Research Report

CITY ELECTRICAL NETWORK ANALYSIS

Prepared by: SINAN R. SAID

Preparation for :MINISTRY OF ELECTRICTY
SAMAWA NETWORK IMPROVEMENT

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SAMAWAH CITY UPGRADE PROGRAMME

Research Report

Summary

The intent is to produce cost effective and practical solutions that lead to full restoration of distribution systems and optimization of the electrical network. Technical decision will be made on the basis of maximum added value to the client at all times.

Initially a series of studies completed and used to develop an early vision of the optimized potential of the network. This ensure we have a full understanding of the networks and we are fully aligned with the expectations of the client.

We developed a detailed plan which will ensure that all of the solutions developed and delivered during the project contribute effectively to a fully regenerated, efficient, optimized and sustainable network.

Broadly the consulting Services for 11kV power distribution network look at operate, maintain, improve, optimize and install appropriate metering system along with 11/0.4kV network Monitoring & Management including Energy Input Aggregation for the Distribution area.

The assignment envisions benchmarking the baseline performance, analyzing the current infrastructure with the purpose to achieve optimization of the network and also to give recommendations from the perspective of future planning. The scope of work includes voltage studies and load growth studies, network vulnerability studies, power quality analysis and improvement measures, network planning and optimization after mapping the network on GIS platform. On the basis of the analysis, recommendations submitted which include indicative Bill of Quantity (BOQ) for proposed network and planning report. Further long term support for implementation of the proposed solutions will be provided. This document summarizes the site work done ,office analysis, calculation of the network, methodologies and tools which are used during the sturdy

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1 Introduction

PROJECT BACKGROUND

with improving the efficiency of distribution network operations for the city of Samawa. It is intended to take up the city upgrade project at Samawa with 140,000 consumers,24 substation ,206 feeders and 4,500+ Distribution Transformers.

A brief scope of activities under "City-wide distribution network upgrade and efficiency improvement program with advanced metering & revenue control measures" is below:

a) Metering of various consumers – Residential, Commercial, Industrial, Agricultural, etc., as per appropriate metering option and revenue management system

b) Manage Connections, Meter data management and Energy audit (11 KV and below)

c) Engineering, improvement and optimization of the network using techniques such as network reconfigurations, refurbishments and augmentation

d) Address power quality issues including Power factor correction and load balancing e) Network vulnerability studies (11 KV and below), with GIS

f) GIS site Survey and geospatial mapping of network assets, as required

g) Prepare Network Master Plan to enable load planning and management, load balancing, PF improvements, growth projections and future network sustainability

h) Develop technical data sheets of proposed network (Substations, Feeders, Distribution Transformers, Control & Protection systems)

BRIEF INTRODUCTION

The assignment envisions benchmarking the baseline performance, analyzing the current infrastructure with the purpose to achieve optimization of the network and also to give recommendations from the prospective of future planning. By checking and preparing the topographical survey capture all information system, location, distances within the distribution network. The engineering survey we did using online application specially developed for this task connected to our main server capture all sizes, types, specifications and current status of the network component substation ,main power transformer ,switchgears, relay protection ,poles ,overhead lines ,underground cables ,distribution transformers and consumers . By using GIS system based on the field readings / data network analysis software analyze the given networks ,run multiple scenarios ,future expansion assumptions and specify the problems ,we suggest different solutions then apply it to the same base network platform and obtain the final solution and modifications .

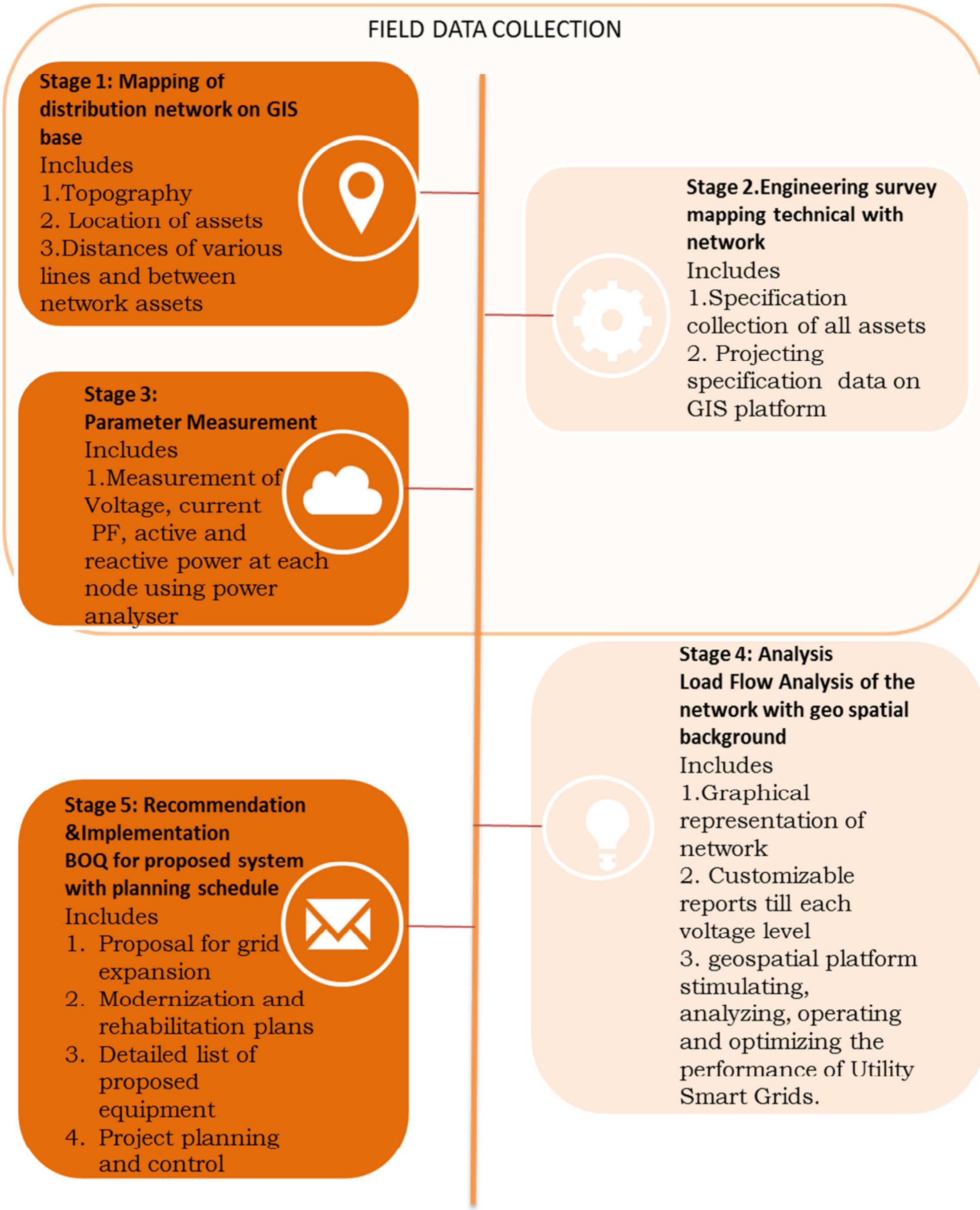
OVERALL APPROACH & METHODOLOGY

The assignment mandates following five stages, they can further be classified as three phases:

a. Data Collection

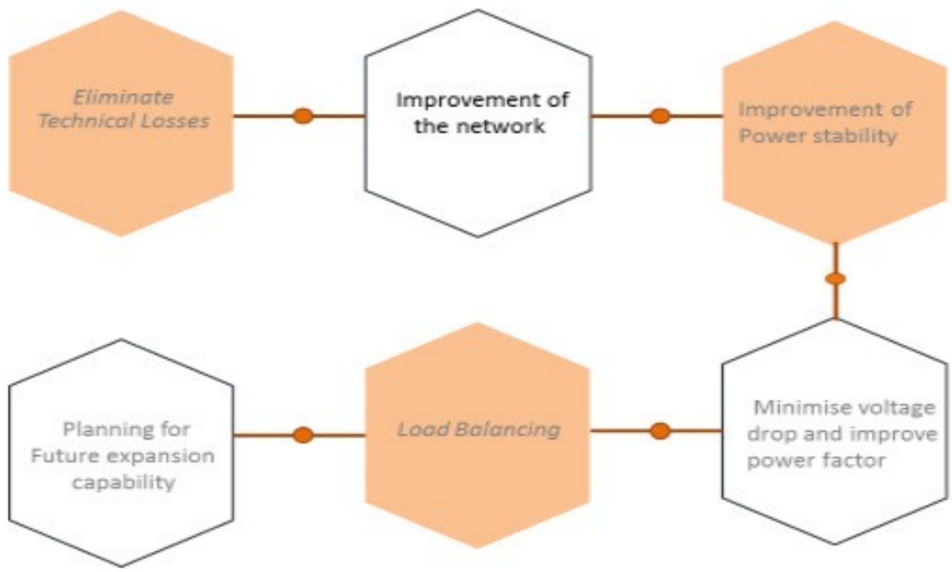
b. Data Analysis & Outcome study

c. Recommendation & Implementation Support



Based on these studies, recommendation and support services decided, and Network master plan and informed decisions on reinstatement, refurbishment or replacement along with indicative Bill of Quantity (BOQ) for proposed network up gradation/ modification with detailed planning report submitted.

we propose a comprehensive implementation plan for installing appropriate metering system along with 11/0.4kV network monitoring and management including energy input aggregation, energy audit and network visualization for the Distribution area. also propose holistic Revenue Management solutions for both cities utilities after in-depth study of their legacy systems in consultation with relevant stakeholders as future work .



On the basis of the results of above analysis further recommendation and implementation planning done.

Network Analysis and Network Planning

These studies allow us to fulfil requirement from the customer end for Analysis report.

Load Flow studies:

- Balanced and unbalanced voltage drop and short-circuit analysis for existing system.
- Balanced and unbalanced voltage drop and short-circuit analysis for proposed system with loss reduction factors, good voltage regulation factors, reducing abnormal voltage variations, load balancing conditions for overloaded system.
- Load balancing, network vulnerability analysis & Load growth studies
- Optimal capacitor placement for the system for power factor correction
- Comprehensive fault analysis for (Voltage and Current) for proposed system

Load Growth studies:

- Load allocation / Estimation study using customer data
- Load forecasting

Methodology for conducting GIS-based network vulnerability studies

The approach and methodology is based on key performance factors which drive a reliable, economical and profitable operation of a distribution utility.

At the highest level, we introduced suitable network analysis tool, based on GIS, to interact with the geospatial network data and asset attributes to perform various analyses e.g. technical loss calculations, load flow analysis, short circuit and open circuit analysis, network stress analysis, voltage regulation and voltage drop analysis, optimum capacitor placements and network protection analysis. We used these techniques not only to identify and assess the vulnerable sections of the electrical distribution network, but also recommend qualitative and infrastructure measures to mitigate network vulnerabilities and to improve the network. We recommend well-defined operational benchmarks to measure the network performance improvements using internationally accepted reliability indices e.g. CAIDI, CAIFI, SAIDI, SAIFI, etc.

