 | 762 | 1 | 500 | 500 | * | |
| | Tameslobt | 24 | Oulad Mansour | 70 | 500 | 83 | 605 | 1 | 300 | 500 | | * |
| | | 25 1 | Oulad Lahjar | 100 | 600 | 119 | 726 | 1 | 700 | 450 | * | |
| | | 25 2 | Oumnas | 150 | 800 | 178 | 968 | 1 | 600 | 300 | * | |
| | | 26 1 | Awin Mazouz | 67 | 420 | 80 | 508 | 3 | 300 | 600 | * | |
| | | 26 2 | Bouchiha Ben Omar | 66 | 400 | 78 | 484 | 1 | 800 | 350 | * | |
| | | 27 | Del El Ain | 110 | 600 | 131 | 726 | 1 | 700 | 300 | * | |
| | | 30 | Bel Abbas | 140 | 900 | 166 | 1,089 | 3 | 1,000 | 1,000 | | * |
| | | 32 | Derb Chem's | 60 | 369 | 71 | 446 | 1 | 300 | 400 | * | |
| | | 33 | Sour Tedrara | 110 | 677 | 131 | 819 | 1 | 600 | 300 | * | |
| | | 34 | Hat Tedrara | 80 | 490 | 95 | 593 | 1 | 800 | 400 | * | |
| Amizmiz | Anougal | 35 | Imin Tala | 70 | 460 | 83 | 557 | 1 | 500 | 500 | * | |
| | | 36 | Addouz | 50 | 300 | 59 | 363 | 1 | 400 | 400 | * | |
| | | 37 | Ain Ghad | 43 | 206 | 51 | 249 | 1 | 300 | 200 | * | |
| | | 38 | Inzaine | 70 | 420 | 83 | 508 | 1 | 250 | 400 | * | |
| | | 39 | Imi N'isly | 86 | 450 | 102 | 544 | 1 | 600 | 400 | * | |
| | | 40 | Dou Anamer | 35 | 220 | 42 | 266 | 1 | 200 | 200 | * | |
| | | 41 | Igoundem | 13 | 100 | 15 | 121 | 1 | 400 | 1,000 | * | |
| | | 42 | Toug Lkheif | 40 | 250 | 48 | 302 | 1 | 200 | 200 | * | |
| | | 43 | Ait Ouzkri | 40 | 250 | 48 | 302 | 1 | 250 | 150 | * | |
| | | 44 | Ait Hmad | 50 | 300 | 59 | 363 | 1 | 500 | 300 | * | |
| | | 45 | Tizgui | 60 | 250 | 71 | 302 | 1 | 800 | 1,000 | * | |
| | | 46 | Adardour | 160 | 700 | 190 | 847 | 4 | 600 | 2,700 | * | |
| | Azgour | 47 | Lemdinat | 160 | 985 | 190 | 1,192 | 1 | 500 | 400 | * | |
| | | 48 | Tnirt | 230 | 1,416 | 273 | 1,713 | 1 | 800 | 750 | * | |
| | | 49 | Anermi | 90 | 540 | 107 | 653 | 1 | 500 | 500 | * | |
| | | 50 | Ansmrou | 160 | 985 | 190 | 1,192 | 1 | 450 | 300 | * | |
| | | 51 | Talat Ait Ihla | 70 | 210 | 83 | 254 | 1 | 500 | 450 | * | |
| | | 52 | Toulkine | 190 | 1,400 | 226 | 1,694 | 1 | 600 | 350 | | * |
| | | 53 | Adghouss | 50 | 200 | 59 | 242 | 1 | 150 | 150 | * | |
| | | 54 | Douzrou | 220 | 1,500 | 261 | 1,815 | 1 | 350 | 200 | * | |
| | | 55 | Ait Outmane | 150 | 600 | 178 | 726 | 1 | 1,750 | 1,100 | * | |
| | | 56 | Tagadirt | 50 | 140 | 59 | 169 | 1 | 150 | 150 | * | |
| | | 57 | Tifirt | 90 | 150 | 107 | 181 | 1 | 600 | 400 | * | |
| | | 58 | Anfrioune | 60 | 120 | 71 | 145 | 1 | 300 | 450 | * | |
| | Dar Jamaa | 59 | Ait Smil | 150 | 1,400 | 178 | 1,694 | 1 | 700 | 700 | | * |
| | | 60 | Tifratine | 80 | 600 | 95 | 726 | 1 | 3,000 | 2,000 | | * |
| | | 61 | Aguenze | 20 | 200 | 24 | 242 | 1 | 300 | 250 | | * |
| | | 62 | Ifit Baragha | 35 | 250 | 42 | 302 | 1 | 1,150 | 1,150 | | * |
| | | 63 | Agadir Baragha | 40 | 300 | 48 | 363 | 1 | 400 | 800 | | * |

# *Table 3.3-2 Nos. of Households and Residential Area Size of Villages (2/2)*

| Administrative Location | | Douar | | Village in 1996 | | Village in 2010 | | Residensial Area in 1996 (identfied by) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cercle | Commue R. | No. | Name | House holds | Popula-tion | House holds | Popula-tion | Frag-ments | E - W (m) | N - S (m) | Map/ | Survey |
| Administrative Location | | Douar | | Village in 1996 | | Village in 2010 | | Residensial Area in 1996 (identfied by) | | | | |
| Cercle | Commue R. | No. | Name | House holds | Popula-tion | House holds | Popula-tion | Frag-ments | E - W (m) | N - S (m) | Map/ | Survey |
| | | 65 | Adar Baragha | 11 | 60 | 13 | 73 | 1 | 500 | 250 | | * |
| | | 66 | Tadchert | 30 | 200 | 36 | 242 | 1 | 600 | 400 | | * |
| | | 67 | Tamsoult | 5 | 37 | 6 | 45 | 1 | 500 | 500 | | * |
| | | 68 | Dar Jamaa Ait Ali | 60 | 220 | 71 | 266 | 1 | 400 | 300 | | * |
| | | 69 | Agadir Ait Brahim | 28 | 120 | 33 | 145 | 1 | 500 | 300 | | * |
| | | 70 | Iouraghan | 18 | 80 | 21 | 97 | 1 | 300 | 200 | | * |
| | | 71 | Imiki | 50 | 500 | 59 | 605 | 1 | 400 | 300 | | * |
| | | 72 | Ifit Ait Alla | 22 | 200 | 26 | 242 | 1 | 1,000 | 500 | | * |
| | | 73 | Boukhelf | 85 | 425 | 101 | 514 | 1 | 1,000 | 500 | | * |
| | | 74 | Addar Ait Ali | 22 | 150 | 26 | 181 | 1 | 400 | 300 | | * |
| | | 76 | Ait Bourd | 100 | 700 | 119 | 847 | 1 | 1,000 | 400 | | * |
| | | 77 | Ait M'Barek | 30 | 120 | 36 | 145 | 1 | 300 | 200 | | * |
| | | 78 | Agadir Ait Bourd | 60 | 400 | 71 | 484 | 1 | 500 | 300 | | * |
| | | 79 | Afella Ouassif | 25 | 120 | 30 | 145 | 1 | 700 | 400 | | * |
| | Ameghrass | 81 | Afella Ighil | 10 | 70 | 12 | 85 | 1 | 150 | 150 | * | |
| | | 83 1 | Anfeg | 15 | 95 | 18 | 115 | 1 | 150 | 200 | * | |
| | | 83 2 | Aguersouak | 20 | 100 | 24 | 121 | 1 | 200 | 100 | * | |
| | | 84 | Ait Bouzid | 119 | 733 | 141 | 887 | 1 | 200 | 250 | * | |
| | | 85 1 | Oumast | 35 | 180 | 42 | 218 | 1 | 250 | 200 | * | |
| | | 85 2 | Ait Zitoun | 35 | 180 | 42 | 218 | 1 | 200 | 200 | * | |
| | | 86 | Tagadirt | 28 | 137 | 33 | 166 | 1 | 200 | 200 | * | |
| | | 87 1 | Zaouit | 9 | 60 | 11 | 73 | 1 | 200 | 200 | * | |
| | | 87 2 | Izalaghan | 12 | 62 | 14 | 75 | 1 | 250 | 200 | * | |
| | | 88 | Tigouder | 24 | 130 | 29 | 157 | 1 | 200 | 200 | * | |
| | | 89 | Amezi | 36 | 181 | 43 | 219 | 1 | 500 | 200 | | * |
| | | 90 | Agouni | 30 | 172 | 36 | 208 | 1 | 100 | 300 | | * |
| | | 91 | Chaabat Tarik | 53 | 254 | 63 | 307 | 1 | 250 | 300 | * | |
| | | 92 | Ighil Sdidene | 14 | 54 | 17 | 65 | 1 | 300 | 500 | | * |
| | | 93 | Tizi | 59 | 284 | 70 | 344 | 1 | 500 | 500 | | * |
| | | 94 | Aghbalou | 90 | 472 | 107 | 571 | 1 | 400 | 500 | * | |
| | | 95 | Ait Hsain | 13 | 75 | 15 | 91 | 1 | 200 | 200 | * | |
| | | 96 | Ait Boubker | 14 | 80 | 17 | 97 | 1 | 300 | 600 | | * |
| | | 97 | Tazatourt | 33 | 152 | 39 | 184 | 1 | 200 | 300 | * | |
| | | 98 | Tamsoulte | 33 | 320 | 39 | 387 | 1 | 200 | 200 | * | |
| | | 99 | Tizgui | 50 | 360 | 59 | 436 | 1 | 300 | 250 | * | |
| | | 100 | Ait Tirghit | 50 | 600 | 59 | 726 | 1 | 400 | 600 | | * |
| | Sidi Badhaj | 101 | Tachbibt Kabli | 30 | 220 | 36 | 266 | 1 | 500 | 1,000 | | * |
| | | 102 | Tachbibt Echatoui | 30 | 150 | 36 | 181 | 1 | 500 | 1,500 | | * |
| | | 103 | Asgoune | 30 | 270 | 36 | 327 | 1 | 1,000 | 400 | | * |
| | | 104 | Ait Aamara Loued | 80 | 420 | 95 | 508 | 3 | 1,000 | 600 | | * |
| | | 105 | Igouder | 120 | 680 | 143 | 823 | 1 | 1,000 | 500 | | * |
| | | 106 | Lakaarna | 30 | 185 | 36 | 224 | 1 | 300 | 1,300 | | * |
| | | 107 | Ait Aamar El Bour | 70 | 492 | 83 | 595 | 1 | 1,000 | 2,000 | | * |
| | | 109 | Chouirige | 120 | 800 | 143 | 968 | 2 | 900 | 600 | | * |
| | | 112 | Lamhamid | 30 | 150 | 36 | 181 | 1 | 600 | 800 | | * |
| Ait Ourir | Ait Aadel | 113 1 | Tarast | 45 | 417 | 53 | 505 | 1 | 800 | 500 | | * |
| | | 113 2 | Assaka | 45 | 387 | 53 | 468 | 1 | 700 | 500 | | * |
| | Abadour | 114 | Abadou | 110 | 800 | 131 | 968 | 1 | 3,000 | 1,000 | | * |
| | Zerkten | 115 | Quriz | 22 | 280 | 26 | 339 | 1 | 300 | 100 | | * |
| | | 116 | Tabant Ighi | 287 | 1,767 | 341 | 2,138 | 18 | 6,500 | 3,000 | * | |
| | Tighdouine | 117 | Ansa | 59 | 300 | 70 | 363 | 1 | 300 | 800 | | * |
| | | 118 | Tidsi | 40 | 316 | 48 | 382 | 1 | 300 | 800 | | * |
| | | 119 | Ait Atmane | 104 | 900 | 124 | 1,089 | 1 | 500 | 200 | | * |
| | | 120 | Ezzaouite | 16 | 121 | 19 | 146 | 1 | 200 | 400 | | * |
| Total | | 114 | | 7,272 | 45,556 | 8,640 | 55,116 | | | | 57 | 57 |

(Notes) 1) Households in 2010 are estimated with an annual growth rates of 1.24% based on those in 1996.
2) Population in 2010 are estimated with an annual growth rates of 1.37% based on those in 1996.
3) Fragments are number of pieces of fragmentation of residential area.

### 3.3.4 Nos. of Facilities to Utilize Power By Category

(1) Schools to be Electrified

Table 3.3-3 indicates the present status (as of 1996) of the target villages with regard to schools. Power demand forecast for schools was based on assumptions of (i) that the number would not increase in the future, and (ii) the number of light fixtures per school.

(2) Public and Commercial Facilities to be Electrified

Table 3.3-4 indicates the present status (as of 1996) of the target villages with regard to public and commercial facilities.

(3) Present Status of Flour Milling and Pottery Industries

Table 3.3-5 indicates the present status (as of 1996) of the target villages with regard to public and commercial facilities. Power demand for these industries was outside the Study scope (details in section 5.4).

