RE-DEVELOPED TSHILIDZINI REGIONAL HOSPITAL

Electrical Services Report

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1. EXECUTIVE SUMMARY

The proposed re-developed Tshilidzini Hospital promises to become a new land mark in public health care design in South Africa which will include the latest developments in health care technology but also in cost effective energy efficient building design. The services report addresses all the fundamental principles of the electrical design starting from the Utility connection, medium voltage distribution, transformation of voltage and finally touching on LV distribution philosophy.

Based on the provisional floor area supplied by the Architect as well as the outcome of a load study report of 100 hospitals in the Western Cape a design demand density of 40VA/sqm was derived implying an expected maximum demand (MD) for the new hospital of 2.4 MVA. By adding the Phase 1 staff accommodation requirements, a provisional external link service of 3 MVA is required from Eskom. The MD for the existing hospital is 1 MVA. Initial indications are that Eskom has in principle capacity in their network but that details can only be obtained after a formal request for the supply has been submitted. It is proposed to only apply at the end of the design development phase. According to Eskom, the risk of Eskom not having capacity at the time of application is extremely low.

The services report further outlines all the clinical areas requiring emergency back-up power as per IUSS and estimates the generator size to have a capacity of at least 2.4 MVA prime/continuous power.

Renewable energy options are analysed in this report and Solar PV recommended as the preferred technology.

2. APPOINTMENT AND SCOPE OF WORK

2.1 Appointment

MVM Africa Consulting Electrical Engineers (Pty)Ltd was appointed by the National Department of Health as part of the LEMEG Consortium to plan and design the external electrical link service as well as the internal services required for the new Tshilidzini Hospital in accordance with its zoning rights. The property presently comprises of a mixed usage development incorporating clinical, residential and steam generation facilities located within the municipal area of the Thulamela Local Municipality.

It is the intention to develop a new 550 bed hospital on the same property covering a total floor area of at least 60 000 sqm.

This report has been prepared on behalf of the LEMEG Consortium by MVM Africa Electrical Engineers (Pty)Ltd.

2.2 Scope of Work

The intention of the services report is to establish the extent of the external electrical link service requirements for the proposed new hospital based on a summary of clinical services to be provided on the property. Detailed floor areas are available:

Planned Clusters in the New Hospital	Bed Quantification		
Description	Status Quo	Clinical Brief	Updated 16.03.2017
TOTAL BEDS	485	482	513
MEDICAL CLUSTER	82	74	74
SURGICAL CLUSTER	96	116	116
MATERNITY CLUSTER (mother & infant)	113	83	73
PAEDIATRIC CLUSTER	106	75	138
MULTIDISCIPLINARY CLUSTER (sub-acute under Medical)	42	38	16
ICU/HCU (Multidisciplinary Adult)	4	12	12
TB CLUSTER (under medical)	29	24	24
MENTAL HEALTH CLUSTER	13	60	60
Spaces not counted as beds			
Description	Status Quo	Clinical Brief	Updated 16.03.2017
Day Ward within Theatre Cluster			15
Emergency Ward /Short Stay (Emergency Cluster)	10	10	16
Overnight Ward/Lodge			16
Delivery Rooms (Maternity Cluster)	5		10
Pregnant Mothers Lodge (Maternity Cluster)			20
Lodger Mothers (Paediatric Cluster)			28

Source: Clinical brief

SURGICAL SERVICES CLUSTER:	Number
MAIN THEATRE	3
General Surgery	3
Emergency & Orthopaedic Theatre (adjacent to Emergency Unit)	2
DAY THEATRE	
Day Theatre (adjacent to OPD and main Theatre)	1
MATERNITY THEATRES	
Theatre (adjacent to Maternity)	2
	8
CSSD	1

Source: Clinical brief

The external and internal distribution philosophy of electrical power are addressed in this report and the distribution standards noted. A redundancy policy of N+1 is a pre-requisite of the new electrical infrastructure and will amongst other sources of energy, impact on emergency electrical supply for all essential clinical services on site.

Lastly to evaluate and report on any renewable and energy efficient solutions which could be offered to reduce the carbon footprint of the development. The following solutions will be considered and the appropriate technologies recommended:

a) Solar PV (Grid tied)
b) Solar Hot Water and heat pump systems
c) Energy Efficient lighting
d) Energy Efficient Heating, Ventilation and Air Conditioning (HVAC)

Bulk and internal service provision inputs will ultimately serve as inputs for the compilation of the Service Level Agreement (SLA) with the Electrical Supply Authority.