However, whenever GIS were not available for a part of the network, could not be collected due to practical constraints, then we employ alternate method of using non-GIS or the first principal method for calculating network vulnerabilities.

the following step-wise approach to prepare for GIS-based network vulnerability studies were implemented :

1. Present Network Data Collection

   The first step involves collection of required data from the distribution network area under consideration. Two types of GIS data are collected: spatial and non-spatial data.

   The spatial data includes GPS data acquired from the field using instruments such as hand-held GPS etc. smart Samsung tablet were used to collect the data

   The non-spatial data includes the information such as

   a. Consumer details : Meter account no. Pillar/Pole no.
   b. Electric network details : 11kV line diagrams with cable sizes, lengths, equipment parameters etc.,
   c. Transformer details : Various details about transformer including rating, capacity etc.,

2. Mapping the collected data to GIS

The collected spatial and non-spatial data transferred on to the digital base maps using digitization. Quality of the data were ensured at all times. A comprehensive database created by overlaying the GIS data on satellite base maps/google maps. The comprehensive GIS database provides the spatial relationships between various assets of the network viz., consumer, transformer, feeder, substation etc.

3. Analysing the existing network for technical losses, voltage profiles, loading conditions and network vulnerabilities

4. Conducting the Power System studies using the appropriate software (2 type of software used ETAP & ENZEN)

5. Providing recommendations to the customer for resolving network vulnerabilities and power quality issues, e.g. network improvements, power factor corrections, harmonic suppression, shunt capacitor compensation, network reconfiguration, optimal network routing, feeder segregation etc.

2 specific Approach Towards Key Tasks & Deliverables

The following are the key stages identified towards successful delivery of the intended outcomes.

a) Situational Analysis: AS-IS study of the existing network by collecting all the network details, configurations, asset structure and feeder, sub-station & distribution transformer schematics.

b) GIS Mapping & Engineering Survey for Asset attribute collection & mapping

c) Field measurement : collection of power parameters at various nodes using appropriate equipment like analyzers & existing metering arrangement (we used FLUKE 435 SERIES II power quality and energy analyzer)

d) Network Analysis & System Study: A detailed network analysis & system study completed for identification of network improvements and recommendations.(ETAP software package used)

e) Work Space / User Interface: Application tools for Network representation, asset mapping and optimization.

f) Project Planning & Scheduling for System Augmentation: Preparation of program planning along with details Bill of Quantities and other requirements.

a. SITUATION ANALYSIS

Activities	Office work	Site work
AS-IS system information gathering	Study of Single Line Diagrams (SLD)	Site team collect & provide the required SLDs & other relevant details.5 years previous consumption /peak load during the year
Network / System Data Collection	Detailed templates for necessary data collection to be shared by site team	Site team collect & provide the required data and information. current status of the transformers and the feeders
Existing process & systems information	Study & review of existing systems	Site team collect & provide the required planning report from the authority .
Agreement on the deliverables of "Situation Analysis"	Workshop with stakeholders	Site team ensure availability of respective stakeholders.

b. GIS MAPPING & ENGINEERING SURVEY

Activities	Office work	Site work
Collection of GPS coordinates for all network elements/assets	Detailed templates for necessary data collection shared	field team did the GIS Survey to physically collect the geospatial data of all the elements/assets.20 engineers walk down through the whole city following each feeder from substation to final consumer and fix coordination for each
Collection of Asset attributes such as transformer capacities, parameters manufacturing specifications, conductor sizes	Templates for providing the attributes data were utilized on online app	field team collect & provide the required data and information. All via the smart tablet and send to server online
Operational data collection such as input energy, billed energy, peak load, collection efficiency etc.,	Templates for providing the attributes data prepared and analysed	field team collect & provide the required data and information.

GIS-based Network vulnerability studies (11 KV and below)

to carry out the network vulnerability studies, for assessing the state of the network, identifying overloaded sections, load and phase imbalance and provide suitable recommendations for correction action plans providing both qualitative measures e.g. power factor improvements, static compensation and harmonic suppression techniques and infrastructural measures e.g. network reinforcements, refurbishments or replacements, as the situation demands in a way which is best suited for the Utility from techno-economic considerations.

Suitable techniques employed depending upon the maturity level of the network in terms of availability of existing network data. we developed the single-line diagrams of the network, no single line diagram were available from client end SLD done initially done using standard network drawing tools, capturing all the essential network information – both electrical and non-electrical.

At the next level, our objective was to capture the field geo-coordinates of electrical network assets for 11 KV and below, develop GIS base maps and overlay the entire network on GIS base maps, which can be accessed by intuitive GIS application for network visualization, network analysis and monitoring. Care were taken to provide economically-viable GIS solution to fulfil the essential operational requirements of the network.

c) FIELD MEASUREMENTS

Activities	Office work	Site work
Key parameters data collection	Design engineer identify key strategic nodal points from where the key additional parameters data is required as per the prescribed format.	field team collect & provide the required data and information. 5 different team with power analyzers collect the 24 hours data measurement for the selected transformers

Sample of energy data measured in the attachement

d. NETWORK ANALYSIS & SYSTEM STUDIES

Activities	Office work	Site work
Identification of appropriate network analysis tool	Senior consultant evaluate the application tool in consultation and discussions with all stakeholders. ETAP or ENZEN software	licenses, users & duration of license requirements to be used for network analysis.
Conducting all the relevant network analysis and system studies as per the requirements.	SOFTWARE engineers conduct the AS- IS study of the network to find out the various parameters. Based on the stakeholder interactions and secondary data, we come up with a new network plan.	Check the network plan and feedback whenever there are obstacles or objections from client
Submission of recommendations for optimized network configuration.	Based on the network analysis and system studies conducted using the application tool, we submit recommendations for optimized network configurations.	field team with client evaluate and confirm the best option out of the proposed recommendations

Network analysis & System studies enables distribution management, network expansion planning, optimisation, service quality improvement, new connections handling, network pricing, regulatory reporting, protection design & coordination, energy auditing and various other business functions of electricity distribution network operations.

Carrying out power system studies also enables identification of Power Quality issues besides the above and also remedial measures for mitigating the power quality issues by various techniques.

Power Quality Issues

Power Quality issues are most common due to wide spread use of power electronics such as variable speed drives, Programmable Logic Controllers (PLC), Information Technology (IT) Equipment etc.

The review of the power quality issues will be helpful in power system designing and optimization of network and quality enhancement. A proper distribution grid with adequate planning and maintenance is essential to minimise the occurrence of Power Quality problems.

The most common Power Quality issues are as outlined hereunder:

Sl. No.	Type of Power Quality Issue	Description	Causes	Consequences
1	Voltage Sag or	Decrease of normal voltage level between 10% and 90% of the nominal rms voltage.	1. Faults on the transmission or distribution network 2. Connection of heavy and start-up of large motors 3. Faults in consumer's locations	a. Tripping of contactors & Dip electromechanical relays b. Malfunction of various IT equipment and household loads equipment c. Disconnection and loss of efficiency in electric rotating machines
2	Short Interruption	Total interruption of electrical supply for duration from few milliseconds to one or two seconds.	1. Insulation failure 2. Lightning 3. Insulator flashover.	a. Tripping of protection devices b. Loss of information and malfunction of data processing equipment. c. Stoppage of sensitive
3	Long Interruption	Total interruption of electrical supply for duration greater than 1 to 2 seconds	1. Equipment failure in the power system network, 2. Storms and objects (trees, cars, etc.,) striking lines or poles, fire, human error	a. Stoppage of all equipment.

4	Voltage Spike	Very fast variation of the voltage value for from a several microseconds to few These variations may reach thousands of volts, even low voltage.	1. Lightning 2. Switching of lines or power factor correction capacitors 3. Disconnection of heavy loads.	a. Destruction of components (particularly electronic durations components) b. Insulation failure milliseconds. c. Data processing errors or data loss d. Electromagnetic in interference.
5	Voltage Swell	Momentary increase of the voltage, at the frequency, outside the normal tolerances, with duration of more than one cycle and typically less than a few seconds.	1. Start/stop of heavy loads 2. Badly dimensioned power sources 3. Badly regulated transformers (mainly during off-peak hours).	a. Data loss b. Flickering of lighting and power screens c. Stoppage or damage of sensitive equipment
6	Harmonic Distortion	Voltage or current waveforms assume non-sinusoidal shape. The waveform corresponds to the different sine-waves with different magnitude and phase, having frequencies that multiples of power system frequency.	1. All modern day non-linear loads, such as power electronics equipment including switched mode power supplies SMPS), data processing equipment, high efficiency lighting etc., 2. Arc furnaces 3. Welding machines 4. Rectifiers 5. DC brush motors	a. Increased probability in occurrence of resonance b. Neutral overload in 3-phase systems c. Overheating of all cables and sum of equipment d. Loss of efficiency in electric machines e. Electromagnetic are interference with communication systems f. Errors in measurements when using average reading meters
7	Voltage fluctuation	Oscillation of voltage value	1. Arc furnaces 2. Frequent start/stop of electric motors (for instance elevators) 3. Oscillating loads	a. Flickering of lighting and screens
8	Voltage	A voltage variation in a three-phase system in which the three voltage magnitudes or the phase angle differences between them are not	1. Large single-phase loads (induction furnaces, traction loads) 2. Incorrect distribution of all single-phase equal. loads by the three phases of the system	a. Existence of a negative imbalance sequence that is harmful to all three phase loads.
9	Noise	Superimposing of high frequency signals on the of the power-system frequency.	1. Electromagnetic interferences due to microwaves etc., 2. Improper grounding	a. Disturbances on sensitive electronic equipment waveform b. Data loss and data processing errors.

The costs of the power quality issues are enormous and are largely dependent on several factors including the business area of activity, sensitivity of equipment etc.

Mitigation Techniques

Power Quality can be mitigated at different levels; distribution and end-user. The Power Quality mitigation techniques include:

1. Grid Availability

   Ensuring there is adequate power in the grid. Adequacy of the grid is the capacity of the distribution infrastructure within the system to satisfy customer electric demand.

2. Use of appropriate equipment

   Use of equipment designed in such a way that the equipment itself does not contributes to power quality problems while having the capability to withstand and be less sensitive to disturbances in the power systems.

3. Grounding of Electrical System

   Proper grounding of electrical system does not only protect installation, equipment and users but also play a key role in enhancing better performance of the system. Poor earthing is one of the causes of poor power quality, particularly at the consumers end.

