VOL.I CHAPTER 6
PRELIMINARY COST ESTIMATE

CHAPTER 6 PRELIMINARY PROJECT COST ESTIMATE

6.1 Cost Estimate Criteria

Criteria applied in preliminary project cost estimate are as follows:

(1) Prices are as of the end of May 1997.

(2) Exchange rate:

US$ 1.0 = DH 9.31 (Dirhams)
US$ 1.0 = ¥ 115.0

(3) Project works will all be carried out by contract. Contractors will provide all necessary construction equipment and temporary facilities, and include depreciation for the same within the contract cost.

(4) It is assumed that the executing agency for the Project will be the Renewable Energy Development Center (CDER) of the Ministry of Energy and Mines (MEM). As such the Project will be a government project, and subject to tax and duty exemptions on imported equipment and materials.

(5) It is expected that the relevant taxes and duties would be paid in the case of local procurement of equipment and materials, and the local sub-contracting of works.

- Equipment and material prices: include value added tax
- Sub-contracted works: include an extra 20% over the actual cost of works

(6) Costs for equipment and civil works were calculated based on market price survey, with reference to project implementation plan, work quantities for each category of construction work, and relevant unit costs. Correlation cross check was also made with performance on past similar projects in Morocco.

(7) Installation of equipment procured domestically includes both actual installation works cost and inland transport cost.

(8) Costs for imported equipment were computed based on market price survey (FOB prices), assuming an additional 20% cost (of FOB) for packing and transportation (to include marine and inland transport, off-loading and storage). Inland transportation component is assumed at 5% of the overall packing and transport cost.

(9) Engineering fee is assumed at 10% of equipment cost, transport and installation cost and civil works cost.

(10) Physical contingency cost is assumed at 10% of equipment cost, transport and installation cost, civil works cost and engineering fee.

(11) Interest and price increases during the project construction period have not been taken into consideration.

(12) Foreign currency portion and local currency portion comprise the following:

· Foreign currency portion	:	imported equipment and material cost, marine transport, engineering fee, physical contingency
· Local currency portion	:	civil construction works, power transmission and distribution facilities, installation cost, taxes and duties, engineering fee, physical contingency

6.2 Preliminary Project Cost Estimate

Table 6.2-1 indicates preliminary project cost estimate including civil construction, equipment cost, packing and transportation, installation works, tax, engineering fee and physical contingency. Detailed breakdowns are as follows:

Table 6.2-2 Breakdown of PV Generation Project Cost
Table 6.2-3 Breakdown of Diesel Generation Project Cost
Table 6.2-4 Breakdown of Micro-hydropower Project Cost
Table 6.2-5 Breakdown of Transmission Line Extension Project Cost

Table 6.2-1 Preliminary Estimate of Overall Project Cost

(10^3 US$)

	PV generation			Diesel generation			Micro-hydropower generation			Transmission line extension			Project Cost		
	Phase I	Phase II	Total	Phase I	Phase II	Total	Phase I	Phase II	Total	Phase I	Phase II	Total	Phase I	Phase II	Grand Total
1 Construction Cost															
1-1 Civil Works				15	15	30	1,036	1,417	2,453				1,051	1,432	2,483
1-2 Equipment															
(1) Generating equipment	1,874	1,114	2,988	49	49	98	295	296	591				2 218	1,459	3,677
(2) Transmission facilities							119	151	270	110		110	229	151	380
(3) Distribution facilities				394	398	792	229	356	585	209		209	832	754	1,586
(4) Packin g and transport	272	176	448	10	10	20	59	60	119				341	246	587
(5) Installation works	731	333	1,064	4	4	8	92	117	209				827	454	1,281
Total	2,877	1,623	4,500	457	461	918	794	980	1,774	319		319	4,447	3,064	7,511
Grand Total	2,877	1,623	4,500	472	476	948	1,830	2,397	4,227	319		319	5,498	4,496	9,994
2 Tax (VAT)	252	114	366	83	83	166	272	377	649	64		64	671	574	1,245
{Civil works (1-1) + Generating equipment (1) + Transmission facilities (2) + Distribution facilities (3) + Installation works (5) + (Packing & trans (4)×0.05)] × 20															
3 Engineering fee	288	162	450	47	48	95	184	240	424	32		32	551	450	1,001
{Construction cost (1) × 10%															
4. Physical contingency	316	179	495	52	52	104	202	264	466	35		35	605	495	1,100
{Construction cost (1) + engineering fee (3) × 10%															
5 Preliminary project cost estimate	3,733	2,078	5,811	654	659	1,313	2,488	3,278	5,766	450		450	7,325	6,015	13,340

Table 6.2-2 Breakdown of PV Generation Project Cost (1/5)

Rate : US$ 1.0/DH 9.31/¥115 (Unit: US$)

Village name	Tizi Oussem			Id Aissa			Tassa Ouirgane			Igrem			Aghella			Ikiss			Tinerhouhrine			Tacheddirt		
No. of households (2000年)		76			46			58			28			67			71			31			63	
PVmodulecapacity (Wp) no. of system		10,225	99		6,515	64		7,650	74		4,010	39		8,715	84		9,155	88		4,380	43		8,760	86
Work	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total
1.Construction cost																								
1-1 Equipment cost																								
(1) PVmodule	68,099		68,099	43,390		43,390	50,949		50,949	26,707		26,707	58,042		58,042	60,972		60,972	29,171		29,171	58,342		58,342
(2) Battery		8,980	8,980		5,700	5,700		6,760	6,760		3,480	3,480		7,720	7,720		8,140	8,140		3,820	3,820		7,640	7,640
(3) Controller		8,910	8,910		5,760	5,760		6,660	6,660		3,510	3,510		7,560	7,560		7,920	7,920		3,870	3,870		7,740	7,740
Subtotal	68,099	17,890	85,989	43,390	11,460	54,850	50,949	13,420	64,369	26,707	6,990	33,697	58,042	15,280	73,322	60,972	16,060	77,032	29,171	7,690	36,861	58,342	15,380	73,722
1-2 Packing,transport, installation cost																								
(1) Installation,distribution line		25,740	25,740		16,640	16,640		19,240	19,240		10,140	10,140		21,840	21,840		22,880	22,880		11,180	11,180		22,360	22,360
(2) Transport cost(FCx20%)	12,919	680	13,599	8,231	434	8,665	9,666	509	10,175	5,066	267	5,333	11,011	580	11,591	11,566	610	12,176	5,533	292	5,825	11,068	583	11,651
Subtotal	12,919	26,420	39,339	8,231	17,074	25,305	9,666	19,749	29,415	5,066	10,407	15,473	11,011	22,420	33,431	11,566	23,490	35,056	5,533	11,472	17,005	11,068	22,943	34,011
Grand total	81,018	44,310	125,328	51,621	28,534	80,155	60,615	33,169	93,784	31,773	17,397	49,170	69,053	37,700	106,753	72,538	39,550	112,088	34,704	19,162	53,866	69,410	38,323	107,733
2.Tax (VAT) (1-1(2)+(3)+1-2(1)+((2)*0.05)) x20%		8,862	8,862		5,707	5,707		6,634	6,634		3,479	3,479		7,540	7,540		7,910	7,910		3,832	3,832		7,665	7,665
3.Engineering fee (1) x10%	8,102	4,431	12,533	5,162	2,853	8,016	6,062	3,317	9,378	3,177	1,740	4,917	6,905	3,770	10,675	7,254	3,955	11,209	3,470	1,916	5,387	6,941	3,832	10,773
4.Physical contingency (1+3) x10%	8,912	4,874	13,786	5,678	3,139	8,817	6,668	3,649	10,317	3,495	1,914	5,409	7,596	4,147	11,743	7,979	4,351	12,329	3,817	2,108	5,925	7,635	4,216	11,850
5.Village project cost	98,032	62,477	160,509	62,461	40,233	102,694	73,344	46,769	120,113	38,445	24,530	62,975	83,554	53,157	136,711	87,771	55,764	143,535	41,992	27,018	69,010	84,691	54,035	138,021

Village name	Sqour			Amagdour			Tamaterte			Awin Mazouz			Bouchiha Bon Omar			Bel Abbas			Derb Chem's			Ait Ouzkri		
No. of households (2000年)		47			23			42			70			69			147			63			42	
PVmodulecapacity (Wp) no. of system		4,280	60		2,075	29		6,000	59		6,335	89		6,315	89		13,195	185		5,700	80		3,740	52
Work	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total
1.Construction cost																								
1-1 Equipment cost																								
(1) PVmodule	28,505		28,505	13,820		13,820	39,960		39,960	42,191		42,191	42,058		42,058	87,879		87,879	37,962		37,962	24,908		24,908
(2) Battery		5,480	5,480		2,680	2,680		5,400	5,400		8,160	8,160		8,060	8,060		16,960	16,960		7,320	7,320		4,840	4,840
(3) Controller		5,400	5,400		2,610	2,610		5,310	5,310		8,010	8,010		8,010	8,010		16,650	16,650		7,200	7,200		4,680	4,680
Subtotal	28,505	10,880	39,385	13,820	5,290	19,110	39,960	10,710	50,670	42,191	16,170	58,361	42,058	16,070	58,128	87,879	33,610	121,489	37,962	14,520	52,482	24,908	9,520	34,428
1-2 Packing,transport, installation cost																								
(1) Installation,distribution line		15,600	15,600		7,540	7,540		15,340	15,340		23,140	23,140		23,140	23,140		48,100	48,100		20,800	20,800		13,520	13,520
(2) Transport cost(FCx20%)	5,407	285	5,692	2,622	138	2,760	7,580	400	7,980	8,004	422	8,426	7,978	421	8,399	16,672	877	17,549	7,201	380	7,581	4,725	249	4,974
Subtotal	5,407	15,885	21,292	2,622	7,678	10,300	7,580	15,740	23,320	8,004	23,562	31,566	7,978	23,561	31,539	16,672	48,977	65,649	7,201	21,180	28,381	4,725	13,769	18,494
Grand total	33,912	26,765	60,677	16,442	12,968	29,410	47,540	26,450	73,990	50,195	39,732	89,927	50,036	39,631	89,667	104,551	82,587	187,138	45,163	35,700	80,863	29,633	23,289	52,922
2.Tax (VAT) (1-1(2)+(3)+1-2(1)+((2)*0.05)) x20%		5,353	5,353		2,594	2,594		5,290	5,290		7,946	7,946		7,926	7,926		16,517	16,517		7,140	7,140		4,658	4,658
3.Engineering fee (1) x10%	3,391	2,677	6,068	1,644	1,297	2,941	4,754	2,645	7,399	5,020	3,973	8,993	5,004	3,963	8,967	10,455	8,259	18,714	4,516	3,570	8,086	2,963	2,329	5,292
4.Physical contingency (1+3) x10%	3,730	2,944	6,675	1,809	1,426	3,235	5,229	2,910	8,139	5,521	4,371	9,892	5,504	4,359	9,863	11,501	9,085	20,585	4,968	3,927	8,895	3,260	2,562	5,821
5.Village project cost	41,034	37,739	78,773	19,895	18,285	38,180	57,523	37,295	94,818	60,736	56,022	116,758	60,544	55,879	116,423	126,507	116,447	242,954	54,647	50,337	104,984	35,856	32,837	68,693

Table 6.2-2 Breakdown of PV Generation Project Cost (2/5)

Rate : US$ 1.0/DH 9.31/¥115 (Unit: US$)

Village name	Ait Hmad			Tizgui			Anermu			Talat Ait Ihla			Adghouss			Tagadirt			Tfirt			Anfrioune		
No. of households (2000年)	52			63			94			73			52			52			94			63		
PVmodulecapacity (Wp) no. of system		4,655	65		5,645	79		12,840	120		9,340	90		6,875	66		6,580	63		12,245	118		8,200	79
Work	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total
1.Construction cost																								
1-1 Equipment cost																								
(1) PVmodule	31,002		31,002	37,596		37,596	85,514		85,514	62,204		62,204	45,788		45,788	43,823		43,823	81,552		81,552	54,612		54,612
(2) Battery		6,000	6,000		7,280	7,280		10,980	10,980		8,320	8,320		6,080	6,080		5,880	5,880		10,860	10,860		7,280	7,280
(3) Controller		5,850	5,850		7,110	7,110		10,800	10,800		8,100	8,100		5,940	5,940		5,670	5,670		10,620	10,620		7,110	7,110
Subtotal	31,002	11,850	42,852	37,596	14,390	51,986	85,514	21,780	107,294	62,204	16,420	78,624	45,788	12,020	57,808	43,823	11,550	55,373	81,552	21,480	103,032	54,612	14,390	69,002
1-2 Packing,transport, installation cost																								
(1) Installation,distribution line		16,900	16,900		20,540	20,540		31,200	31,200		23,400	23,400		17,160	17,160		16,380	16,380		30,680	30,680		20,540	20,540
(2) Transport cost(FCx20%)	5,881	310	6,191	7,132	376	7,508	16,222	855	17,077	11,800	622	12,422	8,687	457	9,144	8,313	438	8,751	15,470	816	16,286	10,360	546	10,906
Subtotal	5,881	17,210	23,091	7,132	20,916	28,048	16,222	32,055	48,277	11,800	24,022	35,822	8,687	17,617	26,304	8,313	16,818	25,131	15,470	31,496	46,966	10,360	21,086	31,446
Grand total	36,883	29,060	65,943	44,728	35,306	80,034	101,736	53,835	155,571	74,004	40,442	114,446	54,475	29,637	84,112	52,136	28,368	80,504	97,022	52,976	149,998	64,972	35,476	100,448
2.Tax (VAT) (1-1(2)+(3)+1-2(1)+((2)*0.05)) x20%		5,812	5,812		7,061	7,061		10,767	10,767		8,088	8,088		5,927	5,927		5,674	5,674		10,595	10,595		7,095	7,095
3.Engineering fee (1) x10%	3,688	2,906	6,594	4,473	3,531	8,003	10,174	5,384	15,557	7,400	4,044	11,445	5,448	2,964	8,412	5,214	2,837	8,051	9,702	5,298	15,000	6,497	3,548	10,045
4.Physical contingency (1+3) x10%	4,057	3,197	7,254	4,920	3,883	8,803	11,191	5,922	17,113	8,140	4,449	12,589	6,042	3,260	9,302	5,735	3,120	8,855	10,672	5,827	16,499	7,147	3,902	11,049
5.Village project cost	45,003	40,975	85,603	54,121	49,780	103,901	123,101	75,907	199,008	89,545	57,023	146,568	65,914	41,788	107,702	63,085	39,999	103,083	117,397	74,696	192,092	78,616	50,021	128,637