# Table 3.3-3 Schools Targeted for Electrification (1/2)

| Administrative Location | | Douars | | Situation in 1996 | | | | Prediction in 2000 & 2010 |
|---|---|---|---|---|---|---|---|---|
| Cercle | Commue R. | No. | Name | Schools | Classes | Students | Space ($m^2$) | Schools |
| Asni | Ouirgane | 1 | Tizi Oussem | 3 | 3 | 85 | 170 | 3 |
| | | 2 | Id Aissa | 2 | 2 | 42 | 84 | 2 |
| | | 3 | Tassa Ouirgane | 1 | 1 | 20 | 40 | 1 |
| | Imgdal | 4 | Igrem | 2 | 3 | 95 | 190 | 2 |
| | Talat N'Yacoub | 6 | Alla Oumzri | 0 | 0 | 0 | 0 | 0 |
| | Ijoukak | 7 | Id Ssior | 1 | 3 | 70 | 140 | 1 |
| | Ighil | 8 | Aghella | 1 | 2 | 50 | 100 | 1 |
| | Aghbar | 9 | Ikiss | 1 | 1 | 30 | 60 | 1 |
| | Asni | 10 | Amsakrou | 2 | 5 | 54 | 108 | 2 |
| | | 11 | Arg | 1 | 2 | 46 | 92 | 1 |
| | | 12 | Tinerhouhrine | 1 | 1 | 35 | 70 | 1 |
| | | 13 1 | El Bour | 2 | 4 | 60 | 120 | 2 |
| | | 13 2 | Imskar | 1 | 1 | 10 | 20 | 1 |
| | | 15 | Ikiss | 2 | 4 | 35 | 70 | 2 |
| | | 17 | Tacheddirt | 2 | 2 | 40 | 80 | 2 |
| Tahanaout | Ourika | 18 | Sqour | 1 | 2 | 35 | 70 | 1 |
| | | 19 | Amagdour | 0 | 0 | 0 | 0 | 0 |
| | | 20 | Tamaterte | 2 | 2 | 40 | 80 | 2 |
| | Settifadma | 21 | Anfli | 2 | 3 | 15 | 30 | 2 |
| | | 22 | Timichi | 2 | 4 | 68 | 136 | 2 |
| | Oukaimeden | 23 | Agouns | 2 | 2 | 55 | 110 | 2 |
| | Tameslcht | 24 | Oulad Mansour | 2 | 2 | 40 | 80 | 2 |
| | | 25 1 | Oulad Lahjar | 1 | 4 | 100 | 200 | 1 |
| | | 25 2 | Oumnas | 1 | 3 | 300 | 600 | 1 |
| | | 26 1 | Awin Mazouz | 1 | 1 | 20 | 40 | 1 |
| | | 26 2 | Bouchiha Bon O | 1 | 3 | 120 | 240 | 1 |
| | | 27 | Del El Ain | 1 | 8 | 200 | 400 | 1 |
| | | 30 | Bel Abbas | 1 | 4 | 160 | 320 | 1 |
| | | 32 | Derb Chem's | 1 | 3 | 80 | 160 | 1 |
| | | 33 | Sour Tedrara | 2 | 2 | 160 | 320 | 2 |
| | | 34 | Tlat Tedrara | 2 | 2 | 30 | 60 | 2 |
| Amizmiz | Anougal | 35 | Imin Tala | 0 | 0 | 0 | 0 | 0 |
| | | 36 | Addouz | 2 | 2 | 32 | 64 | 2 |
| | | 37 | Ain Ghad | 1 | 3 | 130 | 260 | 1 |
| | | 38 | Inzaine | 1 | 2 | 80 | 160 | 1 |
| | | 39 | Imi N'isly | 0 | 0 | 0 | 0 | 0 |
| | | 40 | Dou Anamer | 1 | 1 | 15 | 30 | 1 |
| | | 41 | Igoundem | 0 | 0 | 0 | 0 | 0 |
| | | 42 | Toug Lkheif | 2 | 2 | 40 | 80 | 2 |
| | | 43 | Ait Ouzkri | 1 | 1 | 20 | 40 | 1 |
| | | 44 | Ait Hmad | 1 | 1 | 30 | 60 | 1 |
| | | 45 | Tizgui | 1 | 1 | 31 | 62 | 1 |
| | | 46 | Adardour | 6 | 6 | 105 | 210 | 6 |
| | Azgour | 47 | Lemdinat | 2 | 5 | 60 | 120 | 2 |
| | | 48 | Tnirt | 1 | 6 | 120 | 240 | 1 |
| | | 49 | Anermi | 1 | 2 | 120 | 240 | 1 |
| | | 50 | Ansmrou | 1 | 2 | 50 | 100 | 1 |
| | | 51 | Talat Ait Ihla | 0 | 0 | 0 | 0 | 0 |
| | | 52 | Toulkine | 1 | 4 | 70 | 140 | 1 |
| | | 53 | Adghouss | 2 | 2 | 49 | 98 | 2 |
| | | 54 | Douzrou | 1 | 2 | 40 | 80 | 1 |
| | | 55 | Ait Outmane | 1 | 1 | 68 | 136 | 1 |
| | | 56 | Tagadirt | 0 | 0 | 0 | 0 | 0 |
| | | 57 | Tifirt | 2 | 3 | 42 | 84 | 2 |
| | | 58 | Anfrioune | 1 | 1 | 30 | 60 | 1 |
| | Dar Jamaa | 59 | Ait Smil | 2 | 6 | 75 | 150 | 2 |
| | | 60 | Tifratine | 1 | 2 | 50 | 100 | 1 |
| | | 61 | Aguenze | 1 | 1 | 15 | 30 | 1 |
| | | 62 | Ifit Baragha | 0 | 0 | 0 | 0 | 0 |
| | | 63 | Agadir Baragha | 1 | 2 | 35 | 70 | 1 |
| | | 65 | Adar Baragha | 0 | 0 | 0 | 0 | 0 |
| | | 66 | Tadchert | 0 | 0 | 0 | 0 | 0 |
| | | 67 | Tamsoult | 0 | 0 | 0 | 0 | 0 |
| | | 68 | Dar Jamaa Ait Ali | 1 | 7 | 130 | 260 | 1 |
| | | 69 | Agadir Ait Brahi | 0 | 0 | 0 | 0 | 0 |
| | | 70 | Iouraghan | 0 | 0 | 0 | 0 | 0 |
| | | 71 | Imiki | 0 | 0 | 0 | 0 | 0 |

## *Table 3.3-3 Schools Targeted for Electrification (2/2)*

| Administrative Location | | Douars | | Situation in 1996 | | | | Prediction in 2000 & 2010 |
|---|---|---|---|---|---|---|---|---|
| Cercle | Commue R. | No. | Name | Schools | Classes | Students | Space (m²) | Schools |
| | | 72 | Hit Ait Alla | 0 | 0 | 0 | 0 | 0 |
| | | 73 | Boukhelf | 1 | 2 | 60 | 120 | 1 |
| | | 74 | Addar Ait Ali | 1 | 1 | 15 | 30 | 1 |
| | | 76 | Ait Bourd | 1 | 4 | 40 | 80 | 1 |
| | | 77 | Ait M Barek | 0 | 0 | 0 | 0 | 0 |
| | | 78 | Agadir Ait Bourd | 0 | 0 | 0 | 0 | 0 |
| | | 79 | Afella Ouassif | 0 | 0 | 0 | 0 | 0 |
| | Ameghrass | 81 | Afella Ighil | 0 | 0 | 0 | 0 | 0 |
| | | 83 1 | Anfeg | 0 | 0 | 0 | 0 | 0 |
| | | 83 2 | Aguersouak | 1 | 3 | 25 | 50 | 1 |
| | | 84 | Ait Bouzid | 1 | 2 | 50 | 100 | 1 |
| | | 85 1 | Oumast | 1 | 1 | 35 | 70 | 1 |
| | | 85 2 | Ait Zitoun | 0 | 0 | 0 | 0 | 0 |
| | | 86 | Tagadirt | 0 | 0 | 0 | 0 | 0 |
| | | 87 1 | Zaouit | 0 | 0 | 0 | 0 | 0 |
| | | 87 2 | Izalaghan | 0 | 0 | 0 | 0 | 0 |
| | | 88 | Tigouder | 2 | 6 | 137 | 274 | 2 |
| | | 89 | Amezi | 1 | 4 | 120 | 240 | 1 |
| | | 90 | Agouni | 1 | 3 | 15 | 30 | 1 |
| | | 91 | Chaabat Tarik | 1 | 1 | 30 | 60 | 1 |
| | | 92 | Ighil Sdidene | 0 | 0 | 0 | 0 | 0 |
| | | 93 | Tizi | 1 | 1 | 25 | 50 | 1 |
| | | 94 | Aghbalou | 2 | 4 | 60 | 120 | 2 |
| | | 95 | Ait Hsain | 0 | 0 | 0 | 0 | 0 |
| | | 96 | Ait Boubker | 1 | 1 | 38 | 76 | 1 |
| | | 97 | Tazatourt | 0 | 0 | 0 | 0 | 0 |
| | | 98 | Tamsoulte | 1 | 1 | 38 | 76 | 1 |
| | | 99 | Tizgui | 1 | 1 | 35 | 70 | 1 |
| | | 100 | Ait Tirghit | 1 | 2 | 52 | 104 | 1 |
| | Sidi Badhaj | 101 | Tachbibt Kabli | 0 | 0 | 0 | 0 | 0 |
| | | 102 | Tachbibt Echatou | 1 | 5 | 70 | 140 | 1 |
| | | 103 | Asgoune | 0 | 0 | 0 | 0 | 0 |
| | | 104 | Ait Aamara Loue | 1 | 6 | 120 | 240 | 1 |
| | | 105 | Igouder | 2 | 3 | 70 | 140 | 2 |
| | | 106 | Lakaama | 0 | 0 | 0 | 0 | 0 |
| | | 107 | Ait Aamar El Bou | 1 | 7 | 200 | 400 | 1 |
| | | 109 | Chouirige | 1 | 2 | 30 | 60 | 1 |
| | | 112 | Lamhamid | 0 | 0 | 0 | 0 | 0 |
| Ait Ourir | Ait Aadel | 113 1 | Tarast | 1 | 3 | 50 | 100 | 1 |
| | | 113 2 | Assaka | 0 | 0 | 0 | 0 | 0 |
| | Abadour | 114 | Abadou | 2 | 7 | 170 | 340 | 2 |
| | Zerkten | 115 | Quriz | 1 | 2 | 60 | 120 | 1 |
| | | 116 | Tabant Ighi | 2 | 3 | 214 | 428 | 2 |
| | Tighdouine | 117 | Ansa | 1 | 2 | 70 | 140 | 1 |
| | | 118 | Tidsi | 0 | 0 | 0 | 0 | 0 |
| | | 119 | Ait Atmane | 1 | 6 | 150 | 300 | 1 |
| | | 120 | Ezzaouite | 1 | 1 | 30 | 60 | 1 |
| Total or Average | | 114 | | 112 | 228 | 5,541 | 11,082 | 112 |
| Max. | | | | 6 | 8 | 300 | 600 | 6 |
| Min. | | | | 0 | 0 | 0 | 0 | 0 |
| S.D. | | | | 0.9 | 2 | 55 | 110 | 0.9 |

(Notes) 1) Schools are composed of Koranic and Primary Schools.
2) Space is estimated with $2m^2$ for one student.
3) Numbers of schools in 2010 is predicted not increasse after 1996.

## Table 3.3-4 Public Facilities and Industries Targeted for Electrification (1/2)

| Administrative Location | | Douar | | Mosques | | Public Halls | | Cooperatives | | First Aid | | Warehouse | | Stores | | Butchers | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cercle | Commune R. | No. | Name | Nos. | Space (m²) | Nos. | Space (m²) | Nos. | Space (m²) | Nos. | Space (m²) | Nos. | Space (m²) | Nos. | Space (m²) | Nos. | Space (m²) |
| Asni | Ouirgane | 1 | Tizi Oussem | 1 | 400 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 8 | 0 | 0 |
| | | 2 | Id Aissa | 1 | 250 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 8 | 2 | 6 |
| | | 3 | Tassa Ouirgane | 1 | 240 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 8 | 0 | 0 |
| | Imgdal | 4 | Igrem | 1 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 10 | 0 | 0 |
| | Talat N'Yacoub | 6 | Alla Oumzri | 1 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 40 | 0 | 0 |
| | Ijoukak | 7 | Id Ssior | 1 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 60 | 0 | 0 |
| | Ighil | 8 | Aghella | 1 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 40 | 0 | 0 |
| | Aghbar | 9 | Ikiss | 1 | 30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 20 | 0 | 0 |
| | Asni | 10 | Amsakrou | 1 | 200 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 10 | 0 | 0 |
| | | 11 | Arg | 1 | 400 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 20 | 0 | 0 |
| | | 12 | Tinerhoubrine | 1 | 200 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 8 | 1 | 6 |
| | | 13 1 | El Bour | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 10 | 0 | 0 |
| | | 13 2 | Imskar | 1 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 15 | Ikiss | 1 | 300 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 8 | 2 | 6 |
| | | 17 | Tacheddirt | 1 | 200 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 8 | 1 | 6 |
| Tahanao | Ourika | 18 | Sqour | 1 | 500 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 20 | 0 | 0 |
| | | 19 | Amagdour | 1 | 300 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 20 | Tamaterte | 1 | 200 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Settifadma | 21 | Anfli | 1 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 8 | 0 | 0 |
| | | 22 | Timichi | 1 | 200 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 10 | 0 | 0 |
| | Oukaimeden | 23 | Agouns | 1 | 400 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Tamesloht | 24 | Oulad Mansour | 1 | 300 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 10 | 0 | 0 |
| | | 25 1 | Oulad Lahjar | 1 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 15 | 0 | 0 |
| | | 25 2 | Oumnas | 1 | 200 | 0 | 0 | 0 | 0 | 1 | 100 | 0 | 0 | 4 | 20 | 0 | 0 |
| | | 26 1 | Awin Mazouz | 1 | 150 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 10 | 1 | 10 |
| | | 26 2 | Bouchiha Bon Omar | 1 | 200 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 50 | 0 | 0 |
| | | 27 | Del El Ain | 1 | 200 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 70 | 0 | 0 |
| | | 30 | Bel Abbas | 3 | 300 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 100 | 0 | 0 |
| | | 32 | Derb Chem's | 1 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 30 | 0 | 0 |
| | | 33 | Sour Tedrara | 1 | 150 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 | 20 | 0 | 0 |
| | | 34 | Tlat Tedrara | 2 | 500 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 8 | 0 | 0 |
| Amizmi | Anougal | 35 | Imin Tala | 1 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 100 | 1 | 15 |
| | | 36 | Addouz | 1 | 120 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 37 | Ain Ghad | 1 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 80 | 0 | 0 |
| | | 38 | Inzaine | 1 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 100 | 1 | 15 |
| | | 39 | Imi N'isly | 1 | 100 | 0 | 0 | 1 | 80 | 0 | 0 | 0 | 0 | 5 | 100 | 0 | 0 |
| | | 40 | Dou Anamer | 1 | 150 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 41 | Igoundem | 1 | 100 | 0 | 0 | 1 | 80 | 0 | 0 | 0 | 0 | 1 | 15 | 0 | 0 |
| | | 42 | Toug Lkheif | 1 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 43 | Ait Ouzkri | 1 | 50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 44 | Ait Hmad | 1 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 20 | 0 | 0 |
| | | 45 | Tizgui | 1 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 16 | 0 | 0 |
| | | 46 | Adardour | 1 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 15 | 0 | 0 |
| | Azgour | 47 | Lemdinat | 1 | 200 | 0 | 0 | 1 | 40 | 0 | 0 | 0 | 0 | 4 | 10 | 0 | 0 |
| | | 48 | Tnirt | 2 | 350 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 60 | 3 | 50 |
| | | 49 | Anemi | 3 | 400 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 50 | 0 | 0 |
| | | 50 | Ansmrou | 1 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 10 | 0 | 0 |
| | | 51 | Talat Ait Ibla | 1 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 20 | 0 | 0 |
| | | 52 | Toulkine | 2 | 400 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 200 | 2 | 30 |
| | | 53 | Adghouss | 1 | 80 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 10 | 0 | 0 |
| | | 54 | Douzrou | 1 | 120 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 10 | 0 | 0 |
| | | 55 | Ait Outmane | 1 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 10 | 0 | 0 |
| | | 56 | Tagadirt | 1 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 57 | Tifirt | 1 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 10 | 0 | 0 |
| | | 58 | Anfrioune | 1 | 80 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 10 | 0 | 0 |
| | Dar Jamaa | 59 | Ait Smil | 1 | 200 | 0 | 0 | 2 | 100 | 0 | 0 | 0 | 0 | 7 | 50 | 0 | 0 |
| | | 60 | Tifratine | 1 | 200 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 9 | 0 | 0 |
| | | 61 | Aguenze | 1 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 62 | Ifit Baragha | 1 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 20 | 0 | 0 |
| | | 63 | Agadir Baragha | 1 | 30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 65 | Adar Baragha | 1 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 66 | Tadchert | 1 | 120 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 10 | 0 | 0 |
| | | 67 | Tamsoult | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 68 | Dar Jamaa Ait Ali | 1 | 400 | 1 | 340 | 0 | 0 | 1 | 225 | 0 | 0 | 2 | 50 | 0 | 0 |
| | | 69 | Agadir Ait Brahim | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 8 | 0 | 0 |
| | | 70 | Iouraghan | 1 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 71 | Imiki | 1 | 100 | 0 | 0 | 1 | 153 | 0 | 0 | 0 | 0 | 2 | 10 | 0 | 0 |
| | | 72 | Ifit Ait Alla | 1 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 15 | 0 | 0 |
| | | 73 | Boukhelf | 2 | 400 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 100 | 0 | 0 |
| | | 74 | Addar Ait Ali | 1 | 16 | 0 | 0 | 1 | 48 | 0 | 0 | 0 | 0 | 1 | 4 | 0 | 0 |