4. Distributed Energy Resources

   Increased use of Distributed Energy Resources (DER), which have high potential to provide increased reliability

5. Interfacing Devices

   Power Electronic Devices that can be employed to interface between the supply and the sensitive equipment to prevent the power quality problem from reaching the equipment such as Automatic Voltage Regulator (AVR), Uninterrupted Power Supply (UPS), Dynamic Voltage Restorer (DVR), Harmonic Filters, Static VAR Compensators, STATCOMs etc., Power Quality Monitoring

We also proposed to facilitate the Power Quality Monitoring (PQM) to mitigate the

Power Quality issues and propose suitable mitigation techniques

PQM is the process of gathering, analysing and interpreting raw power measurement data into useful information. It involves, over a period of time, process of measuring voltage and current of the supply and examining their waveform, although the analysis is not limited to these two quantities. It includes inspection of wiring, grounding, and equipment connections. The monitoring of power supply helps to detect present and potential power quality problems that may gradually shorten the life span of equipment. PQ monitoring helps to improve the distribution network's power quality performance.

e. WORK SPACE / USER INTERFACE

Activities	Office work	Site work
Geo-Spatial platform – As work space for representation of network components	The Geo-spatial asset mapping data obtained through the survey of the utility assets represented on a GIS platform. available applications such as Arc GIS, ESRI were used	field team facilitate the necessary permissions / approvals / access to the relevant base maps and work platforms from the concerned government agencies.
	populating the captured data for necessary use. .	corresponding engineering and configuration activities involved which would be brought out as BOQ item.
	Further discussion and understanding were required on the progressive geo-spatial platform specified for optimizing the performance of utility smart grids.	

f. PROJECT PLANNING & SCHEDULING FOR SYSTEM AUGMENTATION

Activities	Office work	Site work
System Augmentation Planning	Planning for execution of system augmentation projects were given after finalising BOQ.	Scheduling driven by site team reflecting the field conditions and delivery requirements. Rehabilitation program for the network were submitted

Accurate metering & billing forms the key for a successful operation of a distribution network operator. Ensuring that all the consumers are metered provides effective energy audit.

We did review the existing metering infrastructure, the meter installation practices (meter enclosures and meter sealing) etc., as it plays very important role in revenue protection in the project area. Inadequate metering and inaccurate metering can be detrimental in sustainable operation of the distribution network operator. Accurate energy metering is the cornerstone for the 11 KV feeders and end-consumer premises metering is fundamental.

It is essential to select right kind of meter for different applications. review, assess and recommend appropriate metering system based on the type of consumer i.e., Residential, Commercial, Industrial, Agricultural etc., and based on the tariffs prevailing.

DELIVERABLES

The deliverable studies will enable enhanced distribution management, network expansion planning, optimization, service quality improvement, new connections handling, network pricing, regulatory reporting, protection design & coordination, energy auditing and various other business functions of electricity distribution network operations.

This shall further enable a platform for implementation of advanced applications like outage management, smart grid technology evaluation.

The key outcomes are

1. reduce technical losses .

2. improve powers availability .

3. improve power quality .

4. Recommendations for Network up gradation.

5. Comprehensive Network Master Plan and all documentation in support of findings and recommendations contained in the final electric system master plan.

6. Indicative Bill of Quantity (BoQ) along with relevant Technical Literature for various equipment (Transformers, Meters etc.,)

QUALITY MANAGEMENT SYSTEM:

All documents delivered to the customer reviewed and validated both by the senior Project Manager and the certified quality team member. All recommendations were compliant with corresponding Institute of Electrical and Electronics Engineers (IEEE) standards, and the Iraqi national standard specified by the ministry of electricity .

Work force :

In addition to the author of this report Mr Sinan Said who perform the main consultant in this work ,2 senior engineers (khaldoon sami and abdul amir jwaid) were joined the team as data collection manager and network design ,2 software analysis engineer , 2 GIS mapping engineers plus 25 data collection and power measurement junior engineers and technicians all the team work together for continuous 6 months from November 2017 till April 2018 for the data collection ,GIS mapping ,design of the network ,computer analysis ,engineering solutions and report presentation .

EXPERTS' TEAM

1. Network Analysis

Experts

2. Network

Upgradation Expert

3. Metering advisor

4. Network Expert

SOFTWARE TEAM

1. System architecture
2. Integrated solutions
3. Grid modernization
4. Network

Electrical Engineering

1. Single Line
2. power analysis
3. Repair program

4.Bill Of Quantity

3. NETWORK STATUS

ENERGY SECTOR -IN PERSPECIVE

Iraq's energy sector is its most significant contributor to the economy with the oil sub -sector accounting for over 65of GDP and more than 90% of annual government revenue and 98% of the country's exports. Iraq relies heavily on energy subsidies as the main tool to provide social protection and share hydrocarbon wealth. Subsidies are estimated to aggregate to 9% of GDP annually, of which

3.4% is on electricity, according to the IMF. In the electricity sector, significant subsidies exist, both in the electricity tariff and in the fuel used for generators. These subsidies reflect a prominent burden on Iraq's budget and form a major portion of the government revenues. According to the latest data available from IMF, the cost of electricity subsidy almost tripled from 2011-2013, reaching 3.4% of GDP and 8% of the total budget expenditure in 2014. Effective January 2016, GoI increased electricity tariffs four-fold to reduce subsidies and later adopted a strategy to reduce operational losses and increase tariff collection.

Iraq has shown more interests in Oil infrastructure in the recent years as compared to other sub sectors of energy. Public investment has been severely curtailed and is further paralyzed by the deficient public investment management. The private sectors have not yet played any substantial role thus far.

The energy sector has become a focal point for consumer dissatisfaction. The economy has suffered over 3 decades of international sanctions and conflicts that have rendered the institutions weak and resulted in under investment and chronic deterioration of infrastructure. Many of the industries have ranked the access to and reliability of power as the biggest obstacle in the progress.

Iraq suffers from deficiencies at all stages from generation to distribution. Low operational efficiency, high losses have led to an aggregate of technical and commercial losses to a level of 40%.

Although Iraq has made significant progress in improving its power generation and increasing oil production, its energy sector continues to face serious issues, including high demand growth of over10% per annum, severe electricity shortages with grid supply availability of fewer than 15 hours per day. In the context of a reduced oil-price and consequent budgetary pressures, the electricity sectors represents increasing fiscal pressure on Iraq's public resources — particularly due to high losses, lower than cost recovery tariffs, and poor revenue collection.

The electricity sector in Iraq suffers from a series of simultaneous and compounding challenges resulting in a broken business model unable to generate adequate revenue neither to sustain itself nor to offer value to its consumers. Due to lack of effective metering, billing, and commercial management systems, only about 50% of the energy billed is collected; leaving the actual electricity paid at less than 30 % of the total electricity generated.

VISION FOR THE ELECTRICITY SECTOR

Decentralized Service Delivery and Private Sector Participation:

To address the dismal technical and commercial performance of the electricity sector, the GoI has initiated actions to restructure tariffs, and progressively move towards achievement of full cost - recovery, whilst ensuring sufficient protection for poor and vulnerable consumers. The policies are founded in the sector strategy, the Iraq Integrated Energy Strategy (INES), adopted by the Cabinet in 2014, and enshrined in the recently passed law, the Electricity Law No. (53) Of 2017. The Minister of Electricity (MoE) has outlined a broad plan to un -bundle the sector, improve its financial position, decrease its reliance on government budgetary transfers and subsidies, and increase the efficiency and reliability of electricity supply.

Distribution Network Rehabilitation: Operational and Commercial Efficiency Enhancement The investments are proposed to include activities related to:

A.) Distribution network rehabilitation and reinforcement to meet both current and projected electricity demand reduce technical losses and increase operations flexibility;

b) Integrated Management Information System (MIS) covering electricity distribution core business functions namely;

1)Network operations and maintenance (O&M)

2)Commercial
3)Management of corporate resources

SAFEGUARD POLICIES AND MANAGEMENT

None of the listed impacts is considered irreversible or of potential large scale as described below.

Construction of the electrical network infrastructure (Overhead transmission lines, low voltage distribution networks, substations, and transformer rooms) has potential impacts on culturally valuable sites and the environment in general.

Below mentioned factor all contribute to the degradation of the living conditions, traffic congestion and blockage of access due to excavation and installation works damage to crops and negative impacts on livelihoods in the affected areas:

- Air emissions from heavy machinery and generators
- Dust generation from excavation activities and open storage of materials and excavated soils
- Noise emissions from heavy machinery
- Improper management of solid, liquid, and hazardous wastes and contamination of soils
- Water consumption in construction activities
- Improper disposal of wastewater from site offices
- Wastewater of subsurface waters and improper disposal of the resulting waste
- Installing overhead transmission and distribution power lines especially in privately owned agricultural lands has following effect:
- land requirements to establish permanent substations; Temporary land requirements for mobilization of machinery and other construction works processes;
- Impact on the illegal occupants and the commercial activities going on along the ROW of the network;
- Risk of damage/breakage of underground utility lines and piping (drinking water, waste water,
- electricity cables, telephone lines) during excavations especially inside urban areas;

Worker health and safety concerns, especially if local subcontractors are utilized in some construction activities, entails construction -related safety risks. Local subcontractors generally don’t have the culture of using personal protection equipment or maintaining good worker health and safety procedures or practices. Operation of High Voltage overhead transmission lines impacts the environment by producing Electromagnetic Field (EMF) together with noise created by the Corona effect. In addition, physical presence creates a visual impact and a threat to birds which may collide with the wires

- The size of the Right of Way and the protection zone is largely determined by EMF.

- The EMF for 400 KV lines at a distance of 25 m from the footprint of the line is < 5 KV/m, which is in conformance with stipulated standard for limitless exposure.
- Therefore, a –Protection Zone along the line should be at least 20 m from both of each side of the line corridor.
- Noise HV Transmission lines produce noise through the Corona effect and noise levels can be significant, especially in foggy, damp, or rainy weather conditions, when power lines can create a subtle crackling sound due to the small amount of the electric current ionizing the moist air near the wires. The Corona effect*can produce ozone** and oxides of nitrogen in the air surrounding the conductor, especially in humid conditions.
- *Corona Effect: phenomenon of ionization of air within a few centimeters immediately surrounding conductors.
- Ozone is a reactive form of oxygen and combines readily with other elements and compounds in the atmosphere.

The HV transmission lines

The HV transmission lines will be permanent structures crossing wide areas of deserts which may disturb the natural aesthetic value of desert landscapes. Therefore, the transmission lines and towers are expected to have a minor impact on the aesthetic value of the desert landscape. It is planned that the low voltage distribution networks will be installed using posts and overhead wires. Routine maintenance of such networks may require cutting some trees or blocking access to some roads. The planned interventions will be mainly replacing damaged or stolen parts of the networks. Any new additions to the network will be in urban settings. Cutting trees, which already exist in the city for landscape purposes, should be avoided as much as possible otherwise re-plantation of trees should take place instead of any ones which are necessary to cut for technical unavoidable reasons.