Village name	Tifratine			Aguenze			Ifit Baragha			Agadir Baragha			Adar Baragha			Tadchert			Tamsoult			Dar Jamaa Ait Ali		
No. of households (2000年)	84			21			37			42			12			31			5			63		
PVmodulecapacity (Wp) no. of system		7,550	106		1,945	27		3,290	46		3,740	52		1,085	15		2,785	39		430	6		5,755	81
Work	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total
1.Construction cost																								
1-1 Equipment cost																								
(1) PVmodule	72,994		72,994	12,954		12,954	21,911		21,911	24,908		24,908	7,226		7,226	18,548		18,548	2,864		2,864	38,328		38,328
(2) Battery		9,700	9,700		2,500	2,500		4,240	4,240		4,840	4,840		1,400	1,400		3,580	3,580		560	560		7,400	7,400
(3) Controller		9,540	9,540		2,430	2,430		4,140	4,140		4,680	4,680		1,350	1,350		3,510	3,510		540	540		7,290	7,290
Subtotal	72,994	19,240	92,234	12,954	4,930	17,884	21,911	8,380	30,291	24,908	9,520	34,428	7,226	2,750	9,976	18,548	7,090	25,638	2,864	1,100	3,964	38,328	14,690	53,018
1-2 Packing,transport, installation cost																								
(1) Installation,distribution line		27,560	27,560		7,020	7,020		11,960	11,960		13,520	13,520		3,900	3,900		10,140	10,140		1,560	1,560		21,060	21,060
(2) Transport cost(FCx20%)	13,847	730	14,577	2,457	130	2,587	4,157	219	4,376	4,725	249	4,974	1,371	72	1,443	3,519	185	3,704	543	29	572	7,271	383	7,654
Subtotal	13,847	28,290	42,137	2,457	7,150	9,607	4,157	12,179	16,336	4,725	13,769	18,494	1,371	3,972	5,343	3,519	10,325	13,844	543	1,589	2,132	7,271	21,443	28,714
Grand total	86,841	47,530	134,371	15,411	12,080	27,491	26,068	20,559	46,627	29,633	23,289	52,922	8,597	6,722	15,319	22,067	17,415	39,482	3,407	2,689	6,096	45,599	36,133	81,732
2.Tax (VAT) (1-1(2)+(3)+1-2(1)+((2)*0.05)) x20%		9,506	9,506		2,416	2,416		4,112	4,112		4,658	4,658		1,344	1,344		3,483	3,483		538	538		7,227	7,227
3.Engineering fee (1) x10%	8,684	4,753	13,437	1,541	1,208	2,749	2,607	2,056	4,663	2,963	2,329	5,292	860	672	1,532	2,207	1,742	3,948	341	269	610	4,560	3,613	8,173
4.Physical contingency (1+3) x10%	9,553	5,228	14,781	1,694	1,329	3,023	2,867	2,261	5,129	3,260	2,562	5,821	946	739	1,686	2,427	1,916	4,343	375	296	671	5,016	3,975	8,991
5.Village project cost	105,078	67,017	172,095	18,646	17,033	35,679	31,542	28,988	60,530	35,856	32,837	68,693	10,402	9,478	19,881	26,701	24,555	51,256	4,122	3,791	7,914	55,175	50,948	106,122

Table 6.2-2 Breakdown of PV Generation Project Cost (3/5)

Rate : US$ 1.0/DH 9.31/¥115 (Unit: US$)

Village name	Agadir Ait Brahim			Iouraghan			Imiki			Ifit Ait Alla			Boukhelf			Addar Ait Ali			Ait M'Barek			Agadir Ait Bourd		
No. of households (2000年)	29			19			52			23			89			23			31			63		
PV module capacity (Wp) no. of system		2,560	36		1,720	24		4,635	65		2,130	30		8,110	114		2,205	31		2,785	39		5,515	77
Work	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total
1.Construction cost																								
1-1 Equipment cost																								
(1) PVmodule	17,050		17,050	11,455		11,455	30,869		30,869	14,186		14,186	54,013		54,013	14,685		14,685	18,548		18,548	36,730		36,730
(2) Battery		3,300	3,300		2,220	2,220		5,960	5,960		2,720	2,720		10,380	10,380		2,800	2,800		3,580	3,580		7,160	7,160
(3) Controller		3,240	3,240		2,160	2,160		5,850	5,850		2,700	2,700		10,260	10,260		2,790	2,790		3,510	3,510		6,930	6,930
Subtotal	17,050	6,540	23,590	11,455	4,380	15,835	30,869	11,810	42,679	14,186	5,420	19,606	54,013	20,640	74,653	14,685	5,590	20,275	18,548	7,090	25,638	36,730	14,090	50,820
1-2 Packing,transport, installation cost																								
(1) Installation,distribution line		9,360	9,360		6,240	6,240		16,900	16,900		7,800	7,800		29,640	29,640		8,060	8,060		10,140	10,140		20,020	20,020
(2) Transport cost(FCx20%)	3,234	171	3,405	2,173	115	2,288	5,856	309	6,165	2,691	142	2,833	10,246	540	10,786	2,786	147	2,933	3,519	185	3,704	6,968	367	7,335
Subtotal	3,234	9,531	12,765	2,173	6,355	8,528	5,856	17,209	23,065	2,691	7,942	10,633	10,246	30,180	40,426	2,786	8,207	10,993	3,519	10,325	13,844	6,968	20,387	27,355
Grand total	20,284	16,071	36,355	13,628	10,735	24,363	36,725	29,019	65,744	16,877	13,362	30,239	64,259	50,820	115,079	17,471	13,797	31,268	22,067	17,415	39,482	43,698	34,477	78,175
2.Tax (VAT) (1-1(2)+(3)+1-2(1)+((2)*0.05)) x20%		3,214	3,214		2,147	2,147		5,804	5,804		2,672	2,672		10,164	10,164		2,759	2,759		3,483	3,483		6,895	6,895
3.Engineering fee (1) x10%	2,028	1,607	3,635	1,363	1,074	2,436	3,673	2,902	6,574	1,688	1,336	3,024	6,426	5,082	11,508	1,747	1,380	3,127	2,207	1,742	3,948	4,370	3,448	7,818
4.Physical contingency (1+3) x10%	2,231	1,768	3,999	1,499	1,181	2,680	4,040	3,192	7,232	1,856	1,470	3,326	7,068	5,590	12,659	1,922	1,517	3,439	2,427	1,916	4,343	4,807	3,792	8,599
5.Village project cost	24,543	22,660	47,203	16,490	15,136	31,626	44,437	40,917	85,354	20,421	18,840	39,262	77,753	71,656	149,409	21,140	19,453	40,593	26,701	24,555	51,256	52,875	48,613	101,487

Village name	Afella Ouassif			Afella Ighil			Anfeg			Aguersouak			Oumast			Ait Zitoun			Tagadirt			Zaouit		
No. of households (2000年)	26			10			16			21			37			37			29			9		
PV module capacity (Wp) no. of system		2,225	31		935	13		1,440	20		1,945	27		3,310	46		3,160	44		2,505	35		860	12
Work	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total
1.Construction cost																								
1-1 Equipment cost																								
(1) PVmodule	14,819		14,819	6,227		6,227	9,590		9,590	12,954		12,954	22,045		22,045	21,046		21,046	16,683		16,683	5,728		5,728
(2) Battery		2,900	2,900		1,200	1,200		1,860	1,860		2,500	2,500		4,280	4,280		4,120	4,120		3,260	3,260		1,100	1,100
(3) Controller		2,790	2,790		1,170	1,170		1,800	1,800		2,430	2,430		4,140	4,140		3,960	3,960		3,150	3,150		1,080	1,080
Subtotal	14,819	5,690	20,509	6,227	2,370	8,597	9,590	3,660	13,250	12,954	4,930	17,884	22,045	8,420	30,465	21,046	8,080	29,126	16,683	6,410	23,093	5,728	2,180	7,908
1-2 Packing,transport, installation cost																								
(1) Installation,distribution line		8,060	8,060		3,380	3,380		5,200	5,200		7,020	7,020		11,960	11,960		11,440	11,440		9,100	9,100		3,120	3,120
(2) Transport cost(FCx20%)	2,811	148	2,959	1,182	62	1,244	1,819	96	1,915	2,457	130	2,587	4,182	220	4,402	3,993	210	4,203	3,165	167	3,332	1,087	57	1,144
Subtotal	2,811	8,208	11,019	1,182	3,442	4,624	1,819	5,296	7,115	2,457	7,150	9,607	4,182	12,180	16,362	3,993	11,650	15,643	3,165	9,267	12,432	1,087	3,177	4,264
Grand total	17,630	13,898	31,528	7,409	5,812	13,221	11,409	8,956	20,365	15,411	12,080	27,491	26,227	20,600	46,827	25,039	19,730	44,769	19,848	15,677	35,525	6,815	5,357	12,172
2.Tax (VAT) (1-1(2)+(3)+1-2(1)+((2)*0.05)) x20%		2,780	2,780		1,162	1,162		1,791	1,791		2,416	2,416		4,120	4,120		3,946	3,946		3,135	3,135		1,071	1,071
3.Engineering fee (1) x10%	1,763	1,390	3,153	741	581	1,322	1,141	896	2,037	1,541	1,208	2,749	2,623	2,060	4,683	2,504	1,973	4,477	1,985	1,568	3,553	682	536	1,217
4.Physical contingency (1+3) x10%	1,939	1,529	3,468	815	639	1,455	1,255	985	2,241	1,695	1,329	3,025	2,885	2,266	5,151	2,754	2,170	4,924	2,183	1,724	3,907	750	589	1,339
5.Village project cost	21,332	19,596	40,928	8,965	8,195	17,160	13,805	12,628	26,433	18,647	17,033	35,680	31,735	29,046	60,781	30,297	27,819	58,116	24,016	22,105	46,120	8,246	7,553	15,800

Table 6.2-2 Breakdown of PV Generation Project Cost (4/5)

Rate : US$ 1.0/DH 9.31/ ¥115 (Unit: US$)

Village name	Izalaghan			Tigouder			Amezi			Agouni			Chaabat Tank			Ighil ndidene			Tizi			Aghbalou		
No. of households (2000年)		13			25			38			31			56			15			62			94	
PVmodulecapacity (Wp) no. of system		1,215	17		2,300	32		3,440	48		2,805	39		5,140	72		1,365	19		5,515	77		8,430	118
Work	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total
1.Construction cost																								
1-1 Equipment cost																								
(1) PVmodule	8,092		8,092	15,318		15,318	22,910		22,910	18,681		18,681	34,232		34,232	9,091		9,091	36,730		36,730	56,144		56,144
(2) Battery		1,560	1,560		2,960	2,960		4,440	4,440		3,620	3,620		6,580	6,580		1,760	1,760		7,120	7,120		10,860	10,860
(3) Controller		1,530	1,530		2,880	2,880		4,320	4,320		3,510	3,510		6,480	6,480		1,710	1,710		6,930	6,930		10,620	10,620
Subtotal	8,092	3,090	11,182	15,318	5,840	21,158	22,910	8,760	31,670	18,681	7,130	25,811	34,232	13,060	47,292	9,091	3,470	12,561	36,730	14,050	50,780	56,144	21,480	77,624
1-2 Packing,transport, installation cost																								
(1) Installation,distribution line		4,420	4,420		8,320	8,320		12,480	12,480		10,140	10,140		18,720	18,720		4,940	4,940		20,020	20,020		30,680	30,680
(2) Transport cost(FCx20%)	1,535	81	1,616	2,906	153	3,059	4,346	229	4,575	3,544	187	3,731	6,494	342	6,836	1,724	91	1,815	6,968	367	7,335	10,651	561	11,212
Subtotal	1,535	4,501	6,036	2,906	8,473	11,379	4,346	12,709	17,055	3,544	10,327	13,871	6,494	19,062	25,556	1,724	5,031	6,755	6,968	20,387	27,355	10,651	31,241	41,892
Grand total	9,627	7,591	17,218	18,224	14,313	32,537	27,256	21,469	48,725	22,225	17,457	39,682	40,726	32,122	72,848	10,815	8,501	19,316	43,698	34,437	78,135	66,795	52,721	119,516
2.Tax (VAT) (1-1(2)+(3)+1-2(1)+((2)*0.05)) x20%		1,518	1,518		2,863	2,863		4,294	4,294		3,491	3,491		6,424	6,424		1,700	1,700		6,887	6,887		10,544	10,544
3.Engineering fee (1) x10%	963	759	1,722	1,822	1,431	3,254	2,726	2,147	4,873	2,223	1,746	3,968	4,073	3,212	7,285	1,082	850	1,932	4,370	3,444	7,814	6,680	5,272	11,952
4.Physical contingency (1+3) x10%	1,059	835	1,894	2,005	1,574	3,579	2,998	2,362	5,359	2,445	1,920	4,365	4,480	3,533	8,013	1,190	935	2,125	4,807	3,787	8,594	7,347	5,799	13,147
5.Village project cost	11,649	10,703	22,352	22,051	20,181	42,232	32,980	30,271	63,251	26,892	24,614	51,506	49,278	45,292	94,570	13,197	11,986	25,073	52,875	48,555	101,430	80,822	74,337	155,159

Village name	Ait Hsain			Ait Boubker			Tazatourt			Tamsoulte			Tizgui			Ait Tirghit			Tachbibt Kabli			Tachbibt Echatoui		
No. of households (2000年)		14			15			35			35			52			52			31			31	
PVmodulecapacity (Wp) no. of system		1,345	19		1,440	20		3,195	45		3,160	44		4,655	65		4,600	64		2,915	41		2,915	41
Work	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total
1.Construction cost																								
1-1 Equipment cost																								
(1) PVmodule	8,958		8,958	9,590		9,590	21,279		21,279	21,046		21,046	31,002		31,002	30,636		30,636	19,414		19,414	19,414		19,414
(2) Battery		1,700	1,700		1,840	1,840		4,080	4,080		4,080	4,080		6,000	6,000		5,960	5,960		3,700	3,700		3,700	3,700
(3) Controller		1,710	1,710		1,800	1,800		4,050	4,050		3,960	3,960		5,850	5,850		5,760	5,760		3,690	3,690		3,690	3,690
Subtotal	8,958	3,410	12,368	9,590	3,640	13,230	21,279	8,130	29,409	21,046	8,040	29,086	31,002	11,850	42,852	30,636	11,720	42,356	19,414	7,390	26,804	19,414	7,390	26,804
1-2 Packing,transport, installation cost																								
(1) Installation,distribution line		4,940	4,940		5,200	5,200		11,700	11,700		11,440	11,440		16,900	16,900		16,640	16,640		10,660	10,660		10,660	10,660
(2) Transport cost(FCx20%)	1,699	90	1,789	1,819	96	1,915	4,036	213	4,249	3,993	210	4,203	5,881	310	6,191	5,812	306	6,118	3,683	194	3,877	3,683	194	3,877
Subtotal	1,699	5,030	6,729	1,819	5,296	7,115	4,036	11,913	15,949	3,993	11,650	15,643	5,881	17,210	23,091	5,812	16,946	22,758	3,683	10,854	14,537	3,683	10,854	14,537
Grand total	10,657	8,440	19,097	11,409	8,936	20,345	25,315	20,043	45,358	25,039	19,690	44,729	36,883	29,060	65,943	36,448	28,666	65,114	23,097	18,244	41,341	23,097	18,244	41,341
2.Tax (VAT) (1-1(2)+(3)+1-2(1)+((2)*0.05)) x20%		1,688	1,688		1,787	1,787		4,009	4,009		3,938	3,938		5,812	5,812		5,733	5,733		3,649	3,649		3,649	3,649
3.Engineering fee (1) x10%	1,066	844	1,910	1,141	894	2,035	2,532	2,004	4,536	2,504	1,969	4,473	3,688	2,906	6,594	3,645	2,867	6,511	2,310	1,824	4,134	2,310	1,824	4,134
4.Physical contingency (1+3) x10%	1,172	928	2,101	1,255	983	2,238	2,785	2,205	4,989	2,754	2,166	4,920	4,057	3,197	7,254	4,009	3,153	7,163	2,541	2,007	4,548	2,541	2,007	4,548
5.Village project cost	12,895	11,900	24,795	13,805	12,600	26,405	30,631	28,261	58,892	30,297	27,763	58,060	44,628	40,975	85,603	44,102	40,419	84,521	27,947	25,724	53,671	27,947	25,724	53,671