3. RELEVANT INFORMATION

3.1 Client:

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3.7 Location of Tshilidzini Hospital

The proposed redeveloped Tshilidzini Regional Hospital (TRH) is located on the Farm Beuster 253 MT, Thulamela Local Municipality within the Vhembe District Municipality, Limpopo. The hospital property is approximately 30 ha in extent.

The site gains access from the R 524 provincial road.

3.8 Site conditions

The site is relatively flat and easily accessible.
Vegetation is mainly natural.
Soil Type: Unknown at this stage
Climate: 10-30 DegC

3.9 Electrical Network Information

A medium voltage (MV) overhead distribution network spans across the width of the development on the entry side (Larsens Road) and also Tee's off to conveniently run on the western boundary of the township. A capacity check was done with Eskom at Pole number SPO 44/1 of which capacity-to be quantified later-was confirmed.

The report will propose that an internal underground ring network (MV) be established for the hospital from a convenient supply point on the Eskom overhead line. Two supplies will be considered.

4. FOCUS AREAS OF SERVICES REPORT

4.1 Internal Services

This section will address the general philosophy of internal MV and LV reticulation for the new hospital.

4.2 Link service to own property

This section will outline the 11kV power supply from two selected T-off points on the overhead line to the hospital. The double T-off will provide for the N+1 redundancy on the supply side.

4.3 External Bulk Services

This section will describe the availability of electrical supply capacity from the Eskom network.

5. EXISTING ELECTRICAL SERVICES ON SITE AND UPGRADED SUPPLY

MVM Africa has previously been involved in a refurbishment project for the existing Tshilidzini Hospital facilities and obtained useful information regarding existing on-site electrical reticulation. The exact routing of existing underground electrical services was not pegged at that stage and will have to be indicated before commencing with any new construction work and acknowledged during the design of the new facilities. This will have to be done to ensure an uninterrupted electrical supply to the present facilities during the construction period of the new buildings.

The hospital presently has an installed capacity of 1 MVA, Notified Max Demand of 1 MVA and actual Maximum Demand of 650 kVA as per average utility bills for the past 12 months. The electrical tariff is set on Nightsave Rural and the possibility to change to a more attractive tariff e.g. Megaflex will be considered for the new facilities.

The present T-off point on the Eskom overhead supply is STS 26/4 with STS 26/10 open ended for emergency ring feed. The metering philosophy is 11kV bulk metering with a CT/VT arrangement. The feeding overhead line is located on the western boundary of the hospital. The main overhead line is located on the southern side of the hospital at the main entrance.

A single line diagram of the Eskom network feeding the area has been attached as Annexure A. The network clearly indicates the present connection points off the 11kV (MV) overhead supply line.

Site visits have revealed the condition of the internal and external MV/LV networks of the existing hospital. It was confirmed that the standby generators (2 off) have a combined capacity of 925 kVA and that the total installation is presently connected to the emergency back-up supply including the accommodation area which was put on back-up supply on request of the end-user about eight years ago.

With the expected new link service requirement estimated to be approximately 3.0 MVA (as outlined in this report), but physical layouts still unknown at this early stage, the connection point to the Eskom overhead line cannot be finalized at this stage however it is clear that an application should be submitted to Eskom to apply for an increase in the NMD from 1 MVA to 3 MVA. The increase in the NMD should be accompanied by an application to upgrade the Eskom tariff to a more suitable tariff e.g. Time-of-Use (TOU) tariff. The TOU tariff creates the opportunity to purchase electricity at different rates during the course of the day.

Initial contact with Eskom customer service has indicated that the increased capacity is in principal available but that this can only be confirmed after a formal application for increased capacity has been submitted to Eskom.

6. DESIGN PHILOSOPHY

6.1 Standards and Specifications

The electrical work shall be carried out strictly in accordance with:-

- SANS Code of Practice - 10142-1:2003: “The Wiring of Premises”
- SANS Code of Practice: NRS 034 – Design guidelines for buildings
- Occupational Health and Safety Act 85/1993.
- The Municipal By-Laws and any Local Authority Regulations which may be in force
- Eskom Distribution Standards

6.2 Proposed MV bulk supply

Annexure B shows the proposed T-off point(s) from the 11kV overhead line at Pole number: SPO 44/1. It is proposed to connect via drop out fuselinks to an 11kV bulk metering arrangement where after underground cabling will be routed to the Energy Centre situated in the basement of the new hospital.

