National Electricity Corporation of Sudan
Energy Loss Reduction Project

By
El Hafiz Hamid Bakheit
1. National Grid

- **Installed Capacity Hydro**: 300Mw
- **Installed Capacity Thermal**: 250Mw
- **Planned Capacity Hydro**: 1500Mw
- **Under Construction Capacity Thermal**: 220Mw
- **Transmission Voltage**: 220Kv, 110Kv, 66Kv
- **Distribution Voltage**: 33Kv, 11Kv and 0.415Kv
- **Planned Transmission Voltage**: 500Kv

2. Isolated Generation

Various capacities ranging from 1Mw to 15Mw over more than 25 Towns

**Introduction**

To reduce energy losses, National Electricity Corporation (NEC) found it necessary to firstly install energy meters to record the energy fed into the system and compare it to the amount of issued billings to determine the amount of losses. The losses are then analysed to elementary source and methods are designed and measures taken to reduce them to an acceptable level.

The project is divided into three stages namely:

1. **Phase 1** *(already executed and presently functioning satisfactory).*
   
   Measurement of energy fed to Greater Khartoum, the capital of Sudan (60% of the load) at the 220Kv, 110Kv and the 33Kv.

2. **Phase 2** *(contract under negotiations)*
   
   Measurement of energy fed at various loads in the national grid — about 600 km transmission lines.

3. **Phase 3**
   
   More precise measurement of energy at the 11Kv at Greater Khartoum.
Phase 1
The contract between NEC and Siemens to implement phase 1 of the project was signed on 27\textsuperscript{th} October 1998.

A. Contract Proposal

♦ To design supervisory metering system to record and store all meter functions* locally and be able to transmit them to a central unit where they can be read, extracted and analysed in data or graphic form.

♦ Measurement of active energy (Kwh), reactive energy (Kvarh), apparent energy (KVAh), demand (KVA), Load graphs, voltage profile and system performance. (i.e. voltage dips and outages versus time)

B. Scope of work:

♦ The procurement, supply, installation and commissioning at the sites of the meters, recording devices, computers and peripheral equipment including all cabling and consumables to interconnect all devices.

♦ Air freighting the goods to site

♦ Training of all relevant staff in installation, testing and use of equipment.

C. Contract Particulars:

\begin{align*}
\text{Total Cost} & \quad \text{US$330,000} \\
\text{Number of Uni-directional Meters} & \quad 52 \\
\text{Number of Bi-directional Meters} & \quad 21 \\
\text{Number of Recorders} & \quad 73 \\
\text{FAF Recorders Installed} & \quad 12 \\
\text{Number of Panels} & \quad 14
\end{align*}

D. Assessment of the Project

To calculate the total energy fed into Greater Khartoum, meters were installed at seven substations.
a. Analysis

- Manipulation of measurements at the (noKv) level results in the total energy fed into the substation.
- Adding the total energy recorded by the 8 33Kv meters and the 4 11Kv meters gives the total energy fed into the system.
- Subtracting 1 – 2 gives the energy consumed in the substation i.e. auxiliaries, lighting and other technical losses.

b. Results

By conducting similar manipulation the energy consumed in the substations (lighting, A/C, auxiliaries and technical losses) and that fed into the system (amount of billing + technical losses + non-technical losses) can thus be computed.

The goal of the project of losses assessment is therefore reached. Extra project benefits of the functions of the metering system mentioned earlier helped system analysis, planning and monitoring.

Corollary

The intensive training given by Siemens sincere staff bread a good team to operate and maintain the project successfully. However it is observed that more training is required in the software to enable the team to take the initiative.

The success of the project is fairly attributed to Siemens since the early stages of negotiations. Flexibility in payment, sincerity in design, share of responsibility and commitment to work in partnership encouraged NEC to get to the second phase.

The metering system is equipped with tariff calculations. At present we didn’t make much use of it. It will be of substantial value when we implement our plan of private generation and system interconnection with neighbouring countries.

