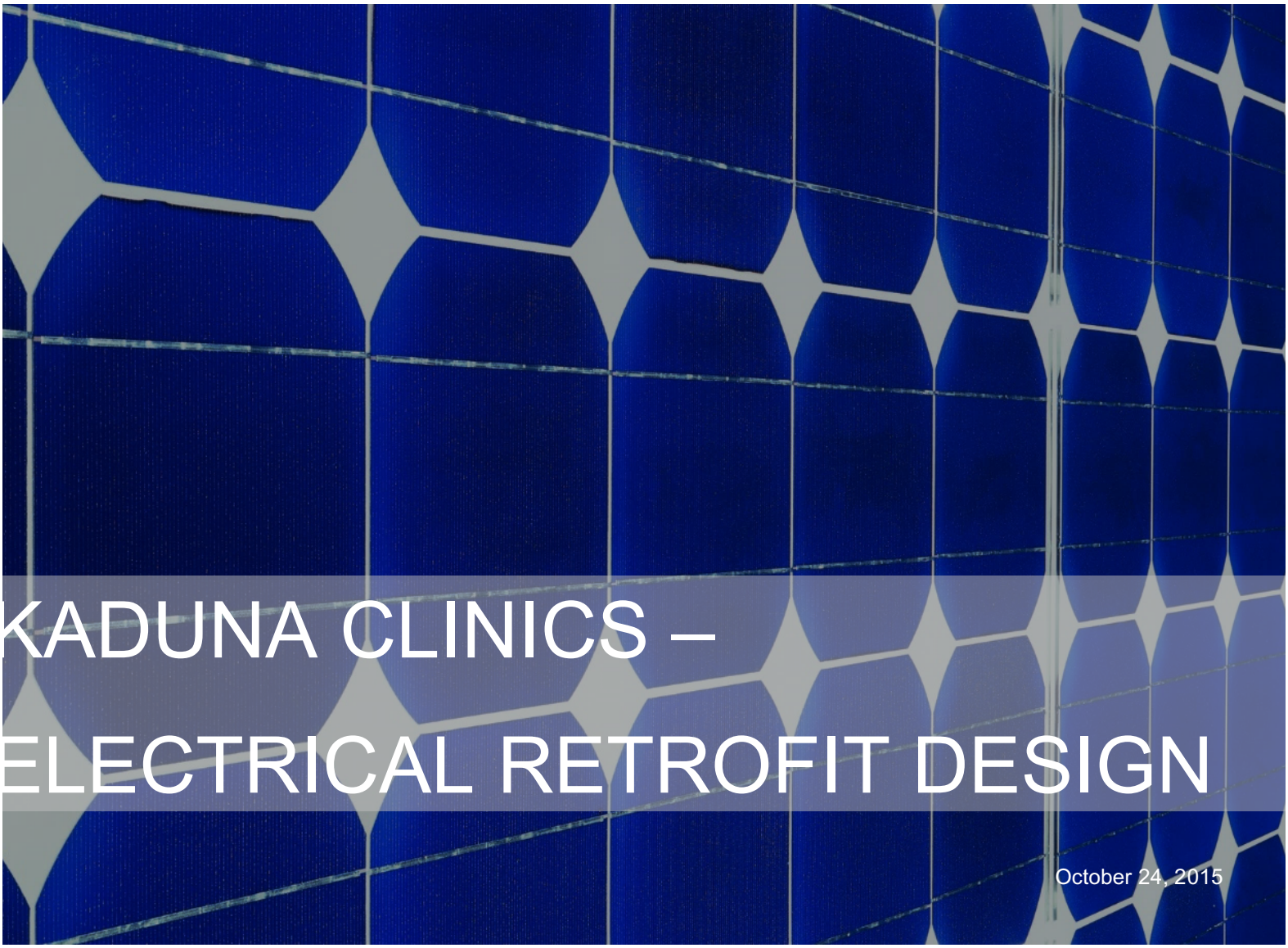

KADUNA CLINICS – ELECTRICAL RETROFIT DESIGN

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THE DESIGN AND ENGINEERING OF OFFGRID PV SOLAR SYSTEMS FOR PRIMARY HEALTH CARE CENTRES IN KADUNA STATE

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1. INTRODUCTION

The DFID 'Kaduna Clinics' project ("the Project") will provide solar power for 40 Primary Healthcare Centres (PHCs) across Kaduna State. The power will be by a stand-alone, off-grid, photovoltaic (PV) solar generating systems ("the System"). To ensure a reliable delivery of this generated power to the PHC, the entire clinic building wiring network is expected to be retrofitted and upgraded to conform to standard and guarantee seamless operation.

1.1. OBJECTIVE OF THIS DESIGN REPORT

The objective of these retrofit and upgrade design are:

- To ensure the system is connected to a reliable wired network in the PHC.
- Replacement of all non-efficient energy installation with energy efficient fittings.
- Provide solar power to critical load only and connect grid power to all non-critical load.
- Replace all obsolete, broken or faulty fittings with new fittings.
- Provide adequate lighting, cooling fan and sockets to the PHC and remove any need for tampering with installations during operation.
- Redistribution of clinic loads and use of proper MCB ratings for robust operation and protection.