A double Eskom supply is envisaged to ensure a reliable main supply to the hospital at all times. (N+1 redundancy)

6.3 General

The overall design will consist of medium voltage (MV) and low voltage (LV) reticulation and electrical services which will include a central Energy Centre in close proximity to the facilities with the highest electrical demand. Emergency power requirements will be established and an LV generator(s) will either be positioned inside the Energy Center or externally on the 11kV supply ring utilizing a 400V/11kV step-up transformer(s). A special study which compared LV and MV emergency supply has shed some light on a proposed technology selection.

Main electrical reticulation between blocks will either be in special service ducts or on cable racks above ground (external) for easy maintenance. Electrical services within buildings will mostly be positioned in ceiling voids via formal wire/cable ways as well as in conduit in concrete structures or walls.

Provision will be made for all IT/data communication between various communication points in the form of conduit or wire mesh. The exact requirements for the IT/Data will be finalized with the Health Technology (HT) / IT services subcommittee at an early stage.

The electrical services requirements for the different types of service platforms as outlined in Table 1 will be designed as per IUSS standards and in co-operation with health specialists.

All technology employed will be energy efficient components to ensure conformance with SANS 10400-XA:2011 referring to the energy usage in buildings.

It will be expected from the designers of the HVAC equipment to utilize heat pumps and heat recovery techniques for hot water and energy efficient heating and cooling of buildings. It will be proposed to utilize thermal storage of renewable energy generated during the day for utilization throughout the night.

Table 1: Electrical Services Requirements

TSHILIDZINI HOSPITAL AREA SUMMARY AND ELECTRICAL LINK SERVICE REQUIREMENTS INCLUDING GENERATOR/EMERGENCY SUPPLY v1							
ABBREVIATION	DESCRIPTION	Square meter per building	Circulation	Total Floor Area	Areas requiring emergency/generator supply	Total expected load fom Eskom (40VA/sqm) (kVA)	Emergency load from generators
Emerg.	Emergency Centre, including Victims of Violence unit	2 439	30%	3 171	100%	126,83	126,83
Theatre	Theatre and CSSD	2 248	30%	2 922	100%	116,88	116,88
ICU&HC	ICU and High Care (Adult)	1 013	32%	1 337	100%	53,49	53,49
Renal Unit	Renal Dialysis Unit	343	30%	445	100%	17,81	17,81
Adt Wrd	Adult Wards	7 251	30%	9 426	100%	377,05	377,05
TB	TB Ward and MDR Clinic	886	30%	1 151	100%	46,05	46,05
Matern	Maternity Unit, including	641	30%	833	100%	33,31	33,31
	Ante Natal Ward	829	30%	1 078	100%	43,11	43,11
	Delivery Unit (10 delivery rooms)	499	30%	649	100%	25,95	25,95
	Maternity High Care	134	30%	174	100%	6,97	6,97
	Caesarean Theatres (x2)	451	30%	586	100%	23,44	23,44
	Post Natal Ward & Kangaroo M	1 199	30%	1 558	100%	62,32	62,32
	Pregnant Mothers Lodge	468	30%	608	100%	24,34	24,34
Paeds	Neonatal, Paediatric Ward, Milk Kitchen and Mother Lodgers	2 726	30%	3 544	100%	141,75	141,75
Ovrn L	Overnight Lodge (People awaiting transport to a higher level of care)	484	30%	629	50% (315 sqm)	25,14	12,57
Drs	Doctors area	388	30%	504	50% (252 sqm)	20,15	10,075
X-R	Diagnostic Radiology	612	30%	795	100%	31,81	31,81
Blood	Blood Services (Blood Bank)	141	30%	183	100%	7,31	7,31
NHLS	National Health Laboratory Services	402	30%	522	100%	20,88	20,88
Cl. Eng	Clinical Engineering	178	30%	231	50% (115 sqm)	9,23	4,615
Phar	Pharmacy	908	30%	1 180	100%	47,22	47,22
OPD	Out Patient Department	4 029	30%	5 237	100%	209,48	209,48
Rehab	Rehabilitation (Allied Health)	2 255	30%	2 932	50% (1466 sqm)	117,26	58,63
Cent Kit R	Central Kit Room	115	30%	149	50% (75 sqm)	5,95	2,977
Adm&Sup	Administration and Support Services	6 121	30%	7 957	50% (3979 sqm)	318,29	159,15
Cent Cl	Central Cleaners & Household	345	30%	448	50%(224 sqm)	17,91	8,96
Resource C	Resource Centre	2 387	30%	3 102	50% (1551 sqm)	124,10	62,05
Kitch	Kitchen	1 031	30%	1 340	50% (670 sqm)	53,59	26,79
Laund	Laundry	758	50%	1 137	20% (209 sqm)	45,49	9,10
Mort	Mortuary	352	30%	458	100%	18,30	18,30
Waste	Waste Management	215	30%	279	20% (55 sqm)	11,15	2,23
Maint	Maintenance (Facility and Grounds) and Plant rooms	814	30%	1 058	50% (529 sqm)	42,33	21,16
Gateway Cl	Gateway Clinic	644	30%	837	50% (420 sqm)	33,49	16,75
O&P	O & P Workshop	805	30%	1 046	20% (523 sqm)	41,84	8,37
	Others			2 500	50% (1250 sqm)	100,00	50,00
	Staff accomodation				N/A	0,00	0
	SUB TOTAL	**43 298**	**16 707**	**60 005**		**2 400,21**	**1 887,71**

