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Power System Planning

تخطيط نظم القوى الكهربائية

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الآية

(أَفَمَن يَمْشِي مُكِبًّا عَلَى وَجْهِهِ أَهْدَى أَمَّن يَمْشِي سَوِيًّا عَلَى صِرَاطٍ مُّسْتَقِيمٍ (22) قُلْ هُوَ الَّذِي أَنشَأَكُمْ وَجَعَلَ لَكُمُ السَّمْعَ وَالأَبْصَارَ وَالأَفْئِدَةَ قَلِيلا مَّا تَشْكُرُونَ (23) **)**

صدق الله العظيم

سورة الملك: الآيات (23-22)

الإهداء

أمي

ذلك الحنان الذي يمشي على قدمين

وذلك الصبر على هيئة إنسان

أمي الملاك الطاهر .

أبي

ذلك العطاء الوافر و الحب الشامخ

الذي علمني كل الأشياء الجميلة

والذي ساعدني في شق طريق الحياة .

أهلي

زهور ملأت قلبي وحياتي ربيعاً .

زملائي

من شاركوني في سنوات الدراسة .

جامعة السودان للعلوم و التكنولوجيا

قلعة العلم والمعرفة .

الشكر والعرفان

الشكر و التقدير إلى معلم الأجيال وصانع النجاح و الذي يعجز عن وصف مدى شكرنا وامتناننا له .

الأستاذ مهندس /

المبارك محمد محمد شاموق .

الذي أرشدنا برأيه السديد ونصائحه المفيدة التي زودت هذا العمل حتى خرج بالصورة النهائية هذه و لم يبخل علينا بشئ من علمه وعمله وراحته ووقته و له منا كل الشكر والتقدير .

الشكر أيضا إلي مدرسة الهندسة الكهربائية بجامعة السودان للعلوم والتكنولوجيا .

كما نتقدم بالشكر والتقدير لأسرة الشركة السودانية لنقل الكهرباء المحدودة ونخص بالشكر قسم التخطيط الاستراتيجي بالشركة .

وكل من ساعدنا بالمعلومات والنصح والإرشاد .

Abstract

Continued growth in the industrial, agricultural and residential sector in the period and the recent stretch transport networks to reach new areas has led to increased consumption of electric makes it necessary to cope with the increase .

This research studies load forecast , generation ,transmission ,distribution and financial planning. It was chosen is the Sudanese Electricity Transmission Company (SETC) medium power system plan (2016 – 2018) as a case study .

After a forecast loads of the above year and find out the stations that have been put excessive possible solutions to meet the expected load growth of the loads and it is real time solutions .

مستخلص

النمو المستمر في القطاع الصناعي , الزراعي والسكني في الفترة الأخيرة وتمدد شبكات النقل لتصل إلي مناطق جديدة أدي إلي زيادة الاستهلاك الكهربي لذلك لابد من مواجهة الزيادة .

هذا البحث دراسة عن توقع الأحمال الكهربائية ، و التخطيط للتوليد ، و خطوط النقل والتوزيع والتخطيط المالي , حيث تم اختيار الخطة المتوسطة للشركة السودانية لنقل الكهرباء (2016 - 2018) كحالة للدراسة .

بعد إجراء توقعات الأحمال للسنين أعلاه و معرفة المحطات التي بها تحميل زائد تم وضع الحلول الممكنة لمقابلة النمو المتوقع في الحمل وهي عبارة عن حلول آنية .

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AC	Alternating current
ATB	Atbara substation
BAG	Bagir substation
BNT	Banat substation
DC	Direct current
FAR	Faroug substation
FAO	Fao substation
FRZ	Free Zone substation
GDF	Gadaref substation
GIAD	Giad substation
GRB	KhashimAlgirba substation
HAG	Hag Abdalla substation
HAS	HasaHeisa substation
HLF	Halfa substation
HVDC	High voltage direct current
IBA	EidBabiker substation
IZG	Izergab substation
KHE	Khartoum East substation
KHN	Khartoum North substation
KLX	Kilo X substation
KSL	Kassala substation
KUK	Kuku substation
MAR	Maringan substation
MAN	Managil substation
MHD	Mahadia substation
MUG	Mugran substation
OMD	Omdurman substation

POR	Port Sudan substation
RBK	Rabak substation
SHN	Shendi substation
SHK	Showak substation
SNJ	Sennar Junction substation
SETC	Sudanese Electricity Transmission Company

CHAPTER ONE

INTRODUCTION

Electricity is so basic to the world economy that certain electricity indices are used to express a country's economic standing (consumption or production of electricity per capita) and the standard of living enjoyed by a people (per capita electricity consumption in the domestic sector). Moreover, electricity supply has special characteristics which make the service unique as compared to other types of industry.

The end product has to be delivered instantaneously and automatically upon the consumer's demand; except for pumped storage plants and electric batteries, technologies do not exist that can produce it economically at uniform rates, hold it in storage in large quantities, and deliver it under convenient schedules; insufficient capacity (shortage) or excessive capacity (idle capacity) have negative effects on the economy; the close inter-relation with economic and social factors imposes labor, environmental, financial and other constraints on the problem.

Careful planning of the electric sector is therefore of great importance since the decisions to be taken involve the commitment of large resources, with potentially serious economic risks for the electrical utility and the economy as a whole.

Commercial loads depend on the commercial activities during the opening hours and type of business. Industrial loads depend on the time of production and considered to have the most stable load variation. The total shape of load variation curves including all customers’ categories represents the daily load variation curve.

The practice is that system planners estimate the annual peak load for the next years, based on past data and future prediction (forecasting), and they use a typical load duration curve for expansion studies.

1.1 Power system planning

Power system planning is done to ensure adequate and reliable power supply to meet the estimated load demand in both near and distant future .this must be done at minimum possible cost keeping the quality of supply satisfactory.

Power system planning is needed to develop and build modern electric power systems. In general, planning time horizons lie in one of the following ranges:

1. short term (up to 1 year).
2. medium term (up to 2-3 years).
3. long term or strategic planning (between 20-30 years).

The power system planning process starts by forecasting the anticipated future loads.

The concern is about load (demand) forecasting and energy forecasting. Load (demand) forecasting defines the capacity needed for the system and the expansions required in the generation, transmission, and distribution systems. Moreover, load forecasting is needed for budgeting purposes and energy forecast is needed to determine future type of generating units and fuel requirements. This is usually performed at different levels including the customer (KWH), the city (MWH), and the country (GWH). Generation planning leads to determining the capacity of units to be installed that will meet the anticipated load demand. It also defines the fuel to be used in addition to the size of units to be installed over the time span. The planning should be conducted to satisfy well-defined criteria that reflect the strategies adopted within the power industry, and contributes in enhancing the security, quality, and reliability of supply at minimum cost.

Transmission and Distribution (T&D) system planning objective, whether a short-term plan, targets developing a deep understanding of the existing system and prepare a roadmap for near term and future investments required to provide services that are adequate, reliable, and economical to new and existing customers. It should be obvious that it is very important to make as accurate forecasts as possible in terms of peak loads and energy demands, as this will affect the selection of generation, transmission, and distribution expansions required, in addition of defining the type of fuel to be selected which is reflected on the final electricity prices.

