The Guide for the Review, Approval and Monitoring of Integrated Power System Plans in Nigeria

1. Introduction

A typical power system comprises of the Generators, the Interfaces and the Loads. The Generators and the Loads are scattered throughout the system. As a result, some Interfaces should be provided to transfer the generated power to the Loads.

The generation resources may be far away from the Load centres. To reduce losses and make transmission possible, the generation voltages will need to be converted to much higher values, that should be reconverted to lower values at the receiving end(Load Centres). As a result, the interfaces between the Generators and the Loads, may consist of several voltages, such as, 400V, 11KV, 33KV, 132KV, 330KV, etc. For the Nigerian Power System, these voltages are classified as:

a. Transmission – 132KV, 330KV
b. Sub- transmission – 33KV, 66KV
c. Distribution – 400V, 11KV

The main elements of the Power System include:

a. Generation infrastructure
b. Transmission infrastructure
    i. Substations
    ii. Network (lines & cables)
c. Distribution infrastructure
    i. Substations
    ii. Network (feeders & cables)
d. Load demand
    i. Residential
    ii. Commercial
    iii. Industrial
    iv. Others

Any change to the power system elements, in the form of transmission lines, distribution feeders, transformers, generators or loads, will produce an impact on the existing system. The impact may be on the reliability, security, or on the quality of the supply to the users.

Technical requirements of the system are intended to ensure that a high reliability of service is maintained when changes to the system or user's installations are made. These technical requirements are in the form of specifications or limits, included in the Codes (Grid Code, Distribution Code, etc.). Therefore, power systems are planned to ensure that they:

a. Provide high quality electricity supply to the users
b. Provide reliable electricity supply to the users
c. Provide secure electricity supply, from the users point of view
d. Meet the relevant safety standards
e. Meet the environmental standards
f. Optimize equipment utilization (ie to ensure minimum surplus or stranded assets in the network, and minimum costs)
g. Optimize losses (and revenues)

The purpose of system planning is to ensure the development of a power supply system where there is a balance between users' need for a safe, secure, reliable high quality electricity supply and the desire for the service to be provided at minimal costs, with adequate considerations for the environmental issues. In other words, System Planning is a process in which the aim is to decide on new, as well as upgrading of the existing system elements, to adequately satisfy the loads, for a foreseen future. Load is always the reference for power system planning, and it should be adequately satisfied in any plan, be it short-term or long-term plan.

The system plans are developed by the operators of the system (generators, System Operator, transmission services providers and the distributors), while the roles of the Regulator, in the whole process, are those of reviewing and approving the plans, as well as monitoring the implementation of the plans. In overseeing the planning processes, the Regulator ensures that the core principles for good planning are adhered to, and that all the relevant laws and Regulations are complied with. Also, he ensures that all parties to the plan are given a fair opportunity to shape the final plan to be approved by the Commission.

Some of the issues to consider in reviewing, approving and monitoring a system plan are the standards applied to maintain system reliability and security, as well as to protect the interest of the users. These standards are also known as the **System Planning Criteria.** These planning criteria are used as tools to maintain system security, reliability and to protect the system against instability. The tools are also used to protect the interest of the users in terms of supply quality and affordability.

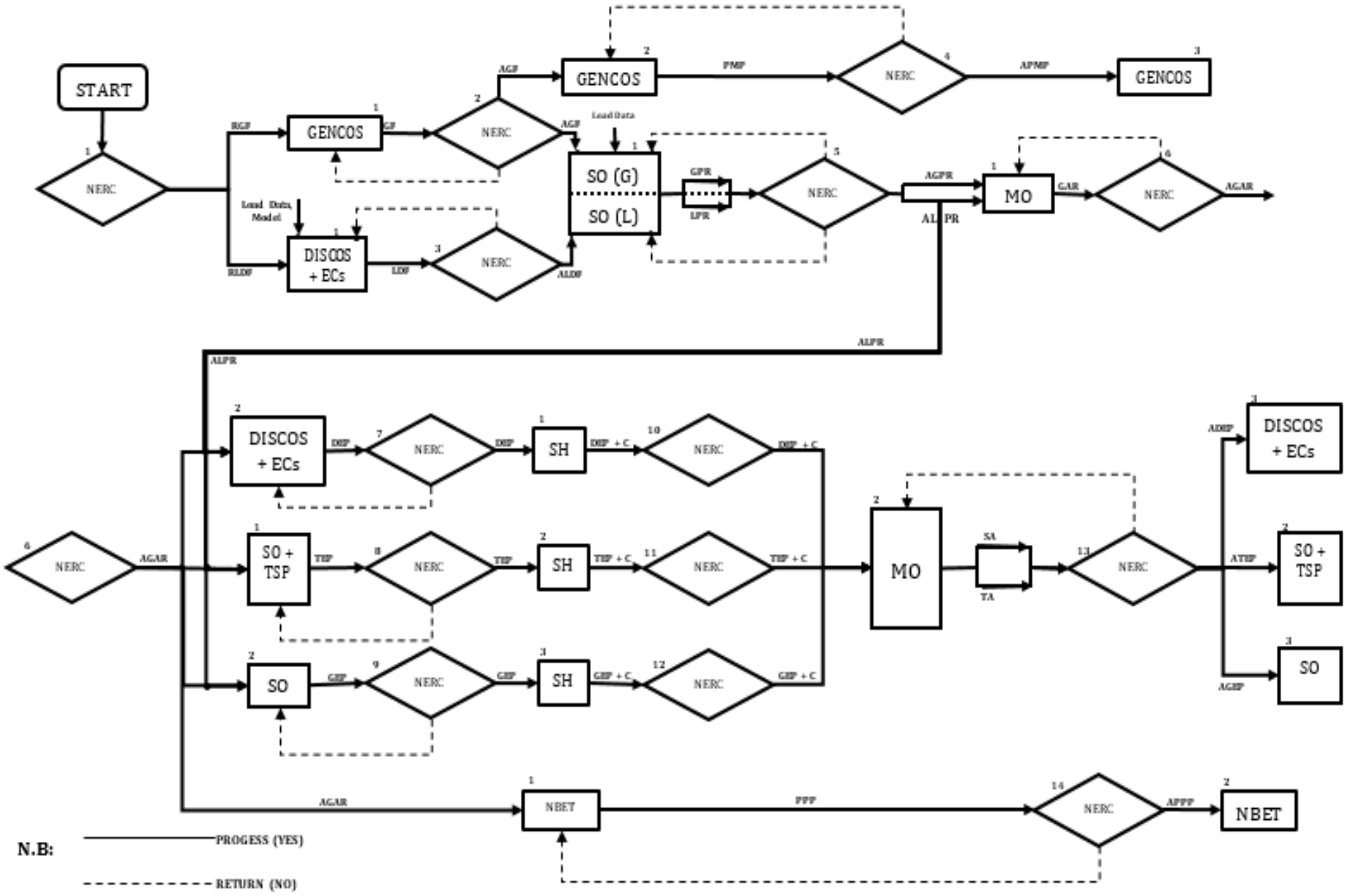
This document presents the Guide for the processes and methods in the review, approval and monitoring (RAM) of the System Plans, with respect to these planning Criteria. The RAM guide is the detailed discussion of the processes involved in the review for approval, and the implementation monitoring of the system plans for the Nigerian electricity industry. It is the Compass for reviewing, approving and monitoring system plans. It shows what to do and how to do it for an efficient system plan for the Nigerian Power Sector. The review is an attempt to see the extent to which the draft plan complies with the criteria. The Guide also discusses the tools and procedures employed in the review and evaluation of the plans. It also presents the monitoring practices and procedures for the approved plans.

There will be need for stakeholder engagement on the RAM Guide before it is operationalized. Also, there should be periodic review of the Guide to make it consistently relevant. Inputs will be required from the Stakeholders for each review.

2. Processes for the development of integrated power system planning

The detailed process flow for integrated system planning is as shown in figure Fig 2.0 below. The figure shows the processes from the point where NERC calls for the Load and generation forecasts (from the Load Participants and the Brown Field Generators, respectively), to the points where the expansion plans have been approved, after the stakeholder engagements.

Fig. 2.0: Integrated System Planning Process Flow Diagram



- **Keys**

- RLDF – Request for Load Demand
- LDF – Load Demand Forecast
- ALDF – Approved Load Demand Forecast
- LPR – Load Projection Report
- GPR – Generation Projection Report
- RGP – Request for Generation Plan
- GEP – Generation Expansion Plan
- MO – Market Operator
- PMP – Plant Mtce Plan
- PPP – Power Procurement Plan
- EC – Eligibility Customers
- RGF – Request for Generation Forecast
- AGP – Approved Generation Plan
- AGPR – Approved Generation Projection
- ALPR – Approved Load Projection
- GAR – Generation Adequacy Report
- AGAR – Approved Generation Adequacy Report
- APMP – Approved Plant Mtce Plan
- DEP – Distribution Expansion Plan
- TEP – Transmission Expansion Plan
- NERC –Nigerian Electricity Regulatory Commission
- GF – Generation Forecast
- SO – System Operator
- SAR – System Adequacy Report
- SH – Stakeholders