## *Table 3.3-4 Public Facilities and Industries Targeted for Electrification (2/2)*

| Administrative Location | | Douar | | Mosques | | Public Halls | | Cooperatives | | First Aid | | Warehouse | | Stores | | Butchers | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cercle | Commune R. | No. | Name | Nos. | Space ($m^2$) | Nos. | Space ($m^2$) | Nos. | Space ($m^2$) | Nos. | Space ($m^2$) | Nos. | Space ($m^2$) | Nos. | Space ($m^2$) | Nos. | Space ($m^2$) |
| | | 76 | Ait Bourd | 1 | 200 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 80 | 0 | 0 |
| | | 77 | Ait M Barek | 1 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 15 | 0 | 0 |
| | | 78 | Agadir Ait Bourd | 1 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 16 | 0 | 0 |
| | | 79 | Afella Ouassif | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Ameghrass | 81 | Afella Ighil | 1 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 83 1 | Anfeg | 1 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 83 2 | Aguersouak | 1 | 110 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 84 | Ait Bouzid | 1 | 50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 20 | 0 | 0 |
| | | 85 1 | Oumast | 1 | 30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 85 2 | Ait Zitoun | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 86 | Tagadirt | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 87 1 | Zaouit | 1 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 87 2 | Izalaghan | 1 | 110 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 88 | Tigouder | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 89 | Amezi | 1 | 150 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 90 | Agouni | 1 | 60 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 91 | Chaabat Tarik | 2 | 400 | 0 | 0 | 1 | 100 | 0 | 0 | 0 | 0 | 2 | 8 | 0 | 0 |
| | | 92 | Ighil Sdidene | 1 | 80 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 93 | Tizi | 1 | 200 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 50 | 0 | 0 |
| | | 94 | Aghbalou | 1 | 225 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 18 | 0 | 0 |
| | | 95 | Ait Hsain | 1 | 200 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 4 | 0 | 0 |
| | | 96 | Ait Boubker | 1 | 150 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 97 | Tazatourt | 1 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 12 | 0 | 0 |
| | | 98 | Tamsoulte | 1 | 200 | 1 | 40 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 6 | 0 | 0 |
| | | 99 | Tizgui | 1 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 16 | 0 | 0 |
| | | 100 | Ait Tirghit | 1 | 300 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Sidi Badhaj | 101 | Tachbibt Kabli | 2 | 300 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 30 | 0 | 0 |
| | | 102 | Tachbibt Echatoui | 1 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 30 | 0 | 0 |
| | | 103 | Asgoune | 1 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 8 | 0 | 0 |
| | | 104 | Ait Aamara Loued | 2 | 200 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 6 | 0 | 0 |
| | | 105 | Igouder | 1 | 120 | 1 | 175 | 1 | 45 | 1 | 94 | 0 | 0 | 2 | 10 | 0 | 0 |
| | | 106 | Lakaama | 1 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 107 | Ait Aamar El Bour | 3 | 300 | 0 | 0 | 1 | 100 | 0 | 0 | 0 | 0 | 3 | 60 | 1 | 20 |
| | | 109 | Chouirige | 1 | 100 | 0 | 0 | 1 | 100 | 0 | 0 | 0 | 0 | 2 | 30 | 2 | 30 |
| | | 112 | Lamhamid | 3 | 300 | 0 | 0 | 1 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ait Ouri | Ait Aadel | 113 1 | Tarast | 2 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 30 | 2 | 30 |
| | | 113 2 | Assaka | 1 | 140 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 50 | 0 | 0 |
| | Abadour | 114 | Abadou | 2 | 300 | 1 | 300 | 0 | 0 | 1 | 500 | 1 | 24 | 0 | 0 | 4 | 24 |
| | Zerkten | 115 | Quriz | 1 | 360 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 116 | Tabant Ighi | 4 | 80 | 0 | 0 | 0 | 0 | 1 | 20 | 0 | 0 | 6 | 8 | 0 | 0 |
| | Tighdouine | 117 | Ansa | 2 | 200 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 60 | 0 | 0 |
| | | 118 | Tidsi | 1 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 50 | 0 | 0 |
| | | 119 | Ait Atmane | 3 | 300 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 120 | 2 | 30 |
| | | 120 | Ezzaouite | 3 | 300 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 50 | 0 | 0 |
| Total | | | 114 | 132 | ###### | 4 | 855 | 12 | 946 | 5 | 939 | 1 | 24 | 234 | 2,538 | 25 | 278 |
| Average size | | | | | 140 | | 214 | | 1,892 | | 188 | | 24 | | 11 | | 11 |
| Villages having public facilities | | | | 107 | 93.9% | 4 | 3.5% | 11 | 9.6% | 5 | 4.4% | 1 | 0.9% | 81 | 71.1% | 14 | 12.3% |

*Table 3.3-5 Status of Flour Milling Industry in the Villages (1/2)*

| Administrative Location | | Douar | | Flour Mill | | | | | Pottery Households |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Number & Energy of Mills | | | | Capacity | |
| Cerele | Commue R. | No. | Name | Total | Petrol | Water | Animal | (kg/day) | |
| Asni | Ouirgane | 1 | Tizi Oussem | 5 | 0 | 5 | 0 | 300 | 0 |
| | | 2 | Id Aissa | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 3 | Tassa Ouirgane | 5 | 0 | 0 | 5 | 200 | 0 |
| | Imgdal | 4 | Igrem | 1 | 0 | 1 | 0 | 150 | 0 |
| | Talat N'Yacoub | 6 | Alla Oumzri | 3 | 0 | 3 | 0 | 150 | 0 |
| | Ijoukak | 7 | Id Ssior | 1 | 1 | 0 | 0 | 100 | 0 |
| | Ighil | 8 | Aghella | 0 | 0 | 0 | 0 | 0 | 0 |
| | Aghbar | 9 | Ikiss | 0 | 0 | 0 | 0 | 0 | 0 |
| | Asni | 10 | Amsakrou | 1 | 0 | 1 | 0 | 124 | 0 |
| | | 11 | Arg | 2 | 0 | 2 | 0 | 224 | 0 |
| | | 12 | Tinerhouhrine | 2 | 0 | 2 | 0 | 320 | 0 |
| | | 13 1 | El Bour | 1 | 0 | 1 | 0 | 150 | 0 |
| | | 13 2 | Imskar | 1 | 0 | 1 | 0 | 80 | 0 |
| | | 15 | Ikiss | 1 | 0 | 1 | 0 | 144 | 0 |
| | | 17 | Tacheddirt | 1 | 0 | 1 | 0 | 140 | 0 |
| Tahanaout | Ourika | 18 | Sqour | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 19 | Amagdour | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 20 | Tamaterte | 0 | 0 | 0 | 0 | 0 | 0 |
| | Settifadma | 21 | Anfli | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 22 | Timichi | 0 | 0 | 0 | 0 | 0 | 0 |
| | Oukaimeden | 23 | Agouns | 0 | 0 | 0 | 0 | 0 | 0 |
| | Tamesloht | 24 | Oulad Mansour | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 25 1 | Oulad Lahjar | 1 | 1 | 0 | 0 | 300 | 0 |
| | | 25 2 | Oumnas | 1 | 1 | 0 | 0 | 300 | 0 |
| | | 26 1 | Awin Mazouz | 1 | 1 | 0 | 0 | 160 | 2 |
| | | 26 2 | Bouchiha Bon Omar | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 27 | Del El Ain | 1 | 1 | 0 | 0 | 960 | 0 |
| | | 30 | Bel Abbas | 2 | 2 | 0 | 0 | 600 | 0 |
| | | 32 | Derb Chem's | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 33 | Sour Tedrara | 1 | 1 | 0 | 0 | 150 | 0 |
| | | 34 | Tlat Tedrara | 1 | 1 | 0 | 0 | 200 | 0 |
| Amizmiz | Anougal | 35 | Imin Tala | 4 | 0 | 4 | 0 | 1900 | 0 |
| | | 36 | Addouz | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 37 | Ain Ghad | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 38 | Inzaine | 3 | 3 | 0 | 0 | 600 | 0 |
| | | 39 | Imi N'isly | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 40 | Dou Anamer | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 41 | Igoundem | 2 | 2 | 0 | 0 | 150 | 0 |
| | | 42 | Toug Lkheif | 0 | 0 | 0 | 0 | 0 | 4 |
| | | 43 | Ait Ouzkri | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 44 | Ait Hmad | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 45 | Tizgui | 1 | 0 | 1 | 0 | 90 | 0 |
| | | 46 | Adardour | 0 | 0 | 0 | 0 | 0 | 0 |
| | Azgour | 47 | Lemdinat | 2 | 0 | 2 | 0 | 240 | 0 |
| | | 48 | Tnirt | 1 | 1 | 0 | 0 | 90 | 0 |
| | | 49 | Anermi | 1 | 1 | 0 | 0 | 100 | 0 |
| | | 50 | Ansmrou | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 51 | Talat Ait Ihla | 1 | 0 | 1 | 0 | 100 | 0 |
| | | 52 | Toulkine | 2 | 2 | 0 | 0 | 400 | 0 |
| | | 53 | Adghouss | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 54 | Douzrou | 2 | 2 | 0 | 0 | 1050 | 0 |
| | | 55 | Ait Outmane | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 56 | Tagadirt | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 57 | Tifirt | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 58 | Anfrioune | .0 | 0 | 0 | 0 | 0 | 0 |
| | Dar Jamaa | 59 | Ait Smil | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 60 | Tifratine | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 61 | Aguenze | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 62 | Ifit Baragha | 1 | 1 | 0 | 0 | 800 | 0 |
| | | 63 | Agadir Baragha | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 65 | Adar Baragha | 0 | 0 | 0 | 0 | 0 | 0 |

## Table 3.3-5 Status of Flour Milling Industry in the Villages (2/2)

| Administrative Location | | Douar | | Flour Mill | | | | | Pottery |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Number & Energy of Mills | | | | Capacity | House- |
| Cerele | Commue R. | No. | Name | Total | Petrol | Water | Animal | (kg/day) | holds |
| | | 66 | Tadchert | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 67 | Tamsoult | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 68 | Dar Jamaa Ait Ali | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 69 | Agadir Ait Brahim | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 70 | Iouraghan | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 71 | Imiki | 1 | 1 | 0 | 0 | 112 | 0 |
| | | 72 | Ifit Ait Alla | 3 | 0 | 0 | 3 | 100 | 0 |
| | | 73 | Boukhelf | 3 | 0 | 0 | 3 | 400 | 0 |
| | | 74 | Addar Ait Ali | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 76 | Ait Bourd | 3 | 3 | 0 | 0 | 450 | 0 |
| | | 77 | Ait M'Barek | 1 | 1 | 0 | 0 | 150 | 0 |
| | | 78 | Agadir Ait Bourd | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 79 | Afella Ouassif | 0 | 0 | 0 | 0 | 0 | 0 |
| | Ameghrass | 81 | Afella Ighil | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 83 1 | Anfeg | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 83 2 | Aguersouak | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 84 | Ait Bouzid | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 85 1 | Oumast | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 85 2 | Ait Zitoun | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 86 | Tagadirt | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 87 1 | Zaouit | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 87 2 | Izalaghan | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 88 | Tigouder | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 89 | Amezi | 1 | 1 | 0 | 0 | 1000 | 0 |
| | | 90 | Agouni | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 91 | Chaabat Tarik | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 92 | Ighil Sdidene | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 93 | Tizi | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 94 | Aghbalou | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 95 | Ait Hsain | 1 | 1 | 0 | 0 | 400 | 0 |
| | | 96 | Ait Boubker | 1 | 1 | 0 | 0 | 540 | 0 |
| | | 97 | Tazatourt | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 98 | Tamsoulte | 1 | 0 | 1 | 0 | 100 | 0 |
| | | 99 | Tizgui | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 100 | Ait Tirghit | 0 | 0 | 0 | 0 | 0 | 0 |
| | Sidi Badhaj | 101 | Tachbibt Kabli | 1 | 1 | 0 | 0 | 100 | 0 |
| | | 102 | Tachbibt Echatoui | 1 | 0 | 1 | 0 | 120 | 0 |
| | | 103 | Asgoune | 1 | 1 | 0 | 0 | 170 | 0 |
| | | 104 | Ait Aamara Loued | 5 | 0 | 5 | 0 | 158 | 0 |
| | | 105 | Igouder | 3 | 3 | 0 | 0 | 1000 | 0 |
| | | 106 | Lakaarna | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 107 | Ait Aamar El Bour | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 109 | Chouirige | 1 | 0 | 0 | 1 | 150 | 1 |
| | | 112 | Lamhamid | 1 | 1 | 0 | 0 | 167 | 0 |
| Ait Ourir | Ait Aadel | 113 1 | Tarast | 3 | 0 | 3 | 0 | 100 | 0 |
| | | 113 2 | Assaka | 3 | 0 | 3 | 0 | 0 | 0 |
| | Abadour | 114 | Abadou | 3 | 3 | 0 | 0 | 165 | 0 |
| | Zerkten | 115 | Quriz | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 116 | Tabant Ighi | 4 | 0 | 4 | 0 | 20 | 0 |
| | Tighdouine | 117 | Ansa | 1 | 0 | 1 | 0 | 80 | 0 |
| | | 118 | Tidsi | 3 | 0 | 3 | 0 | 250 | 0 |
| | | 119 | Ait Atmane | 1 | 0 | 0 | 1 | 100 | 0 |
| | | 120 | Ezzaouite | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | | | 114 | 98 | 38 | 47 | 13 | 16,104 | 7 |
| Villages having a flour mill | | | 53 (46%) | 100% | 39% | 48% | 13% | | |
| Villages making potteries | | | 3 (3%) | | | | | | |

(Note) Energy of pottery is manpower, and production size is medium in all villages.

## 3.4 Base Study of Power Supply Source

Base study was carried out for the following 5 methods of electrification considered possible for the Study area.

(1) PV generation
(2) Wind power
(3) Micro-hydropower
(4) Diesel generation
(5) Extension of existing transmission line

Of the above, (4) is eliminated from priority consideration due to the fact that it is not a renewable energy source. In the case of (5), this is examined as a possible power supply source where under the Study where conditions are considered optimum for the same.

### (1) PV Generation

PV generation method utilizes electrical energy which is generated by the PV module and battery stored during the daytime.