Table (1 –1) lead time of planning :

Lead time	Planning	Activity
5 - 20 years	Long – term planning	Vision , values , mission , load forecasting, regional system and national grid expansion scheme.
2 - 5 years	Medium-term planning	Medium – term utility generation schemes such as coal ,thermal gas turbines , hydro etc.. , renovation and modernization of exiting generation plants .
1 - 2 years	Short term planning	System improvement of transmission and distribution system, small generation schemes ,small hydro ,gas turbines ,diesel power.
15 days - 1year	Operational planning	Maintenance scheduling of units and fuel requirements
1 - 7 days	Operational planning	Generation scheduling and

		network switching
2 - 12 hours	Operational planning	Economic dispatch instructions and power purchases/selling
0 - 2 hours	Operational planning	Network switching ,economic dispatch control

1.2 Traditional power system planning

Traditionally, power system planning has been mainly related to generation expansion planning. This is due mainly to the fact that the investment in transmission lines is a relatively small fraction of the investment in the construction of power stations and that investment in the distribution of electric energy to customers, although sizeable, is to a large extent independent of the generation and transmission system.

1.3 Power system planning today

Today, most power systems are facing drastic challenges such as, the integration of large-scale renewable and distributed power generation, the introduction of smart grid technologies, an increasing degree of automation, faster and more detailed communications, and demand growing faster than capacity.

1.4 Planning in the future

When planning for the future, the main characteristics of the present system should be studied and data collected, e.g. electrical energy demand and peak load demand, rate of growth of energy consumption in the last 20 years ,energy production, type of generation plant and its size, transmission, interconnection and sub transmission systems.

1.5 Planning tools

1. Planning engineer‘s primary requirement is to give power supply to consumers in a reliable manner at a minimum cost with due flexibility for future expansion .

2.The criteria and constraints in planning an energy system are reliability, environmental economics, electricity pricing, financial constraints, society impacts.

3.reliability, environmental, economic and financial constraints can be quantified. Social effects are evaluated qualitatively.

4. The system must be optimal over a period of time from day of operation to the lifetime.

5.Various computer programs are available and are used for fast screening of alternative plans with respect to technical, environmental and economic constraints.

The main steps in power system planning may be summarized as follows :

1.Study of the electric load forecast 5 to 30 years into the future, based on the most reliable information.

2.Evaluation of the energy resources available in the future for electricity generation and the foreseeable trends in technical and economic developments.

3.Evaluation of the economic and technical characteristics of the existing system of generating units and of the plants that are considered as potential units for system expansion. These characteristics include capital investment cost, fuel cost, operation and maintenance costs, efficiencies, construction times, etc.

4.Determination of technical and cost characteristics of the plants available for expansion.

5.Determination of the economic and technical parameters affecting decisions such as discount rate, level or reliability required from the generating system, etc.

6.Choice of a procedure to determine the optimal expansion strategy within the imposed constraints.

7.Qualitative review of the results to estimate the viability of the proposed solution.

The determination of most of these data must take into account the present and future economic and technical environment within which the electric sector is expected to operate.

1.6 Planning criteria

Planning criteria, in general, constitute a set of decision parameters or design variables with which the planner controls the planning scenarios. These criteria are similar to guiding principles and limitations placed on the scenarios for the purpose of narrowing down the selection process.

Usually these criteria are defined and set by consensus after careful studies and analyses. Previous practices and experiences shape and form such planning criteria. However, they need to be revised every now and then in order to reflect changes in the power system, demand structures, and degree of acceptable risk.

Moreover, planning criteria represent boundary conditions that serve to eliminate unfeasible solutions and keep only the feasible ones.

Therefore, they are needed in expansion studies of power systems to guarantee that the scenarios selected are all acceptable by the planners. Close coordination and continuous dialogue among power companies (generation, transmission, and distribution) are strongly recommended for proper planning in order to meet consumers’ demands and satisfaction.

Usually planning criteria are set by management, although some input from planners is needed.

Knowledge of such criteria and how they are calculated provides planners with good practices and enhances the planning process.

1.7 Problem statement

Continued growth in the industrial, agricultural and residential sector in the period and the recent stretch transport networks to reach new areas and the increase of quantity and quality in the use of electrical devices has led to increased consumption of electric makes it necessary to cope with the increase .

1.8 Project layout

The research has five chapters:-

Chapter one: this chapter consists of introduction to power system planning process, lead time will be studied ,planning tools and planning criteria .

Chapter two: this chapter consists of electrical load , load forecasting categories (long , Medium and short), method of load forecasting ,generation, transmission and distribution planning.

Chapter three: financial planning will study the techno-economic viability, private participation, financial analysis, economic analysis, economic characteristics, rural electrification investment ,credit risk assessment optimum ,investment model and tariffs.

Chapter four: this chapter include calculating Load Forecasting ,generation planning and transmission planning for the years (2016 -2018) .

Chapter five: conclusion and recommendation .

CHAPTER TWO

LOAD FORECASTING, GENERATION, TRANSMISSION AND DISTRIBUTION PLANNING

2.1 Electrical load

An electrical load is an electrical component or portion of a circuit that consumes electric power. This is opposed to a power source, such as a battery or generator, which produces power. In electric power circuits examples of loads are appliances and lights. The term may also refer to the power consumed by a circuit.

The term is used more broadly in electronics for a device connected to a signal source, whether or not it consumes power . If an electric circuit has an output port, a pair of terminals that produces an electrical signal, the circuit connected to this terminal (or its input impedance) is the load. For example, if a CD player is connected to an amplifier, the CD player is the source and the amplifier is the load.

Load affects the performance of circuits with respect to output voltages or currents, such as in sensors, voltage sources, and amplifiers. Mains power outlets provide an easy example: they supply power at constant voltage, with electrical appliances connected to the power circuit collectively making up the load. When a high-power appliance switches on, it dramatically reduces the load impedance.

If the load impedance is not very much higher than the power supply impedance, the voltages will drop. In a domestic environment, switching on a heating appliance may cause incandescent lights to dim noticeably.

2.2 Types of loads

A device which taps electrical energy from the electric power system is called a load on the system.

The load may be resistive (*e.g.,* electric lamp), inductive (*e.g.,* induction motor), capacitive or some combination of them. The various types of loads on the power system are :

2.2.1 Domestic load

Domestic load consists of lights, fans, refrigerators, heaters, television, small motors for pumping water etc. Most of the residential load occurs only for some hours during the day (*i.e.,* 24 hours) *e.g.,* lighting load occurs during night time and domestic appliance load occurs for only a few hours. For this reason, the load factor is low (10% to 12%).

2.2.2 Commercial load

Commercial load consists of lighting for shops, fans and electric appliances used in restaurants etc. This class of load occurs for more hours during the day as compared to the domestic load. The commercial load has seasonal variations due to the extensive use of air conditioners and space heaters.

2.2.3 Industrial load

Industrial load consists of load demand by industries. The magnitude of industrial load depends upon the type of industry. Thus small scale industry requires load upto25 kW, medium scale industry between 25kW and 100 kW and large-scale industry requires load above 500 kW. Industrial loads are generally not weather dependent.