The Narratives

Process	Activity
NERC1	The Regulator makes a request for the preparation and submission of the Load Forecasts (LF) from the Discos and Eligible Customers, and the Generation Forecasts from the Brown Field Generators, with templates for uniform submissions. The outputs of this activity are the Requests for Load Demand Forecast (RLDF) and the Request for Generation Forecast. The Discos and the Gencos are given 4 months to respond to the request. The request is made 4 months ahead of the mandatory time stipulated in the Market Rules
Discos +ECs 1	The Discos and ECs receive the request from NERC. The LFs are developed using the approved models, and submitted to NERC within the 4 months, in the requested format, accompanied with the relevant justifications for any assumptions. The output of this activity is the Load Demand Forecast (LDF).
NERC2	The Regulator reviews the LDF, using the Review Guide and following the associated procedures, within 6 weeks from the date of receipt. The submissions are approved, if the conditions for approval are satisfied. The output of this activity is the Approved Load Demand Forecast (ALDF), which is sent to the System Operator (SO), to produce the Load Projection Report (LPR).
Gencos 1	The Brown Field Generators receive the request from the Regulator. The Generation Forecasts (GF) are developed using the approved models, and submitted to NERC within 4 months, in the requested format, accompanied with the relevant justifications for any assumptions. The outputs of this activity are the GF.
NERC 3	The Regulator reviews the GF, using the Review Guide and following the associated procedures, within 6 weeks from the date of receipt. The submissions are approved, if the conditions for approval are satisfied. The output of this activity is the Approved Generation Forecast (AGF), which is sent to the Gencos to develop the Plant Maintenance Plan (PMP), and the System Operator (SO), to produce the Generation Projection Report.
Gencos 2	The Brown Field Generators receive the AGF from NERC and develop the Plant Maintenance Plans within 3 weeks, and these are sent back to NERC for approval

Process	Activity
SO(L/G)	The System Operator receives the approved Load Demand Forecast (ALDF) and the approved Generation Forecast (AGF) from NERC. The SO uses the ALDF to develop the Load Projection Report (LPR) and the Generation Forecast to develop the Generation Projection Report (GPR), using the relevant load and generation data, the approved models and relevant assumptions. The developed LPR and GPR are submitted to NERC, with the necessary supporting documents. The outputs of this activity are the Load Projection Report (LPR) and the Generation Projection Report (GPR).
NERC 4	The Regulator reviews the Plant Maintenance Plan, within 3 weeks, using the Review Guides and following the associated procedures. The Plans are approved, if the conditions for approval are satisfied. The outputs of this process, which are the approved Plant Maintenance Plans (APMP) are returned to the Gencos for implementation
NERC 5	The Regulator reviews the LPR and the GPR, within 3 weeks, using the Review Guides and following the associated procedures. The submissions are approved, if the conditions for approval are satisfied. The outputs of this activity are the Approved Load Projection Report (ALPR) and the Approved Generation Projection Report (AGPR), which are sent to the Market Operator (MO), to produce the Generation Adequacy Report (GAR). Also, the ALPR is sent to the Discos +ECs, the SO+TSP, and the SO for the development of the Expansion Plans
MO 1	The Market Operator (MO) receives the approved Load Projection and Generation Projection Reports from the Regulator. The MO uses the ALPR & AGPR to develop the Generation Adequacy Report (GAR), within 3 weeks, following the necessary procedures. The developed GAR is submitted to NERC, with the necessary supporting documents, For review and approval.
NERC 6	The Regulator reviews the Generation Adequacy Report (GAR), within 3 weeks, using the Review Guide and following the relevant procedures. In reviewing the GAR, the Regulator ensures consistency of the Report with the previous Reports (i.e. the AGPR and ALPR). The validity of the approach and methodology adopted, including the software employed in the analysis, are also verified and confirmed. The Generation Adequacy Report is approved, if the conditions for approval are satisfied. The output of this activity is the Approved Generation Adequacy Report (AGAR), which is sent to the Discos and the Eligible Customers for the development of the Distribution Expansion Plans, to the Transmission Services Provider (TSP) and the System Operator (SO) for the development of the Transmission Expansion Plan, to the System Operator (SO) for the development of the Generation Expansion Plan, and to the Nigeria Bulk Electricity Trader (NBET) to produce the Power Procurement Plan.
Discos +ECs 2, SO +TSP 1 and SO 2	The Discos and the ECs, the System Operator with the Transmission Service Provider (SO+TSP) and the System Operator SO, receive the Approved Load Projection and Generation Adequacy Reports from the Regulator. The Discos +ECs, the SO+TSP and the SO develop the Distribution Expansion Plans (DEP), the Transmission Expansion Plan (TEP) and the Generation Expansion Plan (GEP), respectively, within 8 weeks, using the approved models and following the relevant procedures, with the

Process	Activity
	issued templates. The developed Plans are submitted to NERC, with the necessary supporting documents, For review and approval.
NERC 7, 8 & 9 and NERC 10, 11 & 12	The Regulator receives the Expansion Plans from the Discos, ECs, and the SO and organizes a Stakeholder Engagement forum to present and discuss the system Plans. The Stakeholders comments are captured, and the Plans are reviewed and approved, all within 12 weeks from date of receipt, using the review Guide and following the relevant procedures. In reviewing the plans, the validity of the approach and methodology adopted, including the software employed in the analysis, are also verified and confirmed. Also, consistency with the forecast Reports are confirmed. The outputs of these activities are the AGEP, ATEP and ADEP. These approved Plans are sent to the Market Operator for transmission and system adequacy analysis, and for the preparation of the Transmission and System Adequacy Reports (TAR and SAR). It should be noted that the Stakeholders are very critical to the successful system planning and plan implementation
NBET 1	The Nigerian Electricity Bulk Trader (NBET) receives the AGAR and develops the Power Procurement Plan (PPP), for the procurement of the deficit capacity in the AGAR, within 3 weeks, following NERC's generation capacity procurement guidelines. The PPP is submitted to NERC for review and approval.
MO 2	The Market Operator receives the Expansion Plans from NERC, conducts the Adequacy Analysis and develops the Transmission and System Adequacy Reports, (TAR & SAR) within 3 weeks. These Reports are sent to the Regulator for review and approval
NERC 13	The Regulator reviews the TAR and SAR from the MO, using the Review Guide and following the relevant procedures. The Reports are approved, if the conditions for approval are satisfied. The outputs of this activity are the Approved Generation Expansion Plan, Approved Transmission Expansion Plan and the Approved Distribution Expansion Plan, which are sent to the Discos, the Eligible Customers, the System Operator and the Transmission Services Provider (TSP), for necessary implementation.
NERC 14	The Regulator receives the Power Procurement Plan from NBET, reviews it using the review Guide, and approves within 3 weeks, if the necessary conditions for approval are met. The output of this process, ie the Approved Power Procurement Plan (APPP), is returned back to NBET for implementation

All the Expansion Plans, including the Power Procurement Plan, are brought together under an integrated system adequacy analysis, to evaluate the efficacy and efficiency of the entire supply value chain, from production to consumption. The system adequacy analysis reviews the level of integration of all the power system resources, to achieve a coordinated System Plan

It should be noted that the responsibilities for the development of the system plans are those of the Market Participants, including the Transmission Service Provider (TSP), who own and operate the transmission network. The roles of the Service Providers (the Market and System

Operators) in system planning, are those of process analysis and report production, except NBET which produces the Plan for the procurement of additional power to maintain a demand – Supply balance. However, the roles of the Regulator are to:

- Manage the entire process of system planning, to ensure a robust system with proper integration and transparency
- Provide critical review of the system plans to ensure that they meet the required technical, legal and regulatory conditions
- Monitor project procurement, construction and operation of the system to ensure consistency with the approved plans
- Convene stakeholder engagements to secure adequate buy-in from the affected stakeholders, members of the public and civil society, for the approved investments

The Stakeholders play a critical role in System Planning by seeing to it that the interests of the public and civil society are protected in the development plans.

3. Key Components of power system planning

System Planning refers to the planning done to integrate new elements, such as generators, circuits, equipment or loads into the power grid. The purpose of planning is to ensure that the system will continue to operate reliably given changes to the system. System Planning is performed at both the distribution and transmission levels, and also incorporates new generation planning.

One of the power system planners' main goals is to verify that new system elements will not adversely affect stability of the power grid. Their other main goal is to assess the outcome of the proposed project(s) on the system and how the system will handle the new project(s), when implemented. As equipment is upgraded or load shifts, studies will be done to determine the effects of changes in the power system. Power system planning is a continuous process, and is typically carried out by a multidisciplinary department comprising of engineers, economists, statisticians, etc.

Many analytical tools currently used by System Planners have been developed specifically to address the relevant criteria for review and evaluation of power system. Planners' and Regulators' primary focus should be on least cost investments necessary to achieve certain level of system reliability and security of power supply.

The following approach is usually adopted in carrying out a power system analysis/study:

- Collect and validate data and then establish a credible (calibrated) base case power flow model using system analysis software such as NEPLAN, PSS/E, DigSILENT, etc.
- Model the defined scenarios using appropriate software
- Carry out system analysis as applicable – load/power flow analysis, contingency analysis, fault level analysis, and stability analysis, optimal power flow analysis, etc.
- Abstract the conclusions and recommendations from the analyses

The major components in the system analysis processes are: load forecast; load flow analysis; short circuit analysis; stability analysis; reliability analysis; and least-cost analysis. Briefly describe here are the key components of these system analysis processes, as well as the ancillary components of graphics, porting, and reporting.

3.1. Load Forecast/Projection

Load demand forecast is the starting point in assigning inputs for system studies. The licensees in the electricity industry, especially the load participants are expected to submit to the Regulator, forecast of future load demand in the respective areas of supply of each licensee for a projected period of years. Subsequently System Plans are all developed based on system studies results which are essentially based on load demand forecast.

The planners initially have to forecast the load increase in the future with past data, the trend, and the use of algorithms or formulation for calculating the future load growth in a given region. Load demand forecasting is about estimating future consumptions based on various data and information available and as per consumer behaviour. Load forecasts are extremely important for energy suppliers and other participants in electric generation, transmission, and distribution.