Accordingly, a criteria for adoption of this method is that sufficient daylight hours are essentially available throughout the year. Consideration, nevertheless, must be given to measures to compensate for periods when sunlight may not be available (seasonal fluctuations, etc.). In the case of Haouz Region, sunlight hours are in the range 5.3~5.6. Also, it was confirmed through field survey that mountain mass will not impact on effective sunlight hours. As a result, PV generation is deemed an appropriate power source under the Project. (Base study of the 3 methods of PV generation considered under the Study, i.e. solar home system, battery charging station, and centralized distribution system, is given in the following section 3.5).

### (2) Wind Power

Under this method of electrification, wind energy is used to power generating equipment. Accordingly, a prerequisite for adoption of this type of power source is that a set minimal level of wind speed is available throughout the year. It is considered that a wind velocity of at least 5~6 m/s is necessary for generator operation; and given the fact that wind velocity in Haouz Province is 2~3 m/s conditions are unfavorable for wind power adoption. As a result, wind power was not pursued as an option under the Study.

Incidentally, wind power projects are being pursued along the northern coast of the country where conditions are favorable for this type of energy generation.

### (3) Micro-hydropower Generation

Micro-hydropower utilizes head achieved along rivers to power generating equipment. Accordingly, stable discharge and topography which offers adequate head are prerequisites for this type of energy.

In the case of Haouz Region, the Haut Atlas range runs to the south, and rainfall is a relatively abundant 400~500 mm per year. Also, the rugged topography of the area offers abundant head along rivers and mountain torrents. Accordingly, micro-hydropower is deemed an appropriate electrification method for adoption under the Project.

(4) Diesel Generation

Diesel generation relies on fossil fuels for generator equipment operation. Accordingly, it is neither environmentally friendly, nor a domestic energy source. Also, a steady supply of fuel and availability of spare parts are necessary. However, it has been a major mode of rural electrification in the past due to ease of facility installation and maturity of technological levels in this field.

As a result, diesel generation is adopted under the Study as an option for comparative analysis purposes, but is eliminated from consideration as a priority power supply method due to the fact that it is not a renewable source.

(5) Extension of Existing Transmission Line

Extension of existing transmission line represents the easiest method in terms of operation and maintenance, and is also the most stable power supply source. However, cost performance declines and supply side O&M increases as village distance becomes greater from the existing line.

In the case of the Study villages, those which are already included under ONE planning for grid extension have been eliminated from consideration. However, transmission line extension will still remain an option at future stages of the envisioned Project should this mode of electrification ultimately be identified as most appropriate for certain specific villages. Where such villages should be identified in the future, these would accordingly be incorporated into ONE planning rather than be included under this Project.

## 3.5 Study on 3 Methods of PV Generation

(1) Special Features of the 3 Methods

The following 3 methods are considered under the category of PV generation. The special features of each are described below.

① Solar Home System (SHS)

Under this method, PV module, battery, controller, etc. are installed on a home wise basis as a separate system.

Facilities are installed to meet initial demand only, with expanded installation of PV module, battery, etc. for each new user in the future. This results in a minimized initial investment. Although this approach has no scale merit, facility expansion is simplified.

As the said system is installed on a home-wise basis, there is an intimacy with the system felt on the part of the user resulting in better system care and longer facility life.

② Battery Charging Station (BCS)

The PV module equipment is installed at a single location, with centralized charging of batteries which are then transported back to the individual home. This approach requires establishment of a charge station and deployment of operational and management personnel.

This approach has the disadvantages that (i) it is necessary to transport batteries to and from the home, and (ii) charging at a common location results in shared use of batteries resulting in less personal care of equipment and resultant shorter battery life.

Although this method has economical advantages, supplemental survey under the Study indicated that it is not highly viewed by villagers who perceive battery changing as laborious.

③ Centralized Distribution System

Under this method, PV module, battery, etc. are installed at a single location, from which power is delivered to the user by distribution line. It requires establishing a central station, constructing a distribution line system, installing electricity meters and deployment of operational and management personnel. Furthermore, it is difficult to control power consumption by each user household resulted in the need for excessive facility capacity. The CDS is consequently considerably more expensive than the home solar system approach.

(2) Evaluation of the 3 Methods of PV Generation

In the case of ③ (centralized distribution system) the most important factor is that actual power consumption by the users remains within the design consumption volume for each user. Power use in excess of the design volume results in excessive battery discharge and resultant significant shortening of battery life. Also, this approach has the disadvantage of requiring larger facility capacity to offset transmission loss where user households are located at some distance from the central generator.

As a result, ① (SHS) is adopted where user households are scattered, and power demand is extremely small. Method ③ (CDS) is on the other hand adopted where user households are located in relatively concentrated manner, and comparatively robust power demand is present. Method ② (BCS) is not given high marks on the basis of past performance on projects which have adopted this method. Specifically, users feel inconvenience in the need to carry batteries to recharging stations, and there are cases where users neglect the proper timing for battery recharge which results in excessive discharge and subsequent shortening of battery life.

(3) Comparative Study of SHS and CDS for the Study Area (case study)

① (SHS) and ③ (CDS) differ in terms of system composition, and it is necessary to carry out a comparative examination of construction cost as well an engineering evaluation for the two methods. In making this comparison, consideration was given to factors of demand volume, mode of power use (alternating current or direct current), village configuration and of course the affordability-to-pay of target users.

Details of case study are presented below. On the basis of this study, it was determined not to adopt the CDS under the Study (CDER likewise was negative with regard to CDS).

1) Quantitative Comparison

Results of quantitative comparison of SHS and CDS are as follows:

| Item | Individual home system | Centralized method |
|---|---|---|
| Supplied power | Direct, low voltage current (12 V, 24 V) | Alternating current (110 V, 220 V); requires transformer and inverter |
| Distribution line | Not necessary | Distribution line necessary from power source to each user |
| Facility site | Household roof or pole near house is sufficient | Space must be sufficient for panel and power source equipment installation, and battery placement |
| Engineering and maintenance works | Possible with simple technical skills | Sophisticated electrical engineering skills required |
| Method of use | Improper use has no impact on other users | Excess utilization by one user impacts on other users |
| Electrical equipment | Requires direct, low voltage current equipment only | Standard electrical equipment available on the market can be used |
| Connection to grid | Some improvements required | Can be easily accomplished |

2) Comparative Case Study

Comparative study examined construction cost for 3 cases, i.e. 50 households, 100 households and 150 households.

Assumption-1 (power consumption)

-Comparison is based on power consumption of 240 Wh/day for each case.
-SHS systems are 75 Wp per household, at direct current of 12 V and 24 V.

-CDS is converted to alternating current, at 220 V.

| Item | Individual home system | Remarks | Centralized system | Remarks |
|---|---|---|---|---|
| PV module | 240/5 3/0.6 = 75 (Wp) | Average sunshine hours per day = 5 3 | 240 Wh<br>240 kW × 1 2 = 288 Wh<br>288/5.3/0 6=90 57 | Inverter loss. 20%<br>System efficiency 60% |
| Battery | 100 Ah | | 100 Ah / household | Requires shed for central equipment |
| Charge controller | No of households | Can use existing equipment standardly available on the market | 1 kit | Must be specially ordered |
| Inverter and control | Unnecessary | | 1 kit | Must be specially ordered |
| Installation works | No. of households | Simple works | 1 set | Requires works for panel installation, shed construction, protective fencing and foundation |
| Intra-village wiring works | Unnecessary | | 1 set | Pole installation, and distribution wiring works |
| Home wiring works | 40 nos | | No. of households | |

* The PV module produces electric power (Wp) when it receives a quantity of sunshine equivalent to 1 kW/m²/h. The module capacity is calculated by dividing the required generated power by the average number of sunshine hours per day, and taking into account equipment efficiency factor. In other words, module capacity necessary to produce 240 Wh/day is computed as follows: 240 (Wh/day) / 5.3 (h/day) / 0.6 = 75 (Wp)

Assumption - 2:

Facility unit cost:

| Item | Unit | Cost (US$) | Remarks |
|---|---|---|---|
| PV module | US$/Wp | 8 | Procurement from Japan |
| Battery | US$/Ah | 1 | Modified car battery |
| Charge controller<br>Inverter (centralized system) | US$/kit<br>US$/kit | 90<br>30,000 | To be imported<br>To be specially designed and fabricated (including control panel) |
| Installation (home system)<br>(centralized system)<br>Intra-village wiring works | US$/kit<br>US$/kit | 200<br>10,000<br>20,000 | Pole/equipment installation<br>Foundation, frame, fence, shed<br>Electric pole installation, wiring works, home connection works |
| Home wiring works | US$/home | 60 | $10 per connection equipment |

### 3) Construction Cost Comparison

<Case-1 (50 households)>

| Item | Individual home system | (US$) | Centralized system | (US$) |
|---|---|---|---|---|
| PV module | 75 × 50 = 3,750<br>3,750 Wp × 8 | 30,000 | 75 × 50 = 3,750<br>3,750 Wp × 8 | 30,000 |
| Battery | 100 Ah × 50 × 1 | 5,000 | 5,000 Ah × 1 | 5,000 |
| Charge controller and inverter | 50 kits × 90 | 4,500 | 1 set × 30,000 | 30,000 |
| Installation works | 50 nos. × 200 | 10,000 | 1 set × 10,000 | 10,000 |
| Intra-village wiring | Unnecessary | | 1 set × 20,000 | 20,000 |
| Home wiring works | 50 nos. × 60 | 3,000 | 50 nos. × 60 | 3,000 |
| Total | | 52,500 | | 98,000 |
| Per watt cost | US$/Wp | 14 | | 26 |
| Per home cost | US$/home | 1,050 | | 1,960 |

<Case-2 (100 households)>

| Item | Individual home system | (US$) | Centralized system | (US$) |
|---|---|---|---|---|
| PV module | 75 × 100 = 7,500<br>7,500 Wp × 8 | 60,000 | 75 × 100 = 7,500<br>7,500 Wp × 8 | 60,000 |
| Battery | 100 Ah × 100 × 1 | 10,000 | 10,000 Ah × 1 | 10,000 |
| Charge controller and inverter | 100 kits × 90 | 9,000 | 1 set × 30,000 | 30,000 |
| Installation works | 100 nos. × 200 | 20,000 | 1 set × 10,000 | 10,000 |
| Intra-village wiring | Unnecessary | | 1 set × 40,000 | 40,000 |
| Home wiring works | 100 nos. × 60 | 6,000 | 100 nos. × 60 | 6,000 |
| Total | | 105,000 | | 156,000 |
| Per watt cost | US$/Wp | 14 | | 21 |
| Per home cost | US$/home | 1,050 | | 1,560 |

<Case-3 (150 households)>

| Item | Individual home system | (US$) | Centralized system | (US$) |
|---|---|---|---|---|
| PV module | 75 × 150 = 11,250<br>11,250 Wp × 8 | 90,000 | 75 × 150 = 11,250<br>11,250 Wp × 8 | 90,000 |
| Battery | 100 Ah × 150 × 1 | 15,000 | 15,000 Ah × 1 | 15,000 |
| Charge controller and inverter | 150 kits × 90 | 13,500 | 1 set × 30,000 | 30,000 |
| Installation works | 150 nos. × 200 | 30,000 | 1 set × 10,000 | 10,000 |
| Intra-village wiring | Unnecessary | | 1 set × 60,000 | 40,000 |
| Home wiring works | 150 nos. × 60 | 9,000 | 150 nos. × 60 | 9,000 |
| Total | | 157,000 | | 194,000 |
| Per watt cost | US$/Wp | 14 | | 17 |
| Per home cost | US$/home | 1,050 | | 1,293 |

Construction cost comparison shows that (i) in the case of a small number of households (50) per village, the cost of CDS is twice that of SHS, and (ii) where number of households is large (150), the cost of CDS is on a par with SHS. This is due to the fact that CDS equipment, particularly the control system including inverter must house a minimum number of circuits to support the system and up to a certain capacity the cost of the inverter control board does not change. As a result, the construction cost for the CDS is relatively more costly in the case of a smaller system.

4) Technical Evaluation

In light of the small number of households per village and small individual user demand in the case of the subject Project, the CDS approach has the following disadvantages from a technical standpoint. As a result, it is recommended that the SHS type system be adopted under the Project.

① High Distribution Facility Cost

The output capacity of the generating facilities envisioned for one village under the Project is around 3~4 kW, with distribution of power to be provided to an average 30~60 homes per village. Given the need to distribute power to each household within a target village, it is necessary to take into consideration transmission loss vis a vis th small demand per user. As a result, small diameter transmission line would have to be adopted to cope with conditions of relatively high voltage and small current. In comparison to conventional such facilities, numerous costs would be entailed in ensuring the such small diameter transmission line could bear up under the severe natural conditions in the Project area, i.e. wind and snow.

② System Reliability

Successful examples of full fledged, centralized type systems are few in developing countries. Implementation to date has essentially been limited to experimental, pilot projects. Accordingly, with consideration to subsequent O&M following completion of construction, the centralized system is less desirous in terms of system reliability (particularly with regard to the reliability of the NFB [no fuse breaker] with capacity appropriate to the Project).

<u>NFB (No Fuse Breaker) Reliability</u>:

Supply of alternating current power enables a relatively flexible use of various electrical appliances commonly available on the market; however, at the same time, there is the danger that volume of actual electricity consumption will place a heavy overload on the system after facility construction in excess of the originally envisioned power demand. In some cases, a portion of users may consume a volume of power far above the allocated amount, resulting in occasions where all users lose access to electricity. To counter this, it is a general practice to install NFB (No Fuse Breaker) in each home to control the amount of electricity consumed by each user.

However, NFB's have been generally developed for power over 1 A. In the case of the subject Project, an NFB with around 0.3 A capacity would be necessary for each household. At the present stage, development of such an NFB would require time, and would be of low initial reliability.

5) PV Generation Methods used in Morocco

PERG, the umbrella program for the decentralized electrification under this Study, assumes adoption of either the SHS or BCS approach. On the basis of discussions with CDER (counterpart agency for the Study) at the start of field works, it was confirmed that CDER was in favor of SHS adoption under this Study.

6) Future Issues

The PV electrification methods of (i) individual home system and (ii) centralized system have respective advantages and disadvantages in terms of construction cost and O&M after construction. In consideration of the future connection of the subject area targeted for electrification to the main power grid, it is desirable that various technological development be further pursued with regard to the centralized system such as small capacity NFB and improvements in terms of transmission loss.

## 3.6 Target Villages for Electrification under the Master Plan

(1) Confirmation of Villages to be Electrified by ONE

At the start of the phase 1 field works, it was identified that 7 of the 120 villages contained in the original Study request were already slated for connection to the existing grid under electrification planning already in effect by ONE. These were accordingly eliminated from the scope of the Study. Also, during the latter part of the said phase 1 field works, another 3 villages were identified as already subject to ONE electrification planning and these too were eliminated from the Study scope.

In order to preclude any other redundancy in electrification planning, detailed study of ONE's electrification program was carried out in close collaboration with the agency, and as a result an additional 9 villages were identified as warranting exclusion from the Study.