2.2.4 Municipal load

Municipal load consists of street lighting, power required for water supply and drainage purposes. Street lighting load is practically constant throughout the hours of the night. For water supply, water is pumped to overhead tanks by pumps driven by electric motors. Pumping is carried out during the off-peak period, usually occurring during the night. This helps to improve the load factor of the power system.

2.2.5 Irrigation load

This type of load is the electric power needed for pumps driven by motors to supply water to fields. Generally this type of load is supplied for 12 hours during night.

2.2.6 Traction load

This type of load includes tram cars, trolley buses, railways etc. This class of load has wide variation. During the morning hour, it reaches peak value because people have to go to their work place. After morning hours, the load starts decreasing and again rises during evening since the people start coming to their homes.

2.3 A load characteristics

The load on a power station is never constant; it varies from time to time. These load variations during the whole day (i.e., 24 hours) are recorded half-hourly or hourly and are plotted against time on the graph. The curve thus obtained is known as daily load curve as it shows the variations of load time during the day .

The variable load problem has introduced the following terms and factors in power plant engineering :-

(i) Connected load **:**It is the sum of continuous ratings of all the equipment's connected to supply system.

(ii) Maximum demand: It is the greatest demand of load on the power station during a given period.

(iii) Demand factor: It is the ratio of maximum demand on the power station to its connected load.

(iv) Average load: The average of loads occurring on the power station in a given period (day or month or year) is known as average load or average demand.

(v) Load factor: The ratio of average load to the maximum demand during a given period is known as load factor.

(vi) Diversity factor: The ratio of the sum of individual maximum demands to the maximum demand on power station is known as diversity factor .

(vii) Plant capacity factor: It is the ratio of actual energy produced to the maximum possible energy that could have been produced during a given period .

(viii) Plant use factor: It is ratio of KWH generated to the product of plant capacity and the number of hours for which the plant was in operation .

2.4 Power system load forecast

The forecasting of power system load is an essential task and forms the basis for planning of power systems. The estimation of the load demand for the power system must be as exact as possible. Despite the availability of sophisticated mathematical procedures, the load forecast is always afflicted with some uncertainty, which increases the farther the forecast is intended to be projected into the future. Power systems, however, are to be planned in such a way that changing load developments can be accommodated by the extension of the system . Long – term planning is related either to principal considerations of power system development or to the extra - high voltage system, so that no irrevocable investment decisions are imposed .

These investment decisions concern the short term, as they can be better verified within the short - term range, for which the load forecast can be made with much higher accuracy. One thinks here, for example, of the planning of a medium -and a low - voltage system for a new urban area under development or the planned connection of an industrial area.

Electricity load forecasting is usually divided into three or four time frame categories :

1. Long-term

Long term for a period of one year up to 20 years. This is used for system expansion planning, long-term financial planning, and tariff studies.

2. Medium-term

Medium-term For a period of one to 12 months. The purpose of this forecast is to properly plan maintenance schedules, major tests and commissioning events, and outage times of plants and major equipment.

3. Short-term

Short-term, which covers a period of one day up to several days. It is used for operation planning, unit commitment of generating plants, and load flow studies for economic dispatch.

4. Very short-term

Very short-term is specifically for one to few hours ahead and is used for power exchange and purchase contracts, and tie-line operation. In many power companies the last two forecasts are combined in one under the title short-term forecasting.

2.5 Method of load forecasting

The following methods are normally used for load forecasting :-

2.5.1 Extrapolation technique

In this method the future load predicated from the past historical data available the maximum demands of the past years are plotted against time.

Some standard analytical functions are used in trend curve fitting ,including:

Straight line $y= a + b x^2$ (2 - 1)

parabola $y=a+bx+cx^2$ (2 - 2)

S-curve $y=a+bx+cx^2+dx^3$ (2 - 3)

$$\text{Gompertz } y = e^{(a + b x)} \qquad (2 - 4)$$

Where: Y is a variable to be fitted

X is the time in assigned frame in (day , week , year etc)

a, b, c, d are coefficients to be calculated

2.5.2 Scheer's method

This method is found to be more suitable in our country as it work on the basis of per capita consumption of energy .The load is shared by industry, agriculture, commercial, domestic, public lighting .The increase of population also increase the load demand, more employment opportunities need to be created, more industries are established necessitating more electrical power.

Scheer 's method of load forecasting takes into consideration this factors such as economic condition of people , policy of government ,rainfall and mineral resources .

2.5.3 End-use method

End-use method is a modified form of extrapolation. In the method of extrapolation only the system yearly peak demand of the past years are plotted and future years demand is obtained by the trend curve of the past.

End-use method, the demand of different categories of loads are projected separately.

2.5.4 Probabilistic extrapolation correlation method

It is well documented that most system peak demands occur as a result of seasonal weather extremes. The weather variables usually are dry-build temperatures, humidity and wind-velocity. For example the impact of heat wave during summer peak.

2.6 Generation of Electrical Energy

Electrical energy is a manufactured commodity like furniture or tools. Just as the manufacture of a commodity involves the conversion of raw materials available in nature into the desired form, similarly electrical energy is produced from the forms of energy available in nature.

However, electrical energy differs in one important respect. Whereas other commodities may be produced at will and consumed as needed, the electrical energy must be produced and transmitted to the point of use at the instant it is needed. The entire process takes only a fraction of a second.

This instantaneous production of electrical energy introduces technique and economic considerations unique to the electrical power industry.

2.6.1 Sources of Energy

Since electrical energy is produced from energy available in various forms in nature, it is desirable to look into the various sources of energy.

Out of these sources, the energy due to Sun and wind has not been utilized on large scale due to a number of limitations. At present, the other three sources *viz.*, water, fuels and nuclear energy are primarily used for the generation of electrical energy.

2.6.1.1 The Sun energy

The Sun is the primary source of energy. The heat energy radiated by the Sun can be focused over a small area by means of reflectors. This heat can be used to raise steam and electrical energy can be produced with the help of turbine-alternator combination. However, this method has limited application because:

1.it requires a large area for the generation of even a small amount of electric power.

2.it cannot be used in cloudy days or at night.

3. it is an uneconomical method.

Nevertheless, there are some locations in the world where strong solar radiation is received very regularly and the sources of mineral fuel are scanty or lacking. Such locations offer more interest to the solar plant builders.

Solar power is the conversion of sunlight into electricity, either directly using photovoltaics (PV), or indirectly using concentrated solar power (CSP). CSP systems use lenses or mirrors and tracking systems to focus a large area of sunlight into a small beam. PV converts light into electric current using the photoelectric effect.

2.6.1.2 The Wind energy

The wind energy is used to run the wind mill which drives a small generator. In order to obtain the electrical energy from a wind mill continuously, the generator is arranged to charge the batteries.

These batteries supply the energy when the wind stops. This method has the advantages that maintenance and generation costs are negligible. However, the drawbacks of this method are :

1. variable output.
2. unreliable because of uncertainty about wind pressure
3. power generate disquiet small.

2.6.1.3 Water energy

When water is stored at a suitable place, it possesses potential energy because of then head created. This potential energy of water can be converted into mechanical energy with the help of water turbines. The water turbine drives the alternator which converts mechanical energy into electrical energy. This method of generation of electrical energy has become very popular because it has low production and maintenance costs.