2. DESIGN APPROACH

An electrical audit team had earlier visited the PHC's and found no existing wiring drawings. The team captured the relevant data and developed a building layout upon which the existing electrical installation was shown.

This design begins from the drawings made for the existing electrical installations. Considering the need to install a robust electrical system that will require very minimal routine maintenance, an approach to use certified and documented standards was adopted.

The design approach also gives the best balance of functionality, cost, maintainability and efficiency.

2.1. DESIGN ASSUMPTIONS

A. SCOPE OF THE DESIGN

- The electrical retrofit covers all electrical installations in the buildings within the clinic premises.
- Providing connection of power to the buildings from PV system, grid and other power sources
- The retrofit scope excludes overhead line relocation in the PHC (to be carried out by Kaduna State)

B. LIGHTING

- The existing number of light bulbs and fluorescent are replaced by CFL energy saving bulbs.
- In areas of poor illumination, additional CFL light bulbs are added to improve the illuminance.
- The light bulb are completely powered by the PV system.

C. CEILING FAN

- Existing fans are replaced with energy efficient fans.
- Energy efficient fans are proposed in rooms where there are no existing fans.
- The fans are completely powered by the PV system.

D. SOCKETS (Powered by the Solar System)

- Sockets are provided for all existing equipment's in the rooms in the clinics.
- One additional system socket is provided in each room in the clinics to make provision for temporary / future load. This load is considered in the 30% allowance for future load.
- One system socket is provided for each room in the living quarters.
- The total numbers of sockets installed will be equal to or greater than the numbers of sockets currently existing in the clinics.

E. SOCKETS (Powered by the Grid)

- 15 Amp grid socket is provided for each air conditioner unit in the PHC.
- Water heaters and water pumps that do not connect through sockets will be powered from grid via a switch to grid distribution board and miniature circuit breaker
- 13 Amp grid sockets are provided for each room in the living quarters.

F. DISTRIBUTION BOARD

- Each block in the PHC will have a consumer unit, which will distribute power from the PV system to the building and offer protection to the various sub-circuit through the MCBs
- The PV system will power all lighting sub-circuits, ceiling fan sub-circuits and socket sub-circuits in the clinic blocks
- The PV system will also power water pumps in PHC with no grid supply.
- The PV system will power light bulbs in the detached clinic toilets and also power light bulb, one (1) ceiling fan and one (1) socket in PHCs with security post
- There shall be no provision of grid supply to toilet and security post
- Each block in the PHC will have a distribution board, which will distribute power from the grid to the building and offer protection to the various sub-circuit through the MCBs.
- The loads to be powered by the grid supply is limited to air conditioners, water heaters and water pumps in the clinics with grid connection.
- In PHCs where these loads do not exist presently, the DB will still be installed for future use.

G. WATER PUMPS

- Water pumps will be powered from the solar system in the 29 clinics with the proposed off-grid Solar Systems.
- Water pumps will be powered from the grid in the 11 clinics with the proposed grid connected Solar Systems. These clinics have grid supply for about 6-12 hours (daily supply) and can pump water to the storage during the grid supply availability.

H. CHANGE OVER

- Changeovers are provided at each block on the consumer unit side to enable the connection of alternate power supply when PV system is shutdown for emergency repairs and maintenance.
- The changeover provided at the distribution board side is to enable connection to generator if required.

I. GRID INTERCONNECTIONS

- The grid will connect to the inverter to charge the batteries and power critical loads (if necessary) for the hours it is available.
- The grid connection will power non-critical loads (Water heater, Water pump & Air Conditioning) directly through the distribution board.

2.2. METHODOLOGY

Considering the remoteness of most of the PHCs, a stringent design approach has been adopted to greatly minimize the maintenance service time. Hence, all building structures within the PHC premises are to be powered by the system to discourage inappropriate tapping of supply to unapproved locations by unqualified personnel.

- Within each building, loads are categorized as critical (all essential fittings and equipment necessary for the delivery of health services) and non-critical (fittings and equipment not necessary for the delivery of health care services)
- The system only supply power to all critical load while all non-critical load receive power from either the grid or other available sources. The existing wirings in the PHCs will be pulled out completely and rewired using standard sized cables.
- All lighting circuit are to be upgraded, retrofitted and rewired to receive supply from the PV system.
- All ceiling fans are to be retrofitted, upgraded to energy efficient fans and rewired to receive supply from the PV system.
- All 13 Amp sockets within the clinic blocks are to be retrofitted, upgraded and rewired to receive supply from the PV system.
- All wirings in the PHCs are to completely run in a 25mm PVC pipe from the consumer unit of DB to the load point.
- All indoor and corridor lightings are to be ceiling mounted while all outdoor/security lightings are to be wall mounted.
- The living quarter and District head's office are provided with one (1) PV system powered socket per room.
- The PV system will power light bulbs in the detached clinic toilets and also power light bulb, one (1) ceiling fan and one (1) socket in PHCs with security post
- Each system feeds into the clinic building through a consumer unit fitted with an incomer isolator, an RCCB (Residual Current Circuit Breaker) and outgoing MCBs (miniature Circuit Breaker).
- A change-over is provided on the PV system supply side for emergency alternate power supply in times of maintenance.
- Grid supply feeds into the clinic building through a distribution board fitted with an incomer isolator, an RCCB (Residual Current Circuit Breaker) and outgoing MCBs (miniature Circuit Breaker).The grid supply to the clinic blocks serves to power non-critical loads like air conditioners, water heaters and water pumps. The living quarter and District head's office are provided with sockets powered from the grid in each room for general use.