***Villages Eliminated from Consideration due to Redundancy with Other ONE Electrification Planning***

| Administrative location | | No. | Douar name | No. of households | istance from grid (km) |
|---|---|---|---|---|---|
| Cercle | Commune R. | | | | |
| Asni | Asni | 13 | El Bour 1 | 65 | 2 |
| Tahanaout | Tahanaout | 25 | Oulad Lahjar 1 | 100 | 0.3 |
| | | 25 | Oumnas 2 | 150 | 1 |
| | | 27 | Del El Ain | 110 | 0.7 |
| | Tahanaout | 33 | Sour Tedrara | 110 | 2 |
| | | 105 | Igouder | 120 | 0.5 |
| Amizmiz | Sidi Badhaj | 107 | Ait Aamar El Bou | 70 | 0.4 |
| | | 109 | Chouirige | 120 | 1.4 |
| Ait Ourir | Zerkten | 116 | Tabant Ighi | 287 | 0.2 |
| Total | | 9 | | 1,132 | |

Accordingly, 19 villages were thus eliminated from consideration under the Study due to prior inclusion in planning by ONE to extend transmission lines in the near future. However, 3 alternative villages were nominated for inclusion under the Project making the net reduction in village number 16.

(2) Target Villages for Electrification under the Master Plan

The inventory survey was carried out for 114 villages. Due to exclusion of the 9 villages indicated above, the total number of villages was reduced to 105. However, with the addition of one village (not included in the original request) for electrification by micro-hydropower, the final number of target villages for electrification under the Master Plan is 106.

# VOL.I CHAPTER 4
# POWER SURVEY

# *CHAPTER 4 POWER SURVEY*

## 4.1 Electric Power Situation in Morocco

### 4.1.1 Electric Power Enterprises

Planning and development in the energy sector in Morocco, including power projects, falls under the jurisdiction of the Ministry of Energy and Mining (MEM). ONE as well falls under the supervision of MEM.

Power generation power projects are carried out solely by ONE; however, there are some private companies that develop power for private use. The latter account for only 12~13% of total on-line facility scale. According to ONE procedures, users' associations, beneficiary households and private entities can freely construct, operate and manage, and set electricity tariffs in the case of schemes where power scale is under 6 kW/village.

Control of power transmission projects is the sole jurisdiction of ONE; nevertheless, there are public distribution entities which supervise power distribution in such large urban centers as Casablanca and Marrakech in which case power is bought from ONE for sale to area consumers. Table 4.1-1 indicates entities engaged in electric power distribution and their respective proportions of total power sales.

***Table 4.1-1 Public Power Distribution Entities***

| Name | Service area | Sales proportion (%) |
|---|---|---|
| ONE | All residential area excluding public authorities | 46.3 |
| Public authority: | | 51.7 |
| RAO | Casablanca, Mohamadia, Ain Harouda, Beni Iklef | 24.3 |
| RED | Rabat-Sole, Tamara, Skhirati, Bouznika, Beaknadel | 7.4 |
| RADEEF | Fes | 4.0 |
| RAID | Tanger, Asilah | 4.0 |
| RDE | Tetouan, Larache, Chefchaouen, M'Dig | 3.3 |
| RADEEA | Marrakech, Sidi-Bou-Outmane | 2.9 |
| RADEEM | Meknes | 2.6 |
| RAK | Kenitra, Mehdia, Fourat | 1.7 |
| RADEES | Safi | 0.9 |
| RADEEJ | El Jadida, Azemmour, Sidi Bouzid, Chtouka, Moukay, Abdellah | 0.6 |

### 4.1.2 Power Supply and Demand

Total annual generated power in 1991 was 9,874 GWh (8,675 GWh by ONE and 1,199 GWh by private companies). ONE thus accounts for 88% of total power generation. Total power sales by ONE amount to 7,765 GWh with transmission and distribution power loss at around 11%.

Table 4.1-2 shows the annual generated power for the period 1986~1992, and Table 4.1-3 indicates annual power consumption by use for the period 1982~1991.

***Table 4.1-2 Annual Generated Power***

(unit: GWh)

| Year | ONE | | | Private | | | Total |
|---|---|---|---|---|---|---|---|
| | Thermal | Hydro | Subtotal | Thermal | Hydro | Subtotal | |
| 1986 | 4,075 | 1,025 | 5,100 | 480 | 17 | 497 | 5,597 |
| 1987 | 5,918 | 806 | 6,724 | 715 | 0 | 715 | 7,439 |
| 1988 | 6,622 | 936 | 7,558 | 1,407 | 1 | 1,408 | 8,966 |
| 1989 | 7,001 | 1,157 | 8,158 | 923 | 0 | 923 | 9,081 |
| 1990 | 7,412 | 1,220 | 8,632 | 1,285 | 0 | 1,285 | 9,917 |
| 1991 | 7,409 | 1,266 | 8,675 | 1,199 | 0 | 1,199 | 9,874 |
| 1992 | 8,030 | 981 | 9,011 | 1,314 | 0 | 1,314 | 10,325 |

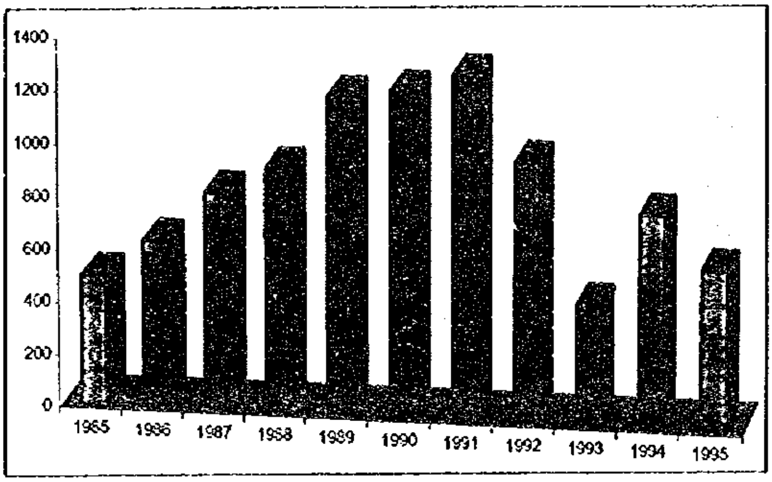
***Table 4.1-3 Annual Power Consumption***

(unit: GWh)

| Voltage range | Purpose | 1982 | 1989 | 1990 | 1991 |
|---|---|---|---|---|---|
| High and middle voltage | Industry | 1,478 | 2,215 | 2,330 | 2,470 |
| | Mining | 529 | 687 | 721 | 720 |
| | Public utilities | 209 | 418 | 452 | 475 |
| | Agriculture and fishing | 246 | 392 | 430 | 442 |
| | Potable water | 201 | 274 | 299 | 330 |
| | Transportation and communication | 169 | 257 | 285 | 307 |
| | Commercial and service | 239 | 205 | 227 | 236 |
| | Subtotal | 3,071 | 4,448 | 4,744 | 4,980 |
| Low voltage | Power | 73 | 99 | 113 | 113 |
| | Public | 93 | 190 | 218 | 210 |
| | Household | 1,197 | 2,106 | 2,268 | 2,462 |
| | Subtotal | 1,363 | 2,395 | 2,599 | 2,785 |
| | Total | 4,434 | 6,843 | 7,343 | 7,765 |

Consumption of high and medium voltage power targeted at industrial sector demand is generally higher than the low voltage power for domestic purposes, with respective shares at 65% and 35%. However, growth in low voltage power consumption is significant, reflecting the progressive electrification of rural areas.

*Figure 4.1-1 Annual Generated Power by Hydropower (GWh)*




Annual generated power by hydropower for the period 1985~1995 is shown in the bar graph in Figure 4.1-1. Fluctuation in the said annual generated energy is marked in recent years (1991~1995). This is a reflection of the unstable rainfall during this period, particularly the severe drought occurring in 1993.

### 4.1.3 Power Facilities

(1) Power Generating Facilities

ONE presently owns the following power generating facilities (as of 1995).

1) Thermal Power Stations (total installed capacity: 2,532 MW)

(a) Steam turbine

| | | | | |
|---|---|---|---|---|
| Jorf Lastar: | 660 | (2 × 330) | 1994 | crude and coal |
| Casablanca: | 120 | (2 × 60) | 1968~75 | crude and coal |
| Jerada | 165 | (3 × 55) | 1971~72 | coal |
| Kenitra | 300 | (4 × 150) | 1978~79 | crude |
| Mohammedia | 600 | (4 × 150) | 1981~85 | crude and coal |
| Subtotal | 1,845 | MW | | |

(b) Gas turbine

| | | | | |
|---|---|---|---|---|
| Mohammedia | 99 | (3 × 33) | 1991~92 | crude |
| Tan-Tan | 99 | (3 × 33) | 1992 | crude |
| Tit Mella | 99 | (3 × 33) | 1993 | crude |
| Tetouan | 40 | (2 × 20) | 1975~77 | crude |
| Agadil | 40 | (2 × 20) | 1974~77 | crude |
| Tanger | 40 | (2 × 20) | 1975~77 | crude |
| Casa Z. Industrielle | 40 | (2 × 20) | 1994 | crude |
| Tetouan | 99 | (3 × 33) | 1995 | crude |
| Subtotal | 615 | MW | | |

(c) Diesel

| | | | | |
|---|---|---|---|---|
| Sedi Kocem | 15.5 | (2 × 7.75) | 1967 | diesel oil |
| Laayoune | 21 | (3 × 7) | 1988~89 | crude |
| Al Hoceima | 2.3 | (1 × 2.3) | 1947~70 | diesel oil |
| Tanger | 6.4 | (2 × 3.2) | 1954~58 | diesel oil |
| Essauira | 2.2 | (1 × 2.2) | 1986 | diesel oil |
| Isolated system | 24.4 | (total) | | diesel oil |
| Subtotal | 71.8 | MW | | |

2) Hydropower Stations (total installed capacity: 926.7 MW)

| | | | |
|---|---|---|---|
| Afourer | 93.6 | (2 × 46.8) | 1995 |
| B. El Oidane | 135.0 | (3 × 45) | 1953~55 |
| Al Massira | 128.0 | (2 × 64) | 1980 |
| Im Fout | 31.2 | (2 × 15.6) | 1947~49 |
| Daourat | 17.0 | (2 × 8.5) | 1950 |
| S. Said Maachou | 20.8 | (4 × 5.2) | 1929 |
| M. Youssef | 24.0 | (2 × 12) | 1975 |
| Kasba Zidania | 7.1 | (2 × 3.55) | 1935~36 |
| Hassan Ier | 67.0 | (1 × 67) | 1990 |
| Allal Al Fassi | 240.0 | (3 × 80) | 1994 |
| Mohammed El Khanis | 23.2 | (1 × 23.2) | 1967 |
| Bou Areg | 6.4 | (1 × 6.4) | 1969 |
| Idriss Ier | 40.6 | (2 × 20.3) | 1978 |
| El Kansera | 14.4 | (2 × 7.2) | 1935~39 |
| O. El Makhazine | 36.0 | (1 × 36) | 1979 |
| Taurart | 2.0 | (2 × 1) | 1951 |
| M. Eddahbi | 10.0 | (2 × 5) | 1973 |
| Takerkoust | 12.0 | (2 × 6) | 1984~87 |
| Lau | 14.1 | (4 × 3.525) | 1934~42 |
| Fes Amount | 1.2 | (3 × 0.4) | 1925 |
| Fes Aval | 1.9 | (2 × 0.95) | 1934 |
| Taza | 0.6 | (2 × 0.3) | 1929 |
| Meknes | 0.6 | (3 × 0.2) | 1925 |

3) Total Installed Capacity for Generation: 3,458 MW (2,531.8 MW of thermal + 926.7 MW of hydropower)

(2) Transmission and Distribution Facilities

The high voltage transmission grid has been established mainly along the coast providing power to such major urban centers as Casablanca, the capital of Rabat, etc.

Trunk transmission lines are 225 kV cables, supplemented in some areas by 150 kV lines. In rural areas (for example Haouz province), transmission lines are 60 kV capacity.

Medium voltage distribution lines presently comprise 20, 22, 30 and 5.5 kV cables; however, ONE is currently in the process of standardizing these at 22 kV capacity. In Haouz province, these are all 22 kV.

Table 4.1-4 indicates the lengths of transmission and distribution lines in 1990, 1992 and 1995.

***Table 4.1-4 Total Lengths of Transmission and Distribution Lines***

<table>
<tr><th>Voltage range</th><th>1990</th><th>1992</th><th>1995</th></tr>
<tr><td>225 kV</td><td>3,142</td><td>3,808</td><td rowspan="2">4,870</td></tr>
<tr><td>150 kV</td><td>864</td><td>762</td></tr>
<tr><td>60 kV</td><td>6,985</td><td>7,946</td><td>8,070</td></tr>
<tr><td>Middle voltage</td><td>13,140</td><td>15,160</td><td>16,000</td></tr>
<tr><td>Low voltage (380/220 V)</td><td></td><td></td><td>24,200</td></tr>
</table>

### 4.1.4 Power Demand Forecast

ONE had formulated 2 scenarios for power demand forecast for the period 1992~2010. One scenario envisions an annual growth in demand of 7%. The second perceives an 8% power demand growth rate per annum to the year 2000, after which demand growth would be 7%. The latter was formulated taking into particular consideration future electrification in rural areas.

However, power demand forecast was revised in 1996 to envision power demand growth of 4% in 1996, and 6% for the period 1997~2010. The revision was prompted by the difficulty in extending the existing grid into rural areas due to the distances and costs required.

### 4.1.5 Future Power Development Planning

ONE has formulated the following power development plans to meet power demand growth.

(1) Facilities Currently under Construction

Hydropower:

| | | | |
|---|---|---|---|
| Al Wahda | 248.1 | MW | by end of 1998 |

Wind power:

| | | | |
|---|---|---|---|
| Koudia Blance | 53 | MW | by end of 1997 |

Thermal power:

| | | | |
|---|---|---|---|
| Jorf III | 330 | MW | by 1999 |
| Jorf IV | 330 | MW | by 2000 |
| Subtotal: | 961.1 | MW | |

(2) Facilities Currently under Planning

Hydropower:

| | | | |
|---|---|---|---|
| Dehhar El Oued | 92 | MW | by end of 2001 |
| Ait Messaud | 6.4 | MW | by end of 2001 |

Thermal power:

| | | | |
|---|---|---|---|
| No.1 Combined Cycle | 470 | MW | by 2002 |
| No.2 Combined Cycle | 470 | MW | by 2004 |
| Subtotal: | 1,038.4 | MW | |

(3) Facilities to be Retired

| | | | |
|---|---|---|---|
| Fac de 6 × 20 MW (Agadir, Tanger, Tefouan) | 120 | MW | by end of 2000 |
| Roches Moires II & III (Casablanca) | 120 | MW | by end of 2001 |
| Subtotal: | 240 | MW | |

(4) Total Installed Capacity by End of 2004

| | | |
|---|---|---|
| Hydro and wind power | 1,326.5 | MW |
| Thermal power | 3,892 | MW |
| Total: | 5,218 | MW |

#### 4.1.6 Electricity Tariffs

In contrast to the short-term grid extension projects by ONE, the Global Regional Electrification Program (PERG) was launched on August 2, 1995 with broad emphasis on rural electrification. This has resulted in a two tiered tariff structure comprising ONE tariffs, and tariffs under PERG.