2.6.1.4 Fossil fuels energy

The main sources of energy are fuels *viz.*, solid fuel as coal, liquid fuel as oil and gas fuel as natural gas. The heat energy of these fuels is converted into mechanical energy by suitable prime movers such as steam engines, steam turbines, internal combustion engines etc.

The prime mover drives the alternator which converts mechanical energy into electrical energy. Although fuels continue to enjoy the place of chief source for the generation of electrical energy, yet their reserves are diminishing day by day. Therefore, the present trend is to harness renewable energy which is more or less a permanent source of power.

2.6.1.5 Nuclear energy

Towards the end of Second World War, it was discovered that large amount of heat energy is liberated by the *fission* of uranium and other fissionable materials. It is estimated that heat produced by 1 kg of nuclear fuel is equal to that produced by 4500 tons of coal.

The heat produced due to nuclear fission can be utilized to raise steam with suitable arrangements. The steam can run the steam turbine which in turn can drive the alternator to produce electrical energy. However, there are some difficulties in the use of nuclear energy. The principal ones are :

1.highinitial cost of nuclear plant.

2.problem of disposal of radioactive waste and dearth of trained personnel to handle the plant.

2.7 Co -generation

Co-generation is the production of electricity in combination with another in industrial process. Co-generation plants are often thermal generators installed in industries that produce or require heat. In effect, the heat is used twice-once to generate electricity and once for another purpose, resulting in a very efficient process overall.

2.7.1 Types of co-generation

Co-generation systems can work in one of two ways :

2.7.1.1 Bottoming cycle

Heat is produced in the form of high-pressure steam and used in the industrial process. The left over heat is then recovered and used to make steam that drives a turbine and generator.

2.7.1.2 Topping cycle

This works the other way around. First , electricity is generated, usually through an open-cycle gas turbine, then the waste heat is used to produce steam for industrial purposes. Many power stations now use the more efficient combined-cycle gas turbine . Technically speaking, combined-cycle gas turbines are themselves .Examples of co-generation, First, gas is ignited, it burns in a gas turbine connected to an electrical generator, then the left over heat from this process is used to make steam ,which drives a steam turbine and a second generator .The second generator is not as efficient as the first, but still produces electricity from what could have been waste heat.

2.7.2 Advantages of co-generation

Co-generation makes use of excess heat, which helps to improve the overall efficiency of the process. Co-generation can save businesses money, as they can generate their own electricity and steam supply at the same time. They can sometimes also sell electricity to the national grid, which provides power to new eland.

2.7.3 Disadvantages of co-generation

Even though co-generation produces electricity efficiently on site, it burns non-renewable sources that produce carbon dioxide emissions.

2.8 Generation planning

The electric power industry is one of the oldest and well-developed industries in the United States. Consequently, all power generation planning is performed in the context of modifications to the existing system. The process begins with electricity load demand forecasting, which is followed by reliability evaluation to determine if and when additional generation is needed. Finally, optimal capacity expansions are selected based on economic considerations. These processes are reviewed briefly in the following sections.

2.9 Generation load forecasting

Total system load generally is well known and a wealth of historic data is available. In the short term, load can be forecast with great accuracy, and this is performed daily to determine generation units' commitment. Load forecasting for the purpose of generation planning, however, requires a substantially longer time horizon, because system expansion projects require long lead times, often between 2 and 10 years

The outputs from a load forecast are a forecast of annual energy sales (in kilowatt-hours), and the annual peak demand (in kilowatts). There are two widely used methods in energy sales forecasting: econometric regression analysis , and end-use electricity models.

The usefulness of each method depends on data availability, customer segmentation, and the degree of detail required. Generally, the accuracy of predictions depends on the accuracy of assumptions, and the predictions can't be made with absolute certainty

End-use electricity models are physical, engineering-based methods that often are used in forecasting the residential load, and sometimes for commercial and industrial loads

Forecasting the peak demand is done based on forecasted energy sales by multiplying forecasted energy with an empirically determined load factor coefficient. Peak load is extremely sensitive to weather, and both the historic data and the forecast must be adjusted consistently to normalize them relative to the weather. After this baseline prediction is made it is adjusted based on the sensitivity to weather and the peak load is then predicted with the desired degree of confidence .

To illustrate the consideration of weather effects, suppose that a baseline prediction is made that a system will have a future peak load demand of 10 gigawatt's (GW) for an expected daily high (temperature) of 77° F. Let us further suppose that the daily high conforms to a normal distribution with a standard deviation of 3°F, and that the historically observed correlation between temperature and peak load is 300 megawatts (MW)/°F. It can then be concluded with 95% confidence that the peak load will be below 11.8 GW; 95% confidence corresponds to two standard deviations away from the mean, and this further corresponds to 6°F and 1800 MW of additional load. Note that this example is intentionally oversimplified; several other factors influence peak load, including wet bulb temperature (to account for humidity), wind speed, solar intensity, weather conditions over the past two days (thermal buildup effect), time of day, and time of year.

Peak load forecasting is important because it directly influences the required generation capacity—on every day of the year there must be enough available

generation to feed the peak load. This is discussed below.

2.10 Relationship between capacity reserves and reliability

Generating stations require regular maintenance, which means that during some periods of the year they are not available to serve the load. The stations also can be out of service due to unforeseen equipment failures; these outages, called forced outages, also contribute to reduced availability. Assuming that maintenance requirements are known, and that forced outages can be characterized by probability, a natural question arising is, what is the appropriate capacity of generation for a given load forecast. Appropriate in this context is directly tied to reliability of service, and it then follows that we need to find a mapping between capacity and service reliability or, more precisely, between capacity margins and service reliability. Capacity margin is a better measure of reliability because it represents the difference between capacity and peak load (capacity alone is meaningless).

2.11 Transmission planning

As noted, the chief role of a transmission system is to optimize the use of a generation portfolio; a transmission system makes it possible to supply loads from the most economical sources of power, and operate generating stations flexibly and thus improve overall system reliability.

Transmission planning therefore ensures that the transmission infrastructure can deliver power from the generators to the loads, and that all the equipment will remain within its operating limits in both normal operation and during system contingencies. Contingencies in this context mean unexpected failures of any system element; for example a generator or a transmission line could have an unexpected outage, which would force the remainder of the system to transition to a new operating point. Studying these transitions and ensuring that a stable operating point can be reached after any contingency is an essential part of transmission system planning.

Transmission system planning is closely interrelated with generation planning. To understand this, it is helpful to note that power flows through a transmission system are a direct result of generation dispatch; a transmission system itself has very limited ability to control the line flows. Therefore, to study the power flow through a transmission system, it is necessary to know the corresponding generation dispatch; to determine the (optimal) generation dispatch, however, the parameters and flow limitations imposed by the transmission system must be known. This “loop” is not always easy to resolve, and it might require complicated iterations between the two planning processes.

2.12 Power system distribution

Distribution system represent an important parts in the electrical grids and for this reasons the electrical companies delicate approximately 40% of the capital investment for distribution systems while the remain is given to generation and transmission (40% generation and 20% transmission).

The distribution system is particularly important for an electrical utility for

two reasons :-

1. it is the closest part to the customers and any failure in distribution system affect the customer directly .for example failure in transmission and generation sections may not cause customer service interruptions.

2. it is high investment cost.