Substations

Many high-voltage circuit breakers, switches, and other pieces of equipment used in the transmission and distribution system are insulated with Sulphur hexafluoride, which is a potent greenhouse gas. This gas can cause leak into the atmosphere from aging equipment or during maintenance and servicing.

Transformer substations and/or switching substations

The installation of the new transformer or switching substations in brickwork cabins will involve the performance of civil works and the use of common construction methods and materials. These cabins are normally in urban areas. There are no plans to open access paths specifically to them.

Rehabilitation

Rehabilitation of transformer substations and/or switching substations:

Removal of obsolete equipment produces metal materials that may be recycled (steel and copper, in particular). However, some transformers may contain oils that are contaminated with polychlorinated biphenyls (PCBs). If it turns out that some transformers actually contain PCBs, special measures should be taken for their packaging and ultimate removal to prevent environmental and public health risks.

Procurement of land for the installation of infrastructure: The installation of new secondary stations and poles require that land be acquired or that compensation be paid for any land occupied by formal or informal dwellers.

SAMAWAH OR AS-SAMAWAH – GEOGRAPHICAL

The city of Samawah is the modern capital of the Al Muthanna Governorate. The city is located midway between Baghdad and Basra at the northern edge of the Governorate. The province was established in 1975, prior to that date it was a unified province along with Qadissiya (Diwaniya) and Najaf.

Samawah is built on both sides of the Euphrates and is surrounded by hundreds of palm groves that give it a tropical feel, especially in the southern and northern suburbs. These groves provide cool respite from the scorching heat of Mesopotamia and were the inspiration for the famous Iraqi folk song "The Palm of Samawah".

Samawah has a large salt lake called Sawa Lake, which once had a tourist village. The lake is located 25 km (15 mi) to the north of the city centre and is accessible by road. The lake has no obvious source, neither river nor ancient link to a sea. The water is extremely salty due to heavy evaporation in the searing heat of Mesopotamia and supports no marine life. A unique feature of the lake is that the water is above ground level surrounded by natural levees. Due to the high levels of salt in the lake, the levees heal themselves if a break is made in the levee, stopping the water from flowing down to ground level. The salt levels also improve buoyancy, and many migratory birds walk on the lake.

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FUTURE GENERATION SUPPLEMENT TO SAMAWAH

ENKA, with its partner General Electric, will design and build the Samawah Combined Cycle Power Plant, which will add 750 MW to the Iraqi Grid. The project is located near Samawah City, 293 km northwest of Basra, in southern Iraq.

The project will consist of 1 power block, which will produce 750 MW of power at 132 and 400 KV transmission levels. It will include four (4) GE 9E series combustion turbine generators which will be able to fire three (3) types of fuels: The main fuel will be the Heavy Fuel Oil (HFO) and the back-up fuels will be Light Distillate Oil (LDO) and Natural Gas. The design of the equipment will be suitable for operating 24-hours/day, 7-days/week with useful life of 25-years.

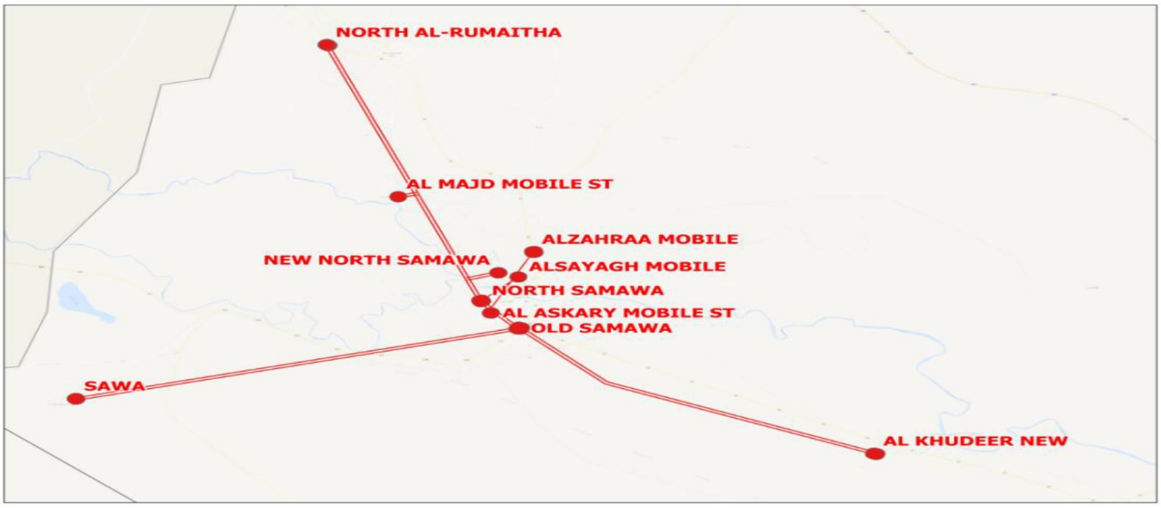
The Plant will be the first combined cycle project of that will be owned and operated by Ministry of Electricity. Its thermal efficiency will be above 50%, which will help Iraq to save 14 billion cubic meter of natural gas, and 32 million tons CO_2 over 25 years. The contract was signed on January 2017 and the project is scheduled to be completed within 34 months after commencement.

ELECTRICAL INFRASTRUCTURE IN SAMAWA

The city of Samawah is catered by six numbers of 132 / 33 KV fixed substations and four numbers of 132/33 KV mobile substations. The details of the 132 KV network are as under:

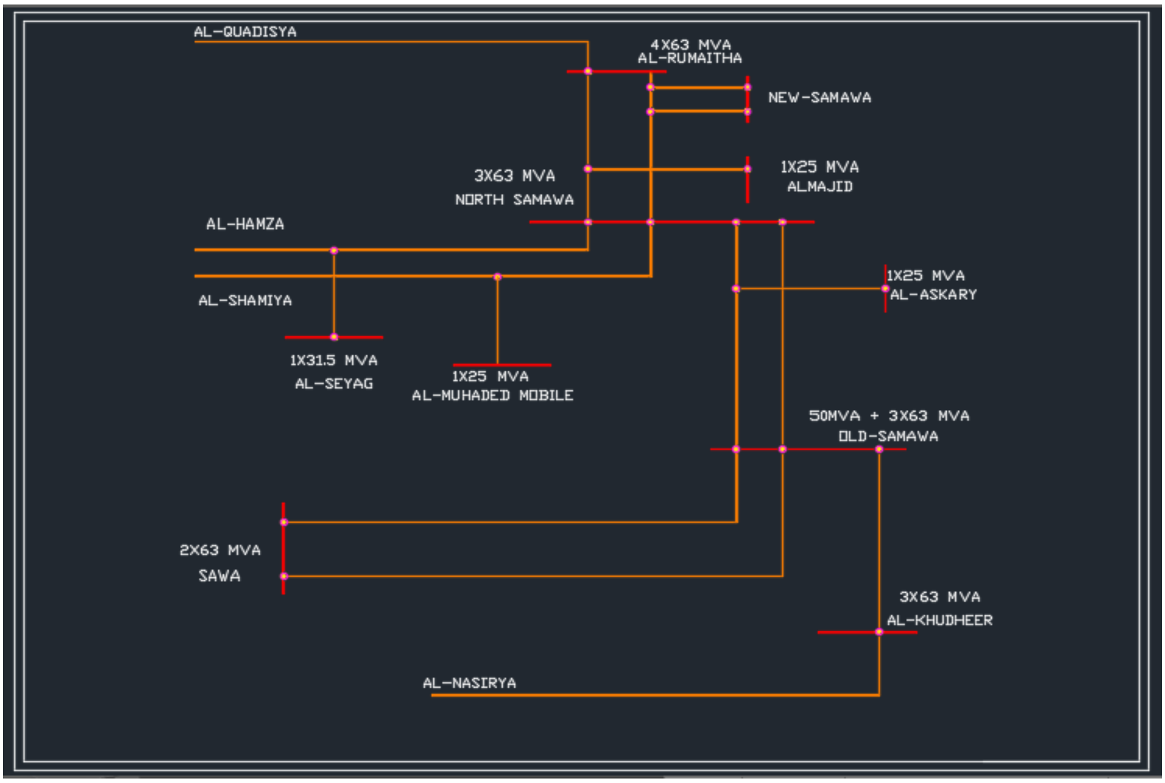
SL NO	NAME OF THE SUBSTATION	CAPACITY
1	AL KHUDHEER	3 x 63 MVA
2	SAWA	2 x 63 MVA
3	OLD SAMAWA	1 X 50 MVA + 3 x 63 MVA
	NORTH SAMAWA	3 x 63 MVA
5	NEW NORTH SAMAWA (UNDER CONSTRUCTION)	3 x 25 MVA
6	NORTH RUMAITHA	4 x 63 MVA
7	AL-MUHADED (AL-KARAMA MOBILE)	1 X 25 MVA
8	AL-SEYAG(MOBILE)	1 X 31.5 MVA
9	AL-ASKARY(MOBILE)	1 X 25 MVA
10	AL-MAJID (MOBILE)	1 X 25 MVA

The geographical sketch and dispositions of these substations are as under:



Geographical sketch and dispositions of the 132kV substations

The single line diagram of the 132 KV network as relevant to Samawah city is as under:



These 132 / 33 KV substations cater loads of downstream side 33 / 11 KV substations as under:

NAME OF 132 KV SUB STATION AND CAPACITY	CONNECTED 33 KV SUBSTATIONS	CAPACITY OF 33 KV SUBSTATIONS	PEAK LOAD (MW)
AL-KHUDEER	AL-KHUDEER OLD	1X 10 MVA	9.4
		1X 10 MVA	10.4
	AL-KHUDEER NEW	1 X 31.5 MVA	7.0
		1 X 31.5 MVA	27.3
	AL-DARRAJY	1 X 31.5 MVA	9.7
		1 X 31.5 MVA	5.3
	AL-KHUDEER MOBILE	1 X 10 MVA	10
	AL-NAKHEEL MOBILE	1 X 16 MVA	7.2

NAME OF 132 KV SUB STATION AND CAPACITY	CONNECTED 33 KV SUBSTATIONS	CAPACITY OF 33 KV SUBSTATIONS	PEAK LOAD (MW)
SAWA	CEMENT FACTORY		
	AL AMEED MOBILE	1 X 16 MVA	11.1
	AL MAMLAHA	1 X 16 MVA	5.3

NAME OF 132 KV SUB STATION AND CAPACITY	CONNECTED 33 KV SUBSTATIONS	CAPACITY OF 33 KV SUBSTATIONS	PEAK LOAD (MW)
OLD SAMAWA 1 X 50 MVA +	CEMENT FACTORY		
	BENZINE REFINERY		
	AL-SHARKY	1 X 31.5 MVA	25.6
		1 X 31.5 MVA	13.4
	AL-SWEAR	1 X 16 MVA	18.0
		1 X 16 MVA	7.6
	AL-ESHEEM	1 X 31.5 MVA	19.8
		1 X 31.5 MVA	19.5
	CATERS 11 NUMBERS OF 11 KV FEEDERS ALSO		