There is an array of methods and tools that are available today for forecasting demand. An appropriate method/tool is chosen by the licensee based on the nature of the data available, the desired nature and level of detail of the forecasts. In choosing the appropriate models and tools the following specifics could be considered:

a) Approach: Which modelling tradition does the model follow? Top-down, bottom-up, or hybrid approach.

b) Purpose: What is the main objective of the model?

c) Geographical coverage: Does the model consider urban-rural divide?

d) Activity coverage: Does the model cover any specific sector or is it a general purpose model?

e) Data requirement: How much data does the model require? What is the nature of data required for running the model?

f) Skill requirement: Does the model require any special skill set?

g) Versatility: Is it a country-specific model or a general model?

Some of the identified model approach and tools for demand forecasting include:

a. Simple Approaches

b. Sophisticated Approaches

a. Simple Approaches

This approach uses simple indicators, such as growth rate or specific consumption for forecasting.

i Growth Rate Based Method- The equation model is

$Dt = D_0(1+g)^t$

Where,

Dt is the Load demand in year t,
D0 is the Demand in the year 0,
g is the Growth rate of demand.

ii. Specific Consumption Method – Is the product of economic activity and unit of consumption for the activity

The equation is

E = A x U

Where E is the energy demand for the activity, A is level of activity and U is energy requirement per unit of activity.

iii. Regression Method – This is widely used statistical technique employed to model the relationship of load consumption and other factors such as weather condition, day types and customer classes.

b. Sophisticated Approaches

This model employs more advanced methodology using criteria such as Top-down and Bottom-up models.

The Top-down model tends to focus on an aggregated level of analysis while the Bottom-up model identify the homogenous activities or end-user for which demand is forecast.

Other classifications rely on the modelling philosophy as below:

- End-User model/approach – also known as the bottom-up approach focuses on end-users or final needs at a disaggregated level. It captures the impact of energy usage patterns of various devices and system focusing on the various uses in the residential, commercial, agricultural and industrial sectors of the economy. The following relation defines the End Use methodology for a sector:

E = S x N x P x H

E = energy consumption of an appliance in kWh

S = penetration level in terms of number of such appliances per customer

N = number of customers

P = power required by the appliance in kW

H = hours of appliance use.

- Trend model/approach – variables are predicted as a function of time rather than other economic, demographic, policy and technological variables. This function of time is obtained as the function that best explains the available data and suitable for short term projections

To make the review process easy, the Commission will need to standardize on the approach and tools to be adopted in developing load forecasts. So far, what is most common among Discos are: End User (Bottom Up), Simple Approach Growth Rate, and Regression.

3.2. Load Flow Analysis

The main objective of load flow analysis is to determine the adequacy or otherwise of the proposed transmission system expansion to evacuate the generation capability being built or has been committed. Load flow analyses are typically carried out under different scenarios to evaluate resultant voltage profiles and equipment loadings given proposed and committed projects. In a power system, power flows from generating station to the load through different branches of the network.

The flow of active and reactive power is known as load flow or power flow. Load flow analysis is an important tool used by power engineers for planning and determining the steady state operation of a power system. Power flow studies provide a systematic mathematical approach to determine the various bus voltages, phase angles, active and reactive power flows through different branches, generators, transformer settings, and load under steady state conditions. The power system is modelled by an electric circuit which consists of generators, transmission network, and distribution network.

3.3. Short Circuit Analysis

Network sequence data are added to the power flow model of the system for short circuit analysis. The verified and converged power flow model of the system is the starting point in the analysis.

The short circuit analysis is then carried out to determine fault current levels at the various buses within the interconnected system for the purpose of checking switchgear rating adequacy and for effective protective relay coordination and setting over the study period. Balanced three-phase short circuits and single-phase-to-ground faults are studied.

The fault levels include all installed and committed generators and an intact network (N-0). This combination results in the maximum fault levels that would be seen on the network at each node.

3.4. Stability Analysis

Stability studies are demanding and require an extensive array of more data to be added to the load flow model. Briefly, stability analyses seek to determine the limits of operation of the power system under normal and contingency situations in order to maintain synchronism of the system.

A power system is said to be stable if it returns to a steady-state or equilibrium condition following a disturbance. This criterion should hold true for all loading conditions and generation schedules. The network should be planned so that it has a high probability of remaining stable following all credible network disturbances. There are various types of stability criteria of the network. These include:

a. Transient Stability

This is the inherent ability of the power system to remain stable and maintain network synchronism when subjected to severe disturbances such as three-phase faults on power lines, loss of generation, loss of large load, etc. Such large disturbances need to be cleared in order to prevent network instability or physical damage to plant. A major factor affecting Transient Stability is the fault clearance time. The critical fault clearance time is the longest time a fault can be allowed to remain on the network, whilst maintaining network stability. Protection should be installed to ensure that the critical fault clearance times are achieved. **This is one of the Regulator's key considerations in the review process of system plans.**

b. Voltage Stability

Voltage instability most commonly results in voltage collapse, but may give rise to excessive high voltage levels under some conditions. Adequate and appropriate reactive power compensation should be provided to ensure that the power system is protected against all forms of voltage instability. This can include the use of shunt and series capacitor and /or reactors, etc. **The Regulator should ensure availability of this during the review process.**

c. Frequency Stability

Frequency stability criteria relates to recovery times for excursions of system frequency from the steady-state limits

To recover from the loss of a generating plant, there are two measures applied to bring back the failing frequency. These are:

- Spinning reserve
- Under frequency load shedding (UFLS)

Under frequency load shedding relays are installed at the 132/33kV substations to shed load at pre-determined levels of frequency, following loss of a major generating unit or its interconnection.

It is a requirement for power system security that about 75% of the system load be available for disconnection, under the automatic control of under frequency or under voltage relays, at any time, for system stability or to prevent a collapse of the system. **The Regulator should insist on this during the plan review.**

3.5. Reliability Analysis

Electrical power systems are very complex and highly integrated. Failure in any part of the system can cause interruptions of supply to end users in the immediate vicinity and can cascade to far-flung areas of the power system. Apart from the direct costs of supply interruption, such failure can lead to injury/fatality to personnel, damage to expensive power equipment, and adverse effects to the environment. Therefore, power system reliability is increasingly a concern to the power industry and society at large.

The term *reliability* has a wide range of meaning and cannot be associated with a single specific definition. Accordingly, power system reliability assessment can be divided into the following basic aspects: system availability, system adequacy, and system security.

"Reliability is defined as the probability that a component or system will perform its designated functions for a given period of time under the conditions in which it was designed to operate.

3.6. Least-Cost Analysis

The power system study aims at determining the timing, the type, and the location of the new or additional facilities – power plants, transmission and distribution lines, transformers, switchgear, compensation equipment, etc. – required to service a projected demand at defined quality of supply over the study horizon. The cost of these resources is then estimated to produce an investment plan; many cost models are available for this. For example, the cost of new transmission lines could be estimated on the basis of cost per unit length of the lines.

Power projects are invariably capital intensive with relatively long gestation periods. Against this background, "every cent counts." There is, therefore, the attendant need to a) minimize the investment required to service a given demand while at the same time b) maximising the system reliability and other benefits accruing from the investment.

Techniques have been derived and built into analysis software to grapple with the challenges and achieve optimal development of the power system. The methodologies used, especially in long-term (20-25 years) integrated expansion plans, are "Least Cost" and "Best Fit" analysis.

One approach to realize the Least-Cost and Best-Fit methodologies is Optimal Power Flow (OPF). In addition to the static load flow parameters of the network, cost parameters of scheduled generation, environmental costs, cost of losses, cost of transmission access, cost of unmet demand, etc., are included in the model to calculate the constrained power flow results. Because of the large body of data involved and the dynamic nature of the analyses, powerful algorithms have been developed to manage the iteration process and guarantee convergence to an optimal/economic solution.

Many other costs are associated with the development of an electric power system, such as economic, social, and environmental impact costs. These costs are, also, accommodated in the optimization processes and cost-benefit analysis.

4. Tool options for Power System Planning

Three options are recommended for the procedures and tools that NERC should use for the review and approval of plans, going forward. The tools should have the capability to evaluate the plans for compliance with requirements on a) adequacy for their purpose, b) reliability criteria, and c) cost minimization, among others, as described in previous sections.

Furthermore, the tools should have modules that analyse specific issues in generation, transmission, and distribution expansion plans, respectively, as well as integration and interface (G&T, T&D) capabilities.

Other useful features of the recommended tools are portability across sundry platforms, modularity, and scalability. Modularity and scalability means the possibility of buying the base model and separate additional modules as needed, to save cost. Portability means cross-export and import of models and results to and from other tools. For example, and as stated above, NEPLAN can export files in formats readable by PSS/E, MS Excel, etc., and can import (and read) files from PSS/E, MS Excel, etc.

Finally, the recommended tools should be available in two versions: single-user and multi-user. The single-user version can be implemented stand-alone on any compatible computer platform with its separate licence, while the multi-user version requires a server environment. To minimize the cost of acquiring the tools, we recommend the procurement of a multi-user version and two single-user versions. The single-user versions are necessary when, invariably, it becomes expedient for a NERC Engineer to work on system expansion plans outside the office. NERC will decide the number of users for the multi-user version. We recommend a dedicated system for the multi-user expansion plans review tools, with requisite backup schemes.

The three tools we recommend are NEPLAN, DIgSILENT, and PSS/E. The tools are described below.

4.1. NEPLAN

NEPLAN (short for Network PLAning) is one of the most complete planning, optimization and simulation tools for transmission, distribution, generation, and industrial networks. We list only the key modules relevant to the needs of NERC in overseeing system planning processes, procedures, and plans. Some of the key modules and their typical usage are described in section 4.4. Relevance of the key modules in power system analysis has been explained elsewhere in the report (e.g. section 4.1).