2.12.1 Load forecasting

Load forecasting is critically important in distribution system planning and, arguably, distribution utilities are in the best position to make accurate load forecasts. Distribution utilities directly meter their customers and therefore have access to the exact data needed. They also are notified of development projects in their service territory early in the process and, through that mechanism, have a good insight into prospective load growth. Other than that, load forecasting generally follows the procedures discussed in section 0 above. Given their proximity to the load, distribution utilities have the necessary data to successfully employ end-use electricity models.

2.12.2 Distribution system planning

Distribution systems are the part of electricity delivery infrastructure that serves the load. Traditionally distribution systems are optimized for the lowest cost that meets the desired reliability of service, and reliability is carefully tracked and reported. This has profound implications on planning practices, because reliability is explicitly engineered into the system, and is used as an important metric in evaluating planning options.

CHAPTER THREE

FINANCIAL PLANNING

A major attribute of planning in all most all Endeavour's is reduction of cost. criteria on service quality and standard must be met and guide lines must be followed but within those limits the planner's goal is to minimize the cost. Every alternative plan contains or implies certain costs: equipment. maintenance, losses, and many others as installation, labor operating well. Alternatives vary not only in the total cost. but often, equally, important, when the costs are incurred(how much must be spent now, and how much later?).

Traditionally electrical utilities have been given a monopoly franchise for electric services in a region, which carried with it both an obligation to serve and a requirement to work with in a regulated price, structure. Regulated price are based on cost and regulated utility planning on cost minimization. The utility can expect to make reasonable return on its investment and recover all its costs, but it must work to reduce its costs as much as possible .

The capital structure of the electricity boards is built up with loans from the state governments, financial institutions like banks, and market borrowing They are also expected to generate internal resources from their statutory earnings after meeting the liabilities of operating expenditure, interest on loans, capital and depreciation.

Financial planning ensures the availability of right amount of finances at the right time at lowest cost. The capital finance debt and or equity is required for fixed capital long term) for land building machinery materials, construction etc. and working capital(short term) for raw material such as fuel for two months etc. Working capital has highest interest rates. Competitive financial markets are emerging. The innovative approach by various financial institutions has made funding a complicated process. The broad options are :

l. Issue of bonds by the central corporations, electricity boards.

2. Internal resources generation by utilities.

3. Subscriptions of shares debentures from public.

4. Loans from power finance corporations.

5. Promoter's money.

6. State plan resources for state electricity boards.

7. New budgetary support from the government.

8. Joint ventures between public and private sectors.

9. Bilateral assistance on selective basis in terms of grant, equity and loans

10. Multilateral assistance from world bank in terms of grant, equity and loans.

11.Loans or equity from financial institutions.

12.Loans from specialized corporations.

13. Lease financing to power utilities.

3.1 Techno-economic viability

One of the basic objectives of the power project report is to determine techno-economic viability for the project identified and also to obtain the investment for construction of generation plants and interconnecting links which ensures an economic and reliable supply. Analytical tools used should be capable of assessing the options for both capacity and transmission linkage expansion and distribution in an integrated fashion to achieve an optimal solution for the future evolution of the system. The project must be clear from the point of regulatory clearances before seeking finance from investment agencies For example the main choices confronting the system planner in case of thermal power are the question of optimal unit size and generation reliability, the location transportation network for coal and extension to higher voltage level of transmission grid For purpose of investment planning it then becomes important to examine the trade-offs between the efficiency of capital allocations to different transport nodes and locations e.g. .rail versus barge and coastal setting, in the context of transmission network additions.

3.2 Private sector participation

Private power projects are important as a part of country's investment resources raising and least cost expansion plan for the supply of electricity. The private sectors may be generating companies, transmission or distribution companies. Another advantage of private sector participation is that it opens up new work and management skills for timely execution of the project and delivery of quality in work and service. The public sector and private sector power utilities have different financial structures. Various private sector options like turnkey contract. BOOT, BOO, BOL, ROL etc. BOO (build-own-operate), BOO (build-own operate-transfer) are the most common schemes for new projects. ROL (rehabilitate-own-lease) are common for old plants and BOM (build-own maintenance) for new transmission lines. Privatization improves efficiency and productivity of the system in the more competitive environment in the country's economy.

3.3 Financial analysis

Financial analysis is investigation of financial profitability of investment. It determines whether financial costs are properly estimated and whether the project funding is ensured and whether the project is financially viable. The capital and operating cost are worked out at market prices. For generation project, cash flow is prepared for the projected cost and the generation flow of energy in each year of their occurrence covering the entire economic life of the project. The costs and units generated and discounted at a rate of discount are specified by the regulatory body to work out the unit cost of generation. For transmission project, the cost and units transmitted are discounted similarly to work out unit cost of transmission In financial analysis, the average cost of capital for the proposed project is calculated on the basis of debt to equity ratio, loan interest rates and repayment periods and required return on equity investment. The electricity authority needs to carry out the appropriate analysis for a project developed by a private company which is a financial analysis when evaluating the avoided cost.

3.4 Economic analysis

Economic analysis and financial analysis are complementary, The project should not be financed unless it represents a desirable use of national resources and will be able to sustain itself financially either with or without a subsidy. Economic analysis usually starts with financial accounts, converting these in to economic measures by certain adjustments. Economic analysis is used to evaluate the total economic effects on society by extending the criteria of financial profitability. The primary objective of the economic analysis of power projects I to determine the cost of generation transmission at their true resources cost to the economy as the financial cost of generation transmission may not reflect the true cost of power to the economy on account of distortion inherent in the market prices While working out the economic cost of generation, transmission both the costs and power generated have to be valued at their true sources cost. This process involves removal of taxes and duties from the costs as they are not costs to the society. Similarly, the subsidies are also hot taken into account as they are only transfer payments. Total generation costs have to be divided by the annual electricity production(provided this is constant) in order to receive the specific energy cost, example of small hydro power which can be easily compared to the respective cost figure of a conventional e energy system e.g. Thermal, diesel generation.

3.5 Economic characteristics

Economic characteristics for generation and transmission are discussed

Below :

3.5.1 Generation units

The economic characteristics of a generating unit are those which determine the cost at which it produces electrical energy. This cost has three components: cost of fuel, cost of operation and maintenance, and capital, or investment cost.

In generation economic studies, one is usually dealing with units to be installed at some future time which makes it necessary to estimate future, not current, plant costs. The conventional way of doing this is to start with a detailed costs estimate using known materials and labor costs for the present year. This would be the cost if the plant could be built instantaneously, as it were. A construction schedule is then developed form which on estimate is made of year-by-a ear expenditures throughout the construction period. It is necessary to be careful, complete and consistent in defining the plant costs used in generation economic studies. The typical annual fixed cost per KW and variable cost per KWH of operation and maintenance in India (1996) for example are given in fig(3 -1) .