Table 6.2-2 Breakdown of PV Generation Project Cost (5/5)

Rate : US$ 1.0/DH 9.31/ ¥115 (Unit: US$)

Village name	Asgoune			Ait Aamara Loued			Lakaarma			Tarast		
No. of households (2000年)	31			84			31			47		
PVmodulecapacity (Wp) no. of system		2,840	40		7,625	107		2,730	38		4,465	63
Work	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total
1.Construction cost												
1-1 Equipment cost												
(1) PVmodule	18,914		18,914	50,783		50,783	18,182		18,182	29,737		29,737
(2) Battery		3,620	3,620		9,780	9,780		3,540	3,540		5,720	5,720
(3) Controller		3,600	3,600		9,630	9,630		3,420	3,420		5,670	5,670
Subtotal	18,914	7,220	26,134	50,783	19,410	70,193	18,182	6,960	25,142	29,737	11,390	41,127
1-2 Packing,transport, installation cost												
(1) Installation,distribution line		10,400	10,400		27,820	27,820		9,880	9,880		16,380	16,380
(2) Transport cost(FCx20%)	3,588	189	3,777	9,633	508	10,141	3,449	182	3,631	5,641	297	5,938
Subtotal	3,588	10,589	14,177	9,633	28,328	37,961	3,449	10,062	13,511	5,641	16,677	22,318
Grand total	22,502	17,809	40,311	60,416	47,738	108,154	21,631	17,022	38,653	35,378	28,067	63,445
2.Tax (VAT) (1-1(2)+(3)+1-2(1)+((2)*0.05)) x20%		3,562	3,562		9,548	9,548		3,404	3,404		5,613	5,613
3.Engineering fee (1) x10%	2,250	1,781	4,031	6,042	4,774	10,815	2,163	1,702	3,865	3,538	2,807	6,345
4.Physical contingency (1+3) x10%	2,475	1,959	4,434	6,646	5,251	11,897	2,379	1,872	4,251	3,892	3,087	6,979
5.Village project cost	27,227	25,111	52,338	73,103	67,311	140,414	26,393	24,001	50,174	42,807	39,574	82,382

Village name	Assaka			Ansa			Ezzaouite		
No. of households (2000年)	47			62			17		
PVmodulecapacity (Wp) no. of system		4,370	62		8,275	80		2,760	27
Work	FC	LC	Total	FC	LC	Total	FC	LC	Total
1.Construction cost									
1-1 Equipment cost									
(1) PVmodule	29,104		29,104	55,112		55,112	18,382		18,382
(2) Battery		5,520	5,520		7,280	7,280		2,320	2,320
(3) Controller		5,580	5,580		7,200	7,200		2,430	2,430
Subtotal	29,104	11,100	40,204	55,112	14,480	69,592	18,382	4,750	23,132
1-2 Packing,transport, installation cost									
(1) Installation,distribution line		16,120	16,120		20,800	20,800		7,020	7,020
(2) Transport cost(FCx20%)	5,521	291	5,812	10,455	551	11,006	3,487	184	3,671
Subtotal	5,521	16,411	21,932	10,455	21,351	31,806	3,487	7,204	10,691
Grand total	34,625	27,511	62,136	65,567	35,831	101,398	21,869	11,954	33,823
2.Tax (VAT) (1-1(2)+(3)+1-2(1)+((2)*0.05)) x20%		5,502	5,502		7,166	7,166		2,391	2,391
3.Engineering fee (1) x10%	3,463	2,751	6,214	6,557	3,583	10,140	2,187	1,195	3,382
4.Physical contingency (1+3) x10%	3,809	3,026	6,835	7,212	3,941	11,153	2,406	1,314	3,720
5.Village project cost	41,896	38,791	80,687	79,336	50,521	129,857	26,461	16,854	43,316

	Project cost total		
Work	FC	LC	Toyal
1.Construction cost			
1-1 Equipment cost			
(1) PVmodule	2,244,154		2,244,154
(2) Battery		375,120	375,120
(3) Controller		368,460	368,460
Subtotal	2,244,154	743,580	2,987,734
1-2 Packing,transport, installation cost			
(1) Installation,distribution line		1,064,440	1,064,440
(2) Transport cost(FCx20%)	425,749	22,408	448,157
Subtotal	425,749	1,086,848	1,512,597
Grand total	2,669,903	1,830,428	4,500,331
2.Tax (VAT) (1-1(2)+(3)+1-2(1)+((2)*0.05)) x20%		366,086	366,086
3.Engineering fee (1) x10%	266,990	183,042	450,042
4.Physical contingency (1+3) x10%	293,689	201,347	495,036
5. Project cost total	3,230,582	2,580,903	5,811,485

Table 6.2-3 Breakdown of Diesel Generation Project Cost (1/3)

Rate : US$ 1.0/DH 9.31/ ¥115 (Unit;US$)

Work item	Agouns (11.2 kW)			Lemdinat (14.0kW)			Tnirt (21.6 kW)			Ansmrou (14.0kW)			Toulkine (14.0kW)		
	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total
1.Construction cost															
1-1 Civil works															
(1) Direct cost	0	2,000	2,000	0	2,000	2,000	0	2,000	2,000	0	2,000	2,000	0	2,000	2,000
(2) Indirect cost	0	500	500	0	500	500	0	500	500	0	500	500	0	500	500
Subtotal	0	2,500	2,500	0	2,500	2,500	0	2,500	2,500	0	2,500	2,500	0	2,500	2,500
1-2 Equipment cost															
(3)Generating equipment	7,853	0	7,853	8,019	0	8,019	9,770	0	9,770	8,019	0	8,019	8,019	0	8,019
a. Diesel generator															
b. Control board, etc															
Subtotal	7,853	0	7,853	8,019	0	8,019	9,770	0	9,770	8,019	0	8,019	8,019	0	8,019
(4) Distribution facilities															
a. Intra-village distribution facilities	0	16,080	16,080	0	27,365	27,365	0	38,870	38,870	0	26,910	26,910	0	32,825	32,825
b. House wiring	0	28,600	28,600	0	43,680	43,680	0	62,920	62,920	0	43,680	43,680	0	52,000	52,000
Subtotal	0	44,680	44,680	0	71,045	71,045	0	101,790	101,790	0	70,590	70,590	0	84,825	84,825
(5) Installation works	0	665	665	0	665	665	0	665	665	0	665	665	0	665	665
(6) Packing transport (FCx20%)	1,492	79	1,571	1,524	80	1,604	1,856	98	1,954	1,524	80	1,604	1,524	80	1,604
Grand total- (3) ~ (6)	9,345	45,424	54,769	9,543	71,790	81,333	11,626	102,553	114,179	9,543	71,335	80,878	9,543	85,570	95,113
- (1) ~ (6)	9,345	47,924	57,269	9,543	74,290	83,833	11,626	105,053	116,679	9,543	73,835	83,378	9,543	88,070	97,613
2.Tax (VAT)	0	9,585	9,585	0	14,858	14,858	0	21,011	21,011	0	14,767	14,767	0	17,614	17,614
((1)+(2)+(4)+(5)+(6x0.05))x20%															
3.Engineering fee	935	4,792	5,727	954	7,429	8,383	1,163	10,505	11,668	954	7,384	8,338	954	8,807	9,761
((1)~(6))x10%															
4. Physical contingency	1,028	5,272	6,300	1,050	8,172	9,222	1,279	11,556	12,835	1,050	8,122	9,172	1,050	9,688	10,737
(1+3) x10%															
5.Village project cast	11,308	67,572	78,880	11,547	104,749	116,296	14,068	148,124	162,192	11,547	104,108	115,654	11,547	124,179	135,726

Table 6.2-3 Breakdown of Diesel Generation Project Cost (2/3)

Rate : US$ 1.0/DH 9.31/ ¥115　　(Unit:US$)

Work item	Douzrou (11.2 kW)			Ait Outmane (11.2 kW)			Ait Smil (14.0kW)			Ait Bourd (8.0 kW)			Ait Bouzid (9.6kW)		
	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total
1.Construction cost															
1-1 Civil works															
(1) Direct cost	0	2,000	2,000	0	2,000	2,000	0	2,000	2,000	0	2,000	2,000	0	2,000	2,000
(2) Indirect cost	0	500	500	0	500	500	0	500	500	0	500	500	0	500	500
Subtotal	0	2,500	2,500	0	2,500	2,500	0	2,500	2,500	0	2,500	2,500	0	2,500	2,500
1-2 Equipment cost															
(3)Generating equipment	9,770	0	9,770	7,853	0	7,853	8,019	0	8,019	7,687	0	7,687	7,687	0	7,687
a. Diesel generator															
b. Control board, etc															
Subtotal	9,770	0	9,770	7,853	0	7,853	8,019	0	8,019	7,687	0	7,687	7,687	0	7,687
(4) Distribution facilities															
a. Intra-village distribution facilities	0	36,855	36,855	0	25,610	25,610	0	26,520	26,520	0	15,960	15,960	0	18,360	18,360
b. House wiring	0	60,060	60,060	0	41,080	41,080	0	41,080	41,080	0	27,300	27,300	0	32,500	32,500
Subtotal	0	96,915	96,915	0	66,690	66,690	0	67,600	67,600	0	43,260	43,260	0	50,860	50,860
(5) Installation works	0	665	665	0	665	665	0	665	665	0	665	665	0	665	665
(6) Packing transport (FCx20%)	1,856	98	1,954	1,492	79	1,571	1,524	80	1,604	1,461	77	1,537	1,461	77	1,537
Grand total- (3) ~ (6)	11,626	97,678	109,304	9,345	67,434	76,779	9,543	68,345	77,888	9,148	44,002	53,149	9,148	51,602	60,749
- (1) ~ (6)	11,626	100,178	111,804	9,345	69,934	79,279	9,543	70,845	80,388	9,148	46,502	55,649	9,148	54,102	63,249
2.Tax (VAT) ((1)+(2)+(4)+(5)+(6x0.05))x20%	0	20,036	20,036	0	13,987	13,987	0	14,169	14,169	0	9,300	9,300	0	10,820	10,820
3.Engineering fee ((1)~(6))x10%	1,163	10,018	11,180	935	6,993	7,928	954	7,085	8,039	915	4,650	5,565	915	5,410	6,325
4. Physical contingency (1+3) x10%	1,279	11,020	12,298	1,028	7,693	8,721	1,050	7,793	8,843	1,006	5,115	6,121	1,006	5,951	6,957
5.Village project cast	14,068	141,251	155,318	11,308	98,606	109,914	11,547	99,892	111,438	11,069	65,568	76,636	11,069	76,284	87,352

Table 6.2-3 Breakdown of Diesel Generation Project Cost (3/3)

Rate : US$ 1.0/DH 9.31/ ¥115 (Unit:US$)

Work item	Abadou (9.6kW)			Tighdouine (8.0 kW)			Total project cost		
	FC	LC	Total	FC	LC	Total	FC	LC	Total
1.Construction cost									
1-1 Civil works									
(1) Direct cost	0	2,000	2,000	0	2,000	2,000	0	24,000	24,000
(2) Indirect cost	0	500	500	0	500	500	0	6,000	6,000
Subtotal	0	2,500	2,500	0	2,500	2,500	0	30,000	30,000
1-2 Equipment cost									
(3)Generating equipment	7,687	0	7,687	7,687	0	7,687	98,070	0	98,070
a. Diesel generator									
b. Control board, etc									
Subtotal	7,687	0	7,687	7,687	0	7,687	98,070	0	98,070
(4) Distribution facilities									
a. Intra-village distribution facilities	0	18,480	18,480	0	17,400	17,400	0	301,235	301,235
b. House wiring	0	30,160	30,160	0	28,340	28,340	0	491,400	491,400
Subtotal	0	48,640	48,640	0	45,740	45,740	0	792,635	792,635
(5) Installation works	0	665	665	0	665	665	0	7,980	7,980
(6) Packing transport (FCx20%)	1,461	77	1,537	1,461	77	1,537	18,633	981	19,614
Grand total- (3) ~ (6)	9,148	49,382	58,529	9,148	46,482	55,629	116,703	801,596	918,299
- (1) ~ (6)	9,148	51,882	61,029	9,148	48,982	58,129	116,703	831,596	948,299
2.Tax (VAT) ((1)+(2)+(4)+(5)+(6x0.05))x20%	0	10,376	10,376	0	9,796	9,796	0	166,123	166,123
3.Engineering fee ((1)~(6))x10%	915	5,188	6,103	915	4,898	5,813	11,670	83,160	94,830
4. Physical contingency (1+3) x10%	1,006	5,707	6,713	1,006	5,388	6,394	12,837	91,476	104,313
5.Village project cast	11,069	73,153	84,222	11,069	69,064	80,133	141,211	1,172,550	1,313,761

Table 6.2-4 Breakdown of Micro-hydropower Project Cost (1/2)

Rate : US$ 1.0/DH 9.31/ ¥115 (Unit;10^3US$)