NAME OF 132 KV SUB STATION AND CAPACITY	CONNECTED 33 KV SUBSTATIONS	CAPACITY OF 33 KV SUBSTATIONS	PEAK LOAD
NORTH SAMAWAH	NEW SAMAWAH	1 X 31.5 MVA	26.2
		1 X 31.5 MVA	24.9
	AL-SEYAG	1 X 31.5 MVA	30.0
	AL-ZAHRAA	1 X 31.5 MVA	25.8
		1 X 31.5 MVA	22.7
	AL KAFA'AT	1 X 31.5 MVA	7.7
		1 X 31.5 MVA	
	CATERS 14 NUMBERS OF 11 KV FEEDERS ALSO		

NAME OF 132 KV SUB STATION AND CAPACITY	CONNECTED 33 KV SUBSTATIONS	CAPACITY OF 33 KV SUBSTATIONS	PEAK LOAD (MW)
NORTH RUMAITHA	NEW RUMAITHA	1 X 31.5 MVA	29.8
		1 X 31.5 MVA	30.7
	AL-HILAL	1 X 16 MVA	19.6
	AL-NAJMI	1 X 16 MVA	11.3
	AL-WARKAA	1 X 16 MVA	11.6
		1 x 5 MVA	7.2
	AL-GHADHEER	1 X 31.5 MVA	9.5
		1 X 31.5 MVA	18.1
	RUMAITHA WEST	1 X 31.5 MVA	14.3
		1 X 31.5 MVA	14.3
	CATERS 14 NUMBERS OF 11 KV FEEDERS ALSO		

NAME OF 132 KV SUB STATION AND CAPACITY	CONNECTED 33 KV SUBSTATIONS	CAPACITY OF 33 KV SUBSTATIONS	PEAK LOAD (MW)
AL-MUHADED MOBILE (AL-KARAMA)	AL-MUHADED (AL-KARAMA)	1 X 16 MVA	13.6

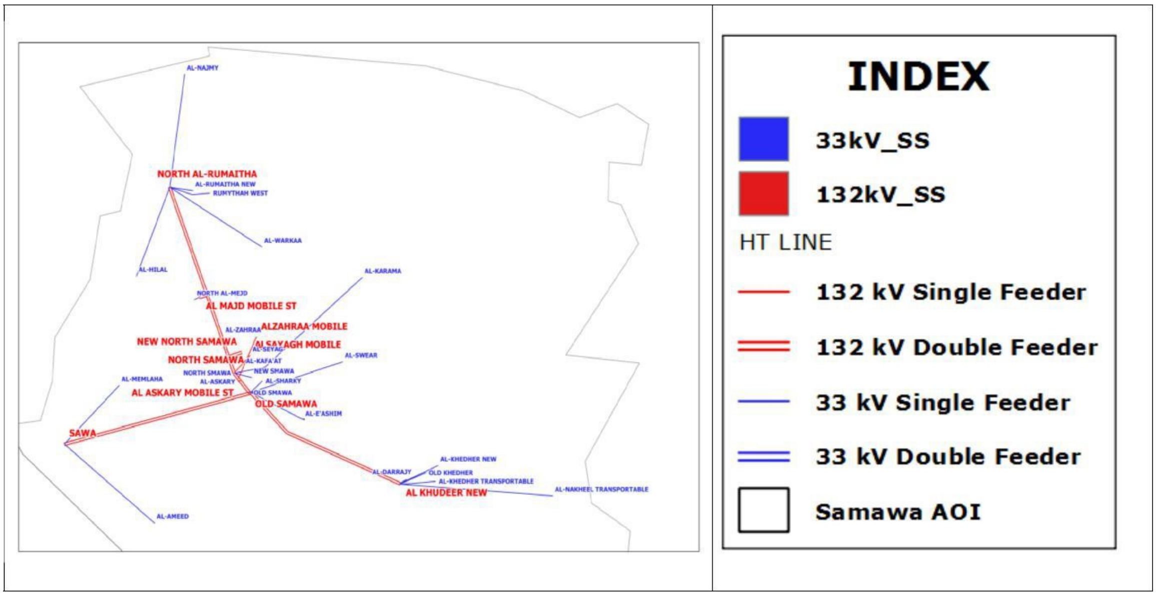
NAME OF 132 KV SUB	CONNECTED 33 KV	CAPACITY OF 33 KV	PEAK LOAD
AL-SEYAG	AL-SEYAG	1 X 31.5 MVA	33.3

NAME OF 132 KV SUB	CONNECTED 33 KV	CAPACITY OF 33 KV	PEAK LOAD
AL-ASKARY MOBILE	AL-ASKARY	1 X 31.5 MVA	13.2
		1 X 31.5 MVA	19.4

NAME OF 132 KV SUB STATION AND CAPACITY	CONNECTED 33 KV SUBSTATIONS	CAPACITY OF 33 KV SUBSTATIONS	PEAK LOAD (MW)
AL-MAJID MOBILE	AL-MAJID	1 X 16 MVA	11.2
		1 X 16 MVA	17.9

NAME OF 132 KV SUB STATION AND CAPACITY	CONNECTED 33 KV SUBSTATIONS	CAPACITY OF 33	PEAK LOAD (MW)
	AL-GHADHEER*	2 X 31.5 MVA	--
	AL-MUHADED*	1 X 31.5 MVA	--
	CATERS PROPOSED 11 KV FEEDERS ALSO		--
NEW NORTH SAMAWAH	Note*: Proposed to be connected		

The geographical sketch and dispositions of the substations are as under:



CONCLUSION

The assignment intends bench marking the baseline performance, analyzing the current infrastructure to recognize the pain areas in the network with objective to achieve optimization of the network, and to propose rehabilitation schemes to enable the network to cater existing loads with

reduced losses and to meet prospective loads. The scope of work includes Voltage studies in conjunction with load growth.

Pattern of power serving in each year - as of now

I. The peak load conditions in the Samawah city occurs in the period between June and September in each year.

II. The loads are served round the clock from January to mid - April in each year

III. The loads are served round the clock from mid-October to December in each year.

IV. The loads are served for 20 hours in each day from mid - April to June.

V. The loads are served in alternate batches of 2 hours in all the 11 KV feeders between June and mid - October each year, due to generation constraints

WORK PLAN

1. The single line diagrams of the 11 KV feeders are etched out based on the data secured from the field survey team. The SLD so prepared are discussed with field survey team and after interactions the data is frozen.

2. The connected load of the distribution transformers in each 11 KV feeder is tabulated and compared with the peak load computed for logistics.

3. The load flow studies are conducted for these conditions and for the present peak load.

4. The load flow studies are again conducted for a projected load of 125% of the present peak load to consider the load growth of 8.5% per year for three years. The pain areas are noted.

5. Rehabilitation process is considered for the scenario of projected load to be able to cater the increased loads. The segments of line and DTR's which are loaded beyond 100% are considered for augmentation.

6. Different options based on acceptable prudent practices in electrical distribution practice across globe are offered for rehabilitation. The options which are best suited on field conditions are chosen for each of the 11 KV feeders.

7. The bills of materials are prepared based on the option selected.

DELIVERY OF THE INTENTS IN PHASES

The study of the 206 numbers of 11 KV feeders, 26 numbers of

33 KV/11 KV sub stations and 10 numbers of 132 KV substations would require considerable time. It was desired that the planning and rehabilitation aspects are split and discussed in phases to enable finalization of the schemes in parts and beginning the execution of the plans.

Accordingly the study of the has been divided into six subsectors as below:

SUB-SECTOR	SUB STATION 132/33 kV	TOTAL	CITY	SUB-STATION 33/11 kV
1	NORTH SAMAWA	37	SAMAWA	132/33/11kV NORTH
			SAMAWA	NEW SAMAWA
			AL-KARAMA	AL-KARAMA
			SAMAWA	AL-KAFA'AT
2	AL-ASKARI MOBILE STATION	7		
	AL-SAYAG MOBILE	14	SAMAWA	AL-SEYAG
	AL-ZAHRAA	11	SAMAWA	AL-ZAHRAA
3	AL-KHUDEER NEW	26	AL-KHDHER	OLD KHUDEER
			AL-KHDHER	AL- KHUDEER NEW
				AL- KHUDEER
				AL-NAKHEEEL
			AL- DARRAJY	AL- DARRAJY
4	OLD SAMAWA	33	SAMAWA	132/33/11 kV OLD SAMAWA
			SAMAWA	AL-SHARKY
			SAMAWA	AL-E'ASHIM
			AL-SWEAR	AL-SWEAR
5	NORTH AL-RUMAITHA	59		132/33/11kV NORTH AL-
			AL-RUMAITHA	AL-RUMAITHA NEW
			AL-HILAL	AL-HILAL
			AL-NAJMY	AL-NAJMY
			AL-RUMAITHA	EAST AL-RUMAITHA
			AL-WARKAA	AL-WARKAA
			AL-WARKAA	AL-GHADEEER
6	AL-MAJID MOBILE STATION	11	AL-MAJID	NORTH AL-MAJID
	SAWA	8	AL-MEMLAHA	AL-MEMLAHA
			AL-MEMLAHA	AL-AMEED
TOTAL		206		

PROBLEM STATEMENT GENERAL

1. Transformer Capacity insufficiency in 132 KV level

2. Transmission line Capacity insufficiency in 132 KV level

3. Transformer Capacity insufficiency in 33 KV level

4. Transmission line Capacity insufficiency in 33 KV level

5. The UG cable arrangements conflict trunk line and loop line concepts in 11 KV level

6. The UG cable trunk line capacity insufficiency.

7. The UG cable network is not provided alternate source of power.

8. The overhead line capacity insufficiency in 11 KV level.

9. The loads of the 11 KV line being far away from the feeding substations.

10. The voltage regulations in the 11 KV feeders are high.

11. Many of the Distribution transformers are loaded beyond 100%.

12. Many of transmission line segments transmit power at poor power factors.

SOLUTIONS – 11 KV NETWORK

1. Augmenting the bits of UG cables which are overloaded.

2. Inserting new RMUs in the trunk line to reorient the loop circuit to be not clashing with the trunk circuit.

3. Making a new UG cable feeder from the substation with a circuit breaker as an express feeder to bifurcate the connected transformers loads.

4. Making express feeders in the overloaded segments in an overhead system using the conductor of 120 sq mm and to distribute the connected transformers, wherever there is paucity of space to create a express feeder.

5. If two or more 11kV lines with UG cables also exist in the same route, the proposal is for making existing single line circuit to be converted to double circuit with independent circuit breaker at the substation.

6. Making proposal to provide new 33 KV substation in segments of lengthy Feeders.

7. Running the load flow analysis to the re-engineered proposal with projected load also to confirm the segments to converge.