7. NORMAL AND EMERGENCY POWER REQUIREMENTS

7.1 Normal Power requirements

The average normal power requirements for design purposes for hospitals in South Africa with reference to SANS 10400-XA:2011 for public buildings is 80 VA/m2 floor area. A study of the maximum load of 200 hospitals in SA has revealed that a demand of only 40VA/sqm is achieved as an average. However, due to the introduction of energy efficient buildings and energy efficient lights, appliances and medical equipment the demand density would most probably reduce even further.

The total expected demand for the new hospital is not expected to exceed 3 MVA as summarized in Table 2 below:

Table 2: Calculation of total expected electrical load

Space	Floor Area	VA/m^2	Total Expected Load
	(m^2)		(kVA)
All areas	60,000	40	2,400 kVA
Staff Accommodation	150 units	3.5kVA each	525 kVA
		Total	**3 000 (3.0 MVA)**

All clinical and industrial areas will be serviced from the proposed Energy Center (2.4 MVA) whilst the staff accommodation will be serviced from separate miniature substations (525 kVA). The option to service the staff accommodation from the Energy Centre as well should be kept open as a possibility as it will then be backed up with emergency supply from the generator system as well.

To ensure an N+1 redundancy service, it will be recommended that 2 x 3.0 MVA 11kV/400V Power Transformers be installed for the hospital. Normal load will be split equally between the two transformers implying a maximum loading of 48% per transformer under normal power supply conditions.

7.2 Emergency Power requirements

Emergency power can either be calculated as a full load back up or else as a back-up for only the selected/critical electrical services of the facility. The emergency capacity is expected to be in the region of 2.5 MVA prime/continuous or 3 MVA of rated/peak power.

In order to respect the N+1 redundancy requirement of 3 MVA (peak), 3 generator sets of 1.5 MVA each is proposed. It is proposed to limit diesel fuel storage on site to the volume required for 36 hours of operation being 23kl in total.

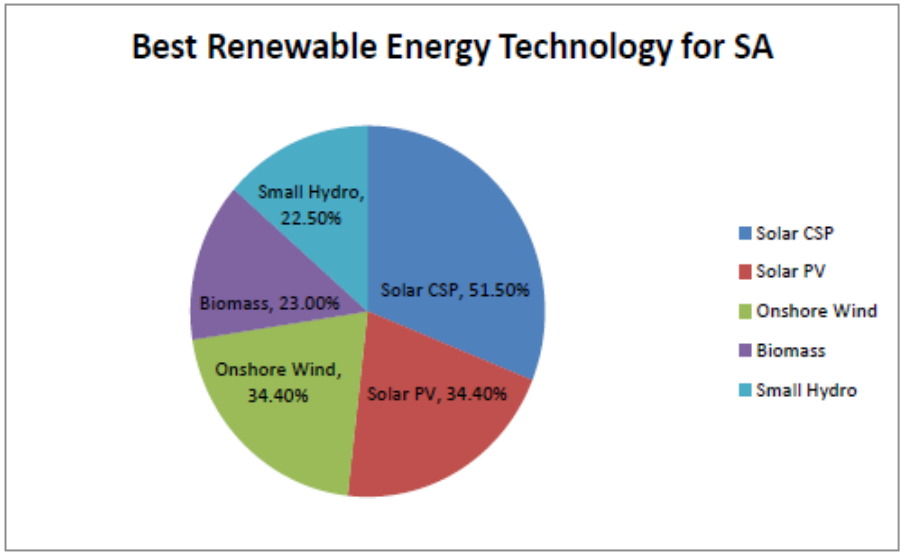
8. RENEWABLE ENERGY OPTIONS

8.1 Available technologies

Various sources of renewable energy generation are available of which the most important technologies are listed below:

a) Solar PV generation;
b) Wind turbines;
c) Biogas power generation;