- There shall be no provision of grid supply to toilet and security post.

2.4. STANDARD & CODES

The following standards and codes were applied in the design:

Specified Equipment	Applicable IEC Standards
Symbols in electrical technology	IEC 60027
Standard voltages specifications	IEC 60038
Distribution boards, Consumer units, Changeovers, Low voltage switchgear, switches, disconnectors and fuses	IEC 60947-1&3
Distribution boards, Consumer units	IEC 61439-3
Electrical installation in buildings	IEC 60364-5-52
PVC insulated cables of up to rated voltage 450V	IEC 60227
Ceiling fan and other household appliance	IEC 60335
Compact Fluorescent Light (CFL)	IEC 60061-1, 60968 & 60969
Ceiling / wall Mounted CFL Light Fitting (Luminaire)	IEC 62722
1Gang 1 way, 2Gang 1way & 3Gang 1way Switches	IEC 60669- 1/SS 227/MS IEC 60669-1, BS EN 60669-1
Socket Outlet (Switched single and double outlet)	IEC 60906
Single Pattress Box (for switches and single sockets)	IEC 60670, BS 4662
Double Pattress Box (for sockets)	IEC 60670, BS 4662
PVC Pipes, Saddle clip, Male bush, Angle bend and Circular junction boxes	Suitable for conduit wiring
Cables and conductors	IEC60227 IEC60502 IEC60331
Functionality and applicability of RCCB at line voltage	IEC 61008-2-2
Distribution boards, Consumer units boxes and enclosures for electrical accessories for household and similar fixed electrical installations	IEC 60670-1, BS EN 61439-3
Degrees of protection provided by enclosures(IP Code)	IEC 60529

3. DESIGN RATIONALE

A. CONSUMER UNIT

The power output from the PV system is a single phase (live and neutral) AC supply. A 100Amps consumer unit being a single phase device is suitable and preferred to handle the distribution of power to various sub-circuit.

B. DISTRIBUTION BOARD

A Three phase distribution board (TP&N) is selected for the distribution of grid power to non- critical load in the PHC. The grid supply; a 3phase supply, is used with MCBs to balance the load on all 3phase. In addition, PHCs with multiple units of PV system are terminated in the buildings as a 3phase supply and a distribution board is best suited to handle such connections.

C. MINIATURE CIRCUIT BREAKER (MCB)

A design to provide protection in the various sub-circuits, from short circuit and overload is achieved with the use of MCBs.To quickly detect fault conditions and interrupt current flow, the ratings of the breaker are selected by considering 100% of non-continuous load and 125% of continuous load. A continuous load is a load where continuous maximum current is drawn for three (3) or more. The light bulbs and ceiling fans in lighting circuits and ceiling fan circuits respectively are considered continuous load since they have high tendency of being operated for more than three hours.

For lighting circuits and ceiling fan circuits;

- Maximum allowable peak load= 900W
- Maximum operating current = 4A
- MCB rating=5A

For socket circuit;

- The high energy demanding appliance are autoclave and sterilizer.
- Autoclave rated power=2200W
- Operating current= 11A
- Running time=1.5 hours
- MCB rating=15A
- Sterilizer rated power=1500
- Operating current= 7.5A
- Running time=2 hours (frequency per day determined by number of patient)

MCB rating=15A

D. COMPACT FLOURESCENT LIGHTS (CFL)

The choice of CFL over LED is due to the poor penetration of LED in most part of Nigeria, especially rural areas where most of these PHCs are situated.

The energy efficiency characteristics of CFL plus its availability even in rural areas and its affordability contributed in its design usage.

E. LIGHT FITTINGS (LUMINAIRES)

Light fitting are provided to secure the CFL tube from direct contact and damage and maintain aesthetic appeal.

The specified fitting is expected to withstand associated temperatures and other environmental conditions.

4. DETAILED ELECTRICAL RETROFIT DESIGNS FOR 40 CLINICS

- Electrical schematics, wiring drawings, load table and resultant bill of materials make up the retrofit design.
- The detailed electrical retrofit design for each PHC is attached in appendix A

4.1. SUMMARY BILL OF MATERIAL FOR THE 40 CLINICS

The bill of material generated from the design is presented in groups of eight (8) PHCs. The addition of all sub-total is done to obtain the total bill of material for the entire project.