8. New Distribution transformers have been proposed to reduce the overload on the existing DTRs.

9. In some of the DTRs which are overloaded, rehabilitation proposal includes increasing of the DTR capacity to reduce the overloads.

10. Suitable Power factor compensation is provided to appropriate transmission line segments where the power factor is less than 0.9.
11. Proposals are incorporated to provide appropriate metering system to 11kV Feeders and DTRs to enable monitoring and energy audits.
12. Proposals are incorporated to provide adequate resources for repairs and modernization of the existing assets.

SOLUTIONS – 33 KV NETWORK

1. New 33/11kV Substations are proposed to release the overload on the existing 33/11kVsubstations.
2. The overloaded Power transformers of capacity less than 31.5 MVA are proposed to be replaced by 31.5 MVA transformers.
3. A second / third 31.5 MVA transformers are proposed in the substation and the 11 KV lines are to be rearranged.
4. Mobile 33/11kV substations have been proposed to be shifted to load centers
5. The mobile 33/11kV Substations requiring more than one power transformer have been proposed to be converted to fixed type of substations.
6. Convert the existing single circuit 33 KV lines to double circuit lines.

ADDITIONAL SOLUTIONS – 132 KV NETWORK

1. In general the power transformers are overloaded. Additional Power transformers have been suggested in the rehabilitation advisory to reduce the overloads.

2. New 132/33kV Substation is proposed to be near the load centres of 33kV loads. The 33kV lines feeding from 132/33kV substations to 33/11kV are also modified accordingly.

3. The 132 KV ring in the city is to be a double circuit ring for greater reliability.

4. The mobile 132/33kV substations requiring more than one power transformers have been proposed to be converted to fixed type of substations.

5. The mobile 132/33kV substations having power transformers of 25 MVA have been proposed to be converted to 132/33kV fixed type of substations with transformer of 1* 63 MVA capacity.

SCHEME OF ANNEXURES FOR EACH 11 KV FEEDER:

1.DETAILS OF THE CONNECTED DISTRIBUTION TRANSFORMERS

2.CONDUCTOR DETAILS

3.G I S SKETCH - AS IS

4.SINGLE LINE DIAGRAM - AS IS

5.RESULT OF THE NETWORK ANALYSIS – AS IS

6.RESULT OF THE NETWORK ANALYSIS – WITH 25% LOAD GROWTH

7.RESULT OF THE NETWORK ANALYSIS–WITH CAPACITOR PLACEMENT

8.PAIN AREAS – DISTRIBUTION TRANSFORMER

9.PAIN AREAS – DISTRIBUTION TRANSFORMER – AS PER FIELD DATA

10. PAIN AREAS - LINE SEGEMENT

11. REHABILITATION – TRANSFORMERS

12. REHABILITATION - LINE SEGMENT

13. BOQ

SNAPSHOT OF THE PROPOSALS FOR SAWAWAH CITY:

S.No	Particulars	Quantity
1	Proposal for New 132/33/11kV Substation	1
2	Proposal for conversion of 132/33kV Mobile Substation to Fixed type AIS Substations	3
3	Proposal for New 33/11kV Substation	15
4	Proposals for New power transformers to the New 33/11kV Substations in MVA	a) 12 x 31.5 b) 2 x 16
5	Proposal for shifting of Mobile 33/11kV Substation to load centres	2
6	Proposal for conversion of 33/11kV Mobile Substation to fixed type AIS Substations	3
7	Proposals Conversion of existing 11kV OH line into 33kV OH Line in KM	29
8	Proposals for Extending 33kV line from Existing SS to Proposed SS in KM	155
9	Proposals for additional power transformers to the existing 33/11kV Substations in MVA	5 x 31.5
10	**Proposals for replacing power transformers to the existing 33/11kV Substations in MVA** a) 5 MVA by 31.5 MVA b) 10 MVA by 31.5 MVA c) 16 MVA by 31.5 MVA	a)1 b) 3 c) 7
11	Proposal of New 11kV Feeders with Independent Circuit breakers in the substation	162
12	Proposed New DTR's	330
13	Proposal for Increasing the capacity of DTR.	8
14	Proposal for PF Compensation by providing 11kV Capacitors	174
	Proposal for providing Interactive metering arrangement for operation ,Control and Energy Audit	
	a) 33kV Power transformers meters	a) 39
	b) Meters at 33kV incomings lines	b) 39
	c) Meters at 11kV outgoing Feeders	c) 206
	d) Distribution transformers meters	d) 4937
	e) Meters at Boundary points	e) 150
	Repairs and Modernization	
	a) Circuit breakers in 33/11kV Substations	15
	b) Circuit breakers for 11kV feeders	61
	c) Distribution transformers	
	i) HT Switchgear	1974
	ii) LT Switchgear	1480
	iii) Earthing	988
	iv) Transformer wiring	1480

SUBSECTOR1-FEEDER DETAILS

132/33/11kV NORTH SAMAWAH SUBSTATION

S.No	SUB-STATION	S.No	FDR_CODE	FEEDER NAME	TOTAL TRANSFORMER CAPACITY (kVA)	PEAK LOAD (MW)	LENGTH (KM)
1	NORTH SAMAWAH	1	NSMF01	AL-HUSAIN HOSPITAL 1	9260	3.3	4.31
		2	NSMF02	SECTOR 15	6670	3	2
		3	NSMF03	MAIN STREET	9930	3.6	2.94
		4	NSMF04	SECTOR 9	11590	3	3.54
		5	NSMF05	DAR 270	9700	5	5.181
		6	NSMF06	AL-HUSAIN HOSPITAL 2	Alternate to NSMF01 Feeder		
		7	NSMF07	AL-SHAHEED AL-SADER	5	6400	2.761
		8	NSMF08	AL-HAKEEM	5.2	5330	2.1
		9	NSMF09	AL-NAFT	4.1	5750	8
		10	NSMF10	AL-ZERAA	5.61	14950	23.501
		11	NSMF11	AL-ESKAN	4.66	7730	5.502
		12	NSMF12	NADI AL-WARKAA	5.72	5000	2.22
		13	NSMF13	OM AL-THAHAB	6.35	10200	11.95
		14	NSMF14	AL-MOALMEEN AL-KADEEMA	5.72	6180	3.997

33/11kV NEW SAMAWAH SUBSTATION:

S.No	SUB-STATION	S.No	FDR_CODE	FEEDER NAME	TOTAL TRANSFORMER CAPACITY	PEAK LOAD (MW)	LENGTH (KM)
		1	NSWF01	AL-SHARQI	11120	4.1	2.477
		2	NSWF02	AL-EMARAT	2260	5.4	1.443
		3	NSWF03	MAAHED AL-MUALLEMAT	10000	5.3	2.412
		4	NSWF04	AL-MUTENAZZAH	6920	4.3	1.774
		5	NSWF05	AL-MUHAFEDA	4810	0.8	1.228
		6	NSWF06	AL-BANY	11690	4.8	1.945
		7	NSWF07	AL-GHARBY	4150	3.8	1.685

		8	NSWF08	AL-TEKA'OD	6040	5	1.877
		9	NSWF09	AL-MUNSHE'AA AL-KADEEMA	3630	3.8	2.125
		10	NSWF10	AL-SUQ AL-KABEER	9240	3.9	3.163
		11	NSWF11	AL-SINEMA	8290	4.2	2.433
		12	NSWF12	HEMAYET AL-ATFAL	2920	0.5	0.79
	NEW	13	NSWF13	JAMI'A AL-SHUHADAA	630	3.7	1.135

33/11kV AL-KAFA'AT SUBSTATION

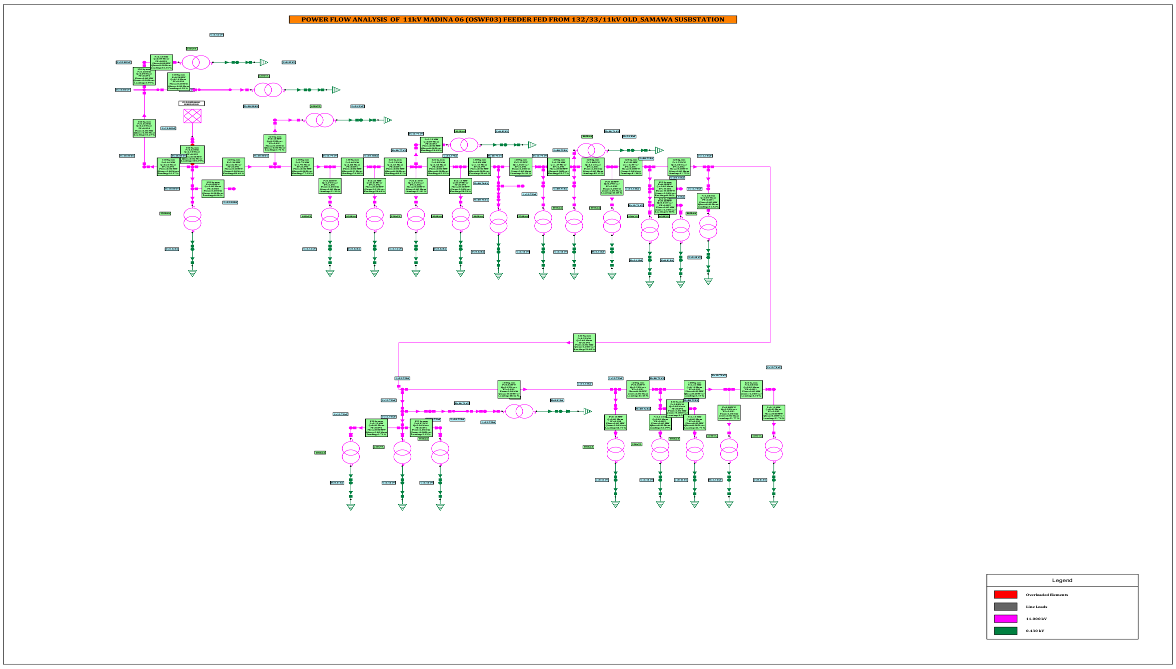
S.No	SUB-STATION	S.No	FDR_CODE	FEEDER NAME	TOTAL TRANSFORMER CAPACITY	PEAK LOAD (MW)	LENGTH (KM)
1	AL-KAFA'AT	1	ALKF01	BESATEEN MOHAMMED ALI	5900	3.8	3.515
		2	ALKF02	AL-BALIDYAT	6550	3.3	2.13
		3	ALKF03	AL- THUBBAT	6510	3.9	2.2
		4	ALKF04	AL-AMMAR	5180	4.45	5.413
		5	ALKF05	AL-KAFA'AT	3800	3.1	3.323