Work Item	Adardour (26 kW) FC	Adardour LC	Adardour Total	Arg (30 kW) FC	Arg LC	Arg Total	Tidsi (15 kW) FC	Tidsi LC	Tidsi Total	Inzaine (62 kW) FC	Inzaine LC	Inzaine Total
1.Construction cost												
1-1.Civil works												
(1) Direct cost	0	214	214	0	264	264	0	170	170	0	411	411
(2) Indirect cost	38	90	128	47	111	158	31	71	102	74	171	245
Subtotal	38	304	342	47	375	422	31	241	272	74	582	656
1-2.Equipment cost												
(3) Generation equipment												
a. Turbine, generator	70	0	70	42	0	42	50	0	50	71	0	71
b. Appurtenant facilities	55	0	55	32	0	32	46	0	46	32	0	32
Subtotal	125	0	125	74	0	74	96	0	96	103	0	103
(4) Transmission and distribution facilities												
a. Transmission facilities	0	25	25	0	59	59	0	35	35	0	85	85
b.Distribution facilities	0	79	79	0	102	102	0	48	48	0	237	237
Subtotal	0	104	104	0	161	161	0	83	83	0	322	322
(5) Installation works		35	35		26	26		31	31		35	35
(6) Packing, transport(FCx20%)	24	1	25	14	1	15	18	1	19	20	1	21
Grand total- (3) ~ (6)	149	140	289	88	188	276	114	115	229	123	358	481
- (1) ~ (6)	187	444	631	135	563	698	145	356	501	197	940	1,137
2.Tax (VAT)												
((1)+(2)+(4)+(5)+(6x0.05))x20%	0	89	89	0	113	113	0	71	71	0	188	188
3.Engineering fee												
((1)~(6))x10%	19	44	63	14	56	70	15	36	51	20	94	114
4.Physical contingency												
(1+3) x10%	21	49	70	15	62	77	16	39	55	22	103	125
5.Scheme project cost	227	626	853	164	794	958	176	502	678	239	1,325	1,564

Table 6.2-4 Breakdown of Micro-hydropower Project Cost (2/2)

Rate : US$ 1.0/DH 9.31/ ¥115 (Unit:10³US$)

Work Item	Alla-Oumzri (10 kW)			Id Ssior (16 kW)			Anfri (20 kW)			Total project cost		
	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total
1.Construction cost												
1-1.Civil works												
(1) Direct cost	0	137	137	0	145	145	0	194	194	0	1,535	1,535
(2) Indirect cost	25	57	82	26	61	87	35	81	116	276	642	918
Subtotal	25	194	219	26	206	232	35	275	310	276	2,177	2,453
1-2.Equipment cost												
(3) Generation equipment												
a. Turbine, generator	35	0	35	35	0	35	48	0	48	351	0	351
b. Appurtenant facilities	25	0	25	25	0	25	25	0	25	240	0	240
Subtotal	60	0	60	60	0	60	73	0	73	591	0	591
(4) Transmission and distribution facilities												
a. Transmission facilities	0	14	14	0	8	8	0	44	44	0	270	270
b.Distribution facilities	0	22	22	0	33	33	0	64	64	0	585	585
Subtotal	0	36	36	0	41	41	0	108	108	0	855	855
(5) Installation works		26	26		26	26		30	30	0	209	209
(6) Packing, transport(FCx20%)	11	1	12	11	1	12	14	1	15	113	6	119
Grand total- (3) ~ (6)	71	63	134	71	68	139	87	139	226	704	1,070	1,774
- (1) ~ (6)	96	257	353	97	274	371	122	414	536	980	3,247	4,227
2.Tax (VAT) ((1)+(2)+(4)+(5)+(6x0.05))x20%	0	51	51	0	55	55	0	83	83	0	649	649
3.Engineering fee ((1)~(6))x10%	10	26	36	10	27	37	12	41	53	100	324	424
4.Physical contingency (1+3) x10%	11	28	39	11	30	41	14	45	59	110	356	466
5.Scheme project cost	117	362	479	118	386	504	148	583	731	1,190	4,576	5,766

Table 6.2-5 Breakdown of Transmission Line extension Project Cost (1/2)

Rate : US$ 1.0/DH 9.31/ ¥115 (Unit:US$)

Work item	Imskar			Oulad Mansour			Tlat Tedrara			Lamhamid			Quriz		
	Qty	Unit cost	Total	Qty	Unit cost	Total	Qty	Unit cost	Total	Qty	Unit cost	Total	Qty	Unit cost	Total
1.Construction Cost															
1-2 Equipments Cost															
(1) Transmission facilities															
a. Transmission line	2.0 km	15,000	30,000	1.5 km	15,000	22,500	1.0 km	15,000	15,000	0.3 km	15,000	4,500	0.2 km	15,000	3,000
b. Circuit breaker	1 set	7,000	7,000	1 set	7,000	7,000	1 set	7,000	7,000	1 set	7,000	7,000	1 set	7,000	7,000
Subtotal			37,000			29,500			22,000			11,500			10,000
(2) Distribution facilities															
a. Intra-village distribution facilities	520 m	8	4,160	990 m	8	7,920	1,070 m	8	8,560	500 m	8	4,000	390 m	8	3,120
b. Distribution line poles	10 nos	1,000	10,000	20 nos	1,000	20,000	21 nos	1,000	21,000	10 nos	1,000	10,000	8 nos	1,000	8,000
c. Transformer	1 nos	6,000	6,000	2 nos	6,000	12,000	2 nos	6,000	12,000	1 nos	6,000	6,000	1 nos	6,000	6,000
b. House wiring	44 set	260	11,440	77 set	260	20,020	88 set	260	22,880	35 set	260	9,100	27 set	260	7,020
Subtotal			31,600			59,940			64,440			29,100			24,140
Grand total- (1) ~ (2)			68,600			89,440			86,440			40,600			34,140
2.Tax (VAT) ((1)+(2))x20%			13,720			17,888			17,288			8,120			6,828
3.Engineering fee ((1)~(2))x10%			6,860			8,944			8,644			4,060			3,414
4.Physical contingency (1+3)x10%			7,546			9,838			9,508			4,466			3,755
5.Village project cost			96,726			126,110			121,880			57,246			48,137

(note: all cost are local currency portion)

Table 6.2-5 Breakdown of Transmission Line extension Project Cost (2/2)

Rate : US$ 1.0/DH 9.31/ ¥115 (Unit;US$)

Work item	Total project cost		
	Qty	Unit cost	Total
1.Construction Cost			
1-2 Equipments Cost			
(1) Transmission facilities			
a. Transmission line	5.0 km	15,000	75,000
b. Circuit breaker	5 set	7,000	35,000
Subtotal		22,000	110,000
(2) Distribution facilities			
a. Intra-village distribution facilities	3,470 m	8	27,760
b. Distribution line poles	69 nos	1,000	69,000
c. Transformer	7 nos	6,000	42,000
b. House wiring	271 set	260	70,460
Subtotal		7,268	209,220
Grand total- (1) ~ (2)			319,220
2.Tax (VAT)			63,844
((1)+(2))x20%			
3.Engineering fee			31,922
((1)~(2))x10%			
4.Physical contingency			35,114
(1+3)x10%			
5.Total project cost			450,100

(note: all cost are local currency portion)

VOL.I CHAPTER 7
FINANCIAL AND ECONOMIC EVALUATION

CHAPTER 7 FINANCIAL AND ECONOMIC EVALUATION

7.1 Task Flow for Financial and Economic Evaluation

1) Power Demand Estimate (Section 5.4, Power Demand Forecast)

Size of power system required for each village is determined on the basis of survey of capacity of electrical appliances / equipment to be utilized and hours of envisioned power use for each type of power demand.

2) Selection of Power Supply Method (Section 5.5, Power Supply Plan)

On the basis of criteria including natural features of the village sites, whether or not water resources are available, distance from existing transmission line, number of village households, etc., standard economic base units are applied for each method of power supply to calculate supply cost and determine the appropriate supply system to be adopted.

3) Design of Power Supply System (Section 5.5, Power Supply Plan)

Separate design is carried out on a village-wise basis for each power supply system (except in the case of PV generation for which a common supply system design was applied).

4) Calculation of Supply System Installation Cost (Section 6.2, Preliminary Project Cost Estimate)

Construction cost estimate is carried out based on system design.

5) Determination of Operational Method for Power Supply System (Section 5.6, Operation and Maintenance Plan

With regards to operation and maintenance structure, CDER will manage system O&M encompassing all of the target villages. Power users' associations will be established in each village, and civilian contractors will attend to system installation and upkeep. An operational approach most appropriate for the installed power system will be determined for each village, and the set fees collected and system management activities pursued.

6) Calculation of Power Supply Cost (this and the items below are described in this chapter)

Power supply cost is calculated on the basis of construction cost and system operational cost.

7) Financial Evaluation

A locally appropriate electricity use tariff (based on affordability of villagers to pay for power) is determined, and envisioned income and outlays under the systems are calculated in order to evaluate the financial viability of the Project (this does not apply, however, to extension of existing transmission line).

8) Economic Evaluation

On a village wise basis, the selected power supply system is compared with an appropriate alternative system which would provide the same service (power supply) in terms of economic value of resource consumption (personnel, materiel). (This does not apply, however, to extension of existing transmission line.)

9) Evaluation of Socio-economic Impact

Socio-economic impacts envisioned to result from electricity supply to heretofore unelectrified villages is evaluated.

7.2 Financial Evaluation

7.2.1 Calculation Method

1) Financial evaluation is done on a village unit basis.

2) On the basis of the above, an integrated financial analysis is carried out for each electrification method.

3) Project life is assumed to be 30 years for micro-hydropower generation, 20 years for PV generation and 10 years for diesel generation.

4) In calculating the monthly cost to be paid by users and the per kWh cost of electricity, recovery ratios for initial investment were considered for cases of 100%, 75%, 50%, 25% and 0%. Initial investment recovery rate has the following 3 meanings:

   (a) The said recovery rate on initial investment is applied to determine the amount of funding which remains at the end of the project period. In the case of a 100% recovery rate for initial investment, an amount of funding remains which is equivalent to the initial investment amount after factoring in of the interest rate (equivalent to the respective discount rates applied) in operation during the said project. This amount is thus available for reinvestment in a subsequent project of identical scale. On the other hand, where recovery rate on initial investment is less than 100%, the scale of funding available for reinvestment drops proportionately.

(b) The said recovery rate on initial investment is used as an index of the financial burden to be borne by the system users during the project period. A recovery rate of 100% implies that the users will eventually bear the entire initial investment amount. Conversely, a recovery rate of 0% means that the users assume no responsibility for repayment of initial investment amount.

(c) From the standpoint of funding procurement, the recovery rate on initial investment serves as a basis for identifying the respective ratios within the initial investment total which (i) must be repaid or (ii) need not be repaid. A recovery rate of 100% implies that the entire initial investment amount must be repaid during the project period. Conversely, a recovery rate of 0% means that none of the initial investment amount need be repaid. In the foregoing, the discount rate signifies the interest on funding necessary for repayment.

5) Discount rates of 0%, 3%, 6% and 9% were applied to determine net present value (NPV). As in the case of the recovery rate on initial investment, the discount rate as well has several implications.

Specifically, the said discount rate implications include (i) the interest rate on profit under the Financial Internal Rate of Return (FIRR) as well as funding in operation during the project period, and (ii) interest on borrowed funds in the course of the project.

6) Cost for power facility consumption for public facilities (street lighting, schools, etc.) is calculated as cost to be borne by the user.

7) Interest on initial investment was excluded from calculation; however, taxes are included in costs for equipment and materials to be procured locally as well as locally contracted construction works. Initial investment also includes engineering fee and physical contingency.

8) Calculation has also been made for the case of collection of a US$ 1/month/household each for both CDER and users' association operating costs, respectively.

7.2.2 Calculation of Power Supply Cost

(1) Calculation of Monthly Cost to be Paid per Household

Monthly payments per household were calculated for varying cases of initial investment recovery rate, and discount rate applied for net present value. (see Table 7.2-1).

Methodology in this regard comprised calculation of total cost incurred during the entire project life for each method of electrification on a village wise basis. Annual discount rates were then applied to determine net present value (NPV).

In the same manner, the number of users per each village are discounted, and this multiplied by 12 months to obtain the NPV in terms of payment months. Village-wise total cost of electrification is shown in Attachments.

Division of the total NPV by NPV in terms of payment months yields the cost for each household per month (LRMC) (equivalent to the per kWh cost as a result of dividing the same by the monthly utilizable power of 240 Wh/day × 30 days = 7.2 kWh).

(LRMC [Long Range Marginal Cost]: The differential between the income garnered through collection of the this computed cost, and the costs incurred during the project period is equivalent to the interest rate on funds in operation during the said project period (i.e., equivalent to the discount rate applied at the time of calculation of initial investment amount).

Table 7.2-1 Monthly Cost to be Paid per Household (excluding operation cost)

(US$ / mo. / home)

Electrification method		PV generation	Diesel generation	Micro-hydropower
No. of villages		71	12	18 (7)
No. of households (year 2000)		3,213	1,890	1,158
Return on initial investment	Discount rate	20 year life	10 year life	30 year life
100%	0%	12.1	8.4	12.8
	3%	13.7	9.4	19.4
	6%	16.2	10.4	27.7
	9%	18.9	11.5	37.5
75%	0%	10.2	7.1	9.9
	3%	11.3	7.8	14.8
	6%	13.2	8.6	21.1
	9%	15.1	9.4	28.4
50%	0%	8.3	5.7	7.0
	3%	9.0	6.2	10.3
	6%	10.2	6.7	14.5
	9%	11.4	7.3	19.4
25%	0%	6.4	4.4	4.1
	3%	6.6	4.6	5.8
	6%	7.1	4.9	7.9
	9%	7.7	5.2	10.3
*0%	0%	4.5	3.0	1.2
	3%	4.2	3.0	1.2
	6%	4.1	3.0	1.2
	9%	4.0	3.1	1.3

* In the case of initial investment recovery rate of 0, the reason the monthly cost becomes less in the case of a higher discount rate under PV generation is that the number of users was assumed as constant from the first year of the project (systems are installed on an individual home basis, with initial investment being the same for each new user added in the course of the Project); in contrast, however, a 1.24% increase in users per annum has been assumed in the case of the other methods of electrification (only system connecting costs are required). Also, in the case of PV generation, a significant difference in household monthly payment amount appears in comparison to other modes of electrification due to the fact that PV generation incurs somewhat larger annual outlays including battery replacement every 3 years and controller replacement after 10 years.

The figures in the above table represent average values for each mode of electrification; in actuality, however, there is some difference depending on the village. For example, a look at the village-wise household monthly payments in the case of a 100% discount rate range of fluctuation is 1.5 fold in the case of PV generation, 1.2 fold in the case of diesel generation, and more than 3 fold in the case of micro-hydropower.

(US$/household/mo.)

Electrification method		PV generation		Diesel generation		Micro-hydropower	
		Max	Min	Max	Min	Max	Min
Initial investment recovery rate	Discount rate						
100%	0%	15.7	10.9	9.5	7.6	29.8	9.1
100%	3%	18.1	12.3	12.3	8.6	45.0	13.9
100%	6%	21.7	14.4	14.4	9.6	64.1	19.9
100%	9%	25.5	16.7	16.7	10.6	86.5	27.0

The above fluctuation in cost stems from differences in construction cost (micro-hydropower), number of households (diesel generation) and number of public facilities (PV generation).