BILL OF MATERIALS FOR PHC 1TO 8 ELECTRICAL RETROFIT

S/No.	Material	Unit	1. BADARAWA PHC	2. JERE PHC	3. ABDU KWARI PHC	4. ASSO PHC	5. AWON PHC	6. BADIKO PHC	7. DADDU PHC	8. DAMAKASUWA	SUB TOTAL
1	Ceiling fan	No.	39	13	17	15	45	13	18	34	**194**
2	18 Watts CFL	No.	118	51	60	43	158	63	81	290	**864**
3	Roof mounted luminaire	No.	91	37	45	34	125	45	46	138	**561**
4	Wall mounted luminaire	No.	27	14	15	9	33	18	35	17	**168**
5	1 Gang light switch	No.	29	13	10	13	43	15	19	34	**176**
6	2 Gang light switch	No.	8	3	4	3	12	3	7	6	**46**
7	3 Gang light switch	No.	1	2	4	0	3	4	1	2	**17**
8	13 Amp socket single	No.	20	6	13	16	14	9	6	46	**130**
9	13 Amp socket double	No.	25	8	5	3	5	9	7	68	**130**
10	15 Amp socket	No.	3	1	5	1	0	4	0	0	**14**
11	Junction box	No.	201	83	71	78	235	103	121	311	**1,203**
12	Single patress box (flush)	No.	58	24	31	32	72	31	33	88	**369**
13	Double patress box (flush)	No.	25	8	5	3	5	9	7	68	**130**
14	Single patress box (surface)	No.	0	0	0	0	0	0	0	0	**-**
15	Double patress box (surface)	No.	0	0	0	0	0	0	0	0	**-**
16	25mm PVC pipes (25 numbers of 3Mts pipe per bundle)	bundle	33	14	20	14	42	16	20	37	**197**
17	PVC accessories, male bush, saddle clamp, angle bend,screws and pegs Packs (100 per pack)	packs	4	3	3	1	3	3	5	2	**24**
18	100A distribution board	No.	1	1	0	0	2	1	2	2	**9**
19	60A distribution board	No.	1	0	2	1	4	0	4	0	**12**

20	30A distribution board	No.	2	0	0	0	0	1	2	0	**5**
21	100A consumer unit	No.	1	1	1	1	0	1	0	2	**7**
22	60A consumer unit	No.	1	0	1	0	0	0	0	0	**2**
23	30A consumer unit	No.	2	2	1	0	0	2	1	1	**9**
24	100A Residual current circuit breaker	No.	2	2	1	1	2	2	2	4	**16**
25	60A Residual current circuit breaker	No.	2	0	3	1	4	0	4	0	**14**
26	30A Residual current circuit breaker	No.	4	2	1	0	0	3	3	1	**14**
27	100A change over	No.	2	2	1	1	2	2	2	2	**14**
28	60A change over	No.	2	0	3	1	4	0	4	0	**14**
29	30A change over	No.	4	0	0	0	0	2	0	0	**6**
30	1.5mmsq cable (Twin & Earth)	Mts	1569	720	1114	646	2140	860	1040	1660	**9,749**
31	2.5mmsq cable (Twin & Earth)	Mts	938	338	375	430	1035	350	425	1150	**5,041**
32	4x16mmsq PVC/SWA/PVC armoured cable	Mts	160	60	80	60	220	50	160	100	**890**
33	4x10mmsq PVC/SWA/PVC armoured cable	Mts	40	0	0	0	0	0	0	0	**40**
34	4x6mmsq PVC/SWA/PVC armoured cable	Mts	60	0	0	0	0	120	180	60	**420**
35	4x4mmsq PVC/SWA/PVC armoured cable	Mts	0	90	40	0	0	0	0	0	**130**
36	Cable terminating lugs	No.	64	32	40	16	48	48	80	32	**360**
37	Recline cable (25mmsq)	Mts	220	50	100	50	160	140	210	60	**990**
38	Earth wire for building (16mmsq)	Mts	210	140	120	50	170	150	310	130	**1,280**
39	Underground marking tape	Mts	260	150	120	60	220	170	340	160	**1,480**