Table (3-1) the typical annual fixed cost per KW and variable cost per KWH

Variable cost (paisa / KWH)	fixed cost (paisa / KW)
2.5	500
5	400
6.5	300
8.5	200
15	100

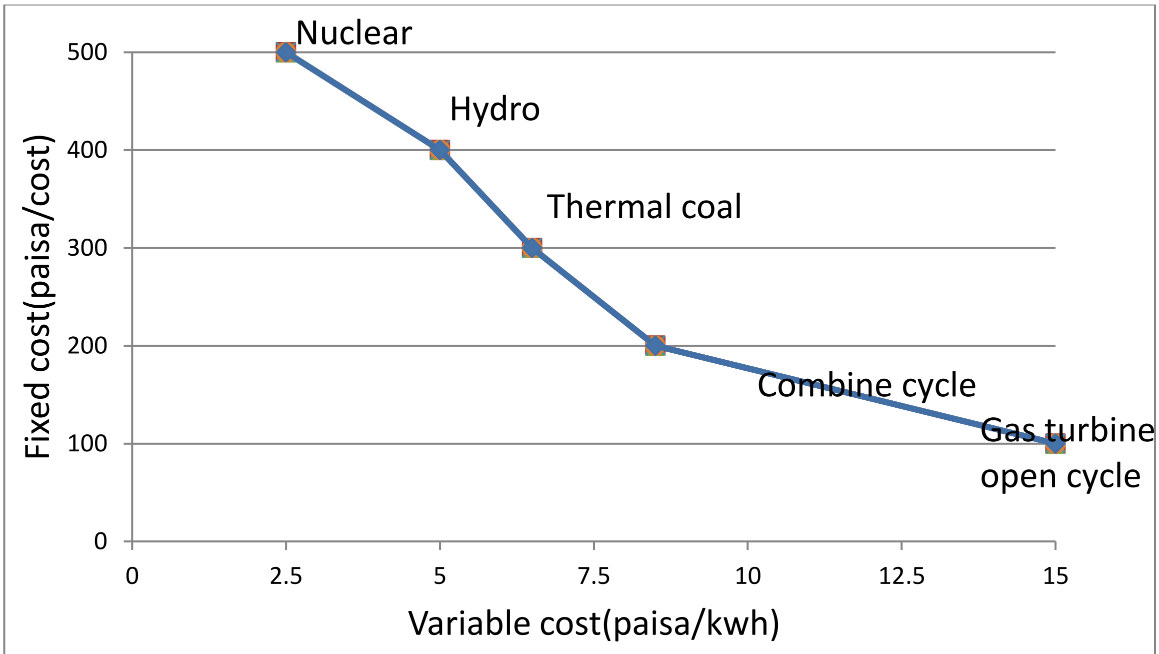

Figure 3.1 the typical annual fixed cost per kw and variable cost per kwh

3.5.2 Transmission

It is widely an accepted that the separation of generation, transmission and distribution is a key step to improve the overall efficiency and effectiveness of power sector in a country. It will encourage private investment in the three separate components of power system. once separation has been achieved it become relatively easy to introduce private sector participation in the transmission sector.

There are three main areas for transmission investment :

1.New connection: the commissioning of new power stations requires investment in the transmission system.

2. Improved efficiency and security: Investment may be required to improve the efficiency and security of an existing transmission system so as to reduce losses.

3. Interconnections: The interconnection of separate grid system is beneficial because it allows generation and demand to be pooled, thereby reducing the required plant margin and reserve, and increases economy of operation by allowing the cheapest stations available to meet demand.

3.6 Rural electrification investment

It is not quite correct to judge rural electrification purely on the criterion of the financial returns on the investments made. A number of indirect socio-economic advantages like harnessing of ground water, resources for increased food production, promotion of rural industries and rural employment, prevention of migration from rural to urban centers, saving in diesel and so on should not be ignored. The real advantages of rural electrification are not limited to the immediate or long-term financial returns but go far beyond and can be truly evaluated by a benefit-cost analysis.

3.7 Credit risk assessment

There are numerous financial, contractual, and regulatory risks which must be allocated to assure that someone will be responsible to pay off the debt if the project is not built or does not operate properly The sensitivity analysis should be done in order to evaluate the project's proposal risk mitigation in respect of:

1. Current capital cost fluctuations(i.e. +20%, +50%, 100%).
2. Interest rate fluctuations.
3. Escrow accounts requirements.
4. Risk premiums(insurance, exchange)
5. Debt sources ratios offshore(commercial, local commercial, public).
6. Construction time over run(ie+20%, +50%, 100%).
7. Operational assumptions.

3.8 Optimum investment models

It is a mathematical approach to minimize the costs and develop a mathematical relation of various variables. ISPLAN and EGEAS models are used in some utilities in power plan studies. The model must satisfy conflicting requirements :

1. It must be sufficiently realistic or accurate to provide meaningful results .
2. It must not be complicated to apply. It would be useful to define the problem in mathematical programming as problem-solving techniques of finding best values of an objective function There are many forms of solutions such as linear. dynamic, quadratic programming etc.

3.9 Tariff

The rate at which electrical energy is supplied to a consumer is known as tariff. Although tariff should include the total cost of producing and supplying electrical energy plus the profit, yet it cannot be the same for all types of consumers. It is because the cost of producing electrical energy depends to a considerable extent upon the magnitude of electrical energy consumed by the user and his load conditions. Therefore, in all fairness, due consideration has to be given to different types of consumers (e.g., industrial, domestic and commercial) while fixing the tariff. This makes the problem of suitable rate making highly complicated.

Objectives of tariff. Like other commodities, electrical energy is also sold at such a rate so that it not only returns the cost but also earns reasonable profit. Therefore, a tariff should include the following items :

1. Recovery of cost of producing electrical energy at the power station.

2. Recovery of cost on the capital investment in transmission and distribution systems.

There are three main objectives of a sound pricing structure consumer Tariff :

1. Financial: ensuring that the revenue yield from the application of tariff to the consumer is sufficient .

2. Economics ensuring that tariffs charged to consumers enable them to make rational and optimal choices in the use energy. discourage waste and promote efficient allocation of resources.

3. Social: ensuring that the price structures take into account fair distribution of costs among various classes of consumers, subsidization of target etc.

CHAPTER FOUR

SUDANESE ELECTRICITY TRANSMISSION COMPANY (STEC) MEDIUM TERM PLAN (2016 – 2018)

4.1 Introduction

At this study report is covering the period (2016 - 2018). The investigations undertaken in this study has identified the most technical feasible and economically viable generation and transmission projects which satisfies the system requirements as options for further detailed studies to ascertain it is viability to National Electricity Corporation , these plans are summarized below and further detailed in this chapter of the study.

4.2 Load forecasting

To calculated loads forecasting for the years of (2009 - 2018) and through the use of exponential method (method of least square) .

The exponential demand may be expressed by the analytical function

$$P_{Di} = e^{A+Bx} \qquad (4\text{-}1)$$

$$X = X_i - X_0 \qquad (4\text{-}2)$$

Where p_{Di}=peak load in MW in ith year.

Xi=the ith year in which the peak load is considered .

X_0=the basic year.

A and B are constant.