(2) Household Monthly Payment (collected amount) which Makes Project Operation Feasible

The household monthly payment which makes possible a sustainable project implies the cost to be borne by the users which effectively covers over the long term variable cost (O&M cost, fuel cost, etc.) as well as the operational costs required by CDER (overall responsibility for project operation) and users' associations (responsible for daily system management) in the case where no outside subsidy is applied to the Project.

Table 7.2.2 sets out the household monthly payment (collected amount) which would result if a US$ 1/month surcharge each is applied to the values in Table 7.2-1 to cover operational costs of CDER and the users' associations, respectively.

Table 7.2-2 Monthly Cost to be Paid per Household (including operation cost)

(US$ / mo. / home)

Electrification method		PV generation	Diesel generation	Micro-hydropower
No. of villages		71	12	18 (7)
No. of households (year 2000)		3,213	1,890	1,158
Return on initial investment	Discount rate	20 year life	10 year life	30 year life
100%	0%	14.1	10.4	14.8
	3%	15.7	11.4	21.4
	6%	17.2	12.4	29.7
	9%	20.9	13.5	39.5
75%	0%	12.2	9.1	11.9
	3%	13.3	9.8	16.8
	6%	15.2	10.6	23.1
	9%	17.1	11.4	30.4
50%	0%	10.3	7.7	9.0
	3%	11.0	8.2	12.3
	6%	12.2	8.7	16.5
	9%	13.4	9.3	21.4
25%	0%	8.4	6.4	6.1
	3%	8.6	6.6	7.8
	6%	9.1	6.9	9.9
	9%	9.7	7.2	12.3
0%	0%	6.5	5.0	3.2
	3%	6.2	5.0	3.2
	6%	6.1	5.0	3.2
	9%	6.0	5.1	3.3

7.2.3 Balance of Payments Calculation

(1) Estimated Payment by Users

On the basis of questionnaire survey, present household expenditure on illumination fuel (butane gas, candles) is estimated at DH 786 per year (DH 66/month). In addition, expenditure for battery to power TV, radio and other electrical appliances comes to an average DH 97/month. Analysis of this expenditure on a household basis in terms of income bracket and geographic location indicates, with the exception of the more economically advantageous class, an expenditure of DH 60~70 /month for illumination fuel and DH 70~100 for power to energize electrical appliances. On this basis, although some difference is evident depending on income bracket, there is no major variation in expenditure geographically with the exception of one affluent sector of the Tahanaout consumer population.

On the other hand, demand was forecast on the basis of general rural electrification planning as a result of consultations with CDER. However, judging from the status of utilization of lighting, TVs and radios by each household and the findings of questionnaire survey, it is anticipated that numbers of light fixtures per household as well as hours of TV and radio will increase in the future beyond this basic demand forecast. In addition, it can be expected that some insufficiency of power supply may occur at times in the case of PV generation (due excessive cloudy weather) or micro-hydropower (due to drought discharge). As a result, it is necessary to assume some continued expenditure by households for illumination fuel and radio dry cell battery, etc.

Under the envisioned Project, electricity tariff level which can be afforded by the user (each household) is assumed on average for all households at the above described DH 163/month (DH 66 + 97/month). However, also as discussed above, it becomes necessary to assume a separate expenditure by each household of DH 20/month for illumination fuel (butane gas) and DH 20/month for radio dry cell batteries.

Accordingly, an appropriate amount which the beneficiary user will be able to afford for electricity tariffs is assumed at around DH 100~120/month (present expenditure for lighting fuel and batteries minus the above separate expenditure to offset times of insufficient power under the schemes). Also, the willing-to-pay amount indicated by the target beneficiaries of DH 50~75 accounts for some 80% of the total, with households indicating DH 50/month being in the largest group. Overall average willing-to-pay amount is DH 71.

It is necessary here to understand that the foregoing gap between willing-to-pay (DH 71/month) and afford-to-pay amounts (DH 100~120/month) is the natural result of the target households desiring maximum electricity service at minimum cost burden.

With consideration to the above criteria, an electricity tariff level which beneficiaries are capable of paying for the power to be supplied under the Project is estimated as follows:

1) Under the PERG electrification program currently under way in Morocco, it is planned to collect tariffs from users of DH 40/month in the case of extension of the grid, and DH 60/month in the case of PV generation (battery replacement cost to be borne by the user).

2) Under the questionnaire survey carried out in the course of this Study, responses were obtained from each village with regards to affordability to pay for electricity tariffs. In this regard, the general villager indicated an average DH 71/month for the same.

3) The questionnaire survey likewise revealed that at present villagers pay per household an average DH 163/month for energy for illumination purposes, including DH 97/month for battery purchase and recharging, plus additional cost for kerosene and candles. After subtracting the above supplemental cost (DH 20 + 20/month) from the present outlay of DH 163/month for

illumination fuel and battery purchase, the result is DH 123/month. However, due to the fact that in actuality the said supplemental cost varies depending on the village and the household, the affordable cost burden by users is assumed at DH 123~163/month for electricity tariffs.

On the basis of the above data, assuming household outlay per month at a minimum of DH 40/month and a maximum of DH 163/month, balance of payment under each category of electrification was computed for household monthly payments of US$ 4, 7, 10 and 14, respectively (DH 1 = US$ 1.0).

(2) Results of Balance of Payment Calculation

Results of balance of payment calculation for each category of electrification are shown in Table 7.2-3

Table 7.2-3 Overall Balance of Payment Calculation

1) PV generation

(US$ 1,000)

Return on initial investment	Discount rate	Monthly payment (US$ / household				
		4	7	10	14	17
100%	0%	-7,975	-5,662	-3,348	-264	2,050
	3%	-7,235	-5,398	-3,562	-1,113	723
	6%	-6,845	-5,403	-3,960	-2,037	-595
	9%	-6,578	-5,406	-4,235	-2,673	-1,501
75%	0%	-6,523	-4,210	-1,896	1,188	3,501
	3%	-5,783	-3,946	-2,110	339	2,175
	6%	-5,393	-3,951	-2,508	-585	857
	9%	-5,126	-3,955	-2,783	-1,221	-50
50%	0%	5,071	-2,758	-445	2,640	4,933
	3%	-4,331	-2,495	-658	1,790	3,627
	6%	-3,941	-2,499	-1,057	867	2,309
	9%	-3,674	-2,503	-1,331	231	1,402
25%	0%	-3,620	-1,306	1,007	4,092	6,405
	3%	-2,880	-1,043	794	3,242	5,079
	6%	-2,490	-1,047	395	2,318	3,761
	9%	-2,223	-1,051	120	1,682	2,854
0%	0%	-2,168	145	2,459	5,543	7,857
	3%	-1,428	409	2,245	4,694	6,530
	6%	-1,038	404	1,847	3,770	5,212
	9%	-771	401	1,572	3,134	4,306

*note: ░ indicates balance of payment in the black

2) Diesel generation

(US$ 1,000)

Return on initial investment	Discount rate	Monthly payment (US$ / household				
		4	7	10	14	17
100%	0%	-1,566	-837	-107	865	1,594
	3%	-1,529	-909	-289	538	1,159
	6%	-1,500	-966	-432	279	813
	9%	-1,476	-1,012	-548	71	535
75%	0%	-1,237	-508	221	1,193	1,922
	3%	-1,201	-580	40	867	1,487
	6%	-1,171	-638	-104	608	1,141
	9%	-1,148	-684	-219	399	863
50%	0%	-909	-180	549	1,522	2,251
	3%	-872	-252	368	1,195	1,815
	6%	-843	-309	224	936	1,470
	9%	-819	-355	109	728	1,192
25%	0%	-581	149	878	1,850	2,579
	3%	-544	76	697	1,524	2,144
	6%	-514	19	553	1,264	1,798
	9%	-491	-27	437	1,056	1,520
0%	0%	-252	477	1,206	2,178	2,908
	3%	-215	405	1,025	1,852	2,472
	6%	-186	348	881	1,593	2,126
	9%	-162	302	766	1,384	1,849

*note: indicates balance of payment in the black

3) Micro-hydropower generation

(US$ 1,000)

Return on initial investment	Discount rate	Monthly payment (US$ / household				
		4	7	10	14	17
100%	0%	-5,372	-3,870	-2,368	-365	1,137
	3%	-5,532	-4,576	-3,620	-2,346	-1,390
	6%	-5,618	-4,963	-4,308	-3,434	-2,779
	9%	-5,668	-5,189	-4,710	-4,071	-3,592
75%	0%	-3,924	-2,422	-920	1,082	2,584
	3%	-4,084	-3,128	-2,173	-898	58
	6%	-4,171	-3,515	-2,860	-1,986	-1,331
	9%	-4,220	-3,741	-3,262	-2,623	-2,144
50%	0%	-2,476	-974	528	2,530	4,032
	3%	-2,636	-1,681	-725	550	1,506
	6%	-2,723	-2,068	-1,412	-538	117
	9%	-2,773	-2,293	-1,814	-1,176	-696
25%	0%	-1,029	473	1,975	3,978	5,480
	3%	-1,189	-233	723	1,998	2,953
	6%	-1,275	-620	36	909	1,565
	9%	-1,325	-846	-367	272	751
0%	0%	419	1,921	3,423	5,426	6,928
	3%	259	1,215	2,171	3,445	4,401
	6%	173	828	1,483	2,357	3,012
	9%	123	602	1,081	1,720	2,199

*Note: indicates balance of payment in the black

(3) Example of Results of Balance of Payment Calculation

1) Case of Monthly Payment of US$ 4

PV generation:	No profit occurs for any of the cases of initial investment recovery rate or discount rate.
Diesel generation:	No profit occurs for any of the cases of initial investment recovery rate or discount rate.
Micro-hydropower:	Profit occurs for an initial investment recovery rate of 0%. Since variable cost and operating cost are borne by the users, facility O&M is possible.

2) Case of Monthly Payment of US$ 7

PV generation:	Profit occurs for an initial investment recovery rate of 0%. Since variable cost and operating cost are borne by the users, facility O&M is possible.
Diesel generation:	Profit occurs for an initial investment recovery rate of 25% and discount rate of 6%. In other words, users can bear responsibility of 25% of initial investment.
Micro-hydropower:	Profit occurs for an initial investment recovery rate of 25% and discount rate of 0%. In other words, users can bear responsibility of 25% of initial investment.

In other words, all 3 modes of electrification are sustainable. In the case of diesel generation and micro-hydropower, 25% of initial investment can be borne by the users.

(4) Envisioned Monthly Payment

1) Under the results of questionnaire survey set out in Section 2.3.2 (Chapter 2, Socio-economic Conditions), outlays for lighting purposes and to operated electrical appliances (TV, radio) in the home average a total DH 163/month, comprising DH 66/month for candle and butane gas, and DH 97/month for battery purchase and recharge. If this outlay becomes available for monthly payment after implementation of the schemes, affordability to pay would be DH 163/month = US$ 17.5 /month (DH 9.3 = US$ 1).

   Calculation of FIRR in Table 7.2-3 assuming the foregoing US$ 17.5 as the monthly payment by users yields a 6% FIRR at 100% recovery rate for PV generation, an FIRR over 10% at 100% recovery rate for diesel generation, and a 1% FIRR at 100% recovery rate for micro-hydropower. In other words, a monthly payment can be collected which makes possible a 100% recovery of initial investment for all three modes of electrification (disregarding profit rate).

2) If the envisioned monthly payment is intended to correspond only to the DH 97/month current outlay per household for battery purchase and recharge, then the said monthly payment would be around US$ 10/month. Calculation of FIRR in Table 7.2-3 assuming the foregoing US$ 10 as the monthly payment by users yields a 10% FIRR at 25% recovery rate for PV generation, a 3% FIRR at 75% recovery rate for diesel generation, and a 6% FIRR at 25% recovery rate for micro-hydropower. Resulting in the user assuming responsibility for approximately 25% of overall initial investment. This is roughly equivalent to conditions under the PERG program. A US$ 10/month payment under conditions of the foregoing initial investment burden by the users achieves an internal rate of return (including interest) of over 6% overall.

3) A monthly payment of US$ 14, corresponding to a midway point between 1) and 2) above, yields a 4% FIRR at 75% recovery rate for PV generation, a 10% FIRR at 100% recovery rate for diesel generation, and a 1% FIRR at 75% recovery rate for micro-hydropower.

(5) Collection, Use and Management of Monthly Payments

Implementation of the Project does not merely imply a redirection of the present household outlay for lighting and electricity purposes, but also the establishment of cleaner and safer energy source, elimination of the laborious task of battery recharging at charging stations, and the inconvenience of not having electricity during the period of battery recharge.

Full collection of the envisioned household monthly payment would result in an approximate monthly income for CDER of US$ 6,000. This capital could then be used, in addition to Project operation and management, for related purposes including research and personnel training in renewable energy exploitation, training and awareness programs for users, and public relations campaigning throughout Morocco with regard to the advantages of renewable energy development.

Also as discussed earlier, analysis for each electrification category was done on an overall basis for the entire Project area. In actuality, however, a considerable fluctuation in cost is seen from village to village.

Accordingly, collection of an overall uniform monthly payment (or a fixed monthly payment by mode of electrification) from the system users would result in a profit for some villages and a deficit for others. To rectify this, it will be necessary to manage collected funds such that the surplus at one village is effectively rerouted to cover the insufficiency at another village, thereby ensuring the long term stability and sustainability of project operation. For this purpose, it is necessary that CDER secure the personnel and operational resources to make such management of funds possible.

(6) Collection in the Form of Electricity Tariff

In comparing the power cost for each mode of electrification, comparison of per kWh is the most readily understandable yardstick. For this purpose, the monthly payment amounts calculated in Table 7.2-2 have been divided by the monthly electricity consumption of 7.2 kWh to give the per kWh cost. However, in the case of micro-hydropower generated energy is high at an available 15.5 kWh/month, and this has been reflected in the calculated unit prices.

Table 7.2-4 Cost per kWh of Consumed Power (including operation cost)

(US$ / kWh)

Electrification method		PV generation	Diesel generation	Micro-hydropower	
No. of villages		71	12	18 (7)	
No. of households (year 2000)		3,213	1,890	1,158	
Generated energy by hydropower				7.2 kWh	15.5 kWh
Return on initial investment	Discount rate	20 year life	10 year life	30 year life	
100%	0%	1.96	1.44	2.06	1.03
	3%	2.18	1.58	2.97	1.48
	6%	2.39	1.72	4.12	2.06
	9%	2.9	1.87	5.49	2.75
75%	0%	1.69	1.26	1.65	0.82
	3%	1.85	1.36	2.33	1.16
	6%	2.11	1.47	3.21	1.61
	9%	2.37	1.58	4.22	2.11
50%	0%	1.43	1.07	1.25	0.62
	3%	1.53	1.14	1.71	0.85
	6%	1.69	1.21	2.29	1.14
	9%	1.86	1.29	2.97	1.48
25%	0%	1.17	0.89	0.85	0.43
	3%	1.19	0.92	1.08	0.54
	6%	1.26	0.96	1.37	0.68
	9%	1.35	1	1.71	0.86
0%	0%	0.9	0.69	0.44	0.22
	3%	0.86	0.69	0.44	0.22
	6%	0.85	0.69	0.44	0.22
	9%	0.83	0.71	0.46	0.22

1) Electricity tariffs for home power use in Morocco are reported nation-wide at DH 1/kWh (US$ 0.1/kWh). At this rate under the envisioned schemes of this Project, all villages would operate in the red even with a recovery rate on initial investment of 0%. In other words, power supply under these conditions would not be sustainable without some kind of subsidization.