BILL OF MATERIALS FOR PHC 9 TO 16 ELECTRICAL RETROFIT

S/No.	Material	Unit	9. DAMAU PHC	10. DAN ALHAJI PHC	11. DANJINJIRI PHC	12. DANGUZURI PHC	13. DANWATA PHC	14.FAI PHC	15. GALADIMAWA PHC	16. GANGARA PHC	SUB TOTAL
1	Ceiling fan	No.	16	21	7	22	6	9	23	12	**116**
2	18 Watts CFL	No.	56	59	24	88	20	33	106	48	**434**
3	Roof mounted luminaire	No.	48	46	18	67	12	25	87	37	**340**
4	Wall mounted luminaire	No.	8	13	7	21	8	8	19	11	**95**
5	1 Gang light switch	No.	17	23	5	28	4	10	25	12	**124**
6	2 Gang light switch	No.	5	2	3	6	1	3	6	3	**29**
7	3 Gang light switch	No.	0	0	0	3	0	0	2	1	**6**
8	13 Amp socket single	No.	6	21	5	17	6	8	25	9	**97**
9	13 Amp socket double	No.	6	4	3	5	1	2	4	3	**28**
10	15 Amp socket	No.	0	0	0	1	0	0	9	0	**10**
11	Junction box	No.	0	109	41	147	32	56	168	76	**629**
12	Single patress box (flush)	No.	28	46	13	54	11	21	58	25	**256**
13	Double patress box (flush)	No.	6	4	3	5	1	2	4	3	**28**
14	Single patress box (surface)	No.	0	0	0	0	0	0	0	0	**-**
15	Double patress box (surface)	No.	0	0	0	0	0	0	0	0	**-**
16	25mm PVC pipes (25 numbers of 3Mts pipe per bundle)	bundle	13	17	7	19	5	9	34	13	**117**
17	PVC accessories, male bush, saddle clamp, angle bend,screws and pegs Packs (100 per pack)	packs	1	3	2	3	1	2	2	3	**17**

18	100A distribution board	No.	1	1	1	2	1	1	4	1	**12**
19	60A distribution board	No.	0	2	0	0	0	0	0	0	**2**
20	30A distribution board	No.	0	0	0	0	0	0	0	0	**-**
21	100A consumer unit	No.	1	1	1	2	1	1	0	1	**8**
22	60A consumer unit	No.	0	2	0	0	0	0	0	0	**2**
23	30A consumer unit	No.	0	0	1	1	0	1	1	2	**6**
24	100A Residual current circuit breaker	No.	2	2	2	4	2	2	4	2	**20**
25	60A Residual current circuit breaker	No.	0	4	0	0	0	0	0	0	**4**
26	30A Residual current circuit breaker	No.	0	0	1	1	0	1	1	2	**6**
27	100A change over	No.	2	2	2	4	2	2	2	2	**18**
28	60A change over	No.	0	4	0	0	0	0	0	0	**4**
29	30A change over	No.	0	0	0	0	0	0	0	0	**-**
30	1.5mmsq cable (Twin & Earth)	Mts	770	910	350	1140	250	470	1500	740	**6,130**
31	2.5mmsq cable (Twin & Earth)	Mts	210	380	140	311	130	170	1060	230	**2,631**
32	4x16mmsq PVC/SWA/PVC armoured cable	Mts	50	260	100	200	60	100	100	80	**950**
33	4x10mmsq PVC/SWA/PVC armoured cable	Mts	0	0	0	0	0	0	0	0	**-**
34	4x6mmsq PVC/SWA/PVC armoured cable	Mts	0	0	50	100	0	50	50	150	**400**
35	4x4mmsq PVC/SWA/PVC armoured cable	Mts	0	0	0	0	0	0	0	0	**-**
36	Cable terminating lugs	No.	16	48	24	40	16	24	32	32	**232**
37	Recline cable (25mmsq)	Mts	40	150	60	100	50	60	60	50	**570**
38	Earth wire for building (16mmsq)	Mts	50	150	120	150	50	130	120	150	**920**
39	Underground marking tape	Mts	50	260	160	300	60	160	150	230	**1,370**

BILL OF MATERIALS FOR PHC 17 TO 24 ELECTRICAL RETROFIT

S/No.	Material	Unit	17. GARU KURAMA PHC	18. GESHERE PHC	19. GIDAN TAGWAI PHC	20. GIDAN WAYA PHC	21. GWARAJI PHC	22. HANWA PHC	23. KADAGE PHC	24. KAMURU (IKULU) PHC	SUB TOTAL
1	Ceiling fan	No.	26	22	11	17	13	13	5	25	**132**
2	18 Watts CFL	No.	90	77	43	61	44	44	22	92	**473**
3	Roof mounted luminaire	No.	63	59	32	45	34	32	18	74	**357**
4	Wall mounted luminaire	No.	27	18	11	16	10	12	4	18	**116**
5	1 Gang light switch	No.	25	26	13	15	11	11	11	23	**135**
6	2 Gang light switch	No.	8	4	2	3	2	3	0	6	**28**
7	3 Gang light switch	No.	1	1	1	1	2	3	0	2	**11**
8	13 Amp socket single	No.	15	19	7	14	10	11	6	14	**96**
9	13 Amp socket double	No.	7	6	5	8	3	2	2	6	**39**
10	15 Amp socket	No.	0	0	0	0	0	0	0	0	**-**
11	Junction box	No.	146	133	71	102	72	74	41	143	**782**
12	Single patress box (flush)	No.	49	50	23	33	25	28	17	45	**270**
13	Double patress box (flush)	No.	7	6	5	8	3	2	2	6	**39**
14	Single patress box (surface)	No.	0	0	0	0	0	0	0	0	**-**
15	Double patress box (surface)	No.	0	0	0	0	0	0	0	0	**-**
16	25mm PVC pipes (25 numbers of 3Mts pipe per bundle)	bundle	25	20	9	16	11	12	6	22	**121**
17	PVC accessories, male bush, saddle clamp, angle bend,screws and pegs Packs (100 per pack)	packs	5	2	1	3	1	2	1	2	**17**
18	100A distribution board	No.	4	2	1	1	1	1	1	2	**13**
19	60A distribution board	No.	4	0	0	2	0	0	0	0	**6**
20	30A distribution board	No.	0	0	0	0	0	0	0	0	**-**
21	100A consumer unit	No.	0	0	1	1	1	1	1	0	**5**