Table 3 Available renewable technologies - S Pillay MEng UJ Oct 2016



Of all the above-mentioned technologies, solar PV promises to be the most effective solution in the specific area with an average annual solar irradiation level of 2100 kWh/m^2. Cost for generation has also reduced considerably over the past 5 years and is now the lowest according to the sources summarized below. A special report was prepared which detailed the pros and cons of the various technologies and Table 4 summarizes these findings:

Table 4: Summary of costs of energy over 10 years

TECHNOLOGY	RESOURCE REQUIRED	CAPITAL COST TO INSTALL (DOE 2015)	COST OF ENERGY OVER 10 YEARS (NO MAINTENANCE)	OPTION TSHILIDZINI
WIND ENERGY	WIND SPEED 3 m/s +	R 30 000/kW	**R 0.68 / kWh**	No
HYDRO ELECTRICITY	MOVING WATER (GRAVITY)	R 80 000/kW	**R 0.91 / kWh**	No
BIOENERGY	AGRICULTURAL WASTE/WOOD	R 100 000/kW	**R 1.42 / kWh**	No
GRID TIED SOLAR PV (NO STORAGE)	SUFFICIENT SUN	R12 000/kWp	**R 0.55 / kWh**	Yes
CONCENTRATED SOLAR POWER (CSP)	IRRADIATION 1000W/m^2 +	R 90 000/kW	**R 4.11 / kWh**	No

The low cost of energy generation of R 0.55 / kWh utilizing Solar PV (Grid Tied without energy storage) confirms the suitability of the technology for the new hospital which will reduce both the carbon footprint of the hospital and the monthly energy bills.

8.2 Solar PV technology for Tshilidzini Hospital

Figure 1 below shows the irradiation levels in the various provinces of SA and further confirms the suitability of solar power for the new hospital:

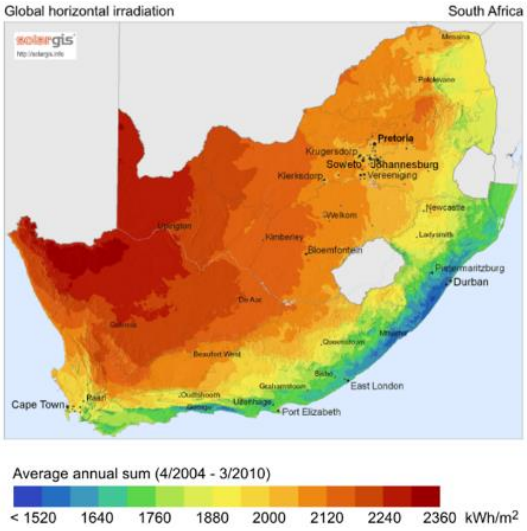


Figure 1: Global Irradiation levels – annual sums

A proposal will be developed during the concept design phase for the installation of a 750 kWp Solar PV installation as a roof covering solution for the parking area as well as on roof structures of predominantly north-facing buildings. Initial indications are that the required mounting area will be approximately 4 700 m^2.

A 750kWp Solar PV system will conservatively provide supplementary energy of 1 300 MWh per annum which will be sufficient to provide for the additional chiller power requirements to generate and store cold water for evening peak demand clipping.

Table 5: Initial indicators of possible 750 kWp Solar PV system

SOLAR PV TO PROVIDE BASELOAD + HVAC PEAK ENERGY FOR NEW HOSPITAL
ESKOM MEGAFLEX TARIFF 2018/19

FLOOR AREA	POWER REQUIREMENT	TOTAL kW (MD)	SOLAR PV kWp [31%]	COST/W SOLAR PV
60 000 m^2	40 W/m^2	2 400	750	R 12

SOLAR ENERGY PER YEAR (1000W/m2)	AVOIDED COST FROM ESKOM (Tariff @ +8% p.a.) (R1.15/kWh)	TOTAL COST SOLAR PV (Exl VAT)	ROOF AREA (m^2)	SIMPLE PAYBACK
1 300 MWh	R 1 500 000 / Year	R 9 000 000.00	4 700	5 Years

9. SUMMARY

The Electrical Services Report has been presented.