2) Under ERD (decentralized rural electrification) of PERG, users serviced by grid extension are subject to a steady base fee of DH 15/month and DH 40/month to cover construction cost (this ranges from a minimum of DH 0.842/kWh to a maximum of DH 4/kWh. Under the envisioned Project, users of 7.2 kWh/month will be subject to a payment of DH 61/month over the first 7 years (DH 84/month in the case of higher electricity tariffs). After this, it is assumed that payment would drop to DH 21/month (DH 44/month in the case of higher electricity tariffs). Converted into an average payment over a 20 year period, the result is as follows depending on the applied discount rate:

At a discount rate of 3%: DH 40.5/month
At a discount rate of 6%: DH 43.1/month
At a discount rate of 9%: DH 45.5/month

In the case of higher electricity tariff:

At a discount rate of 3%: DH 63.5/month
At a discount rate of 6%: DH 66.1/month
At a discount rate of 9%: DH 68.4/month

Since a 6% discount rate is applied under PERG, electricity tariffs to be collected in line with the PERG framework would be DH 43/month (US$ 4.6/month at an exchange rate of DH 9.3 = US$ 1) and DH 66/month (US$ 7.1/month).

Monthly household payment calculated under the Project is an average US$ 5.3 (PV, diesel and micro-hydropower) at an initial investment recovery of 0% and discount rate of 6%. Application of the minimum tariff of US$ 0.7/month would result in inadequate funding base for system operation and maintenance; however, application of the high tariff would bring in US$ 7.1/month per household which generates sufficient funding for O&M.

On the other hand, due to the fact that a monthly payment of DH 60/month for 7 years only is indicated for beneficiaries of PV generation in the case of PERG, costing under the Project assumes an outlay by the user from the eighth year for battery replacement of US$ 2.4/month. In such case, payments become DH 43.5/month for a discount rate of 6%, DH 45.6/month for a discount rate of 6% and DH 47.5/month for a discount rate of 9%. Adoption of DH 45.6/month for a discount rate of 6% is equivalent to US$ 4.9/month which represent a deficiency in O&M cost of US$ 0.4; however, system operation is considered to be viable given this limited degree of insufficiency.

7.2.4 Initial Investment Structure

From Table 7.2-3, calculation was done for monthly payment based on varying ratios of (i) portion of initial investment funding which must be repaid, and (ii) portion of initial investment funding which need not be repaid. (Interest on portion of initial investment funding which must be repaid was assumed in this case at 6%.) Monthly payments (preliminary estimate) by users under each electrification category are as follows for varying rations of portion of initial investment funding which must be repaid, and portion of initial investment funding which need not be repaid.

(US$/month/household)

Portion of funding to be repaid	Portion of funding that need not be repaid	PV generation	Diesel generation	Micro-hydropower	Overall average (reference value)
100%	0%	17	13	30	18.2
75%	25%	15	11	22	15.1
50%	50%	12	8	16	11.5
25%	75%	10	7	10	9.1
0%	100%	7	6	4	6.1

Overall average was computed on the basis of household number as of the year 2000 as a reference figure (does not include subsequent future increase in number of households).

In the case where portion of funding to be repaid is 100%, necessary monthly household payment is US$ 17 for PV generation, US$ 13 for diesel generation, and US$ 30 for micro-hydropower generation, with an average reference value for all modes of electrification at US$ 18.2. In the case where the portion of funding to be repaid is 25%, necessary monthly household payment is US$ 10 for PV generation, US$ 7 for diesel generation, and US$ 10 for micro-hydropower generation, with an average reference value for all modes of electrification at US$ 9.1.

As reference, the funding plan would be as follows in the case of a recovery rate of 25% on initial investment.

(US$ 10^3)

Electrification method	Preliminary project cost estimate	Portion which must be repaid	Portion which need not be repaid
PV generation	5,811	1,453	4,358
Diesel generation	1,313	328	985
Micro-hydropower	5,766	1,442	4,324
Total	12,890	3,223	9,667

7.2.5 Examination of Village-wise Economic Indices

On the basis of survey of socio-economic conditions as set out in Chapter 2, a study was carried out of the relationship between income and afford-to-pay / willing-to-pay amounts for each target village under the Master Plan. Also, on the basis of the foregoing, study was made of (i) amount which must be returned and (ii) amount which need not be returned for each village.

1) Correlating Coefficients for General Economic Indices

Economic index A	Econmic Index B	Correlating coefficient
Total income	Total expenditure	0.717
Total income	Expenditure for energy	0.431
Total income	Electricity related expenditure	0.286
Total income	Willing-to-pay amount	0.306
Total expenditure	Expenditure for energy	0.376
Total expenditure	Electricity related expenditure	0.406
Total expenditure	Willing-to-pay amount	0.407
Electricity related expenditure	Willing-to-pay amount	0.395

On the basis of the above, it is concluded that a correlation exists between total income and total expenditure (over 0.5). Conversely, it is assumed that a correlation does not exist between the other economic indices (less than 0.5). In particular, a correlation is not seen between the present electricity related expenditure and the willing-to-pay amount for future electrical power supply.

In other words, it is not necessarily the case that high income villages consume a proportionately higher amount of power. Likewise, it cannot be concluded that low income villages indicate a correspondingly low willingness to pay for future electricity supply.

Accordingly, it is judged feasible to establish a set monthly payment amount regardless of individual village income levels.

2) Village-wise Income, and Initial Investment Amount for Electrical Power Facilities (Appendix-2C)

In Appendix-2C, target villages for electrification are ranked in order of income level, the corresponding initial investment for electrification of each village entered, and the cumulative initial investment amount determined.

Average village-wise income (simple average value) is around DH 27,000/year/household. Number of villages which fall below this average total 62, which is equivalent to roughly 2/3 of all the target villages (in the case of micro-hydropower, all villages to be supplied by a single scheme are considered together).

If portion of initial investment which need not be repaid (grant-aid) is to be directed at villages which fall below the average income, and conversely, portion of initial investment which need be repaid (loan) is directed at villages which are above the average income, then ratio of the former to the latter becomes (coincidentally) 50 : 50.

On the other hand, the weighted average for household income which takes into consideration the number of households per village is DH 29,000/year/household. In such case, cumulative ratio of initial investment to be directed at villages which fall below this average is 53%.

Incidentally, in the case where portion of initial investment to be repaid is 50% at an interest rate of 6%, necessary monthly household payment is US$ 12 for PV generation, US$ 8 for diesel generation, and US$ 16 for micro-hydropower generation, with an average reference value for all modes of electrification at US$ 11.5.

3) Village-wise Monthly Payment, and Initial Investment Amount for Electrical Power Facilities (Appendix-2D)

Data in Appendix-2C was re-ranked on the basis of size of household monthly payment by village (initial investment recovery rate of 100%, discount rate of 0%), and cumulative calculation of initial investment amount carried out.

Monthly payment in the case of micro-hydropower showed a considerable range; while that for PV generation and diesel generation showed a more steady distribution.

A clear differential was also seen between villages targeted for PV generation / micro-hydropower, and those targeted for diesel generation. If funding supply is to comprise portions under differing financial conditions, one possible approach would be to use the former and the latter as the criteria for determining the direction for application of the said funding packages under differing financial conditions.

In the case where the funding portion which need not be repaid (grant-aid) is directed at the villages where a high monthly payment is required, and conversely the funding portion which need be repaid (loan) is directed at villages where a lower monthly payment is required, 77.7% of the initial investment amount would comprise the said portion which need not be repaid, and 22.3% would comprise that portion of the same which need be repaid. This scenario is close to the 25% burden for initial investment payment which falls on the users under the previously discussed PERG program.

7.2.6 Funding Operational Structure

In the case of both 2) and 3) above, the initial investment funding would be supplied in total to the counterpart agency (CDER in the case of this Project).

CDER would then carry out electrification facility construction, collect the determined household monthly payments from the villages via the users' associations. CDER would then manage these funds, and effect repayment of that portion of initial investment which falls under the loan category.

Envisioned flow of funding and related tasks is given in Figure 7.2-1. Task content for each arrow in the said figure is as follows:

A. Supply of funding (grant, loan) to CDER by the funding agency.
B. Installation of power generating facilities by CDER (PV generating systems to be installed by private contractors).
C. Utilization of electric power by system users.
D. Monthly payment by users (to the users' associations).
E. Payment of electricity tariffs to CDER by the users' associations (after deducting operating costs for the users' associations, and maintenance fees to go to the PV system private contractors).
F. Payment of maintenance fees to the PV system private contractors.
G. Of the fees received from the users' associations, CDER sets aside that portion which is designated for repayment of the loan portion of initial investment financing (loan repayment fund).
H. Of the fees received from the users' associations, CDER sets aside that portion which is designated for CDER operational costs (CDER operational fund).
I. Of the fees received from the users' associations, CDER sets aside that portion which is designated for battery replacement (battery replacement fund).
J. Of the fees received from the users' associations, CDER sets aside that portion which is designated for cost adjustment (cost adjustment fund).
K. CDER disburses funding from the cost adjustment fund to those users' associations where cost adjustment is necessary.
L. In the case of PV systems where batter replacement is necessary, disbursement is made by CDER to the PV system private contractors from the battery replacement fund.
M. PV system private contractors carry out battery replacement.
N. Users' associations under the diesel generation and micro-hydropower generation schemes carry out operation and maintenance of their respective systems.
O. CDER makes repayment from the loan repayment fund on the loan portion of financing in line with the arranged deadlines.
P. CDER carries out training to upgrade the technical levels of PV system private contractors.

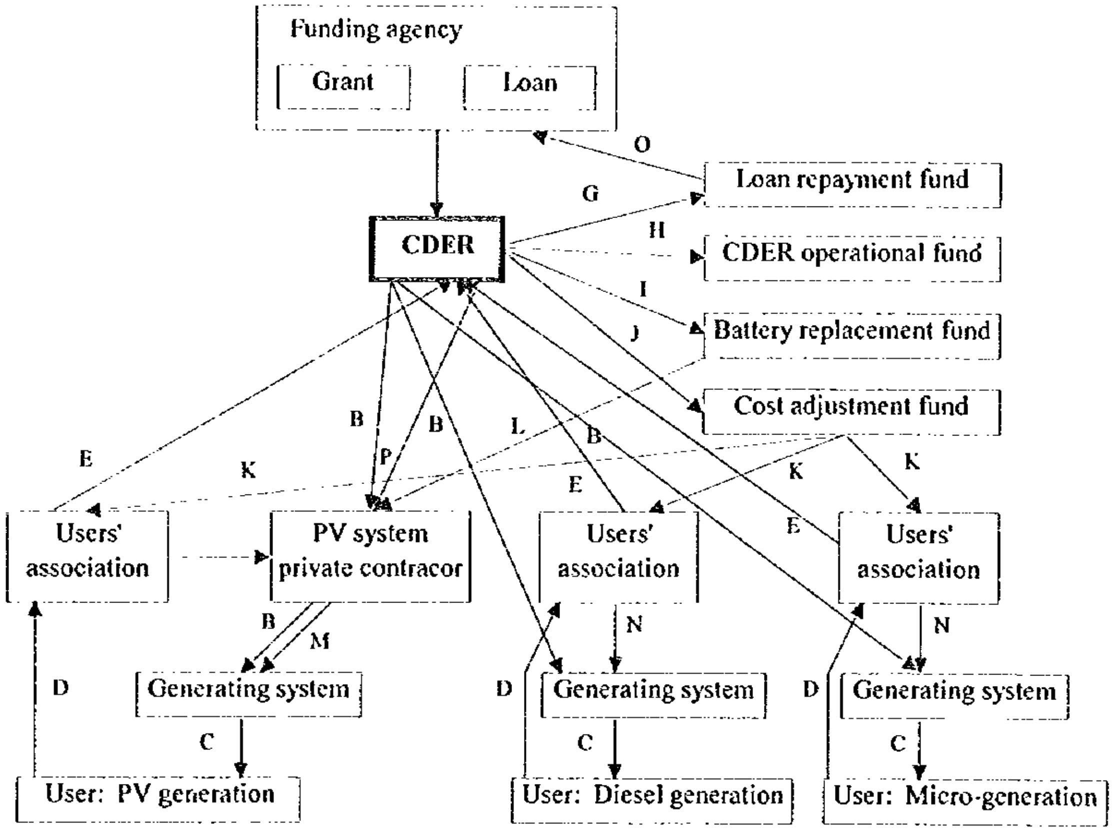

Figure 7.2-1 *Flow of Funding and Related Tasks*

7.3 Economic Evaluation

Economic evaluation is carried out by comparing the total cost during the project life for the designated electrification method (cost) with that over the same period for the alternative method (benefit). In this case the economic evaluation cost (shadow cost) is applied.

In order to determine shadow cost, a conversion factor is assumed on the basis of market prices. In this process, market prices are considered to comprise material cost and personnel cost. An appropriate ratio of the two is determined and conversion factors of 0.9 for material cost and 0.5 for personnel cost are applied.

Table 7.3-1 Setting of Conversion Factors

Item	Material cost ratio (%)	Personnel cost ratio (%)	Conversion factor
Generator, PV module, battery	100	0	0.90
Civil works	40	60	0.66
Transmission / distribution line, etc.	60	40	0.74
Fuel	100	0	0.90
Maintenance works	0	100	0.50
Overhaul	50	50	0.70

However, tax, engineering fee, and physical contingency have not been considered in the above economic calculation.

7.3.1 Results of Economic Analysis (B/C)

Calculation was performed on a village-wise basis for each method of electrification. Diesel generation was adopted as the alternative electrification method for the purposes of comparison, with the exception of villages where diesel generation is to be adopted from the outset, in which case PV generation was used as the alternative method for comparison.

Calculation assumes that initial investment would occur in the 1st year of the Project, with actual power generation to commence from the 2nd year. In all cases a 20 year supply of power was assumed, with costs incurred each year calculated in terms of shadow prices. NPV were computed by applying an annual factor corresponding to the determined discount rate.

In the case of benefit under PV generation and micro-hydropower, the cost for comparable scale power supply by diesel generation has been factored in.