2. Phase 2 (agreed upon – to be signed)

1. Under the same purpose of phase 1 the proposal and scope of work are similar. It covers all measurable points down the national grid at voltage levels 220Kv, 110Kv, 33Kv and 11Kv.

2. In this phase it is decided to provide all concerned compared departments access to the data management by installing four central units to one in phase 1.
3. For reliable data organisation GSM access is provided parallel telephone access.

4. Voltage monitoring devices will be installed to cut-off the voltage supply to the modem when the voltage fluctuates beyond pre-determined levels -- such relays were lately provided by Siemens to solve the problem of modems loosing programme under voltage fluctuations in phase 1.

5. Contract Particulars:

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<tbody>
<tr>
<td><strong>Total Cost</strong></td>
<td><strong>$ 545,502</strong></td>
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<tr>
<td><strong>Number of Uni-directional Meters</strong></td>
<td>83</td>
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<tr>
<td><strong>Number of Bi-directional Meters</strong></td>
<td>25</td>
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<tr>
<td><strong>Number of Recorders</strong></td>
<td>23</td>
</tr>
<tr>
<td><strong>Number of Panels</strong></td>
<td>22</td>
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3. Phase 3

The proposal is to meter at the 11Kv level at Khartoum Area to reduce the errors by coming closer to the consumer voltage level. It will also cover the revised unmetered locations.

4. Other Projects

1. Supply of Check Meters:
   Portable check meters will be provided by Siemens to check existing magnetic meters on site to satisfy the complaints of customers.

2. Supply of Bulk Portable Meters:
   Bulk portable meters will be provided by Siemens to measure the losses at selected suspected consumer areas. The meter will be installed at the infeed terminals after reading all individual meters. The reading of the check meter will be compared to the same reading of the individual after an elapse of an adequate period.
Total energy fed into the s/s = XMWH
(a – b) + (b – c)

Total Energy fed into the system = 1. MWH
(E1 + E2 + E3 + E4) = (F1 + F2)

Total energy consumed in the substation = Z
= X – Y

1. To be compared to the amount of billing issued to estimate the losses at the 33 kv level. At present Phase 2 a closer estimate will be reached by metering at the 11 kv level and also an index will be developed for the losses between the 110 and 33 kv, technical losses.

2. Is further analysed to technical losses and consumption by the substation i.e. auxiliaries, lighting, a/c’s etc.
<table>
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<tr>
<th>Name:</th>
<th>El Hafiz Hamid Bakheit - Mr</th>
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<tbody>
<tr>
<td>Position:</td>
<td>Project Manager: Energy Loss Project</td>
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<tr>
<td>Company:</td>
<td>National Electricity Corporation</td>
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<td>Country:</td>
<td>Sudan</td>
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Mr Bakheit completed his B.Sc in Electrical engineering at the university of Khartoum, Sudan in 1972.

He is presently the Planning Division Manager at the National Electricity Corporation (NEC), Khartoum, Sudan as well as the Project Manager on the Energy Loss Reduction Project.
Electricity generation started in 1908 with a 100 Kw generator, reached 3 Mw in 1925, 33 Mw in 1956, 48 Mw at 1962 by installing 15 Mw Hydro at Sennar /dam 300 km south of Khartoum, then 126 Mw Hydro at Griba Dam in Eastern Sudan, 280 Mw Hydro at Rosseries Dam 500 km south of Khartoum with simultaneous phased thermal generation to reach the present installed capacity at 300 Mw Hydro, 250 Mw thermal a 220 Mw thermal generation is already planned and contract negotiation completed, finance arrange to be constructed at Khartoum Town making use of indigenous full as a result of oil discovery in Sudan a 12 00 Hydro generation is planned at Hamadab, Northern Sudan, with other Hydro – potential sites in the northern and southern parts of Sudan.

NEC is a state owned corporation responsible of all Sudan electrification. However a decree is already (passed, issued) giving the right and encouraging private generation by locals or foreigners.