The following table shows the loads forecasting for years mentioned above

Table (4 -1): Forecasting for total demand in the years between (2016 -2018)

Year	Peak load MW	Exponential MW	Error MW	Forecasting MW
2009	1151	1153.693	2.693079	1170.598029
2010	1314	1320.444	6.444166	1337.349116
2011	1525	1511.297	13.70308	1528.20187
2012	1727	1729.735	2.734917	1746.639867
2013	2011	1979.745	31.25476	1996.65019
2014	2295	2265.891	29.10875	2282.796201
2015	2561	2593.396	32.39589	2610.300836
2016		2968.237		2985.141937
2017		3397.256		3414.161367
2018		3888.285		3905.189885
			Average= 16.90495	

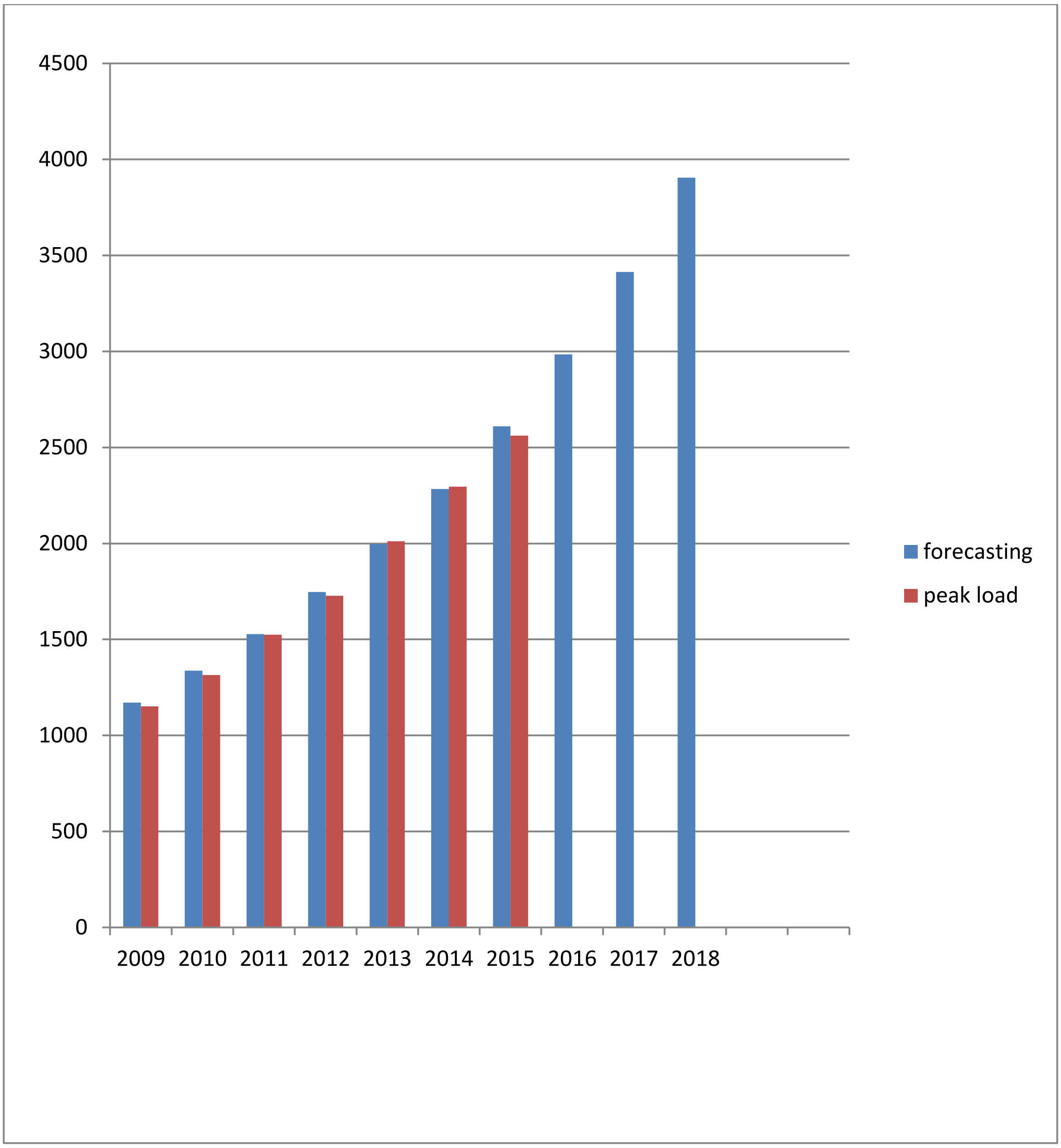

Figure (4-1) : The total demand (MW) in each year

Maximum load of 2015 is 2561 MW , up 13 % from the previous year, maximum load of 2016 is 2985 MW , up 14.36 % from the previous year, maximum load of 2017 is 3414 MW , up 14.37 % from the previous year and the maximum load of 2018 is 3905 MW , up 14.38 % from the previous year .

4.3 Generation planning

Table (4 -2): The status of the network at peak generation

P/S	P(MW)
MWP	1140
ROS	220
GAR	420
OTHERS	8
SNP	10
KHN	330
KOSTI	500
POR(FT)	50
GRB	10
KHN(FT)	140
Total Generation	2828
Interchange	150
Total supply	2978

Forecast load for the year 2016 is 2978 MW and generation opposite him in the same year it is 2828 MW this requires enter unit of the generation of an additional amount 150 MW , at 2017 the forecast load is 3414 MW and generation in this year it is 2798 MW this requires enter unit of the generation additional amount 436 MW and forecast load for the year 2018 is 3905 MW and the generation at this year is 3414 MW this requires enter unit generation of an additional amount 491 MW.

4.4 Transmission planning

At the side of electricity transmission has been the case study of the stations voltage level of 110 KV and that by forecasting the required load of each station and to know increasing load in each station has been the use of growth factor in the load and was found that a very small change in the growth factor in the load and therefore has been considered as fixed for the years under study It is equal to 14%.

The following tables clarify the status of the stations of the year :

Table (4 -3): Peak Load forecast for Khartoum area (2016-2018)

Capacity			ACT.s/s MW	FOR.2016 (14%)MW	FOR.2017 (14%)MW	FOR.2018 (14%)MW
s/s	MVA	MW	JUN (2015)	JUN (2016)	JUN (2017)	JUN (2018)
KLX	135	108	68.6	78.2	89	101.6
SHG	270	216	89.5	102.0	116.3	132.6
MUG	200	160	147.3	167.9	191.4	218.2
GAD	60	48	26.1	29.8	34	38.8
FAR	120	96	102.7	117.1	133.5	152.2
KHE	200	160	138.9	158.3	180.5	205.8
LOM	200	160	135.9	154.9	177.6	201.3
BAG	70	56	47.4	54.1	61.6	70.2
JAS	100	80	48.3	55.1	62.8	71.6
AFR	200	160	44.1	50.3	57.3	65.3
Total			848.8	967.7	1103	1257.6

The color red shows that there is increased load on the station .