On the other hand, in the case of villages to be electrified by diesel generation, the cost for comparable scale power supply by PV generation has been factored in.

Table 7.3-2 Benefit-Cost Comparison (Total Villages under Each Category of Electrification Method)

Benefit/cost	Discount rate	PV generation	Diesel generation	Micro-hydropower
Benefit (US$ 1,000)	0%	5,490	3,381	962
	3%	4,553	2,991	854
	6%	3,929	2,729	782
	9%	3,501	2,549	732
Cost (US$ 1,000)	0%	6,679	2,563	3,360
	3%	5,952	2,235	3,243
	6%	5,465	2,016	3,179
	9%	5,129	1,866	3,141
Benefit/cost	0%	0.82	1.32	0.33
	3%	0.77	1.34	0.30
	6%	0.72	1.35	0.27
	9%	0.68	1.37	0.26

In cases where the benefit/cost ratio exceeds 1, the selected method of electrification is advantageous compared to the alternative. In this regard the subject calculations indicates that PV generation for 31 villages is advantageous over diesel generation.

In the cases where benefit/cost ratio exceeds 1, the EIRR (Economic Internal Rate of Return) can be computed. In the case of PV generation for 31 villages, the EIRR is within the limits of 0 ~ over 100%. On the other hand, for villages targeted for adoption of diesel generation, this method of electrification is advantageous over PV generation in all the subject cases.

7.3.2 Sensitivity Analysis for Changes in Fuel Cost for Diesel Generation

In estimating system installation cost, it is difficult to anticipate those costs which will fluctuate greatly; however, it is conceivable that a certain amount of fluctuation in fuel cost may occur. In this regard, sensitivity analysis was done for a scenario envisioning a 2 fold increase in the cost of fuel (see Table 7.3-3).

Table 7.3.3 Benefit-Cost Comparison (Assuming a Two Fold Increase in Fuel Cost for Diesel)

Benefit/cost	Discount rate	PV generation	Diesel generation	Micro-hydropower
Benefit (US$ 1,000)	0%	6,964	3,381	1,357
	3%	5,637	2,991	1,148
	6%	4,756	2,729	1,009
	9%	4,153	2,549	913
Cost (US$ 1,000)	0%	6,679	3,313	3,360
	3%	5,952	2,786	3,243
	6%	5,465	2,436	3,179
	9%	5,129	2,197	3,141
Benefit/cost	0%	1.04	1.02	0.40
	3%	0.95	1.07	0.35
	6%	0.87	1.12	0.32
	9%	0.81	1.16	0.29

In cases where either the price of diesel fuel has increased or fuel combustion efficiency worsens to the point where fuel consumption cost rises two fold, cost economic advantage between PV and diesel generation for the villages target for PV generation shows almost no difference.

On the other hand, although the benefit/cost ratio for micro-hydropower schemes shows virtually no change.

Although the villages originally targeted for diesel electrification show a narrowing of advantage over PV electrification as an alternative, a margin of economic advantage still remains.

7.3.3 Economic Evaluation of Change in Power Source for Present Illumination, TV and Radio Purposes

At present, candles, butane gas, etc. are used for illumination, and dry cell and automobile batteries are used to energize TVs and radios. Electrification of the target villages will result in a shift to power supply from the envisioned systems. The economic impact as a result is evaluated below.

(Pre-conditions)

Present:	lighting:	DH 66/month for purchase of gas, kerosene, and candles (breakdown is estimated on the basis of village social survey)
	TV, radio:	DH 97/month for battery purchase and charging cost (breakdown is estimated on the basis of village social survey)

Post-electrification:	power supply for lighting, TV, radio from project schemes
Target households:	6,261 (as of the year 2000)
System cost:	adopting initial investment recovery rate of 100% and discount rate of 0%
Conversion rate:	DH 9.3 = US$ 1

Table 7.3-4 Breakdown of Cost Elements, and Calculation of Monthly Shadow Prices

	Cost item	Monthly cost (DH)	Converted cost (US$)	Conversion rate	Shadow price (US$)
Present:	Gas	30	20197	0.9	18177
	Kerosene	10	6732	0.9	6059
	Candle	26	17504	0.5	8752
	Battery purchase	57	38374	0.9	34537
	Battery charging	40	26929	0.4	10772
	Total	163	109736		78297
Post-electrification:	System repayment		47620	1	47620
				0	0
	Fuel (diesel)		2835	0.9	2552
	Battery replacement		9639	0.9	8675
	Maintenance		10008	0.5	5004
	Operation		12522	0.5	6261
	Total (including repayment)		82624		70112
	Total (excluding repayment)				22492

Under economic evaluation, Project cost merit is US$ 55,800/month, with a 6.1 EIRR for initial investment of US$ 12 million (US$ 7.6 million at economic price). In other words, in a micro-economic sense switch to electricity is advantageous.

In terms of financial evaluation as well for the same case, total present outlay by users for illumination, TV and radio use of US$ 109,700/month drops to US$ 82,624/month including repayment cost burden. Added to this is the fact that power service improves as well. Overall, the switch to electricity is advantageous.

FIRR calculated for initial investment of US$ 12 million is 3.4%.

7.3.4 Study of Benefit from Micro-hydropower

In carrying out economic evaluation of micro-hydropower, benefit is considered in terms of the cost of an alternative power source as in the case with other modes of electrification. In this section, evaluation is done on the basis of total for kW value and kWh value.

The kW value and kWh value applied in economic evaluation comprise power-value (kW-value) and energy-value (kWh-value). Power-value is the per kW fixed cost factored over the system lifetime. Energy-value corresponds to the variable cost per kWh in the course of annual power generation.

The power-value and energy-value applied to economic price for micro-hydropower, and the alternative power sources of diesel generation and PV generation for the 3 micro-hydropower sites is as follows:

Micro-hydropower

	Unit	Arg	Adardour	Tidsi
Target household no. (year 2000)		205	168	110
Facility capacity	kW	30	26	15
Initial investment	US$	495,820	461,500	364,900
Initial investment per kW	US$/kW	16,587	17,750	24,327
Discount rate	%	6	6	6
System lifetime	year	30	30	30
Fixed repair cost	US$/year	1,005	1,279	1,120
Power-value	US$/kW/year	1,153	1,251	1,731
Fuel cost	US$/kWh	0	0	0
Variable repair cost	US$/kWh	0.065	0.098	0.143
Energy-value	US$/kWh	0.065	0.098	0.143

Diesel generation

	Unit	Arg	Adardour	Tidsi
Target household no. (year 2000)		205	168	110
Facility capacity	kW	20.3	16.7	7.7
Initial investment	US$	94,347	61,924	57,128
Generating equipment	US$	10,048	9,001	5,390
Trans./distr. line	US$	84,299	52,923	51,738
Initial investment per kW	US$/kW	4,648	3,708	7,439
Discount rate	%	6	6	6
System lifetime				
Generating equipment	year	10	10	10
Trans./distr. line	year	30	30	30
Initial investment recovery rate	gener. equip	0.136	0.136	0.136
	trans/distr.line	0.068	0.068	0.068
Power-value	US$/kW/year	350	289	560
Fuel cost	US$/kWh	0.162	0.17	0.18
Variable repair cost	US$/kWh	0.079	0.097	0.135
Energy-value	US$/kWh	0.241	0.268	0.315

PV generation (solar home system)

	Unit	Arg	Adardour	Tidsi
Target household no. (year 2000)		205	168	110
Facility capacity	kWp	27.6	21.9	14.1
Initial investment	US$	231,734	183,135	118,203
Initial investment per kW	US$/kW	8,396	8,362	8,383
Discount rate	%	6	6	6
System lifetime	year	20	20	20
Initial investment recovery coefficient		0.087	0.087	0.087
Power-value	US$/kW/year	730	727	729
Fuel cost	US$/kWh	0	0	0
Variable repair cost	US$/kWh	0.345	0.358	0.366
Energy-value	US$/kWh	0.345	0.358	0.366

In the case of the investment cost (shadow price) for PV generation, the amount is essentially the same for all villages. Battery replacement and maintenance cost are computed as variable cost.

In the case of the subject project where decentralized power sources are independent, sources for surplus power consumption are not present, and energy use will be roughly the same in the future, economic viability comparison applying kW-value and kWh-value is the same as analysis of cost benefit using shadow prices.

As a result of cost-benefit analysis using diesel generation as the alternative power source for comparison with village electrification by micro-hydropower, B/C ratio is less than 1 in all cases which does not yield computation of internal rate of return (see Volume 2).

Where PV generation is used as the alternative power source for comparison, assumption of micro-hydropower generating cost as "cost" and PV generating cost as "benefit" results in the following for the case of 30 year system life at 6% discount rate.

	Unit	Arg	Adardour	Tidsi
Benefit/cost		1.44	1.21	0.98
EIRR	%	2.8	1.4	-0.2

Utility life for PV generating schemes is assumed at 20 years. However, in the case where comparison is done for a 30 year system life period, replacement of PV generating equipment would occur and this residual cost is factored into the evaluation of cost in the final year.

Applying a discount rate of 6%, micro-hydropower is advantageous over PV generation for Arg and Adardour in terms of economic evaluation.

7.4 Evaluation of Socio-economic Impacts to Result from Village Electrification

1) Electricity Use

Project implementation will result in the electrification of the households and facilities indicated in the table below by means of clean, safe and readily accessible energy (based on survey of socio-economic conditions).

	Village no.	General households	Street lighting	Schools	Mosques	Shops	Beneficiary population
2000	106	6,512	1,303	112	132	281	41,380
2010	106	6,938	1,389	112	132	281	44,663

2) Improved Educational Levels

Increased opportunity for TV and radio use in schools and the home will promote the dissemination of information and contribute upgraded educational levels.

3) Better Access to Information · Increased Leisure Opportunities

Improved access to TV, radio and other telecommunication sources will significantly expand the information horizon of the Project area population. Also, increased leisure opportunities will become possible both in the home and at public gatherings through availability of TV, radio, karaoke, etc.

4) Contribution to Global Environmental Improvement

At present, butane gas is a common means of energy for illumination in the mountainous regions of Morocco. With illumination possible by electrification, this butane gas use can be directed at cooking purposes, thereby reducing the consumption of fuel wood for the same.

Electrification by means of PV and micro-hydropower schemes, which are the primary focus of the subject Project, results in zero emissions of sulfur oxides and nitrogen oxides which occur in the case of fossil fired power generation. The subject power sources are both clean and renewable and have major positive significance from the standpoint of improved global environment.

5) Reduced Work Load for Women

Fuel wood and water fetching are primarily performed by women in the Project area. Electrification of the target villages will reduce the need for fuel wood, and make possible domestic water via pump. This will greatly reduce the labor load in this regard, and free women for more productive educational and work pursuits.

6) Improved Productivity

In the areas electrified by diesel generation and micro-hydropower, power will become available in the off-peak hours to operate threshing, milling and grinding (pottery) equipment. Also, nighttime work as a result of electric lighting is facilitated, and a power source for operation of simple electrical machinery becomes available.

7) Regional Economic Development · Prevention of Population Influx to Urban Centers

During the project implementation period, installation and civil construction works will increase employment opportunities for local labor. After completion of construction as well, maintenance works, and operational materiel/equipment procurement and transport will result in movement of capital into the Project area, which can be expected to have a stimulating effect on general economic activity in the region. With regional economic development and increase in employment opportunities, the resultant improved rural living standards will serve to suppress the influx of young persons to urban centers and contribute to an overall invigoration of the rural socio-economy.

VOL.I CHAPTER 8
CONCLUSION AND RECOMMENDATION

CHAPTER 8 CONCLUSION AND RECOMMENDATIONS

8.1 Conclusions Drawn from Study

Due to geographical conditions, Haouz region suffers from backward economic development, and exhibits indices of per capita GNP and electrification rate which are well below the national average. Most villages in the region are small, and these are scattered over a wide area often with poor access. In the case of such an area, electrification by extension of the existing grid is not cost effective in terms of the relationship between initial investment and resultant power consumption volume. Accordingly, power supply becomes necessary under a framework of decentralized electrification. Against this background, a Master Plan was formulated under the Study targeting 120 villages for decentralized electrification. A Pre-feasibility Study was subsequently carried out for high priority micro-hydropower schemes selected under the said Master Plan.

(1) Study Methodology

① In carrying out the subject Study, existing socio-economic conditions in the Study area were first identified, and a questionnaire survey in this regard carried out to reflect the same in Master Plan formulation.

② In designated the mode of electrification for each village, criteria were formulated for selection of power supply source. Determination of the most appropriate power source was then done in line with the foregoing criteria.

③ Power demand was forecast for each village, and this used as a basis for formulating the subsequent power supply plan.

④ Study was carried out for an O&M plan following completion of project construction.

⑤ A project implementation schedule was formulated, and preliminary project cost estimated.

⑥ Financial and economic evaluation was carried out, and study made of project operational methodology and socio-economic impacts to result from the Project.

⑦ Selection of viable micro-hydropower sites was done, and a Prefeasibility Study carried out for 3 of the most promising sites from among these.

(2) Selection of Power Supply Source

The methodology in this regard comprised (ii) first a priority ranking of electrification method assuming 20 year total cost (including fixed and variable costs) necessary to electrify a village of fixed size, followed by (ii) a final selection of power source after making correction for special features of each mode of electrification as well as the site area, and the specific needs of the targeted villagers.

Four categories of electrification were considered, i.e. PV generation, diesel generation, micro-hydropower and extension of the existing grid. Eliminating from consideration redundant villages which will be electrified under the ongoing program by ONE, finally selected target villages under the Study total 106. A description of these is as follows:

① In the case of PV generation, economic advantage increases with smaller village size and greater distance from the existing grid. Total number of villages selected for PV generation is 71.

② In the case of diesel generation, economic advantage increases with greater village size and greater distance from the existing grid. Total number of villages selected for diesel generation is 12.

③ In the case of micro-hydropower, fixed cost is greater than that for other modes of electrification, making it less attractive for adoption. However, due to lesser variable cost, micro-hydropower becomes favorable compared to other modes of electrification in the case of project funding under advantageous financial conditions which make the need to repay initial investment significantly reduced (or eliminated altogether). With consideration to the original intent of the request from the Moroccan side, and on the basis of comparison of variable cost only, total number of villages selected for micro-hydropower electrification is 18.

④ In the case of extension of the existing grid, economic advantage increases with greater village size and closer distance from the existing grid. Total number of villages selected for diesel generation is 5. These are within 0.2~2.0 km of existing transmission line and are not included the under on-going ONE program for rural electrification.

(3) Power Supply Plan

Village-wise power demand was forecast, and the power supply plan for each category of electrification formulated taking into account necessary reserve capacity. In principle, separate power sources are to be established for each village; however in the case of hydropower where site conditions yield a potential with sufficient surplus to electrify more than the immediate village, a power supply plan was formulated for electrification of multiple nearby villages from the same scheme. In such case, the optimum micro-hydropower scheme scale was determined through (i) comparative study with a hybrid approach were one portion of the subject villages would be powered by PV generation, as well as (ii) a comparative study of varying scales of strictly micro-hydropower generation.