NEPLAN has the following modules, among others:

4.1.1. Base Modules

- Load Flow/Contingency Analysis
- Short Circuit Analysis
- Harmonic Analysis
- Investment Analysis
- Overcurrent Protection
- Distance Protection
- Reliability Analysis

4.1.2. Transmission Modules

These have the Base Modules in addition to the following:

- N-1 constrained Optimal Power Flow
- Voltage stability
- etc

4.1.3. Distribution Modules

They have the Base Modules in addition to the following:

- Load Forecast / Load profiles
- Optimization of Distribution Network
- Optimal Feeder Reinforcement
- Optimal Capacitor Placement
- Cable Thermal Analysis
- Low Voltage Calculation

4.2. DIgSILENT

DIgSILENT stands for "Digital SImuLation and Electrical NETwork calculation." It has the following modules:

4.2.1. Base Package

The Power Factory Base Package provides the following:

- Load Flow Analysis
- Short-Circuit Analysis
- Load Flow Sensitivities
- Basic MV/LV Network Analysis
- Power Equipment Models
- Network Model Management
- Network Diagrams and Graphic Features
- Results and Reporting

3. Various Data Converters

4.2.2. Advanced Modules

4. Contingency Analysis
5. Quasi-Dynamic Simulation
6. Protection Functions
7. Cable Analysis
8. Power Quality and Harmonic Analysis
9. Transmission Network Tools
10. Distribution Network Tools
11. Outage Planning
12. Reliability Analysis Functions
13. Optimal Power Flow (OPF)
14. Stability Analysis Functions (RMS)

DIgSILENT is particularly good for generation and other adequacy analyses, and the Commission should acquire this for its reviews.

4.3. PSS/E

Power System Simulation for Engineering (PSS/E) is an industry-standard tool with a comprehensive set of programs for studies of power system transmission network and generation performance in both steady-state and dynamic conditions. It has the following modules:

4.3.1. Standard Features

15. Load Flow Analysis
16. Integrated Node-breaker Network Representation
17. Network Reduction
18. Linear Analysis
19. Interactive Single-line Diagrams
20. Steady-state Stability (PV-QV)

4.3.2. Optional Add-On Modules

a. Analytical Modules

21. Dynamic Simulation
22. Short-circuit Analysis
23. Optimal Power Flow (OPF)
24. Transmission Line Parameter Calculation (LINEPROP)
25. Small Signal Stability Analysis
26. Advanced Contingency and RAS Tools

b. Modelling and Data Exchange/Interface Modules

- Measurement Interface
- Model Management
- Graphical Module Builder (GMB)
- CIM Importer
- PSS®E-PSCAD™ Data Conversion (E-TRAN)

c. Visualization Modules

- Data Visualization and Reporting (DVRM)

d. Enhanced Performance / Workflow Speedup Modules

4.4. Porting and Reporting

Portability means cross- export and import of models and results to and from other tools. For example, NEPLAN can export files in formats readable by PSS/E, MS Excel, etc., and can import (and read) files from PSS/E, MS Excel, etc.

The tools can output the results of the analyses as text, tables, and graphics, in various formats.

5. Key Modules of the Tools required for Reviewing System Plans

Not all the modules in the software tools are required in the processes and procedures for reviewing the expansion plans submitted by the Market Participants. Furthermore, different expansion plans need different set of modules. For example, transmission expansion plans need a different set of modules for their review, from the set needed by distribution expansion plans.

In the following tables, we list the set of modules from the three tools (software), required to review the different components of the system planning processes leading up to the expansion plans. These modules, we call Key Modules, and they are listed under the following key components and issues of the system planning: load flow analysis; short circuit analysis; stability analysis; reliability analysis; and least-cost analysis. In addition to these Key Modules, there are modules for graphics display, porting of network electronic models across software platforms, and reporting of results.

5.1. Key Modules for Reviewing Load Forecast/Projection

S/N	SYSTEM PLANNING COMPONENT	NEPLAN	DIGSILENT	PSS/E
1	LOAD FORECAST/PROJECTION	Load Forecast / Load profiles		

5.2. Key Modules for Reviewing Generation Expansion Plans

S/N	SYSTEM PLANNING COMPONENT	NEPLAN	DIGSILENT	PSS/E
1	LOAD FLOW	Load Flow/Contingency Analysis	Load Flow Analysis	Load Flow Analysis
			Load Flow Sensitivities	
2	SHORT CIRCUIT	Short Circuit Analysis	Short-Circuit Analysis	Short-circuit Analysis
3	STABILITY	Dynamic Simulator: RMS-Simulation	Contingency Analysis	Steady-state Stability (PV-QV)
		Dynamic Simulator: RMS, EMT, Phasor dynamics	Quasi-Dynamic Simulation	Dynamic Simulation
		Voltage Stability	Transmission Network Tools	Small Signal Stability Analysis

		Small signal Stability	Stability Analysis Functions (RMS)	Advanced Contingency and RAS Tools
			Small Signal Stability (Eigenvalue Analysis)	
4	RELIABILITY	Reliability Analysis	Reliability Analysis Functions	
			Probabilistic Analysis	
5	LEAST COST	Investment Analysis (present value)	Optimal Power Flow (OPF)	Optimal Power Flow (OPF)
		N-1 constrained Optimal Power Flow	Techno-Economical Analysis	Linear Analysis
		Available Transfer Capability Analysis (ATC)		
6	GRAPHICS	Variant Manage	Power Equipment Models	Interactive Single-line Diagrams
		Auxiliary Graphics	Network Model Management	Graphical Module Builder (GMB)
		Symbol-Editor	Network Diagrams and Graphic Features	Graphical Module Builder (GMB)
7	PORTING	SQL Database Connection	Various Data Converters	CIM Importer
		Library Manager		PSS®E-PSCAD™ Data Conversion (E-TRAN)
8	REPORTING	Chart Manager	Results and Reporting	Data Visualization and Reporting (DVRM)

5.3. Key Modules for Reviewing Transmission Expansion Plans

S/N	SYSTEM PLANNING COMPONENT	NEPLAN	DIGSILENT	PSS/E
1	LOAD FLOW	Load Flow/Contingency Analysis	Load Flow Analysis	Load Flow Analysis
			Load Flow Sensitivities	
2	SHORT CIRCUIT	Short Circuit Analysis	Short-Circuit Analysis	Short-circuit Analysis
3	STABILITY	Dynamic Simulator: RMS-Simulation	Contingency Analysis	Steady-state Stability (PV-QV)
		Dynamic Simulator: RMS, EMT, Phasor dynamics	Quasi-Dynamic Simulation	Dynamic Simulation
		Voltage Stability	Transmission Network Tools	Small Signal Stability Analysis
		Small signal Stability	Stability Analysis Functions (RMS)	Advanced Contingency and RAS Tools
			Small Signal Stability (Eigenvalue Analysis)	
4	RELIABILITY	Reliability Analysis	Reliability Analysis Functions	
5	LEAST COST	Investment Analysis (present value)	Optimal Power Flow (OPF)	Optimal Power Flow (OPF)
		N-1 constrained Optimal Power Flow	Techno-Economical Analysis	Linear Analysis
		Available Transfer Capability Analysis (ATC)		
6	GRAPHICS	Variant Manage	Power Equipment Models	Interactive Single-line Diagrams

		Auxiliary Graphics	Network Model Management	Graphical Module Builder (GMB)
		Symbol-Editor	Network Diagrams and Graphic Features	Graphical Module Builder (GMB)
7	PORTING	SQL Database Connection	Various Data Converters	CIM Importer
		Library Manager		PSS®E-PSCAD™ Data Conversion (E-TRAN)
8	REPORTING	Chart Manager	Results and Reporting	Data Visualization and Reporting (DVRM)

5.4. Key Modules for Reviewing Distribution Expansion Plans

S/N	SYSTEM PLANNING COMPONENT	NEPLAN	DIGSILENT	PSS/E
1	LOAD FLOW	Load Flow/Contingency Analysis	Load Flow Analysis	Load Flow Analysis
		Low-voltage calculation	Load Flow Sensitivities	
			Basic MV/LV Network Analysis	
			Cable Analysis	
			Distribution Network Tools	
2	SHORT CIRCUIT	Short Circuit Analysis	Short-Circuit Analysis	Short-circuit Analysis
		Fault Finding		
3	RELIABILITY	Reliability Analysis	Reliability Analysis Functions	
		Assessment of network disturbances		

4	LEAST COST	Investment Analysis (present value)	Optimal Power Flow (OPF)	Optimal Power Flow (OPF)
		Optimization of Distribution Network	Techno-Economical Analysis	Linear Analysis
		Optimal Feeder Reinforcement		
		Optimal Capacitor Placement		
5	GRAPHICS	Variant Manage	Power Equipment Models	Interactive Single-line Diagrams
		Auxiliary Graphics	Network Model Management	Graphical Module Builder (GMB)
		Symbol-Editor	Network Diagrams and Graphic Features	Graphical Module Builder (GMB)
6	PORTING	SQL Database Connection	Various Data Converters	CIM Importer
		Library Manager		PSS®E-PSCAD™ Data Conversion (E-TRAN)
7	REPORTING	Chart Manager	Results and Reporting	Data Visualization and Reporting (DVRM)

5.5. Key Modules for Reviewing Adequacy Reports

S/N	SYSTEM PLANNING COMPONENT	NEPLAN	DIGSILENT	PSS/E
1	LOAD FLOW	Load Flow/Contingency Analysis	Load Flow Analysis	Load Flow Analysis
			Load Flow Sensitivities	