Table (4 - 4): Peak Load forecast for the North area (2016-2018)

Capacity			ACT.s/s MW	FOR.2016 (14%)MW	FOR.2017 (14%)MW	FOR.2018 (14%)MW
s/s	MVA	MW	JUN (2015)	JUN (2016)	JUN (2017)	JUN (2018)
SHN	100	80	35.4	40.4	46.1	52.6
ATB	200	160	167	190.4	217.1	247.5
MWT	80	64	24.6	28.1	32	36.5
DEB	80	64	20.7	23.6	27	30.8
DON	80	64	32.4	26.9	42	47.9
WWA	120	96	0.5	0.6	0.7	.8
WHL	120	96	1.3	1.5	1.7	1.9
Total			281.9	321.5	366.6	418

Table (4 -5): Peak Load forecast for Bahri area (2016-2018)

Capacity			ACT.S/S MW	FOR.2016 (14%)MW	FOR.2017 (14%)MW	FOR.2018 (14%)MW
S/S	MVA	MW	JUN (2015)	JUN (2016)	JUN (2017)	JUN (2018)
IZG	270	216	96	109.4	124.7	142.2
KUK	90	72	64.4	73.4	83.7	95.4
IZB	200	160	112.3	128	146	166.4
IBA	200	160	56.8	64.7	73.8	84.1
FRZ	80	64	22	25.1	28.6	32.6
Total			351.5	400.6	456.8	520.7

Table (4 -6) :peak load of forecasting for Aljazeera area(2016 – 2018)

Capacity			ACT.S/S MW	FOR.2016 (14%)MW	FOR.2017 (14%)MW	FOR.2018 (14%)MW
S/S	MVA	MW	JUN (2015)	JUN (2016)	JUN (2017)	JUN (2018)
MAR	155	124	77.3	88.1	100.4	114.5
HAS	70	56	20.4	23.3	26.7	30.4
NHAS	300	240	22.1	25.2	28.7	32.7
HAG	35	28	12.7	14.4	16.4	18.7
MAN	35	28	27.6	31.5	36	41
GND	120	96	38.9	44.3	50.5	57.8
Total			199	266.8	258.7	295.1

Table (4 -7): Peak Load forecast for the Blue Nile area (2016-2018)

Capacity			ACT.S/S MW	FOR.2016 (14%)MW	FOR.2017 (14%)MW	FOR.2018 (14%)MW
S/S	MVA	MW	JUN (2015)	JUN (2016)	JUN (2017)	JUN (2018)
SNJ	110	88	26.2	29.9	34.1	38.9
MIN	52.2	42	12.2	13.9	15.8	18
SNG	200	160	11.5	13.1	14.9	17
ROS	120	96	22	25.1	28.6	32.6
RNK	120	96	0.1	0.1	0.13	0.15
Total			72.0	82.1	93.5	106.7

Table (4 -8): Peak Load forecast for the East area (2016-2018)

Capacity			ACT.S/S MW	FOR.2016 (14%)MW	FOR.2017 (14%)MW	FOR.2018 (14%)MW
S/S	MVA	MW	JUN (2015)	JUN (2016)	JUN (2017)	JUN (2018)
GDF	200	160	29.8	33.9	38.6	44
FAO	25	14	7.41	8.44	9.6	11
SHK	200	160	0.7	0.8	0.9	1
GRB	200	160	18.1	20.4	23.5	26.8
KSL	200	160	23.0	26.2	29.9	34.1
HLF	200	160	17.1	19.5	22.2	25.3
POR	200	160	84.2	95.9	109.3	124.6
Total			180.31	205.1	231.3	266.8

Table (4 -9): Peak Load forecast for the White Nile area (2016-2018)

Capacity			ACT.S/S MW	FOR.2016 (14%)MW	FOR.2017 (14%)MW	FOR.2018 (14%)MW
S/S	MVA	MW	JUN (2015)	JUN (2016)	JUN (2017)	JUN (2018)
MSH	95	76	23.6	26.9	30.7	35
RBK	120	96	72.3	82.4	93.9	105
TND	120	96	1.3	1.5	1.7	1.9
URM	120	96	5.6	6.4	7.3	8.3
OBD	120	96	33.4	38.1	43.4	49.4
RBK	17.5	14	0.0	0.0	0.0	0.0
Total			136.1	155.3	177	201.7

Table (4 -10): Peak Load forecast for Omdurman area (2016-2018)

Capacity			ACT.S/S MW	FOR.2016 (14%) MW	FOR.2017 (14%) MW	FOR.2018 (14%) MW
S/S	MVA	MW	JUN (2015)	JUN (2016)	JUN (2017)	JUN (2018)
OMD	200	160	121.6	138.6	158	180.1
BNT	200	160	114	130	148.2	169
MHD	170	136	132.5	151	172.1	196.2
JAM	100	80	20	22.8	26	29.6
Total			388.1	442.4	504.3	574.9

After studying The above stations have been developed solutions is observed that there are stations with over load and developed solutions with the knowledge that these timely , cost-less and short period of time solutions. And it is described as follows three cases :

4.4.1 Case 1: 2016

- ATB :Entry Berber station or increase the number of transformers in the side of the 220KV to three transformers.
- FAR :Reduce the load by converting some of them to AFRAstation, until the project is completed strengthening the network Khartoum.
- KUK :Enlarge transformer capacity and upgrade the station to 220 KV voltage level.
- BAG :Entry Soba station and terminal division of loads at the level of the 110 kV between stations SOBA and GIAD. Enlarge the manufacturing plant to a capacity of 2 x 100 MVA This

requires modifying the line carrier and feeder station zooms wires BAGAIR line size.

4.4.2 Case 2: 2017

- KLX :Enlarge SHG voltage station to 220 KV, enlarge the manufacturing capacity to 2 * 150 MVA and convert feed the LOM station of the KLX to ALSHAGRA.
- Add transformer on RBK station .

4.4.3 Case 3: 2018

Add transformer on IZB ,OMD and BNT stations .

Change in the feeding station or add adapter to meet the overload must change the space used wire clip in the distribution to be able to cope with the increase in pregnancy, and must be taken into account in all stations .

CHAPTER FIVE

CONCLUSION&RECOMMENDATION

5.1 Conclusion

Power system planning process, planning categories i.e. Long, medium and short term planning and objective of each category with their time range are studied. The base(first step) of any power system planning is load forecasting. It has three categories according to the planning type. From load forecasting, build generation, transmission and distribution planning. Also generation type was studies , criteria of planning, and its environmental effect. In transmission planning, types of transmission lines(AC or DC), voltage level selection, and planning criteria are discussed. Distribution types and its criteria had been studied. Finally, execution of the plan and its viability depends on financial planning.

In the case study, it is found that STEC used the end use approach for agriculture and domestic load forecasting, which is considered to be more accurate and is used by many utilities in the world.

The load was forecasted for the year. It was the growth coefficient was calculated in the load. It was the deficit in generation and in the side of the transmission processing has been studied 110 KV manufacturing plants palm of a case study were predicted loads for years above the stations found that the stations by an excessive load was developed solutions to these problems, and these solutions at low cost .

5.2 Recommendation

The following is recommended :-

- The Use of the HVDC transmission instead of AC because the economy in DC transmission is that only two conductors per circuit are need rather than the three required for AC. Consequently DC transmission towers carry less conductor dead weight ,and they can be smaller ,less costly ,and easier to manufacturing .
- Refer to the information of historical load growth and the percentage of the growth in each year to be used as a guide for the subsequent plan .
- Increase in capacity due to under construction and committed power plant projects ,introduction of new consumption areas due to transmission lines and distribution networks expansions , give chance to boost demand .
- Distribution plan must be included in the next medium term plan .
- Find out the level of implementation of the previous plan for each ministry, regarding their requirement of electric power , and use it as a factor to determine the future demand .
- Further studies must be carried for load forecasting and environmental impact .

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