On the basis of the foregoing, supply plan by power source is summarized as follows:

	No. of villages	No. of households	Facility output (kW)
PV generation	71 [1]	3,213	333.6 [3]
Diesel generation	12	2,136	156.8
Micro-hydropower	18 [2]	1,301	179
Extension of existing gri	5	288	23.2 [4]
Total	106	6,938	692.6

Note 1) No. of systems is 4,094
2) Scheme total is 7. The Tidsi scheme will provide supplemental power to Afra (not on the original request list)
3) Indicates PV module capacity (kWp)
4) Indicates grid load

(4) Implementation Schedule

Due to the large number of target villages under the Master Plan, project implementation is planned for 2 phases (i.e. Phase I and Phase II). Under Phase I, PV generation for 54 villages, diesel generation for 6 villages and 3 micro-hydropower schemes (the 3 schemes selected for Prefeasibility Study) would be carried out. Under Phase II, PV generation for 17 villages, diesel generation for 6 villages and 4 micro-hydropower schemes would be carried out.

Since extension of the existing grid is under the jurisdiction of ONE, these works have been eliminated from consideration under the subject Project. Phase I construction is planned to begin in June 1998 and end in March 2001. The subsequent Phase II construction is planned to begin in June 2000 and end in March 2003.

(5) Preliminary Project Cost Estimate

Preliminary estimate envisions a total project cost of US$ 13,295,000 which after elimination of existing grid extension comes to US$ 12,845,000. Breakdown is as follows:

Method of electrification	Phase I	Phase II	Total
PV generation	3,730	2,036	5,766
Diesel generation	654	659	1,313
Micro-hydropower	2,488	3,278	5,766
Total	6,872	5,973	12,845
Extension of existing grid	450	--	450
Grand total	7,322	5,973	13,295

(note: US$ 1 = DH 9.31 = ¥ 115)

(6) Financial and Economic Evaluation

1) Financial Evaluation

Based on the overall balance of payment calculation (Table 7.2-3) depending on the household monthly payment level, results of financial evaluation are as set out below.

① Case of Monthly Payment of US$ 4/month

<Monthly payment corresponding to the electricity tariffs of DH 40/month in the case of extension of the existing grid and DH 60/month in the case of PV generation under the PERG program>

Under PV generation and diesel generation, no portion of initial investment is recoverable at this monthly payment rate. Furthermore, even payment of variable cost and operational costs becomes impractical. Only in the case of micro-hydropower, which features a relatively cheaper variable cost, can facilities be maintained at this rate of monthly payment (assuming no need to recover total initial investment).

② Case of Monthly Payment of US$ 7/month

<Monthly payment corresponding to the affordability to pay of DH 70/month in the case of the general villager, as indicated by the results of questionnaire survey>

In all cases of PV generation, diesel generation and micro-hydropower, facility maintenance is possible. Under diesel generation and micro-hydropower, a 25% recovery of initial investment can be achieved.

③ Case of Monthly Payment of US$ 10/month

<Monthly payment corresponding to the outlay for battery purchase and recharge of DH 97 per month by the average household, as indicated by the results of questionnaire survey>

At this level of monthly payment, facility maintenance becomes possible for all 3 categories of electrification. Initial investment recovery rates of 25%, 25% and 75% become possible in the cases of PV generation, micro-hydropower and diesel generation, respectively. This corresponds to the PERG program under which a 25% burden of initial investment is placed on the users. At this rate of initial investment recovery, an FIRR of 6% is achieved.

④ Case of Monthly Payment of US$ 14/month

<Monthly payment corresponding to the average affordability-to-pay amount of DH 140/month as indicated by village leaders during the questionnaire survey>

At this level of monthly payment, facility maintenance becomes possible for all 3 categories of electrification. Initial investment recovery rates of 75%, 75% and 100% become possible in the cases of PV generation, micro-hydropower and diesel generation, respectively.

⑤ Case of Monthly Payment of US$ 17.5/month

<Monthly payment corresponding to expenditure by household per month for illumination purposes of DH 66 (candles, butane gas), and DH 97 for battery purchase and recharging (TV, radio use), for a total monthly outlay of DH 163, as indicated by the results of questionnaire survey>

At this level of monthly payment, not only does facility maintenance become possible for all 3 categories of electrification, but an initial investment recovery rate of 100% become possible for all 3 types of power source as well.

On the basis of the above, a household monthly payment of around US$ 17 becomes necessary in order to achieve a 100% initial investment recovery rate for all three modes of electrification. If a lesser amount is collected from the users, a subsidy by the government becomes necessary to address the differential in order to achieve a recovery rate of 100%.

Also, if the monthly payment level is set at US$ 7, which was the affordability-to-pay amount as indicated by the average villager during the questionnaire survey, an initial investment recovery rate of around 25% is achieved. In order to preserve a balance of payments which needs no government subsidy, it becomes necessary that the remaining 75% of initial investment be procured under conditions which require no repayment.

2) Economic Evaluation

Calculation was carried out on a village-wise basis for each electrification category. The alternative energy source used in evaluation was diesel generation in the case of PV generation and micro-hydropower, and PV generation in the case of diesel generation.

The benefit-cost ratio for PV generation (with the exception of one portion) and micro-hydropower was economically disadvantageous at less than 1, while the same for diesel generation was advantageous at over 1. Accordingly, PV generation and micro-hydropower appear difficult to adopt strictly in terms of economical evaluation; however, these modes of electrification were ultimately adopted on the basis of favorable comparison with diesel generation in terms of special merits of such systems, and in terms of financial evaluation considerations.

Also, study was carried out of the economic impact (benefit) to result from switch to electricity for illumination purposes (as replacement for the present candle and butane gas use) and for energizing TVs and radios (as replacement for the present dry cell battery use). As a result, EIRR is shown to be 6.1% under conditions of initial investment recovery rate of 100% and discount rate of 0%. This implies that a switch to electricity as the power source is advantageous.

(7) Conclusions

Under implementation of the Master Plan, 106 target villages in Haouz Region will be electrified, resulting in some 6,938 households (equivalent to a beneficiary population of 44,663) having access to daily electricity for TV, radio, lighting and public facility purposes. This will result in an improving the electrification rate for Haouz Region from 14% to 23%. It is anticipated that the 5 villages designated for connection to the existing grid will be electrified in the near future under the ongoing rural electrification program by ONE.

Furthermore, electrification of the Haouz Region is expected to have a range of direct and indirect beneficial impacts on area development.

In the above manner, electrification of Haouz Region is anticipated to have a major upgrading effect on the public welfare of the area; however, a somewhat lower robustness in terms of project cost-effectiveness makes it recommendable that the envisioned Project be subject to subsidy from the Moroccan government as well as implementation funding under financially advantageous terms.

8.2 Recommendations on Implementation

(1) Operation and Maintenance Organization

1) Users' Associations

The rural electrification effort by CDER will begin with establishment of users' associations at the village level. The associations would be made up of persons from the member households, who would elect from among themselves typically 7 officers comprising an association representative, deputy representative, secretary, accountant, village leader, etc. However, in the case of PV generation, it is recommended that user associations be set up at the hamlet (sub-village) level in order to ensure close, hands on operation of the systems.

2) CDER

Although CDER has good technological expertise in electrification projects, it is considered necessary that the agencies capability be strengthened in the area of project management. This need would have to be responded to at the time of Project implementation within the framework of appropriate measures to upgrade CDER's operational and management capacity. Direct technology transfer in effective management methodology would be achieved through the dispatch to CDER of expatriate management experts who would work closely with the agency in both the management of the subject Project as well as provide advice with regards to other CDER projects. Also, consideration would be given to the dispatch of Japanese Overseas Volunteers to assist in the training of villagers in system use, particularly with regard in the early stages to correct utilization of home solar systems.

3) Private Contractors

In the case of micro-hydropower and diesel generation, the presence of permanent system operational staff in the subject villages will be essential. It will accordingly be necessary that CDER and the concerned private contractors take measures to train such persons in each village to operate the village system and perform simple maintenance duties. However, where more sophisticated facility repair measures are required under any of the envisioned systems (PV, diesel, micro-hydropower generation), the contractor so engaged would be called upon to perform the same.

In the case of PV generation, a single self contained system from solar panel to battery has been designed. In order to effect sustained, safe use of the envisioned PV systems in the early stages, the user would be expected to carry out only simple maintenance such as cleaning of the solar panel with a professional technician to make periodic visits to check the equipment. This would be continued until the user has achieved an appropriate level of understanding of the system equipment. The Project envisions a 3 year period of after service following system installation during which the contractor would make frequent tours of the villages to check the systems, and CDER would supervise the training of operational personnel as well as the villagers themselves such that they attain a suitable level of maintenance technology.

Under such a plan to utilize private contractors, it is necessary to fully understand the trends within the said sector. In recent years in the Marrakech area, there has been a move to provide engineering and financial support to contractors based in villages who engage in the marketing, installation and maintenance of PV systems. It is considered a high possibility that this trend will continue to grow in the future with regard to extension services for PV generating equipment and any assistance under Japan's cooperation program should make active use of such contractors at the system installation and maintenance level.

Private contractors to be selected must be fully capable of responding to the future maintenance, rehabilitation and repair works envisioned to occur under the systems. When tendering for such contractors, a crucial criterion to be closely looked at is whether or not the candidate contractor has the structure in place to carry out sustained maintenance of the subject system(s). In this regard, contracts would call for periodic after service following facility installation, and contract zoning carried out for the Project area such that a single contract covers an appropriate combination of areas relatively easy to visit as well as more remote points in order to ensure the most effective after service activities.

4) Committees

In order to optimize service under the schemes, committees will be established for the purpose of eliciting views of the users, as well as to maintain close linkage between the public and private sector entities related to the Project. One committee would encompass roughly all the users' associations in a single Commune R., and would be made up of members comprising representatives of the associations within its area of jurisdiction, the private contractor, CDER, the commune, and ONE. The committee would be chaired by the CDER representative.

(2) Method of O&M

1) O&M Cost

O&M costs to go to the private contractors would be covered under the monthly payments to be made by the users. However, due to the fact that accumulated money in this regard would be small for about the first 3 years of the Project operation, it is anticipated that such would not be sufficient to cover all O&M costs. To offset this, CDER would carry out during the Project implementation period sufficient training of users' associations, private contractors and the general village population in system operation and maintenance technology in order to make possible a joint maintenance effort by the associations, contractors and villagers. This will serve to reduce the amount of money which would need to be paid to the contractors for O&M works. It is recommended that such training be implemented with funding assistance under advantageous financial conditions. Such training would be expected to provide as well an incentive to the private contractors.

2) Electricity Tariffs and Users' Association Costs

Procedure in this regard would be as follows: ① At the time of coordinating meetings, CDER would collect the electricity tariff portion (monthly set fee) of the monthly payments by user households. ② During the first 3 years of Project operation, the O&M fees that otherwise would go to the private contractors would be banked by the users' association themselves and function as operating funds for the associations. After the third year of Project operation, the users' associations would then begin direct payment of the O&M cost portion to the private contractors. ③ The users' association cost and battery cost portion of the household monthly payments would be banked and managed by the associations.

3) Transparency of Payment Collection and Management

In this regard, it would be assumed that (i) users' associations would be obligated to issue receipts and keep appropriate accounting records, (ii) copies of these would be submitted to CDER at the time of coordinating meetings, and (iii) CDER would take suitable measures to manage these records. Where households are delinquent in their monthly payments, disciplinary measures would be pursued on the basis of the said records.

4) Bank Account Management

The users' association accountant would open and bank account and deposit funds at interest. Since the associations will collect the electricity tariff and the O&M cost (including battery cost) in a single lump sum, they will be guided in the opening of two separate bank accounts and the separate management of these funds. The join-up fees to be collected by members will serve as the operating fund base for the users' associations with possible future application to facility expansion if necessary with increase in number of new system users.

5) Equipment

According to financial analysis, collection of a monthly payment per household of US$ 7 will enable minimum system maintenance in the case of PV generating systems. Furthermore, US$ 7 per household is within the affordable to pay range of the targeted village population. A breakdown of this US$ 7 amount would comprise US$ 1 electricity tariff, US$ 3 towards eventual battery replacement, US$ 2 as maintenance fee to the private contractor, and US$ 1 to the users' association. The total US$ 7 would be collected monthly from each user household by the users' association, which would then pass on the electricity tariff and maintenance portions to CDER and the private contractor, respectively. The battery cost and users' association portions would be placed in a bank account with interest.

In addition to the above monthly payment, a potential beneficiary would be required to pay a set join-up fee to the users' association in order to become eligible to utilize electricity. An appropriate level for such a fee would be in the range DH 500~1,000 per household. This money would be banked along with the users' association's portion of the household monthly payments, and serve as the associations funding source.

Equipment would remain in the ownership of CDER. If equipment were to be handed over to the users' associations prior to establishment of a functioning operation and maintenance structure, this would greatly diminish the right of CDER to remove equipment in cases where malfunctioning had occurred due to improper system O&M by the users, or in the event of extension of the existing grid into the target villages. Accordingly, the equipment is planned to remain under the ownership of CDER throughout the 20 year duration of the Project life.

(3) Equipment Development

Various companies are currently directing efforts particularly at the development of PV generating equipment as well as batteries. It was discovered in the course of the Study that PV system batteries under development with the generally used capacity of 85~105 Ah capacity can be marketed for a price of DH 1,000 which is comparable to the cost of the commonly available car battery.

In Morocco, batteries used for electricity purposes in the home are car batteries which have been diverted for the same. Where such are used under PV generating systems, battery life expectancy can be assumed at around 3 years. In order to prolong battery life, it is important that battery discharge depth be controlled. If discharge depth can be kept below 50%, a 5 year life expectancy can be achieved even with currently available batteries. In the case of independent solar home systems where battery charge and discharge is repeated on a daily basis, establishment of an ample facility capacity will serve to prevent excessive discharge in light of the fact that there is no longer the need to transport the discharged battery to a charging station as has been the practice in the past.

(4) Selection of Target Villages for Electrification, and Electrification Method

As of this report, electrification approach has been planned for 106 target villages. However, a full confirmation for all villages has as yet not been accomplished with regard to villager aspirations concerning electrification. Toward this end, it is anticipated that in the course of subsequent stages of actual Project implementation in the future that villager aspirations continue to be reflected in planning by the National Rural Electrification Committee (COSPER) in line with stipulated procedure under PERG.

(5) Future Study Plan

It is recommended that the following studies be carried out in order to move smoothly to the next phase of the envisioned Project.

① Sunshine intensity observations in mountainous region of the Project area
② Water level and discharge observations at newly installed gauging stations