(1) ONE Tariffs

From January 1, 1996, ONE has adopted a new electricity tariff which establishes electricity tariffs for medium (22 kV) and low (400/220 V) voltages aimed at unifying tariff rates.

Objectives of the tariff structure revision are as follows:

① Global and effective management for electrical energy

② Control of peak demand and promotion of power use during off-peak hours

③ Standardization of tariffs of ONE and other public entities which sell power

④ Shift to a unified tariff system for the entire country

⑤ Establishment of a new household tariff system with consideration to electricity consumption per month

⑥ Review of tariffs for large consuming households (more than 500 kWh)

⑦ Procurement of funds to promote rural electrification

In order to promote rural electrification, ONE has adopted a broad ranging rural electrification plan including establishment of a Rural Electrification Department, and assessment of a 2 centime (DH 1/100) per kilowatt surcharge on urban power users to establish a rural electrification fund.

In the case of decentralized rural electrification, CDER is the principal in establishing electrification associations which then set up their own electricity tariff structures and operate independently. As these tariffs are higher than those imposed by ONE, it is recommended that certain measures be taken. Specifically with regard to ONE's electricity tariff structure, the following apply.

Power consumption by medium voltage (22 kV) users is divided into that for general use and that for agricultural purposes. Furthermore, time periods of power consumption are divided into three, i.e. peak hours, daytime hours, and off peak hours. Electricity tariffs for agricultural power are calculated according to seasonal criteria as well as whether use is on a regular day or holiday.

This new tariff system for general medium voltage (22 kV) consumption based on the above is as follows:

General Medium Voltage Tariffs (3 time periods):

1) Time periods

| | Winter (6 mos.: 10/1~3/31) | Summer (6 mos. 4/1~9/30) |
|---|---|---|
| Peak hours | 17~22:00 | 18~23:00 |
| Day time hours | 07~17:00 | 07~18:00 |
| Off peak hours | 22~07:00 | 23~07:00 |

2) Base charge (including tax)

| | |
|---|---|
| Output base charge: | DH 291 / kVA / year |
| Tariff: | |
| Peak hours | DH 1.1657/kWh |
| Day time hours | DH 1.0714/kWh |
| Off peak hours | DH 0.7820/kWh |

General Medium Voltage Tariffs (2 time periods):

Two time period tariffs would be adopted as a temporary measure until completion of installation of meters for 3 time periods.

1) Time periods

| | |
|---|---|
| Peak hours | 07~23:00 |
| Off peak hours | 23~07:00 |

2) Base charge (including tax)

| | |
|---|---|
| Peak hours | 07~23:00 |
| Off peak hours | 23~07:00 |

Electricity tariffs for medium voltage (22 kV) users for agricultural purposes would be as follows:

Agricultural Purpose Medium Voltage Tariffs:

1) Seasonal time periods

| Time period: | Daytime hours | Off-peak hours |
|---|---|---|
| Regular day: | 07~24:00 | 0~07:00 |
| Sunday: | 17~24:00 | 0~17:00 |

Season: Winter (5 mos.) Summer (7 mos.)

Period: November 1 ~ March 31 April 1 ~ October 31

2) Base charge (including tax)

| Option | Fixed tariff (DH/kVA/p.a.) | DH/kWh (including tax) | | | |
|---|---|---|---|---|---|
| | | Day time | | Off-peak | |
| | | Winter | Summer | Winter | Summer |
| TLU | 1,924.34 | 0.57125 | 0.53673 | 0.45973 | 0.45973 |
| MU | 865.93 | 1.12607 | 0.64197 | 0.52251 | 0.45973 |
| CU | 384.80 | 1.68073 | 0.74705 | 0.58514 | 0.45973 |
| Discount coefficient | | r - 1 = 1 | r - 2 = 0.25 | r - 3 = 0.05 | r - 4 = 0.06 |

In the case of medium voltage electricity tariffs, output charge is the base charge to which a utility fee is added depending on amount consumed and timing of consumption.

<u>Low Voltage (440/220 V) Tariffs</u>:

| | Commercial lighting | | | | Home lighting | | | |
|---|---|---|---|---|---|---|---|---|
| Consumption | 0~100 kWh | 101~200 kWh | 201~500 kWh | >500 kWh | 0~100 kWh | 101~200 kWh | 201~500 kWh | >500 kWh |
| Code | 1 | | | | 31 | | | |
| Tariff (standard) | 0.842 | 0.9055 | 0.9851 | 1.3464 | 0.842 | 0.9055 | 0.9851 | 1.3464 |
| Code | 7 | | | | | | | |
| Tariff (without MN | 1.011 | 1.087 | 1.183 | 1.616 | none | | | |

| | Commercial lighting | | Industrial and agricultural | | | Government building | Public lighting |
|---|---|---|---|---|---|---|---|
| Consumption | 0~150 kWh | >150 kWh | 0~100 kWh | 101~500 kWh | >500 kWh | | |
| Code | 3 | | 41 | | 21 | 11 | 15 |
| Tariff (standard) | 1.1770 | 1.3080 | 1.0600 | 1.1130 | 1.2720 | 1.2204 | 1.0058 |
| Code | 8 | | 48 | | 28 | 18 | |
| Tariff (without MN | 1.4130 | 1.5700 | 1.2720 | 1.3360 | 1.5270 | 1.4650 | none |

MNA: fee applied when power consumption does not reach the predetermined amount at time contract.
Commune and public lighting: discount for public / commercial lighting applied by commune.

On the basis of the above electrical tariff structure, application of ONE tariffs to the target villages under the Project would result in a fee of DH 0.842 / kWh for lighting purposes, and DH 1.060 / kWh for power purposes.

(2) Electrification Methods and Tariffs under PERG

PERG was formulated by ONE and formally adopted by the Moroccan government on August 2, 1995. The said program aims to electrify all regions of Morocco by the year 2010 at a rate of 100,000 households per year over the 15 year period 1996~2010. The annual budget under the program is DH 1 billion per year, with electrification costs to be borne 25% by the beneficiary households, 20% by the commune rurales / users' associations, and the remaining 55% by ONE.

PERG tariffs vary depending on whether electrification is by (i) extension of existing transmission line, (ii) diesel generation or (iii) PV generation.

Examples of cost burden sharing for each type of electrification are described below:

1) Extension of Existing Transmission Line

A. <u>In the case of cost sharing by ONE, the commune rurale and the beneficiary households</u>:

Criteria: Villages to be energized are selected by COSPER (National Rural Electrification Committee)

Cost sharing: -The commune rurale bears a cost of DH 2,085 (in the case of payment by installment, this becomes DH 500 per year for 5 years) for each beneficiary household.
-Each beneficiary household bears a cost of DH 2,252 (in the case of payment by installment, this becomes DH 40/month for 7 years).
-ONE bears the remaining cost.

B. <u>In the case of cost sharing by ONE, the users' associations and the beneficiary households</u>:

Criteria: No participation by the commune rurale

Cost sharing: -The users' association bears a cost of DH 2,085 for each beneficiary household.
-Each beneficiary household bears a cost of DH 2,252 (in the case of payment by installment, this becomes DH 40/month for 7 years).
-ONE bears the remaining cost.

C. In the case of cost sharing by ONE and the users' associations:

<Case 1>

Criteria: Villages only without participation of commune rurale

Cost sharing: -The users' association bears a cost of DH 4,337 for each beneficiary household.
-ONE bears the remaining cost.

<Case 2>

Criteria: Villages only without application of PERG criteria

Cost sharing: -The users' association bears 50% of construction cost
-ONE bears the remaining cost (50%).

<Case 3>

Criteria: Villages for which standard criteria do not apply

Cost sharing: -ONE bears a cost of DH 5,000 for each beneficiary household.
-The users' association bears the remaining cost.

2) Diesel Generation

Cost is shared by the commune rurale, user's association and beneficiary households in line with that for transmission line extension.

3) PV Generation

PV generation comprises solar home systems installed in individual households. Energizing capacity is 4 lights.

Cost sharing: -The users' association bears a cost of DH 1,440 for each beneficiary household.
-Each beneficiary household bears a cost of DH 60/month for 7 years.
-ONE bears the remaining cost.

Specific amounts to be borne by the user for each category of electrification under the above tariff framework are described below.

1) PV Generation (energy for 4 lights)

The user pays DH 60/month for 7 years to cover construction cost. In addition, the user must bear costs for battery replacement.

2) Diesel Generation

The user pays DH 40/month for 7 years to cover construction cost. Base fee for 4~5 hours of power use per day is DH 15/month, with a tariff of DH 4~5/kWh/month for actual power used. Converted into a monthly payment, the foregoing comes to DH 25~40/month.

3) Extension of Existing Transmission Line

The user pays DH 40/month for 7 years to cover construction cost. Electricity tariff is in accordance with that determined by ONE.

In summary, the user bears a DH 40 per month cost for 7 years to cover construction cost and electricity tariffs of DH 10~40/month in the cases of diesel generation and transmission line extension. Total payment per month thus comes to DH 50~80. In the case of PV generation, the user bears DH 60 per month to cover construction cost; however, no electricity tariff need be paid (although the user must bear the cost for battery replacement).

Accordingly, monthly payment by users in the case of all modes of electrification is in the range DH 50~80/month.

This monthly payment (DH 50~80/month) is on a par with the present outlay by households in unelectrified villages for oil lamp, butane gas, candles, battery, etc. currently used for illumination purposes (DH 30~180/month per household; average: DH 75/month per household).

### 4.1.7 Per Capita Power Consumption, and Electrification Rate

Per capita GNP for Morocco was US$ 1,040 in 1993; however, annual per capita power consumption remains at a low 400 kWh. This is due to the fact that the principal industries in Morocco of agriculture, mining, tourism, etc. are low electricity consuming sectors, and that electrification lags in rural areas.

Although the overall electrification rate in the country is 75%, electrification is mainly prevalent in urban areas with the electrification rate solely for rural area being only at 21%. Furthermore, the overall electrification rate for Haouz province is 41%, with the rate for rural area in the province being 14% (as of 1995). Also, an electrification rate of only 20% is forecast for rural area in the province by 1997. The above low per capita power consumption and rural electrification rate are clearly seen in comparison with nearby countries of the region:

| | kWh/person/year | Rural electrification rate |
|---|---|---|
| Tunisia: | 700 | 76 |
| Algeria: | 1,400 | 86 |

kWh/person/year (as of 1990)

| | |
|---|---|
| Libya | 4,180 |
| Egypt | 754 |
| Lebanon | 1,767 |
| Morocco | 384 |

## 4.2 Rural Electrification in Morocco

### 4.2.1 History of Rural Electrification

Rural electrification commenced in the 1970's under programs carried out by Le Ministere de l'Energie et des Mines and Ministere de l'Agriculture et de la Mise en Valeur Agricole. In 1975, a special fund for electrification was established corresponding to 4.5% of ONE's development profit. The fund was applied to grid expansion projects for ONE's supply service centers.

In the early 1980's, the Moroccan government launched The National Rural Electrification Program (PNER) aimed at ultimately electrifying all rural areas in the country. The program is being implemented in 2 stages. According to the study report (Sigmatrch, May 1987) at the conclusion of PNER-1, living standards in electrified villages had been improved and economic activities expanded. PNER-2 subsequently followed; however, achieved targets of village electrification by 1994 were less than anticipated due to funding difficulties.

In August 1995, the Moroccan government embarked on the Global Regional Electrification Program (PERG). Within this framework, the special program ERD (decentralized rural electrification) was launched in June 1997 which elicits the participation of the Ministry of the Interior in garnering cooperation of regional autonomies. ERD establishes the details for implementation of decentralized rural electrification under PERG.

### 4.2.2 National Rural Electrification Program (PNER)

As indicated above, PNER is being carried out in 2 stages.

PNER-1

This comprises the first stage under PNER, and was implemented over the period 1982~86. In the course of PNER-1, 286 villages totaling 64,000 households were electrified, corresponding to an average rate of 50 villages per year. To achieve this, facility construction included 1,340 km of middle voltage transmission network, 1,215 km of low voltage distribution network, 341 locations of middle/low voltage substations, and 5 locations of high/middle voltage substations.

Funding required for this construction was DH 519 million, consisting of a local portion of DH 239 million and a foreign portion of US$ 36 million (extended by the World Bank). Burden for funding procurement was borne 50% by the national government and 50% by local autonomies. The executing agency was ONE. The problem experienced under PNER-1 was an accumulative deficit by the executing agency and local autonomies of DH 200 million.

PNER-2

PNER-2 is scheduled for implementation over the period 1990~99. As of the present, 600 villages have been targeted and 25,000 households electrified. Target facilities at the end of this stage are 4,800 km of middle voltage transmission network, 3,200 km of low voltage distribution network and 910 locations of middle/low voltage substations.

Required cost for PNER-2 is DH 2,532 million, comprising a local portion of DH 1,300 million and a foreign portion of DH 1,232 million (ECU 130 million). Burden for funding procurement is completely the responsible of local autonomies, with ONE acting as the executing agency. The problem experienced under PNER-2 is a shortage of funding.

### 4.2.3 Global Rural Electrification Plan (PERG)

ONE has been the principal executing entity for rural electrification projects in Morocco, and these have centered on expansion of the existing grid under PNER. However, as the target villages become located at greater distance from the said grid, the cost involved in achieving electrification through extension of transmission lines increases accordingly ultimately reaching a point where this approach is no longer cost-effective.

On the other hand, since the creation of CDER with assistance from USAID in 1982, empirical research and development efforts have been pursued with regard to the utilization of renewable energy sources. As a result of these efforts, it has been demonstrated that PV energy, hydropower and wind power where such are available represent a practical means to meet electricity demand in more isolated rural areas, and this approach has emerged as a viable option for rural electrification.

Against the above background, a new cooperative framework has emerged between CDER and ONE since 1994 to jointly pursue the exploitation of renewable energy sources in isolated areas. ONE has show particular interest in the incorporation of renewable energy schemes under rural electrification planning, and has subsequently nominated CDER as a member of the National Rural Electrification Committee (COSPER) marking a new institutional strategy in the form PERG.

PERG aims at a unified effort at rural electrification integrating the past experience of both ONE and CDER. An implementation proposal for the program has been evolved, and a master plan is now in the process of being formulated with scheduled completion at the end of 1997. Basic strategy under PERG is described below.

(1) Demand

The number of unelectrified households of 1.92 million (12.6 million persons) as of 1994 can be expected to increase to 2.3 million (13.8 million persons) by 2003 and to 2.6 million (15.9 million persons) by 2010.

To meet this demand, rate of electrification must accelerate from the current 50 villages per year to 2,000 villages per year.

(2) Targets

Since electrification must be pursued within the framework of an integrated rural development strategy, it must be combined with a program of establishing and upgrading water supply, roads, schools, medical facilities, etc. to allow scattered rural settlements to interact on a community basis. The present electrification target is to provide electrical power supply to 1.5 million households (9 million persons) between 1996 and 2010. In order to achieve this, the following are to be carried out:

① Electrification of the entire country by the end of 2010
② Integration of electrification technology (connection to existing transmission grid, development of renewable energy sources, and introduction of diesel generation)
③ Project costs are to be shared among ONE, regional autonomies and subscribers

(3) Action Plan

A master plan for rural electrification is to be formulated to incorporate the following.