2	SHORT CIRCUIT	Short Circuit Analysis	Short-Circuit Analysis	Short-circuit Analysis
3	STABILITY	Dynamic Simulator: RMS-Simulation	Contingency Analysis	Steady-state Stability (PV-QV)
		Dynamic Simulator: RMS, EMT, Phasor dynamics	Quasi-Dynamic Simulation	Dynamic Simulation
		Voltage Stability	Transmission Network Tools	Small Signal Stability Analysis
		Small signal Stability	Stability Analysis Functions (RMS)	Advanced Contingency and RAS Tools
			Small Signal Stability (Eigenvalue Analysis)	
4	RELIABILITY	Reliability Analysis	Reliability Analysis Functions	
			Probabilistic Analysis	
5	LEAST COST	Investment Analysis (present value)	Optimal Power Flow (OPF)	Optimal Power Flow (OPF)
		N-1 constrained Optimal Power Flow	Techno-Economical Analysis	Linear Analysis
		Available Transfer Capability Analysis (ATC)		
6	GRAPHICS	Variant Manage	Power Equipment Models	Interactive Single-line Diagrams
		Auxiliary Graphics	Network Model Management	Graphical Module Builder (GMB)
		Symbol-Editor	Network Diagrams and	Graphical Module Builder (GMB)

			Graphic Features	
7	PORTING	SQL Database Connection	Various Data Converters	CIM Importer
		Library Manager		PSS®E-PSCAD™ Data Conversion (E-TRAN)
8	REPORTING	Chart Manager	Results and Reporting	Data Visualization and Reporting (DVRM)

6. Key Issues and Considerations in the Review, Approval and Monitoring of System Plans

The objectives of power system planning, include adequate, efficient, economical and reliable power supply, and due consideration for the impact of system development on the environment. In short, the objectives of system planning are focused on maximizing reliability and minimizing costs of electricity supply. Expanding access to electricity by the populace is another objective, from government policy point of view. Therefore the key issues to consider in reviewing, approving and monitoring a system plan are those issues necessary to drive the maximization of reliability as well as minimization of cost of electricity supply. These are referred to as the **System Planning Criteria.** The system to be approved for implementation and operation should comply with these criteria. These criteria/conditions are:

- Definite Forecasted load
- Contingency criteria
- Steady state criteria
- Stability criteria
- Reliability criteria (security is one of the reliability criteria of the power system)
- Protection criteria
- Quality of service criteria
- Metering criteria – in accordance with the Metering Code
- Environmental criteria (this criteria also addresses the issue of safety in general)
- Affordability/Financial criteria
- Stakeholder engagement – inputs from the public and other interested parties

These criteria are discussed in some details as follows:

6.1. Definite Forecasted Load

The first crucial step for any system planning is to predict the consumption for the planning period, as all subsequent studies will be based on that. This process of predicting future consumption is referred to as Load Forecasting.

Some of the parameters affecting the forecasted load, which the Regulator should consider in the review process, include:

- Population
- Class and mix of customers (different classes of customers contribute to load growth differently)
- Economic indicators (eg, per capita income, GNP, GDP, etc.)
- Special events (TV programmes, football matches, public holidays, etc.)
- Weather (temperature and humidity)
- Electricity prices (if electricity price is predicted to be high, it may result in reduced forecasted load. However, this depends on the weather and the class of customers)

In reviewing the load forecast, the Regulator verifies the consistency of the forecasts and their compatibility with expected and historical growth. It is also the duty of the Regulator to rationalize the assumptions based on the above load driving parameters in the review exercise. He should consider the geographic details included in the load forecast, in the process. This refers to the locations and magnitudes of the forecasted loads, which will help to localize the generation capacity and the corresponding network infrastructure, to meet the load requirements.

6.2. Contingency Criteria

This relates to the ability of the network to be reconfigured after a fault, so that the un-faulted parts are restored. The system is planned so that the System Average Outage Duration (SAOD) is minimized. The network should also be planned so that loads can be transferred to adjacent feeders in the event of failure of any part. This is to ensure a system with high level of supply availability to the users.

In the process of reviewing the system plan, it is the duty of the Regulator to ensure that this criteria is planned for.

6.3. Steady State Criteria

This defines the adequacy of the network to supply the energy requirements of users with the ratings, frequency and voltage limits of the network elements, taking into accounts planned and un-planned outages. This is looking at the voltage, frequency and capacity limits for normal operations of the network. For example, this is referring to the safe loading, safe over voltage and under frequency limits for the normal operation of the system.

In planning a system, these criteria are very critical to be ensured of. Also, in reviewing the plan for approval and during the implementation and post-implementation monitoring, this should be considered by the Regulator.

6.4. Stability criteria

A power system is said to be stable if it returns to a steady-state or equilibrium condition following a disturbance. These criteria should hold true for all loading conditions and generation schedules. The network should be planned so that it has a high probability of remaining stable following all credible network disturbances. There are types of stability criteria of the network. These include:

6.4.1. Transient stability

This is the inherent ability of the power system to remain stable and maintain network synchronism when subjected to severe disturbances such as three-phase faults on power lines, loss of generation, loss of large load, etc. Such large disturbances need to be cleared in order to prevent network instability or physical damage to plant. A major factor affecting Transient Stability is the fault clearance time. The critical fault clearance time is the longest time a fault can be allowed to remain on the network, whilst maintaining network stability. Protection should be installed to ensure that the critical fault clearance times are achieved. This is one of the Regulator's key considerations in the review process of system plans.

6.4.2. Voltage Stability

Voltage instability most commonly results in voltage collapse, but may give rise to excessive high voltage levels under some conditions. Adequate and appropriate reactive power compensation should be provided to ensure that the power system is protected against all forms of voltage instability. This can include the use of shunt and series capacity and /or reactors, etc. The Regulator should ensure availability of this in the planned system during the review process.

6.4.3. Frequency Stability

Frequency stability criteria relates to recovery times for excursions of system frequency from the steady-state limits. The steady- state frequency limits for the Nigerian grid system is 50Hz + or – 2%. Any deviation from these limits is an excursion of the system frequency from the steady –state limits. Ability of the frequency to recover from such a disturbance, and the time taken to do so, is a stability criteria. To recover from the loss of a generating plant, there are two measures applied to bring back the failing frequency. These are:

- Spinning reserve

At all times, there is a balance between demand and supply of electricity (ie between load and generation) in the grid system. When a major generating unit or its interconnection trips off, the instantaneous balance between the load and generation is disturbed, resulting in low system frequency, that may eventually lead to system collapse. Spinning Reserves, which are generating units running without load, but can be made to synchronize to the system and pick load within microseconds, are provided in the plan to cancel the effect of the tripped generating unit on the system frequency

- Under frequency load shedding (UFLS)

Under frequency load shedding relays are installed at the 132/33KV substations to shed load at pre-determined levels of frequency, following loss of a major generating unit or its interconnection.

It is a requirement for power system security that about 75% of the system load be available for disconnection, under the automatic control of under frequency or under voltage relays, at any time, for system stability. The Regulator should insist on this during the plan review.

6.5. Reliability Criteria

Reliability is one of the most important criteria to be taken into consideration during all phases of power system planning, design and operations.

6.6. Quality of Supply Criteria

The transmission and distribution networks are analysed and reviewed to ensure satisfactory performance, in accordance with the quality of supply criteria, whenever a new load is connected. These criteria regulate the voltage and current waveforms in the network. The Regulator, in reviewing the plans, is required to verify what the planners have done in this regard.

6.7. Environmental Criteria

The Nigerian Power Sector recognizes and accepts its environmental responsibilities arising from the provision of electricity infrastructure. It therefore seeks to minimize the impacts of such works and comply with the relevant environmental regulations. In-spite of every effort to minimize the impacts of such constructions on the environment, there are usually some residue. Mitigation measures are always provided for such residual impacts. It is the responsibility of the Regulator to confirm that such mitigation measures are provided in the plan, as well as to ensure that they are implemented in accordance with the approved plan.

6.7.1. Social Issues

The ultimate impact of power system infrastructure development is positive, usually for the larger society, but there are some adverse effects on a fewer members of the community. Therefore, power system planners are required to consult with the relevant public bodies and community interest groups, and general public on the planning of new developments and facilities, to ensure that all those adversely affected are adequately compensated.

Compensation can be in many forms, including ensuring that the community is provided with electricity for its own development. The impact can be that of displacement of the community. It is the duty of the planners to ensure that the community is adequately resettled and assisted to set up new sources of livelihood, and the Regulator should confirm this in the review exercise.

6.7.2. Electromagnetic Field

It has been revealed that there are some adverse health effects from exposure to power frequency electric and magnetic fields. Power system planners are therefore required to act prudently in the planning, designing, construction and operation of all power system

equipment and facilities to maintain electromagnetic field exposure to the public and power employees at levels within the industry standards. The Regulator has to ensure compliance with this during the review process of the plans. He also should ensure this during monitoring of the construction and operation of the network.

6.7.3. Land-use Considerations

Planners should plan for safe and reliable operation of the electricity supply network, but with due regards to the natural, cultural and historical sites of the people. Damage to such sites should be minimized, and adequate compensation provided for any damage. For every project, the developers should develop a plan for land owners' compensation and resettlement. There must be an agreement with the land owners on the use of the land. The Regulator should ensure these, both in the review of the plans and in the monitoring of plan implementations and operations.

6.8. Financial Criteria

Expenditure on network extensions and reinforcements is supported by rigorous financial analysis. Least Cost and Best Fit options are selected, and the Regulator should ensure consistency with this.