22	60A consumer unit	No.	0	0	0	2	0	0	0	0	**2**
23	30A consumer unit	No.	1	1	0	0	0	1	0	1	**4**
24	100A Residual current circuit breaker	No.	4	2	2	2	2	2	2	2	**18**
25	60A Residual current circuit breaker	No.	4	0	0	4	0	0	0	0	**8**
26	30A Residual current circuit breaker	No.	1	1	0	0	0	1	0	1	**4**
27	100A change over	No.	4	2	2	2	2	1	2	2	**17**
28	60A change over	No.	4	0	0	4	0	0	0	0	**8**
29	30A change over	No.	0	0	0	0	0	0	0	0	**-**
30	1.5mmsq cable (Twin & Earth)	Mts	1310	990	570	810	630	700	300	1240	**6,550**
31	2.5mmsq cable (Twin & Earth)	Mts	550	530	120	390	210	220	140	400	**2,560**
32	4x16mmsq PVC/SWA/PVC armoured cable	Mts	400	100	100	220	100	100	60	100	**1,180**
33	4x10mmsq PVC/SWA/PVC armoured cable	Mts	0	0	0	0	0	0	0	0	**-**
34	4x6mmsq PVC/SWA/PVC armoured cable	Mts	100	60	0	0	0	50	0	60	**270**
35	4x4mmsq PVC/SWA/PVC armoured cable	Mts	0	0	0	0	0	0	0	0	**-**
36	Cable terminating lugs	No.	80	24	16	48	16	24	16	32	**256**
37	Recline cable (25mmsq)	Mts	270	120	60	200	50	60	50	60	**870**
38	Earth wire for building (16mmsq)	Mts	310	130	60	190	50	130	50	120	**1,040**
39	Underground marking tape	Mts	500	160	100	220	100	160	60	160	**1,460**

BILL OF MATERIALS FOR PHC 25 TO 32 ELECTRICAL RETROFIT

S/No.	Material	Unit	25. KASAYA PHC	26. KURMIN KOCI PHC	27. KURMIN BI PHC	28. LIKORO PHC	29. MADAKIYA PHC	30. MAH PHC	31.MANCHOK PHC	32. MARO PHC	SUB TOTAL
1	Ceiling fan	No.	13	12	9	24	11	7	16	14	**106**
2	18 Watts CFL	No.	44	40	36	101	38	23	48	41	**371**
3	Roof mounted luminaire	No.	30	33	24	81	24	17	29	33	**271**
4	Wall mounted luminaire	No.	14	8	11	20	14	6	19	8	**100**
5	1 Gang light switch	No.	11	10	13	28	14	6	24	15	**121**
6	2 Gang light switch	No.	2	3	2	5	1	1	2	2	**18**
7	3 Gang light switch	No.	0	3	0	2	0	0	0	1	**6**
8	13 Amp socket single	No.	16	8	7	22	7	7	15	10	**92**
9	13 Amp socket double	No.	1	3	2	6	3	2	11	3	**31**
10	15 Amp socket	No.	0	1	0	0	0	0	0	0	**1**
11	Junction box	No.	74	68	59	164	63	39	100	72	**639**
12	Single patress box (flush)	No.	29	24	22	57	22	14	41	28	**237**
13	Double patress box (flush)	No.	1	3	2	6	3	2	11	3	**31**
14	Single patress box (surface)	No.	0	0	0	0	0	0	0	0	**-**
15	Double patress box (surface)	No.	0	0	0	0	0	0	0	0	**-**
16	25mm PVC pipes (25 numbers of 3Mts pipe per bundle)	bundle	12	11	9	24	9	6	17	12	**100**
17	PVC accessories, male bush, saddle clamp, angle bend, screws and pegs Packs (100 per pack)	packs	2	1	2	2	3	1	2	1	**14**
18	100A distribution board	No.	2	1	1	2	1	1	2	1	**11**
19	60A distribution board	No.	0	0	0	0	1	0	2	0	**3**
20	30A distribution board	No.	0	0	0	0	0	0	0	0	**-**
21	100A consumer unit	No.	2	1	1	0	1	1	0	1	**7**
22	60A consumer unit	No.	0	0	0	0	1	0	0	0	**1**