External electrical supply and supplementary appropriate renewable energy options have been addressed. The availability of an increased external link service from 1MVA to 3 MVA has been discussed with *Eskom and no red flags were raised at this early stage*. An official application for the increase in NMD will only be done after completion of the design development phase.

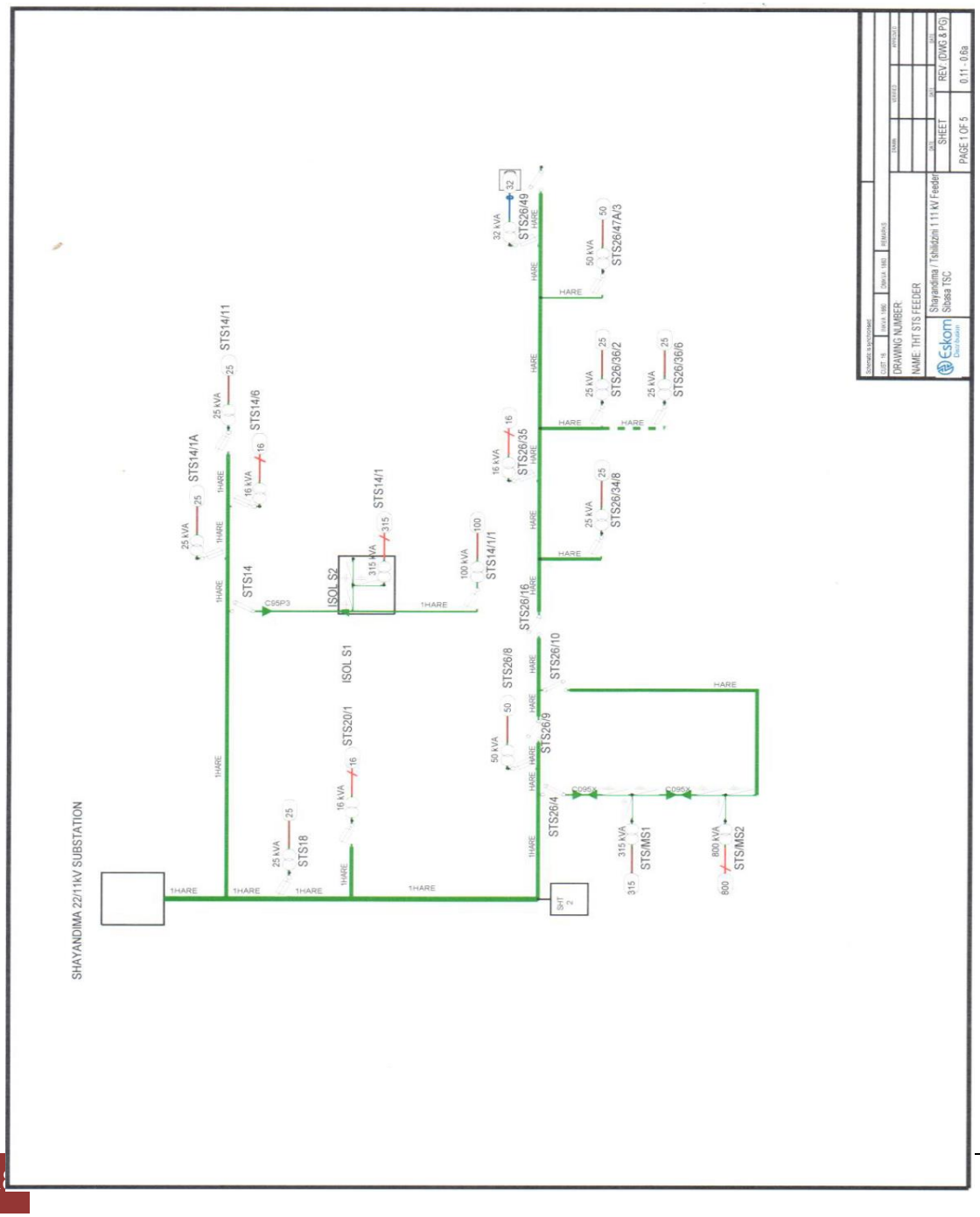
The possibility of utilizing solar energy during the day to supply chillers with electricity for evening cold water requirements was outlined and the savings in consumption from Eskom indicated

Emergency power requirements for the new hospital have been identified. A provisional rating for emergency back-up power has been calculated.

ANNEXURE A

Eskom network supplying existing hospital

(STS 26/4)



ANNEXURE B

Site Development Plan