6.9. Protection Criteria

The system Protection objectives requires that each party shall implement protection initiatives and standards that shall improve their system reliability with the least adverse effect on the interconnected network. All protective schemes and system shall be in accordance with internationally accepted standards, philosophies and performance. The Regulator should ensure that protection schemes are designed for reliable clearance of network faults in an effective manner and within acceptable time duration. The system shall also be secured against unwanted operation.

6.10. Stakeholder engagement

This is an opportunity for inputs from the public and other interested parties into the plan of the power system. Stakeholder engagement ensures transparent and inclusive consultation with the relevant bodies in system planning.

At the moment, stakeholder engagement is not a significant part of the system planning process in the Nigerian Electricity Industry. Going forward, this should be treated with every seriousness. It is at the stakeholder forum that issues on the social and environmental impacts of power projects, including the mitigation measures, are discussed and agreed. No project should therefore, be approved for implementation without evidence of stakeholder engagement on it, as well as the impact mitigation plan and the associated budget.

The impact mitigation plan should include the following items:

- Area of each type of land to be used
- Number of land owners in the area to be used
- Estimated cost for compensation for each type and position of land
- The resettlement plan (estimated number of households and manner of resettlement

- Estimated total amount to be paid for compensation and resettlement, and source of funds

7. Procedures for the Review and Approval of System Plans

7.1. Responsiveness of System Development Plans

This activity is the first stage in the system plan review exercise. The checks to be conducted to determine the responsiveness of a plan, include the following:

a. Documents - ensure that the documents are completed and properly submitted

b. Format of plan – ensure that the plans are submitted in the proper formats given by NERC

c. Submission date – ensure that the plans are submitted on or before the deadline for submission

d. Compliance - ensure that the development of plan complies with the high level process flow consistent with the requirements of the Grid Code, Market Rules, Distribution Code and Industry Best Practices.

Invariably, affected Market Participants will submit to NERC, the soft copies of the models they studied in the process of arriving at the plans they wish NERC to review and approve. Therefore, NERC Engineers will not need to create a model right from the beginning.

7.2. Procedures for Reviewing Load Demand Forecast from DisCos and ECs

Load Forecast is the first stage in planning any power system. It serves as an input for the most critical areas of system planning, namely, generation, transmission and distribution planning, and tariff setting. Load Forecast activity is performed and the Report produced by the Discos and the Eligible Customers.

The issues that affect the quality of load forecast in Nigeria are:

a. Accuracy in the estimation of suppressed load demands

b. High rate of estimated consumption

c. Uncertainty in the ATC&C Loss levels

d. Unavailability and unreliability of historical data

The procedures for reviewing the load demand forecast for approval involve the following:

a. Confirm responsiveness of the forecast Report

b. Confirm validity of the objectives of the Load Demand Forecast

c. Verify the reliability of the unconstrained Load data, i.e. the constrained load, the on-grid and off-grid suppressed load, and the load shedding data

d. Verify the suitability of the forecast framework (outlook years, data type and arrangement) and the validity of the assumptions

e. Check the reliability of the sources of the load data

f. Verify the suitability of the approach and methodology adopted in the forecast

g. Verify the models (eg equations) employed in the development of the forecasts

h. RUN the data and assumptions through the appropriate Module(s) of the Tool being used for the review, e.g. the Load Forecast / Load profiles Module in NEPLAN

i. Verify that the Results from NEPLAN agree reasonably well with the values submitted by the Market Participant (DisCos + ECs)

j. Confirm the output met the established objectives, as well as the other conditions necessary and sufficient, for the approval of the forecast, by NERC

The outcome of this activity is the approved load forecast report, which is sent to the System Operator, as the input into the Load Projection Report.

There must be a start and end date for the load forecast review and approval, every year.

7.3. Procedures for Reviewing Load Projection Report from the System Operator (SO)

The Load Projection Report is developed by the System Operator, with the approved Load Forecast Report as one of the inputs into the process, and sent to the Commission for review and approval. The Commission reviews the Load Projection Report (LPR) and approves if all the necessary conditions for approval are met.

The procedures for reviewing the Load Projection Report for approval involve the following:

a. Confirm responsiveness of the Load Projection Report

b. Confirm validity of the objectives of Load Projection Report in system planning

c. Confirm the key sectoral policies and activities examined by the SO to identify the trends affecting the growth of electricity consumption

d. Confirm the electricity tariffs considered as being capable of affecting the demand for electricity

e. Verify the key government policies and plans examined by the SO to determine their effects on electricity demand, e.g.
    i. Rural electrification plans
    ii. Energy efficiency and conservation policies

f. Verify model and assumptions employed

g. Check the approach and methodology adopted for validity

h. RUN the data and assumptions through the appropriate Module(s) of the Tool being used for the review,

i. Verify that the Results from the tool agree reasonably well with the values submitted by the SO

j. Confirm the output met the established objectives, as well as the other conditions necessary and sufficient for the approval of the forecast, by NERC

7.4. Procedures for Reviewing Generation Forecast from the Brown Field Generators

The Generation Forecast developed by the Brown Field Generators, and sent to the Commission for review and approval. The Commission reviews the Generation Forecast (GF) and approves if all the necessary conditions for approval are met

The procedures for reviewing the generation forecast for approval are as follows:

a. Confirm responsiveness of the Generation Forecast Report

b. Confirm validity of the objectives of the generation forecast in system planning

c. Confirm compliance with guidelines and Power Purchase Agreements (PPA)

d. Confirm historical generation availability

e. Verify installed plant capacity and average degradation over the years

f. Check the approach and methodology adopted in the forecast

g. Check the preliminary plant maintenance programme, including plant overhaul, costs and financing structure

h. Verify the impact of the maintenance work on grid stability, supply reliability and the overall benefits to the system

i. Verify any model employed and the associated assumptions

j. Generation forecast from the Brown Field Generators does not require review with NEPLAN or any tool

k. Confirm the output met the established objectives, as well as the other conditions necessary and sufficient for the approval of the forecast, by NERC

7.5. Procedures for Reviewing Plant Maintenance Plan (PMP) from the Brown Field Generators

The Plant Maintenance Plan Generation Forecast is developed by the Brown Field Generators, and sent to the Commission for review and approval. The Commission reviews the Plant Maintenance Plan (PMP) and approves if all the necessary conditions for approval are met

The procedures for reviewing the Plant Maintenance Plan for approval are as follows:

a. Confirm responsiveness of the submission on Plant Maintenance Plan

b. Confirm validity of the objectives of the plant maintenance plan in system planning
c. Confirm compliance with guidelines and Power Purchase Agreements (PPA)
d. Confirm historical generation availability
e. Verify installed plant capacity and average degradation over the years
f. Check the approach and methodology adopted in the maintenance plan
g. Check the preliminary plant maintenance programme, including plant overhaul, costs and financing structure
h. Verify the impact of the maintenance work on grid stability, supply reliability and the overall benefits to the system
i. Verify any model employed and the associated assumptions
j. Confirm the output of the plan met the established objectives, as well as the other conditions necessary and sufficient for the approval of the forecast, by NERC

7.6. Procedures for Reviewing Generation Projection Report from the System Operator (SO)

The Generation Projection Report is developed by the System Operator, with the approved Generation Forecast Report as one of the inputs into the process, and sent to the Commission for review and approval. The Commission reviews the Generation Projection Report (GPR) and approves if all the necessary conditions for approval are met

The procedures for reviewing the Generation Projection Report for approval are as follows:

a. Confirm responsiveness of the Generation Projection Report
b. Confirm validity of the objectives of Generation Projection Report in system planning
c. Confirm the Generation forecast from the Brown Field Generators, including the forecasting approach and methodology
d. Verify the key government policies considered capable of affecting generation capacity, going forward, e.g.
    i. Renewable energy generation policy
    ii. Energy efficiency and conservation policies (energy conserved is energy generated)
e. Verify the expected contracts for power
f. Verify any model and assumptions employed
g. Check the impacts of the new capacities on the retail tariffs for power
h. Check the approach and methodology adopted in the projection for validity
i. Confirm international Agreements for power imports

j. Generation Projection Report from the System Operator does not require review with NEPLAN or any other tool

k. Confirm the output met the established objectives, as well as the other conditions necessary and sufficient, for the approval of the Report, by NERC

7.7. Procedures for Reviewing Generation Adequacy Report from the Market Operator (MO)

The Generation Adequacy Report is developed by the Market Operator, with the approved Load Projection and Generation Projection Reports as the major inputs into the process, and sent to the Commission for review and approval. The Commission reviews the Generation Adequacy Report (GAR) and approves if all the necessary conditions for approval are met

The procedures for reviewing the GAR for approval are as follows:

a. Confirm responsiveness of the Generation Adequacy Report

b. Confirm validity of the objectives of Generation Adequacy Report in system planning

c. Check the approach and methodology adopted for validity

d. Verify data and assumptions

e. Compare gap/divergence between Approved Generation Projection Report (AGPR) and Approved Load Projection Report (ALPR)

f. Review model adopted in aligning AGPR and ALPR for convergence to generate GAR by the MO

g. Verify that requisite reliability criteria are met

h. Obtain the NEPLAN model(s) MO used to carry out the generation adequacy studies. If MO did not carry out the studies with the NEPLAN tool, require MO to export the model(s) to NEPLAN or to any other platform readable by NEPLAN

i. RUN the model(s) and verify that the Results from NEPLAN agree reasonably well with the values submitted by the MO

j. Confirm the output met the established objectives, as well as the other conditions necessary and sufficient for the approval of the Report, by NERC

7.8. Procedures for Reviewing Generation Expansion Plans from the System Operator (SO)

The Generation Expansion Plan is developed by the System Operator, with the approved Generation Adequacy Report as the major input into the process, and sent to the Commission for review and approval. The Commission reviews the Generation Expansion Plan (GEP) and approves if all the necessary conditions for approval are met