23	30A consumer unit	No.	0	0	1	1	1	0	0	0	**3**
24	100A Residual current circuit breaker	No.	4	2	2	2	2	2	2	2	**18**
25	60A Residual current circuit breaker	No.	0	0	0	0	2	0	2	0	**4**
26	30A Residual current circuit breaker	No.	0	0	1	1	1	0	0	0	**3**
27	100A change over	No.	4	2	2	2	2	2	2	1	**17**
28	60A change over	No.	0	0	0	0	2	0	2	0	**4**
29	30A change over	No.	0	0	0	0	0	0	0	0	**-**
30	1.5mmsq cable (Twin & Earth)	Mts	580	630	540	1290	510	300	790	660	**5,300**
31	2.5mmsq cable (Twin & Earth)	Mts	290	200	160	510	200	170	470	220	**2,220**
32	4x16mmsq PVC/SWA/PVC armoured cable	Mts	160	100	100	100	160	60	200	100	**980**
33	4x10mmsq PVC/SWA/PVC armoured cable	Mts	0	0	0	0	0	0	0	0	**-**
34	4x6mmsq PVC/SWA/PVC armoured cable	Mts	0	0	60	60	50	0	0	0	**170**
35	4x4mmsq PVC/SWA/PVC armoured cable	Mts	0	0	0	0	0	0	0	0	**-**
36	Cable terminating lugs	No.	32	16	32	32	40	16	32	16	**216**
37	Recline cable (25mmsq)	Mts	100	60	120	60	120	50	140	60	**710**
38	Earth wire for building (16mmsq)	Mts	100	70	120	130	180	50	130	70	**850**
39	Underground marking tape	Mts	160	100	160	160	220	60	200	100	**1,160**

BILL OF MATERIALS FOR PHC 33 TO 40 ELECTRICAL RETROFIT

S/No.	Material	Unit	33. RAFIN GUZA PHC	34. RIMIN DOKO PHC	35. RUZIA PHC	36. TASHAN KADE PHC	37. TELEVISON GARAGE PHC	38. TURAWA PHC	39. ZANGO AYA PHC	40. MAKARFI PHC	SUB TOTAL
1	Ceiling fan	No.	16	21	9	13	16	7	17	16	**115**
2	18 Watts CFL	No.	51	65	20	40	70	26	52	48	**372**
3	Roof mounted luminaire	No.	36	49	15	32	60	18	38	37	**285**
4	Wall mounted luminaire	No.	15	16	5	8	10	8	14	11	**87**
5	1 Gang light switch	No.	13	19	5	17	18	9	17	18	**116**
6	2 Gang light switch	No.	6	3	2	2	6	1	3	3	**26**
7	3 Gang light switch	No.	2	4	0	1	1	0	0	2	**10**
8	13 Amp socket single	No.	16	15	12	9	17	6	19	14	**108**
9	13 Amp socket double	No.	6	6	0	1	5	3	6	6	**33**
10	15 Amp socket	No.	0	0	0	0	0	2	0	0	**2**
11	Junction box	No.	94	112	39	70	117	45	80	91	**648**
12	Single patress box (flush)	No.	37	41	19	29	42	16	39	37	**260**
13	Double patress box (flush)	No.	6	6	0	1	5	3	6	6	**33**
14	Single patress box (surface)	No.	0	0	0	0	0	0	0	0	**-**
15	Double patress box (surface)	No.	0	0	0	0	0	0	0	0	**-**
16	25mm PVC pipes (25 numbers of 3Mts pipe per bundle)	bundle	17	18	7	11	17	8	18	16	**113**
17	PVC accessories, male bush, saddle clamp, angle bend,screws and pegs Packs (100 per pack)	packs	2	2	1	1	2	1	3	2	**14**
18	100A distribution board	No.	1	1	1	1	1	1	1	1	**8**
19	60A distribution board	No.	1	1	0	0	1	0	0	1	**4**
20	30A distribution board	No.	0	0	0	0	0	0	2	0	**2**
21	100A consumer unit	No.	1	1	1	1	1	1	1	1	**8**
22	60A consumer unit	No.	1	1	0	0	1	0	0	1	**4**