① Creation of a data base for rural electrification

② Extension forecast for existing transmission line

In formulating the extension forecast, it is necessary to determine power demand in the target areas and whether or not electrical supply is feasible by extension of the grid.

③ Identification of areas which cannot be electrified over the short · long term by extension of the transmission grid, and consideration of adopting a decentralized electrification approach (wind power, PV energy, small-scale independent grid diesel, or micro-hydropower)

④ Setting of objective and realistic standards with consideration to technical and socio-economic aspects within the framework for national land development (with particular attention to border areas, and the northern and southern regions).

(4) Cost Reduction

A number of cost reduction policies have been adopted under the objective of promoting electrification. These are as follows:

① Introduction of the principle of competition

② Project grouping

③ Facility cost reduction through liberalizing of house connection installation for subscribers and simplification of appurtenant equipment

④ Use of shorter power poles (reduction of both cost for the pole itself, and transport cost)

⑤ Use of pole mounted transformers (reduction of civil works cost)

⑥ Improvement of ONE's material and equipment procurement procedures

As a result of the above measures, a cost reduction per household of DH 13,000 was achieved in 1993. A cost reduction of DH 10,000 is anticipated for 1995.

In addition to the above, the following measures are under study:

① Adoption of the turnkey project format to reduce the construction period

② Introduction of a geographical data system (Such a system would be adopted to optimize the selection of the most appropriate technology for electrification [grid extension, wind power, PV power generation, biomass energy, small-scale independent diesel systems, micro-hydropower, etc.] and relationship between cost and the selected engineering approach.)

(5) Maintenance and Training

Operation and maintenance structures for decentralized electrification are to be established through contractual arrangements with the concerned villages or local autonomies. Such agreements would be temporary, with responsibility for O&M to be transferred to the private sector at a later date. This plan would be pursued under the leadership of ONE, to include a training program for villagers in facility maintenance.

(6) Funding

The subject plan has as its target the electrification of 100,000 households per year at a cost of DH 10,000 per household. Necessary funding over 15 years for the envisioned electrification is DH 15 billion.

In procuring such funding, the cooperation of all parties involved will be necessary (local autonomies, subscribers and ONE). Under the plan, the following sharing of financial burden is envisioned:

① 20% : ONE (at an annual rate of DH 200 million)

② 35% : Development tax (in addition to a sign-up fee for subscribers to ONE and other electricity providers, a 2 centime [DH 0.02] per kilowatt is to be collected from customers)

③ 20% : Local autonomies (at an annual rate of DH 200 million from tax base)

④ 25% : Subscribers (at DH 250 million per year in total, with option to repay over a 7 year period at the interest rate imposed on ONE by its source of lending)

Cost sharing under each case is as follows:

<Extension of existing transmission line>

1. Method of cost sharing

A. <u>In the case of cost sharing by ONE, the commune rurale and the beneficiary households</u>:

Criteria: Villages to be energized are selected by COSPER (National Rural Electrification Committee)

Cost sharing: -The commune rurale bears a cost of DH 2,085 (in the case of payment by installment, this becomes DH 500 per year for 5 years) for each beneficiary household.
-Each beneficiary household bears a cost of DH 2,252 (in the case of payment by installment, this becomes DH 40/month for 7 years).
-ONE bears the remaining cost.

B. <u>In the case of cost sharing by ONE, the users' associations and the beneficiary households</u>:

Criteria: No participation by the commune rurale

Cost sharing: -The users' association bears a cost of DH 2,085 for each beneficiary household.
-Each beneficiary household bears a cost of DH 2,252 (in the case of payment by installment, this becomes DH 40/month for 7 years).

-ONE bears the remaining cost.

C. <u>In the case of cost sharing by ONE and the users' associations</u>:

<Case 1>

Criteria: Villages only without participation of commune rurale

Cost sharing: -The users' association bears a cost of DH 4,337 for each beneficiary household.
-ONE bears the remaining cost.

<Case 2>

Criteria: Villages only without application of PERG criteria

Cost sharing: -The users' association bears 50% of construction cost
-ONE bears the remaining cost (50%).

<Case 3>

Criteria: Villages for which standard criteria do not apply

Cost sharing: -ONE bears a cost of DH 5,000 for each beneficiary household.
-The users' association bears the remaining cost.

2. Management and Agreement

A. Target households for electrification

The commune rurale is to connect the minimum number of households by transmission line within 5 years of the start of installation works. In cases where this is not possible, cost borne by households as yet unelectrified is to be returned.

B. Role of ONE

- Survey works and supervision required in the course of construction
- Construction of medium and low voltage transmission lines, and technology development in this regard
- Financial burden for construction

C. Role of commune rurale

- Preparatory works for introduction of electrification
- Financial burden for construction

D. Facility ownership

Facility ownership is in the hands of ONE to ensure development and management in line with TOR.

<Diesel power generation>

1. Method of cost sharing

In line with that for transmission line extension.

<PV generation (solar home system kits>

1. Method of cost sharing

In the case of cost sharing among ONE, users' associations and beneficiary households.

Cost sharing: -The users' association bears a cost of DH 1,440 for each beneficiary household.
-Each beneficiary household bears a cost of DH 60/month for 7 years.
-ONE bears the remaining cost.

2. PV kits and panels for each beneficiary household

a. Indoor facilities

- 4 low voltage lights, 4 switches, 1 fuse, 1 battery, wiring

b. Outdoor facilities

- 1 PV panel, 1 regulator

3. Management and Agreement

a) Responsibility of ONE

- PV kit supply
- Validation of the choice of young promoters
- Management of indoor facility installation works
- Funding cost for indoor and outdoor facilities

b) Responsibility of the users' association

- Funding cost for both indoor and outdoor facilities
- Suggestion of lists of young promoters according to the criteria of selection fixed by ONE

- Support in collection of PV facility and management costs
- Collection management for monthly burden to be paid by beneficiary households

c) Role of commune rurale

Support to users' associations in facility and financial management

d) Role of CDER

- Engineering support to ONE
- Ensure is necessary the training of young promoters suggested by the local authorities or associations and accepted by ONE

e) Facility ownership

Indoor facilities become the property of the user upon payment of the cost borne by the users' association. Outdoor facilities remain the property of ONE until payment of the cost borne by the user, at which time ownership of the same is transferred to the user.

f) Guarantee

Outdoor facilities are to be guaranteed for a 7 year period. Indoor facilities are to be guaranteed for a 1 year period (with the exception of low voltage lights).

(7) Organization

In order to pursue PERG under the optimum conditions, the roles of related agencies are to be clarified as follows:

① MEM : Confirmation of action plan and the execution of related studies. It is necessary that action plans be concurred to by a committee comprising representatives from the related sectors.

② ONE : Strengthening of national electrification programs. In addition to formulating action plans that maximize local autonomy institutional and know-how capabilities, ONE would undertake technical and funding management.

③ CDER : Extension and development of renewable energy technologies, maximizing CDER's extensive experience and engineering capability regarding decentralized electrification.

(8) Items for Consideration based on Past Experience

The following items bear note based on overall experience and achievement in Morocco with regard to electrification:

① Formulation of simple and practical projects

② Careful selection of the technology to be promoted. Initially, individual household PV energy systems (SHS) would be considered (forecast demand nationwide is 350,000 units)

③ Encouragement of diffusion over competition in the marketing of electrical power

④ Promotion and strengthening of local importers and contractors, and establishment of a quality control system

⑤ Support for the establishment of beneficiary groups, with officers to be elected by the local residents themselves. Such groups are to be nurtured and given guidance over an appropriate period of time (adoption of a suitable and simplified group management approach).

⑥ Appropriation of a portion of subsidy for communal facilities (battery charge stations, public facilities, pump stations, etc.). Such facilities are effective for promotional and practical instruction purposes. Cost for facility O&M is to be included in the budget of the concerned local autonomy.

⑦ After sales service in the form of mini-workshops (with consideration to service facilities in neighboring areas with well established electrical supply systems.)

⑧ Establishment of area teams strongly connected to the locale (to be responsible for coordination, survey, training), to be integrated by a national level coordinator and information network (rapid response to contingencies, creation of a data bank)

⑨ Other support measures:

- Request for strong political support (establishment of a village electrification fund subsidized from electrical power and petroleum taxes)
- Strengthening of public relations campaign to raise citizen awareness (in addition to mass media, exhibitions in market places and other rural centers)
- Exemption from value added tax for PV batteries

In project formulation, attention is to be given to the following:

① Concentration on areas where electrification efforts have already commenced

② Incorporation of ample budget for the creation and nurturing of local groups (at present 10% of budget), and provisions for long term guidance and support to such groups

③ Priority to local contractors not only for facility construction and installation, but for the procurement of materials as well.

(9) Pursuit of ERD (decentralized rural electrification)

In June 1997, ERD (decentralized rural electrification) was established as a special project within the PERG framework. This project establishes the detailed procedure for implementation of decentralized rural electrification under PERG, and adopts the following 2 part strategy:

- Installation of diesel generating equipment connected to a mini-grid at investment of DH 4,000~8,000.

- Installation of solar home systems and centralized battery charging stations at an investment of DH 5,000~12,000.

In particular, diesel electrification according to the above can be expected to result in the following:

- As standard criteria are not adopted, the likelihood of successful electrification is considered low.

- Development cost is expensive.

- No planning is done for future connection to the existing grid.

- Operating time for diesel generating equipment is constrained to 4~5 hr/d

PV generation, on the other hand, is seen to be an extremely advantageous method of electrification in cases where user households are highly scattered.

In conclusion, electrification of the target region should be carried out within the special ERD project framework in light of the following:

- The experience acquired on the ERD theme confirms the strong demand of rural population and their capacity to contribute.

- The developed experience indicates mean costs for ERD around DH 10,000 for equipment and installation per household.

- The ERD is the economic solution for a proportion of rural villages (especially those with weak demand, either grouped or scattered housing, and far from medium voltage grid, etc.)

- In order to be a strong option of rural electrification, the ERD must shift to a large scale program.

- ERD must rest on the local dynamic and on an institutional framing, improving the capacities of regional and local entities.

Accordingly, although electrification of the entire country by connection to the existing grid is the ultimate objective, there exists a considerable difference in village distance from existing transmission lines making it necessary to first carry out decentralized rural electrification based on a wide range of appropriate technology development.

### 4.2.4 Rural Electrification Centered on CDER Activities

(1) Establishment and Role of CDER

Following the oil crisis in 1979, the Moroccan government placed new focus on the utilization of renewable energy sources culminating in the establishment of Le Centre de Developpement des Energies Renouvelables (CDER). The mission of this agency is as follows:

① To carry out studies and research on the promotion, development and utilization of renewable energy sources

② System and equipment adjustment

③ Identification of the technical, economical and social advantages of renewable energy

④ Establishment of an engineering framework to pursue the above

(2) CDER Objectives

The philosophy behind CDER activities encompass the following:

① Pursuit of the following in expanding the utilization of renewable energy sources in rural areas:

- Replacement of an appropriate ratio of conventional energy sources (kerosene, candles, gas, fuel wood) with renewable energy supply.

- Stabilization of local energy sources.

② Reevaluation of policy to address the issue of alternative energy sources.

Attention to effective control of local energy sources which are a fundamental prerequisite for the socio-economic development of the country.

③ Not simply to arrange for new energy supply, but to strive to satisfy the true needs of the intended beneficiaries through a new analysis of demand. Efforts are to focus on an improvement of living standards.

On the basis of the above philosophy, CDER has the following objectives:

① Strengthening of the role of the public sector in the areas of scientific research and development with regard to renewable energy sources, as well as in the areas of promotion and implementation of renewable energy schemes.

② Management and direction of important projects in the areas of rural electrification, effective use of energy in the industrial sector, and the economic use of energy in tertiary sectors and households.

③ Involvement of CDER in the commercial and industrial sphere through the identification of products adapted to local conditions and with good marketing potential.

④ Pursuit of study and engineering projects.

(3) Activities and Achievements of CDER

Since its inception, CDER has carried out numerous projects in the areas of PV heated water, electrification (PV energy, hydropower, wind power), groundwater pumping by PV power, and the production of biogas, as well as a wide range of general studies related to the foregoing.

Principal activities of CDER are as follows:

① Energy planning

② Energy management and conservation

③ Study on cost-effectiveness and marketability of energy

④ Collection and collation of information and data pertaining to renewable energy sources

⑤ Feasibility studies on renewable energy sources

⑥ Funding planning for the development of renewable energy sources

⑦ Public relations and information dissemination to promote the use of renewable energy sources

⑧ Implementation of model schemes for rural electrification (PV energy, micro-hydropower generation)

⑨ Liaison with related domestic and international agencies

⑩ Seminars and conferences on renewable energy sources

⑪ Training of local engineers and specialists

Since 1992, major projects in which CDER has been involved are as follows:

| | |
|---|---|
| ① National Decentralized Electrification Project (PNED) | |
| ② Special Energy Project (PSE) | assisted by GTZ (Germany) |
| ③ Rural Electrification Pilot Project (PPER) | assisted by France |
| ④ Rural Solar Electrification Project (PRES) | assisted by KfW (Germany) |
| ⑤ Solar heating system (80 MW) | |
| ⑥ Wind power generation project in the northern region (3 MW) | assisted by KfW (Germany) |
| ⑦ Biogas research project | assisted by GTZ (Germany) |
| ⑧ Village electrification project | assisted by Spain |

(4) CDER Organization

The General Director of CDER is stationed in Casablanca, and serves simultaneously as the Director of ONE. CDER's main headquarters is in Marrakech, and its organization centers administratively on the Secretary General. A CDER branch is located in Rabat which is responsible for liaison with other central government agencies and the promotion of special projects.

(5) Description of CDER

Budget : DH 9,421,930 (FY 1996); in Japanese yen: 116,376,000 (US$ 1 = DH 9.31 = ¥ 115)

Personnel : As of May 1997:

| | |
|---|---|
| Total | 84 |
| Engineers | 19 |
| Technicians | 20 |
| Administration | 19 |
| Others | 26 |
| Temporarily assigned personnel | 18 |

Legal status : Special corporate body under MEM, established for the purpose of rural decentralized electrification. At present, no plan for privatization.

(6) Renewable Energy

Renewable energy sources being given attention by CDER are as follows:

① PV energy
② Wind power
③ Biomass energy
④ Hydropower

All of the above represent inexhaustible energy sources which, furthermore, are environmentally friendly and easy to manage in terms of engineering aspects. Specifically, in the area of PV energy, study is being carried out on PV power electricity generation, PV powered pumping systems, PV powered water heating and PV powered drying systems. In the area of wind power, study is being carried out on direct wind power exploitation (wind powered pumping systems, etc.) and wind powered electricity generation. In the area of biomass energy, attention is being given the more efficient use of fuel wood and equipment to produce biogas. In the area of hydropower, efforts are directed at studies on micro-hydropower potential and electrical power generation by micro-hydropower.

(7) Decentralized Rural Electrification

Generally speaking, extension of the existing power grid is the firmest method of electrifying areas over the long term. However, where the area targeted for electrification comprises numerous isolated villages, the cost required for electrification by extension of the existing grid sharply rises.