The procedures for reviewing the generation expansion plans from the System Operator for approval are as follows:

a. Confirm responsiveness of the Generation Expansion Plan submission
b. Confirm validity of the objectives of the Generation Expansion Plan (GEP)
c. Verify the Load and Generation Projections used in the GEP
d. Check for compliance with any Government policies on the power system
e. Verify sources and validity of data and assumptions
f. Verify the suitability of the approach and methodology adopted in the analyses and confirm that it is based on Least-Cost and considers environmental factors
g. Verify the model employed in the analyses
h. Obtain the NEPLAN model(s) the SO used to carry out the generation expansion planning studies. If the SO did not carry out the studies with the NEPLAN tool, require the SO to export the model(s) to NEPLAN or to any other platform readable by NEPLAN.
i. RUN the model(s) and verify that the Results from NEPLAN agree reasonably well with the values submitted by the SO
j. Verify the cost estimates and the investment plan
k. Confirm the output met the established objectives, as well as the other conditions necessary and sufficient for the approval of the GEP, by NERC

7.9. Procedures for Reviewing Transmission Expansion Plans from the Transmission Service Provider (TSP)

The Transmission Expansion Plan is developed by the System Operator, with the corporation of the Transmission Service Provider (TSP), with the approved Generation Adequacy Report and the approved Generation Expansion Plan as the major inputs into the process, and sent to the Commission for review and approval. The Commission reviews the Transmission Expansion Plan (TEP) and approves if all the necessary conditions for approval are met

The procedures for reviewing the TEP for approval are as follows:

a. Confirm responsiveness of the Transmission Expansion Plan submission
b. Confirm validity of the objectives of the Transmission Expansion Plan (TEP)
c. Verify the Load Projection used in the TEP
d. Verify the Generation Expansion Plan used
e. Check for compliance with any Government policies on the transmission system
f. Verify sources and validity of data and assumptions
g. Verify base case network/asset data

h. Verify the suitability of the approach and methodology adopted in the analyses and confirm that it is based on Least-Cost and considers environmental factors

i. Verify any models employed in the analyses

j. Obtain the NEPLAN model(s) the SO/TSP used to carry out the transmission expansion planning studies. If studies were not carried out with the NEPLAN tool, require the SO/TSP to export the model(s) to NEPLAN or to any other platform readable by NEPLAN.

k. RUN the model(s) and verify that the Results from NEPLAN agree reasonably well with the values submitted by the TSP

l. Verify the cost estimates and the investment plan

m. Confirm the output met the established objectives, as well as the other conditions necessary and sufficient, for the approval of the TEP, by NERC

7.10. Procedures for Reviewing Transmission Adequacy Report from the Market Operator

The Transmission Adequacy Report is developed by the Market Operator, with the approved Load Projection Report, Generation Projection Report, Generation Expansion Plan and Transmission Expansion Plan as the major inputs into the process, and sent to the Commission for review and approval. The Commission reviews the Transmission Adequacy Report (TAR) and approves if all the necessary conditions for approval are met

The procedures for reviewing the Transmission Adequacy Reports for approval are as follows:

a. Confirm responsiveness of the Transmission Adequacy Report

b. Confirm validity of the objectives of Transmission Adequacy Report in system planning

c. Verify the Load Projection used

d. Verify the Generation Expansion Plan used

e. Verify validity of data and assumptions

f. Verify the suitability of any model employed in the analyses

g. Verify that requisite reliability criteria are met

h. Obtain the NEPLAN model(s) MO used to carry out the Transmission Adequacy Analysis. If MO did not carry out the studies with the NEPLAN tool, require MO to export the model(s) to NEPLAN or to any other platform readable by NEPLAN.

i. RUN the model(s) and verify that the Results from NEPLAN agree reasonably well with the values submitted by the MO

j. Confirm the output met the established objectives, as well as the other conditions necessary and sufficient for the approval of the TAR, by NERC

k. Confirm there are no signs of congestion on the network

l. Confirm interconnection needs are captured

7.11. Procedures for Reviewing Distribution Expansion Plans from DisCos

The Distribution Expansion Plan is developed by the Distribution Companies, with the approved Generation Adequacy Report and the approved Load Projection Report as the major inputs into the process, and sent to the Commission for review and approval. The Commission reviews the Distribution Expansion Plan (DEP) and approves if all the necessary conditions for approval are met

The procedures for reviewing the DEP for approval are as follows:

a. Confirm responsiveness of the Distribution Expansion Plan submission

b. Confirm validity of the objectives of the Distribution Expansion Plan (DEP)

c. Check if system studies/modelling/analysis were performed by Discos using acceptable software and inputs from AGAR/ALPR scenarios before generating new capacity expansions and reinforcement projects

d. Check submission of associated single line drawings (existing and new network) on which system studies were performed

e. Check completeness of other Capital Investment Drivers (such as metering, rehabilitation works, Communication/Scada, Standardization of substations, Billings etc.)

f. Check for "Least Cost" and "Best Fit" considerations on projected investments plan

g. Check compliance with projection period for project delivery

h. Obtain the NEPLAN model(s) the DisCos used to carry out the distribution expansion planning studies. If the DisCos did not carry out the studies with the NEPLAN tool, require them to export the model(s) to NEPLAN or to any other platform readable by NEPLAN.

i. RUN the model(s) and verify that the Results from NEPLAN agree reasonably well with the values submitted by the the DisCos

j. Confirm the output met the established objectives, as well as the other conditions necessary and sufficient, for the approval of the Report, by NERC

7.12. Procedures for Reviewing System Adequacy Reports from the Market Operator

The System Adequacy Report is developed by the Market Operator, with the approved Generation Expansion Plan, Transmission Expansion Plan and the approved Distribution Expansion Plan as the major inputs into the process, and sent to the Commission for review and approval. The Commission reviews the System Adequacy Report (SAR) and approves if all the necessary conditions for approval are met

The procedures for reviewing the System Adequacy Report (SAR) for approval are as follows:

a. Confirm responsiveness of the System Adequacy Report
b. Confirm validity of the objectives of System Adequacy Report in system planning
c. Verify key Government and sectoral policies considered by the MO in preparing the SAR
d. Verify sources and validity of data and assumptions
e. Verify the suitability of the approach and methodology adopted in the analyses and confirm that it is based on integrated planning concepts
f. Verify the model employed in the analyses
g. Obtain the NEPLAN model(s) MO used to carry out the system adequacy studies. If MO did not carry out the studies with the NEPLAN tool, require MO to export the model(s) to NEPLAN or to any other platform readable by NEPLAN.
h. RUN the model(s) and verify that the Results from NEPLAN agree reasonably well with the values submitted by the MO
i. Confirm the output met the established objectives, as well as the other conditions necessary and sufficient, for the approval of the SAR, by NERC

7.13. Procedures for Reviewing Power Procurement Plan (PPP) from NBET

The Power Procurement Plan is developed by the Nigerian Electricity Bulk Trader (NBET), with the approved Generation Adequacy Report as the major input into the process, and sent to the Commission for review and approval. The Commission reviews the Power Procurement Plan (PPP) and approves if all the necessary conditions for approval are met

The procedures for reviewing Power Procurement Plan for approval are as follows:

a. Confirm responsiveness of the submission on Power Procurement Plan
b. Confirm validity of the objectives of the Power Procurement Plan (PPP)
c. Check for compliance with any Government policies on the power system
d. Verify compliance with the Guidelines provided by NERC for power procurement
e. Verify sources and validity of data and assumptions
f. Verify the cost estimates and the investment plan
g. Verify the procurement plan complies with other relevant procurement statutes
h. Confirm the output met the established objectives, as well as the other conditions necessary and sufficient, for the approval of the PPP, by NERC

7.14. Summary

The software tool options recommended for review and approval of generation, transmission, and distribution expansion plans by the SO, SO/TSP and DisCos, respectively, as well as the generation and transmission adequacy analyses by the Market Operator (MO), have been described.

It is recommended for the Commission to procure NEPLAN for reviewing transmission and distribution expansion plans; procure DIgSILENT for reviewing the adequacy reports as well as the generation expansion plans; and PSS/E as a sort of "check tool." NERC already has capability in NEPLAN. The NEPLAN toolkit is available elsewhere as well in the Nigerian power system.

The foregoing recommendations for acquisition by NERC notwithstanding, the imposition of any tools on the Market Participants is not recommended. However, it is recommended that the Market Participants be required to procure tools with the requisite features for their particular needs with the proviso that such tools must have export-import portability with the above three tools recommended to the Commission for acquisition.

8. Templates for the Review, Approval and Monitoring of System Plans

Two sets of Templates are described in this section: the Review Templates for reviewing and approving the system planning processes and plans in the Nigerian power sector, and the Project Monitoring Template for monitoring the implementation of the projects contained in the sundry approved power system expansion plans.

The Review Templates contain the procedures for reviewing the processes involved in all the components of power system planning, from load forecast to the development of system expansion plans for generation, transmission, and distribution. After these plans are satisfactorily subjected to the review procedures, the result is the approved plans for generation, transmission, and distribution –AGEP, ATEP, and ADEP, respectively. The Templates are shown hereunder (sections 8.1 – 8.11), while the key components of the sundry expansion plans to be reviewed are shown in the Templates in sections 8.12 to 8.14.