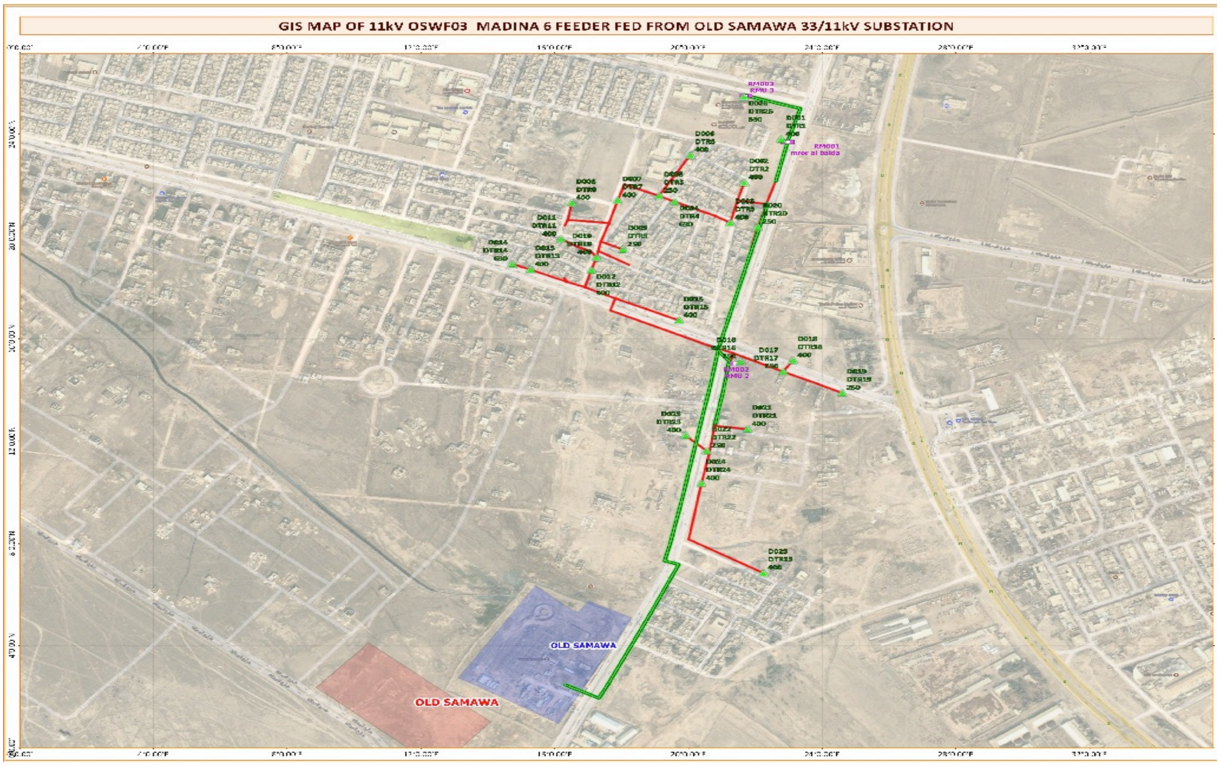
33/11kV AL-KAFA'AT SUBSTATION

S.No	SUB-STATION	S.No	FDR_CODE	FEEDER NAME	TOTAL TRANSFORMER CAPACITY	PEAK LOAD (MW)	LENGTH (KM)
1	AL-KARAMA	1	AKMF01	AL-TOBA	8900	2.1	27.919
		2	AKMF02	AL-KARAMA	15250	2.4	26.448
		3	AKMF03	AL-BEADHA	10600	3.3	26.795
		4	AKMF04	AL-GHANIM	8000	2.4	19.257
		5	AKMF05	REEF AL-MHADDAD	19163	3.4	34.745

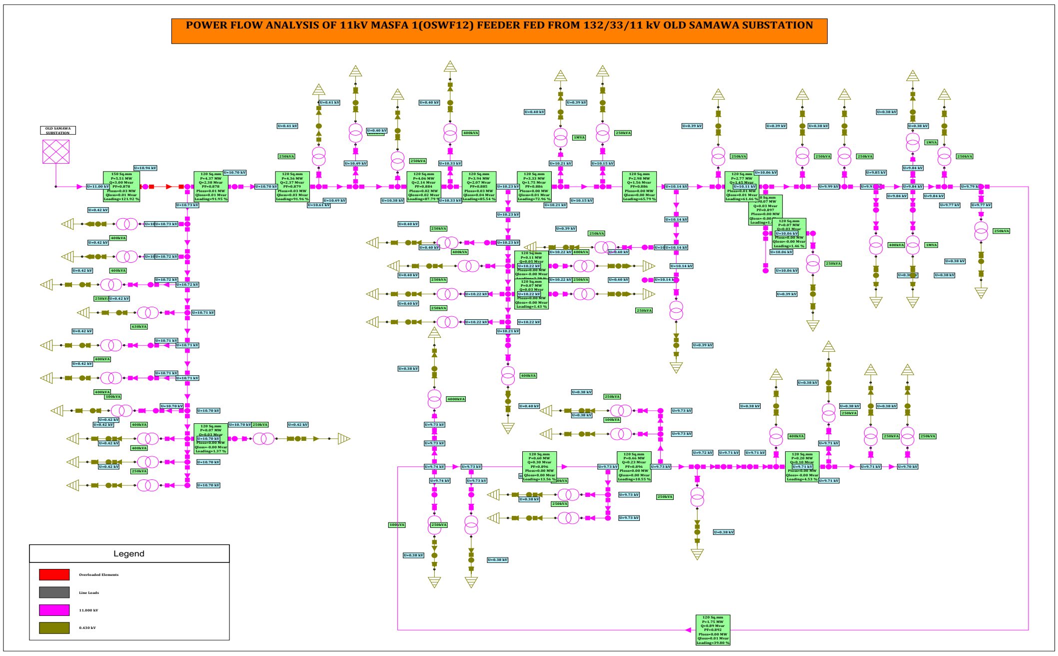
AS-IS TECHNICAL LOSS SUMMARY						PROPOSAL TECHNICAL LOSS SUMMARY			
Sl.No	Substation Name	Sl. No	Feeder_code	Feeder Name	Technical loss in %	Substation Name	Proposed_Feeder_code	Proposed_Feeder_name	After Proposal Technical loss in %
		1	NSMF01	AL-HUSAIN	3.21%	NORTH SAMAWA	NSMF01	AL-HUSAIN	
		2	NSMF02	SECTOR 15	1.68%	NORTH SAMAWA	NSMF02	SECTOR 15	
		3	NSMF03	MAIN STREET	3.14%	NORTH SAMAWA	NSMF03	MAIN STREET	
		4	NSMF04	SECTOR 9	2.04%	NORTH SAMAWA	NSMF04	SECTOR 9	No Proposal
		5	NSMF05	DAR 270	3.07%	NORTH SAMAWA	NSMF05	DAR 270	1.61%
						AL-ASKARY MOBILE	NSMF05_1	NEW_FEEDER	1.02%
		6	NSMF06	AL-HUSAIN	ALTERNATIVE TO NSMF01				
							NSMF07	AL-SHAHEED	1.90%
							NSMF07_1	NEW_FEEDER	1.55%
		8	NSMF08	AL-HAKEEM	6.73%	NORTH SAMAWA	NSMF08	AL-HAKEEM	2.19%
						AL-ASKARY MOBILE	NSMF08_1	NEW_FEEDER	1.11%
		9	NSMF09	AL-NAFT	3.56%	NORTH SAMAWA	NSMF09	AL-NAFT	1.30%
							NSMF09_1	NEW_FEEDER	1.18%
						OSOUL AL-BASTER	NSMF10	AL-ZERAA	1.07%
						OSOUL AL-BASTER	NSMF10_1	NEW_FEEDER-	2.38%
						OSOUL AL-BASTER	NSMF10_2	NEW_FEEDER-2	2.31%
						NORTH SAMAWA	NSMF11	AL-ESKAN	0.83%
						NORTH SAMAWA	NSMF11_1	NEW_FEEDER	1.25%
		12	NSMF12	NADI AL-	2.43%				
		13	NSMF13	OM AL-	5.82%	NORTH SAMAWA	NSMF13	OM AL-	2.90%
						NORTH SAMAWA	NSMF13_1	NEW_FEEDER	0.87%
		14	NSMF14	AL-	3.99%	NORTH SAMAWA	NSMF14	AL-	2.15%
						NORTH SAMAWA	NSMF14_1	NEW_FEEDER	2.01%
						NEW SAMAWA	NSWF01	AL-SHARQI	1.17%
						NEW SAMAWA	NSWF01_1	NEW_FEEDER	1.72%
		2	NSWF02	AL-EMARAT	1.74%	NEW SAMAWA	NSWF02	AL-EMARAT	1.36%
						NEW SAMAWA	NSWF03	MAAHED AL-	2.24%
						NEW SAMAWA	NSWF03_1	NEW_FEEDER	1.24%
						NEW SAMAWA	NSWF04	AL-	1.05%
						NEW SAMAWA	NSWF04_1	NEW_FEEDER	1.53%
		5	NSWF05	AL-	0.30%	NEW SAMAWA			
						NEW SAMAWA	NSWF06	AL-BANY	0.51%
						NEW SAMAWA	NSWF06_1	NEW_FEEDER	1.32%
		7	NSWF07	AL-GHARBY	1.68%	NEW SAMAWA			
		8	NSWF08	AL-TEKA'OD	2.54%	NEW SAMAWA	NSWF08	AL-TEKA'OD	2.62%
		9	NSWF09	AL-	2.87%	NEW SAMAWA	NSWF09	AL-	2.60%
						NEW SAMAWA	NSWF10	AL-SUQ AL-	0.98%
						NEW SAMAWA	NSWF10_1	NEW_FEEDER	1.65%
		11	NSWF11	AL-SINEMA	2.40%	NEW SAMAWA	NSWF11	AL-SINEMA	2.29%
		12	NSWF12	HEMAYET AL-	1.20%	NEW SAMAWA			
		13	NSWF13	JAMI'A AL-SHUHADAA	1.01%	NEW SAMAWA			