Thus, in order to respond to the strong desire on the part of residents of isolated villages for access to electrical power, a decentralized electrification approach is necessary.

In Morocco, there are approximately 35,000 villages which cannot be practically electrified over the short term by extension of the existing grid. Average number of households in these villages is around 50. In order to electrify these villages, CDER contemplates the following 3 basic approaches.

① Concentrated PV power and wind power generation in combination with battery charging centers

② Separate PV power generation schemes

③ Mini power grids based on micro-hydropower and diesel generation (in principal, however, due to CDER's focus on renewable energy sources, diesel generation is not given major emphasis)

In light of the above activities, the role of CDER is as follows.

① Development of independent, decentralized electrification schemes

② Promotion of the extension of electrification

③ Training of technical personnel in electrification by renewable energy sources

④ Project monitoring · management

⑤ Selection, testing and management of equipment related to renewable energy development

(8) Village Electrification Project Achievement

Main efforts at village electrification by CDER have been carried out jointly with various international donor agencies. As of the present, approximately 10,000 households have been electrified applying various renewable energy technologies, and it is anticipated that 20,000 households will be so electrified by 1998.

Principal projects currently in progress are PPER (Pilot Rural Electrification Program) being jointly implemented with ADME (Development and Control Agency) of France, and SAER (Regional Energy Supply Program) being carried out with cooperation from GTZ of Germany.

The most marked achievement has occurred under PPER. This project was commenced in 1990 with 50% funding each by the Moroccan and French governments, and by 1995 under phase 1 electrification of 30 villages has been completed at a cost of DH 30 million. Under phase 2, another 90 villages (210 systems) are scheduled to be electrified in 1997. SAER on the other hand is not limited solely to electrification, but aims to supply all energy needs of remote areas (in 1988, SHS were trial installed in 120 households)

A description of PPER is given below. In summary, the program covers 1,597 households, 1,105 subscriptions, 19 groups and 30 villages. Breakdown by type of electrification is as shown in Table 4.2-1, indicating a total of 272 subscriptions for 3 groups (4 villages) in the case of diesel generation. Battery charge stations by PV generation have been established for 22 villages, comprising 14 groups and 698 subscriptions. Micro-hydropower services 3 villages, comprising 1 group and 95 subscriptions.

*Table 4.2-1 Breakdown by Method of Electrification (under PPER)*

| Method of electrification | No. of villages | No. of subscriptions | No. of associations | Subscriptions/group |
|---|---|---|---|---|
| Diesel | 4 | 272 | 19 | 90 (272/3) |
| PV (BSC) | 22 | 698 | 14 | 50 (698/14) |
| PV (SHS) | 1 | 40 | 1 | 40 (40/1) |
| Micro-hydropower | 3 | 95 | 1 | 95 (95/1) |

note: 1) BCS : PV battery charging station
2) SHS : individual household PV system

Classification of household electrification levels by province is indicated in Table 4.2-2. Although major utilization of electricity is for lighting and television operation, power is also used for radios (although this is not indicated in the table)

The most commonly electrical use is 8 W fluorescent bulb × 2, corresponding to level 2, at 39%. Roughly half of this level of user also owns a television. Next is level 3 (8 W fluorescent bulb × 2 + 13 W bulb × 1 = 3 lights) at 25%. Roughly half of this level of user as well owns a television. Level 4 (8 W fluorescent bulb × 3 + 13 W bulb × 2 = 5 lights) accounts for 17%, and over half of this level of user also owns a television (more than 20% the number not owning televisions). Level 1 (8 W fluorescent bulb × 1) is the least at 16%, also with the lowest percentage of television ownership at about 19%.

Overall, roughly 40% of total subscribers own televisions.

*Table 4.2-2 Level of Household Electrification*

| Province | Item | Level 1 | Level 2 | Level 3 | Level 4 | Level 5 | Total |
|---|---|---|---|---|---|---|---|
| | Fluorescent lights | 1 × 8 W | 2 × 8 W | 2 × 8 W + 1 × 13 W | 3 × 8 W + 2 × 13 W | 5 × 8 W + 3 × 13 W | |
| Errachidia | w/ television | 33 | 108 | 71 | 40 | 14 | 266 |
| | wo/ television | 10 | 63 | 71 | 40 | 14 | 200 |
| Azilal | w/ television | 28 | 67 | 43 | 36 | -- | 174 |
| | wo/ television | 9 | 40 | 29 | 48 | -- | 126 |
| Safi | w/ television | 88 | 110 | 29 | 6 | -- | 232 |
| | wo/ television | 9 | 46 | 38 | 14 | -- | 107 |
| Total | w/ television | 148 | 285 | 143 | 82 | 14 | 673 |
| | wo/ television | 28 | 149 | 138 | 104 | 14 | 433 |
| | Total | 176 | 434 | 281 | 186 | 28 | 1,105 |
| | % | 16% | 39% | 25% | 17% | 3% | 100% |

### 4.2.5 Rural Electrification by Micro-hydropower

Micro-hydropower is a renewable energy source and is a mainstay of CDER's power development strategy. The hydropower potential developed to date in Morocco is a total of 927 MW at 23 sites (equivalent to around 40% of the total potential). On this basis, it is assumed that the remaining potential which can be economically and technically developed is around 30%.

On the other hand, under the inventory survey carried out by MEM in 1979 at the directive of ONE with regard to micro-hydropower in the 4 districts of Atlantique Centre, Atlantique Nord, Mediterraneene and Schavienne, 200 sites with potential for development in the range of 20 kW ~ 200 kW were identified with total output of 20 MW and annual generated energy of 25 GWh.

Under cooperation from USAID (Renewable Energy Development Study; Chas. T. Main), detailed study of 20 sites was carried out with basic design, project costing and technical, social and environmental feasibility being done for a minimum of 4 sites.

The selected 4 sites are as follows:

| Site | Province | Water source |
|---|---|---|
| Tabant Ait Imi | Azilal | Ait Imil spring |
| Tilloguit | Azilal | Assif Ahancal river |
| Aghbalon N'Kerdous | Errachidia | Assif N'Ifsas river |
| M'Semrir | Ouarzazate | Boy Koula river |

All 4 of the above sites are well suited for micro-hydropower development; however, in the case of M'Semrir, diesel generation is concluded to be more cost-effective.

Under support from ONE, CDER participated in the realization of the Tabant Ait Imi scheme, which constituted the first such micro-hydropower development project in Morocco. The scheme utilizes 5 m of head and 210 ℓ/s of discharge to generate 6.7 kW of power supply to 182 households. The project was carried out under cooperation from USAID with MEM as the executing agency. Under the terms of cooperation, DH 98,450 of the total project cost of DH 191,000 was extended.

Subsequent to the above, ADEME and DGCL jointly accorded priority to micro-hydropower development in Azilal Province as a method of rural electrification.

CDER has also since carried out a study on micro-hydropower potential in Wilaya (Haut Atlas) south of Marrakech which has yielded promising results. Approximately 50 primary sites (5~30 kW) have been selected under the above. Each site is capable of providing electricity to 50~100 households. In the case of 4 sites out of the foregoing, feasibility study has been done with cooperation from GTZ in May 1993.

These sites are summarized as follows:

| Site | Cercle | No. of households | Output (kW) | Construction cost (DH) |
|---|---|---|---|---|
| Tacheddirt | Asni | 70 | 7.8 | 453,845 |
| Ouinskra | Asni | 100 | 8.0 | 529,436 |
| Tizgui | Asni | 120 | 12.0 | 630,908 |
| Ain El Atrouss | Ait Ourir | 146 | 3.5 | 832,969 |

Of the above, the 2 sites at Ouinskra and Tizgui are under construction within a funding framework including grant aid from GTZ (supply of generating and control equipment), and cost sharing among rural autonomies and user households. However, reassessment of construction cost at the detailed design stage indicates a probable large increase in ultimate installation cost over that estimated at the pre-feasibility stage (according to CDER). Also, reduced cost sharing by beneficiaries resulted in constraints on provision of services and material procurement (cement, rebar, etc.) at the construction stage, causing construction works to fall well behind schedule.

In the case of the Tacheddirt site, residents expressed discontent at utilization of river discharge for any other purpose aside from irrigation, and indicated their desire for PV generation. Accordingly, no micro-hydropower scheme was carried out. Also, the scheme at Ain El Atrouss was originally envisioned to supply power to adjacent villages as well; however, subsequent survey indicated insufficient discharge to achieve this, and the battery charging station approach was accordingly adopted instead. The project has yet to be implemented due to funding adjustment difficulties in light of the substantial cost burden to be borne by the beneficiaries for battery purchase, etc.

With regard to micro-hydropower development on the Sahara desert side of the Atlas range, ONE carried out an inventory study in 1988 which identified 19 potential sites as indicated in Table 4.2-3.

*Table 4.2-3 Micro-hydropower Sites under ONE Inventory Survey*

| Site | No. of villages | No. of households | Head (m) | Discharge ($m^3/s$) | Maximum output (kW) | Firm output (kW) | Additional no. of villages which can be supplied |
|---|---|---|---|---|---|---|---|
| Taroudant: | | | | | | | |
| Agounsa | 14 | 960 | 140 | 300 | 325 | 106 | 0 |
| Agadir Nait M'ham | 18 | 912 | 66 | 650 | 300 | 100 | 1 |
| Tizi N'test | 29 | 770 | 340 | 100 | 275 | 85 | including Ouarg village |
| Askaw | 15 | 599 | 83 | 350 | 200 | 66 | 1 |
| Igounanae | 11 | 540 | 174 | 165 | 200 | 60 | 4 |
| Itorra | 14 | 540 | 25 | 100 | 195 | 60 | 0 |
| Tinighas | 9 | 300 | 187 | 130 | 180 | 33 | 1 |
| Tnine Tigouga | 9 | 435 | 110 | 150 | 140 | 48 | 4 |
| Ouarg | 12+9 | 327+140 | 230 | 80 | 140 | 52 | 0 |
| Asseys | 10 | 350 | 145 | 115 | 120 | 39 | 1 |
| Mgount | 3 | 322 | 218 | 65 | 100 | 36 | 1 |
| Ouarzazate: | | | | | | | |
| Tasga | 17 | 792 | 105 | 350 | 275 | 87 | 0 |
| Oussikis | 10 | 707 | 30 | 1000 | 210 | 78 | 1 |
| Timatras | 9 | 532 | 163 | 150 | 184 | 59 | 1 |
| Aguerd Nissil Amont | 6 | 473 | 95 | 240 | 155 | 52 | 3 |
| Issoumar | 6 | 392 | 21 | 800 | 115 | 43 | 0 |
| Errachidia | | | | | | | |
| Bendrat | 4 | 520 | 130 | 145 | 145 | 57 | 0 |
| Tasfalout | 3+4 | 334+321 | 40 | 360 | 100 | 72 | 0 |
| Taaddaouine | 2 | 451 | 50 | 300 | 100 | 50 | 0 |

As indicated in the above table, the subject sites are scattered throughout the 3 provinces of Errachidia, Ouarzazate and Taroudant, and are capable of supplying electricity to over 207 villages comprising 10,717 households. At present, request is being made to the French government for cooperation in the realization of these schemes.

In addition to the above, cooperation is being received from the Spanish government for the implementation of 10 kW a micro-hydropower scheme and PV power generation scheme at Bab and Tara C.R. in Chefchaouen Province.

### 4.2.6 International Collaboration on Rural Decentralized Electrification Programs

CDER has extensive experience with projects implemented in collaboration with various international funding agencies. Major such projects are described below. (see Table 4.2-4, and 4.2-5).

(1) United States (USAID)

1982
Funding amount: US$ 7 million
Description of assistance:
- CDER building
- PV test equipment
- Computer
- 4 month training course at Seri in the US
- PV pump facilities (15 locations implemented jointly by CDER and USAID)
- 150 locations of clinic PV lighting (100 W)

(2) France (ADEME)

| | |
|---|---|
| 1990: | Study commenced under 50 : 50 funding outlay by the Moroccan and French governments (PPER) |
| Phase-1: | PV electrification of 30 villages in 1995 at a cost of DH 30 million |
| Phase-2: | 210 PV systems (90 villages) including public facilities (clinics, schools, mosques, etc.). Electricity is used for TV, indoor lighting, street lighting. Revolving fund format. |

(3) Germany (GTZ)

PV electrification extension program: 120 households in 1988; 400 households in 1996

Biogass
Improvement of fuel wood energy efficiency
Planning, estimation, economics
Micro-hydropower (under 20 kW) at 2 locations near Marrakech
CDER restructuring: particularly regarding upgrading of technical skills of CDER personnel through training programs, engaging of instructors from outside, dispatch of personnel overseas, etc.

(4) Spain

| | |
|---|---|
| 1994: | Equipment supply and training of personnel in Spain |
| Village electrification plan: | Electrification completed for 10 villages, 500 households |

(5) Canada (CIDA)

| | |
|---|---|
| 1994: | PV pump facilities at 5 locations |
| 1995: | PV pump facilities at 130 locations |

PV pump facilities at 2 other locations in cooperation with Ministry of Interior

(6) China

1996: Grant of 2 micro-hydropower units

***Table 4.2-4 Projects with International Collaboration (completed or ongoing)***

| Project name | Framework | Partner | Description |
|---|---|---|---|
| Moroco Demonstration Phase | CDER-USA cooperation | =USAID =CDER | 1982(US$ 7mill.)<br>CDFR facilities<br>PV test equipment<br>Training PV pump<br>Clinic PV lighting 150 |
| PSE-MAROC * | Moroc-German cooperation | CDER-GTZ | 1988SHS120<br>1996SHS400<br>-one BCS station<br>-2MCH(mini hydro) |
| ** | Moroc-Canada | MOI-CIDA | 1994 PV pump 5 |
| *** | | | 1995 PV pump 130 |
| PPER | Moroc-France cooperation | CDER/MOI -ADEME -CDER | phase-1:1995-1996 cooperation<br>30 villages-1500 households<br>(PV,MCH diesel)<br>Budget: 30mill. DH<br>50% Morocco<br>50% France<br><br>Phase-2: 1996-1997<br>90 villages(210 villase planed)<br>public facilities by rotating fund |
| Power Village | Morocco-Spanish cooperation | | 10 villages,<br>(SHS,BCS,PV pumping) |
| PNED-MCH | Morocco-China cooperation | Electrification | electrification of 2 villages |

* Program includes PV, bio-gas, bio-mass, planing estimation economics, mini hydro, CDER restructuring.

** CDER involved in technical matter only.

*** More than 200PV pump are installed by now.

*Table 4.2-5 Projects with International Collaboration (under planning)*

| Project name | Framework | Partner | Description |
|---|---|---|---|
| PNED-CEE | Morocco - EC | CDER,MEM<br>-CEE | electrification of approx.150 villages (~5000homes) |
| PERG-KFW | Morocco - Germany | ONE-CDER | electrification of approx. 150 villages(~7500homes)<br>Budget: 70% KFW, 30% ONE |
| PNED--JICA | Morocco - Japan | CDER - JICA | rural electrification of Haouz region<br>electrification of approx. 200 |
| PERG | National Plan | ONE - CDER | villages (~100,000homes) |