23	30A consumer unit	No.	0	0	0	0	0	0	2	0	**2**
24	100A Residual current circuit breaker	No.	2	2	2	2	2	2	2	2	**16**
25	60A Residual current circuit breaker	No.	2	2	0	0	2	0	0	2	**8**
26	30A Residual current circuit breaker	No.	0	0	0	0	0	0	4	0	**4**
27	100A change over	No.	2	2	2	2	2	2	2	2	**16**
28	60A change over	No.	2	2	0	0	2	0	0	2	**8**
29	30A change over	No.	0	0	0	0	0	0	4	0	**4**
30	1.5mmsq cable (Twin & Earth)	Mts	890	1020	330	620	900	350	810	790	**5,710**
31	2.5mmsq cable (Twin & Earth)	Mts	400	340	210	180	400	280	510	410	**2,730**
32	4x16mmsq PVC/SWA/PVC armoured cable	Mts	160	160	100	60	160	70	100	160	**970**
33	4x10mmsq PVC/SWA/PVC armoured cable	Mts	0	0	0	0	0	0	0	0	**-**
34	4x6mmsq PVC/SWA/PVC armoured cable	Mts	0	0	0	0	0	0	200	0	**200**
35	4x4mmsq PVC/SWA/PVC armoured cable	Mts	0	0	0	0	0	0	0	0	**-**
36	Cable terminating lugs	No.	32	32	16	16	32	16	48	32	**224**
37	Recline cable (25mmsq)	Mts	100	140	60	50	140	50	150	120	**810**
38	Earth wire for building (16mmsq)	Mts	100	130	70	50	120	50	150	120	**790**
39	Underground marking tape	Mts	160	160	100	60	160	70	300	160	**1,170**

BILL OF MATERIALS FOR 40 PHC ELECTRICAL RETROFIT

S/No.	Material	Unit	PHC 1 TO 8	PHC 9 TO 16	PHC 17 TO 24	PHC 25 TO 32	PHC 33 TO 40	TOTAL
1	Ceiling fan	No.	194	116	132	106	115	**663**
2	18 Watts CFL	No.	864	434	473	371	372	**2,514**
3	Roof mounted luminaire	No.	561	340	357	271	285	**1,814**
4	Wall mounted luminaire	No.	168	95	116	100	87	**566**
5	1 Gang light switch	No.	176	124	135	121	116	**672**
6	2 Gang light switch	No.	46	29	28	18	26	**147**
7	3 Gang light switch	No.	17	6	11	6	10	**50**
8	13 Amp socket single	No.	130	97	96	92	108	**523**
9	13 Amp socket double	No.	130	28	39	31	33	**261**
10	15 Amp socket	No.	14	10	0	1	2	**27**
11	Junction box	No.	1203	629	782	639	648	**3,901**
12	Single patress box (flush)	No.	369	256	270	237	260	**1,392**
13	Double patress box (flush)	No.	130	28	39	31	33	**261**
14	Single patress box (surface)	No.	0	0	0	0	0	**-**
15	Double patress box (surface)	No.	0	0	0	0	0	**-**
16	25mm PVC pipes (25 numbers of 3Mts pipe per bundle)	bundle	197	117	121	100	113	**648**
17	PVC accessories, male bush, saddle clamp, angle bend,screws and pegs Packs (100 per pack)	packs	24	17	17	14	14	**86**
18	100A distribution board	No.	9	12	13	11	8	**53**
19	60A distribution board	No.	12	2	6	3	4	**27**
20	30A distribution board	No.	5	0	0	0	2	**7**
21	100A consumer unit	No.	7	8	5	7	8	**35**
22	60A consumer unit	No.	2	2	2	1	4	**11**

23	30A consumer unit	No.	9	6	4	3	2	**24**
24	100A Residual current circuit breaker	No.	16	20	18	18	16	**88**
25	60A Residual current circuit breaker	No.	14	4	8	4	8	**38**
26	30A Residual current circuit breaker	No.	14	6	4	3	4	**31**
27	100A change over	No.	14	18	17	17	16	**82**
28	60A change over	No.	14	4	8	4	8	**38**
29	30A change over	No.	6	0	0	0	4	**10**
30	1.5mmsq cable (Twin & Earth)	Mts	9749	6130	6550	5300	5710	**33,439**
31	2.5mmsq cable (Twin & Earth)	Mts	5041	2631	2560	2220	2730	**15,182**
32	4x16mmsq PVC/SWA/PVC armoured cable	Mts	890	950	1180	980	970	**4,970**
33	4x10mmsq PVC/SWA/PVC armoured cable	Mts	40	0	0	0	0	**40**
34	4x6mmsq PVC/SWA/PVC armoured cable	Mts	420	400	270	170	200	**1,460**
35	4x4mmsq PVC/SWA/PVC armoured cable	Mts	130	0	0	0	0	**130**
36	Cable terminating lugs	No.	360	232	256	216	224	**1,288**
37	Recline cable (25mmsq)	Mts	990	570	870	710	810	**3,950**
38	Earth wire for building (16mmsq)	Mts	1280	920	1040	850	790	**4,880**
39	Underground marking tape	Mts	1480	1370	1460	1160	1170	**6,640**

5. ACRONYMS / ABBREVIATIONS

PV System - Photovoltaic System

PHC- Primary Health Center

MCB- Miniature Circuit Breaker

CFL- Compact Fluorescent Light

PVC - Polyvinyl Chloride

DB - Distribution Board

RCCB - Residual Current Circuit Breaker

IEC - International Electro-technical commission

BS - British Standards

IP code - International Protection Code (Ingress Protection)

TP&N - Triple Pole and Neutral

LED - Light-Emitting Diode

6. APPENDIX A

Design Drawings for Electrical Retrofit for 40 Clinics