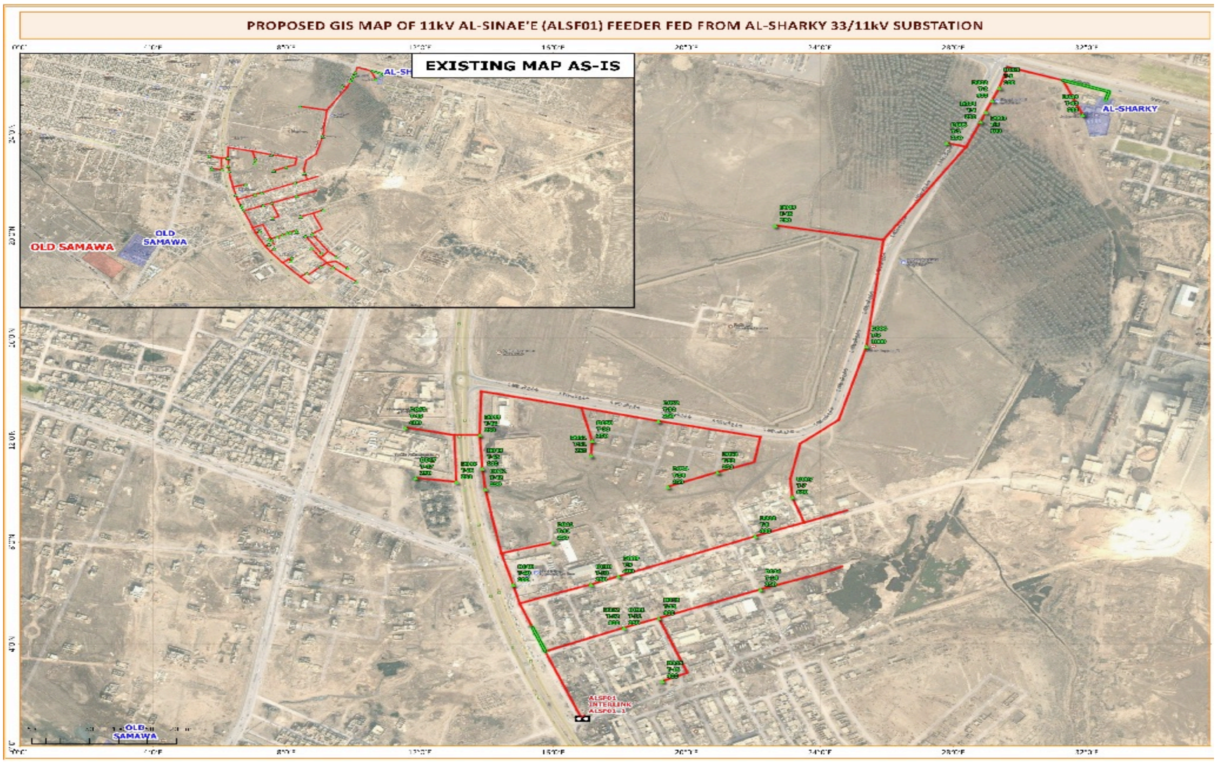
Sl.No	Substation	Sl. N	Feeder_code	Feeder Name	Technical loss	Substation Name	Proposed_Feeder_code	Proposed_Feeder_name	After Proposal Technical loss in %
						AL-KAFA'AT	ALKF01	BESATEEN	0.80%
						AL-KAFA'AT	ALKF01_1	NEW_FEEDER	0.75%
		2	ALKF02	AL-BALIDYAT	1.67%				
		3	ALKF03	AL- THUBBAT	1.03%				
						AL-KAFA'AT	ALKF04	AL-AMMAR	0.72%
						AL-KAFA'AT	ALKF04_1	NEW_FEEDER	0.84%
		5	ALKF05	AL-KAFA'AT	1.15%	AL-KAFA'AT	ALKF05	AL-KAFA'AT	0.95%
						AL-KARAMA	AKMF01	AL-TOBA	1.99%
						AL-KARAMA	AKMF01_1	NEW_FEEDER	1.79%
						AL-KARAMA	AKMF02	AL-KARAMA	1.02%
						AL-KARAMA	AKMF02_1	NEW_FEEDER-	1.86%
		2	AKMF02	AL-KARAMA	5.21%	AL-KARAMA	AKMF02_2	NEW_FEEDER-	2.83%
						AL-KARAMA	AKMF03	AL-BEADHA	1.22%
						AL-KARAMA	AKMF03_1	NEW_FEEDER	5.49%
						AL-KARAMA	AKMF04	AL-GHANIM	1.89%
						AL-KARAMA	AKMF04_1	NEW_FEEDER	1.57%
						AL-KARAMA	AKMF05	REEF AL-	2.25%
						AL-KARAMA	AKMF05_1	NEW_FEEDER-	4.93%
		5	AKMF05	REEF AL-	9.82%	AL-KARAMA	AKMF05_2	NEW_FEEDER-	6.07%

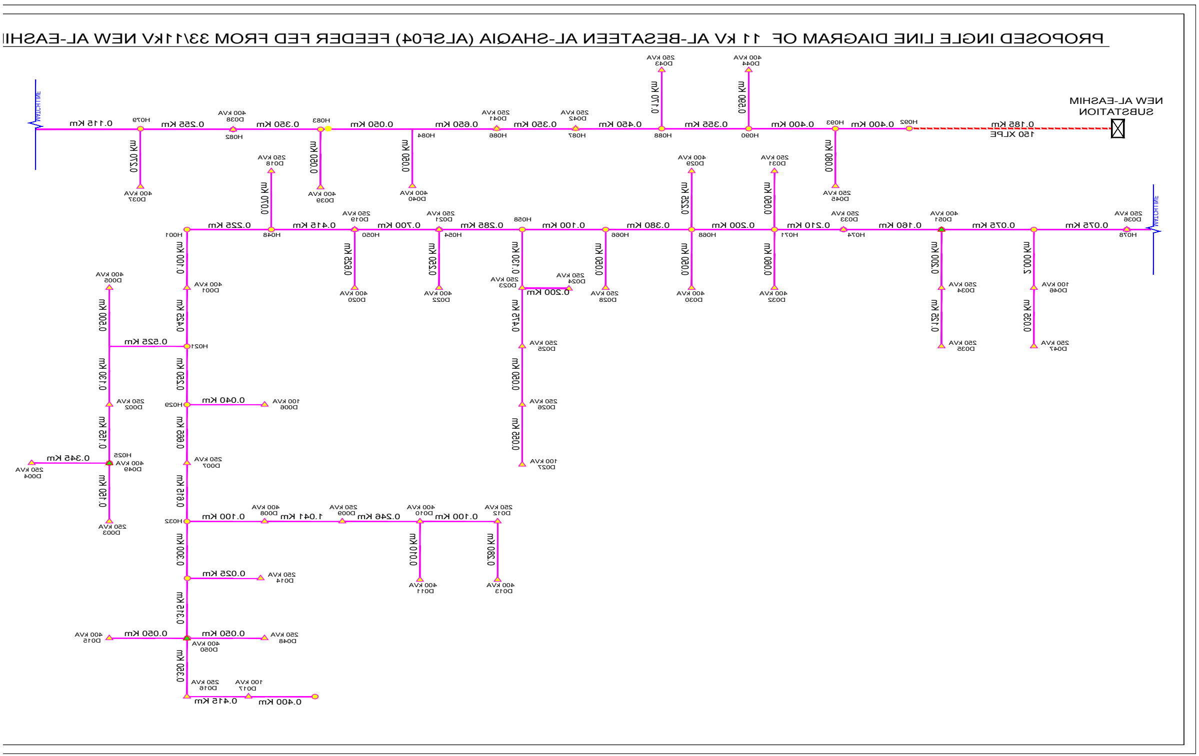


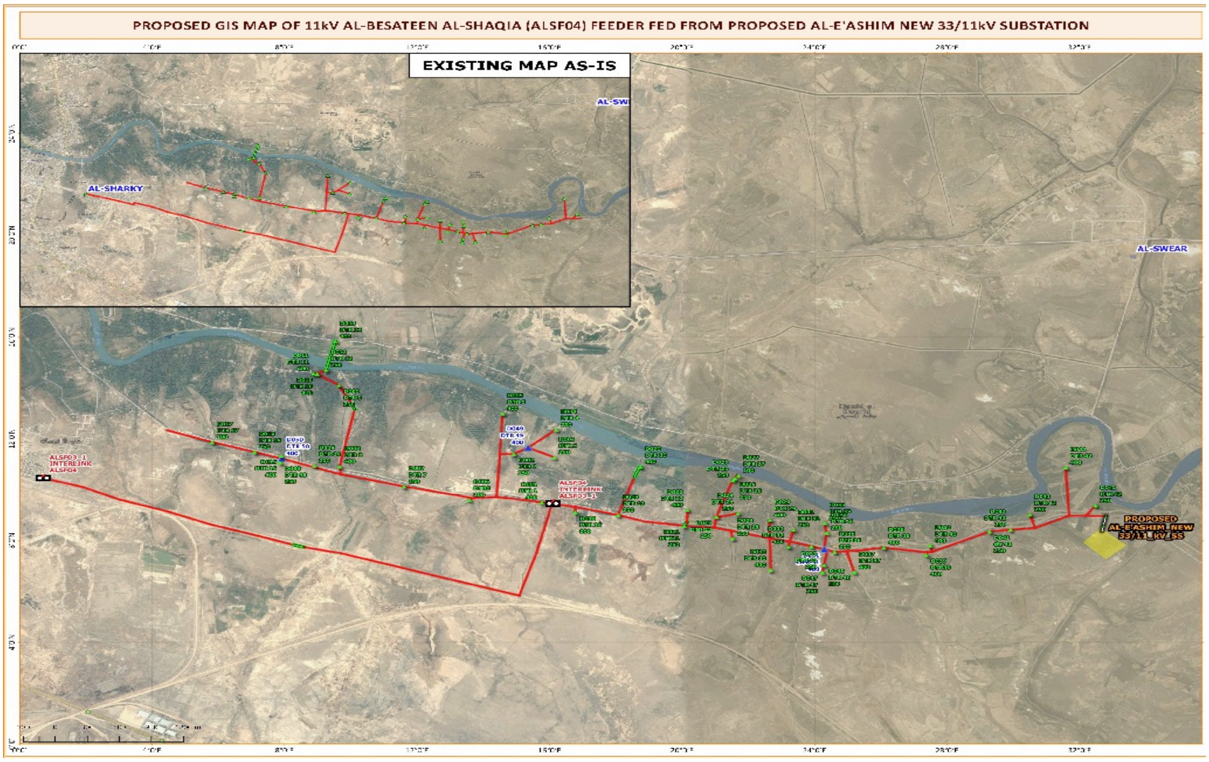


SAMPLES OF GIS DRAWINGS AND FLOW CALCULATION


POWER FLOW ANALYSIS OF 11kV MASFA 1(OSWF12) FEEDER FED FROM 132/33/11 kV OLD SAMAWA SUBSTATION
Legend


PROPOSED GIS MAP OF 11kV AL-SINAE'E (ALSF01) FEEDER FED FROM AL-SHARKY 33/11kV SUBSTATION
EXISTING MAP AS-IS
OLD SAMAWA
OLD SAMAWA
AL-SHARKY
OLD SAMAWA


PROPOSED INGLE LINE DIAGRAM OF 11 KV AL-BESATEEN AL-SHAQIA (ALSF04) FEEDER FED FROM 33/11KV NEW AL-EASHI
NEW AL-EASHIM SUBSTATION
0.185 Km
150 XLPE


PROPOSED GIS MAP OF 11kV AL-BESATEEN AL-SHAQIA (ALSF04) FEEDER FED FROM PROPOSED AL-E'ASHIM NEW 33/11kV SUBSTATION
EXISTING MAP AS-IS
AL-SHARKY
AL-SWEAR
PROPOSED AL-E'ASHIM NEW 33/11kV SS