8.1. Review Template for Load Forecast by Discos and ECs

NAME OF PARTICIPANT				
S/N	**OBJECT**	**SCORE**	**Y/N**	**REMARKS**
A	**RESPONSIVENESS REQUIREMENTS**			

NAME OF PARTICIPANT				
S/N	**OBJECT**	**SCORE**	**Y/N**	**REMARKS**
A	Completeness of submitted documents (eg forecast spreadsheet)			
B	Promptness of Submission date			
C	Adequacy of the forecast outlook period			
D	Format for submission of Load Forecast Report			
B	**CHECK VALIDITY OF OBJECTIVES**			
	Assess the objectives of the participant for performing the forecast, and evaluate its validity			
C	**EVALUATIONS**			
a	Evaluate reliability of the un-constrained load data			
I	Base Load			
Ii	Suppressed Load			
iii	Load Shedding data			
B	Verify sources of Load data			
C	Evaluate suitability and validity of:			
I	Forecast Framework			
Ii	Forecast Assumptions			
iii	Forecast approach			
iv	Forecast Model			
D	Evaluate Results/Outputs			
	TOTAL SCORE			
	RECOMMENDATION			
	ASSESSMENT BY: NAME:…….. …….DESIGNATION…….. SIGN:……DATE……			
	REVIEWED BY:			

NAME OF PARTICIPANT				
S/N	**OBJECT**	**SCORE**	**Y/N**	**REMARKS**
	NAME:……DESIGNATION:…… SIGN:……..DATE:……			
	APPROVED BY: NAME:……DESIGNATION:…… SIGN:……DATE:……			

Narratives on Load Demand Forecast by DisCos and Eligible Customers

- Name of Participant: The load demand forecast is performed by the Discos and Eligible Customers, and this is submitted to NERC for review and subsequent approval. In the above template, the name of the market participant (Disco/Eligible Customer) should be clearly indicated.
- Check for Responsiveness: This is a check for the completeness of the documentations in the submission, as the load forecast Report. It is a check for the promptness in the submission, and for the correctness of the format in which the submission is made. It is also a check for the adequacy of the outlook period for the forecast. Absence of any document/item or presence in the wrong format, attracts a NO, while availability in the correct format attracts a YES score.
- Check validity of Objectives: In reviewing load demand forecast, check for the objectives of the participant for performing the forecast, and evaluate its validity. Such objectives may include to estimated future consumption of customers based on various relevant data and information available and as per consumer behavior. System expansion plans are all developed based on system studies results which are essentially based on Load Demand Forecast.
- Evaluation:
    - Verify reliability of the unconstrained load data: The reliability and authenticity of the unconstrained load data is verified considering the base load used for projection, existing suppressed load on the network, load shedding statistics and sources of data used for forecasting.
    - Verify suitability and validity: The suitability of the forecast framework and validity of the assumptions in performing the forecast are verified. Also the justification for the choice of forecast approach and models are evaluated.

All the above conditions are rated and scores allocated, according to the criteria agreed among the evaluators. If satisfactory, approval is granted by NERC for further necessary action.

8.2. Review Template for Load Projection Report by System Operator (SO)

NAME OF PARTICIPANT:				
S/N	**OBJECT**	**SCORE**	**Y/N**	**REMARKS**
A	**RESPONSIVENESS REQUIREMENTS**			
A	Compliance with the process flow requirements			
B	Use of load forecast Report			
C	Promptness of submission date			
D	Adequacy of forecast outlook			
B	**CHECK VALIDITY OF OBJECTIVES**			
A	Assess the objectives of the participant for performing the forecast, and evaluate its validity			
C	**EVALUATION**			
A	Evaluate key sectoral policies and activities examined to identify trends affecting growth of electricity consumption			
b	Evaluate the electricity tariffs considered as capable of affecting demand for electricity			
C	Evaluate the key government policies and plans examined to determine their impacts on electricity demand during the period			
I	Rural electrification plans			
Ii	Energy efficiency			
iii	Energy conservation policies			
iv	Others			

NAME OF PARTICIPANT:				
S/N	**OBJECT**	**SCORE**	**Y/N**	**REMARKS**
D	Verify quality of load data, including international connections for power exports			
E	Evaluate validity of approach			
F	Evaluate model and the associated assumptions			
G	Evaluate Results/Outputs			
	TOTAL SCORE			
	RECOMMENDATION			
	ASSESSMENT BY: NAME:……DESIGNATION…….. SIGN:……DATE……			
	REVIEWED BY: NAME:……..DESIGNATION:…… SIGN:……DATE:……			
	APPROVED BY: NAME:……..DESIGNATION:…… SIGN:……DATE:……			

Narratives on Load Projection by System Operator (SO)

- The Participant: The load projection analysis is performed by System Operator, and this is submitted to NERC for review and subsequent approval. In the above template, the name of the Participant, the SO should be clearly indicated.
- Check Responsiveness: In this, compliance of this activity with the integrated system planning process flow is confirmed, the regulated submission date is not violated. The proper input into the development of the Load Projection Report is the Load Demand Forecast Report from the Discos. The use of this input should be confirmed, as well as the data from the other sectors of the economy. Absence of any document/item or presence in the wrong format, attracts a NO, while availability in the correct format attracts a YES score.

- Check Validity of Objectives: In reviewing load projection, check for the objectives of the service provider in performing the Load projection. Essentially, this is a report showing the aggregation of the load data from the Discos' Load Forecast Reports and the forecasted loads from the various sectors of the economy.
- Evaluation:
    - Confirm if key sectoral policies and activities to identify major trends affecting power consumption growth in each sector were considered in producing the load projection report by the SO.
    - Tariff increase or decrease obviously affects electricity demand. The extent to which the electricity tariff changes during the period affected the demand for electricity in the preparation of load projection by the SO is evaluated.
    - The government policies and plans, such as rural electrification plans, energy efficiency program and energy conservation, examined by the SO in the projection electricity demand is evaluated.
    - Verify quality of all data, including international connections for power export, used in the analysis.
    - Check the validity of approach and methodology adopted by SO for the projection
    - The models and assumptions employed by the SO in producing the projection is evaluated

All the above conditions are rated and scores allocated, according to the criteria agreed among the evaluators. If satisfactory, approval is granted by NERC for further necessary

8.3. Review Template for Generation Forecast by GenCos

NAME OF PARTICIPANT:				
S/N	**OBJECT**	**SCORE**	**Y/N**	**REMARKS**
A	**RESPONSIVENESS REQUIREMENTS**			
A	Completeness of submitted documents (eg forecast spreadsheet)			
B	Promptness of Submission date			
C	Adequacy of the forecast outlook period			
D	Submission format			
B	**CHECK VALIDITY OF OBJECTIVES**			
A	Assess the objectives of the participant for performing the forecast, and evaluate its validity			

NAME OF PARTICIPANT:				
S/N	**OBJECT**	**SCORE**	**Y/N**	**REMARKS**
C	**EVALUATION**			
A	Confirm compliance with any guidelines and the requirements of the associated Power Purchase Agreement (PPA)			
B	Verify and evaluate historical generation availability			
C	Verify and evaluate installed plant capacity and average degradation over years			
D	Evaluate plant maintenance programme and financing structure			
E	Evaluate suitability of approach			
F	Evaluate Results/Outputs			
	TOTAL SCORE			
	RECOMMENDATION			
	ASSESSMENT BY: NAME:……..DESIGNATION…….. SIGN:……DATE……			
A	**REVIEWED BY:** NAME:……DESIGNATION:…… SIGN:……DATE:……			
B	**APPROVED BY:** NAME:……..DESIGNATION:…… SIGN:…….....DATE:……			

Narratives on Generation Forecast by GenCos

- Name of Participants: The Generation forecast is performed by the Brown Field Generators (Gencos). The forecast is submitted to NERC for review and subsequent

approval. In the above template, the name of the participant (Genco) should be clearly indicated.

- Check Responsiveness: This is a check for the completeness of the documentations in the submission, as the generation forecast Report. It is a check for the promptness in the submission, and for the correctness of the format in which the submission is made. It is also a check for the adequacy of the outlook period for the forecast. Absence of any document/item or presence in the wrong format, attracts a NO, while availability in the correct format attracts a YES score.
- Check validity of the Objectives: In reviewing generation forecast, check on the objectives of the participant for performing the forecast, and assess its validity. Such objectives may include to determine approximate generation capacity of the plant over the outlook years
    - Compliance with guidelines and power purchase agreement entered into by the Genco is confirmed and evaluated.
    - The historical generation trend and availability of the Genco generation plants for supply is confirmed, and evaluated with respect to the forecast.
    - The installed capacity of the plants and their average degradation over the years is assessed and evaluated with respect to the forecast.
    - Maintenance of thermal stations is scheduled during off-peak months of the years. For hydro stations, plants maintenance program is scheduled when there is no sufficient water to run the plants. Gencos are expected to prepare maintenance schedule of plants in their forecast showing unavailability. Adequacy of the maintenance programme is evaluated.
    - The suitability of approach and methodology used in the forecast is verified and evaluated.
    - Models and assumptions are employed in the preparation of forecast. The appropriateness of model adopted and associated assumptions are verified and evaluated.
    - Evaluate Results/Output

All the above conditions are rated and scores allocated, according to the criteria agreed among the evaluators. If satisfactory, approval is granted by NERC for further necessary action.

8.4. Review Template for Plant Maintenance Plan by the GenCos

NAME OF PARTICIPANT:				
S/N	**OBJECT**	**SCORE**	**Y/N**	**REMARKS**
A	**RESPONSIVENESS REQUIREMENTS**			
A	Completeness of submitted documents			
B	Promptness of Submission date			
C	Adequacy of the forecast outlook period			
	Documents submitted in the proper format or template issued by the Commission			
	Complies with the planning process flow			
B	**CHECK VALIDITY OF OBJECTIVES**			
	Assess the objectives of the participant for performing the forecast, and evaluate its validity. Such objectives may include:			
A	To comply with the PPA conditions			
B	To ensure plants are available to provide the required capacity, as and when due			
C	**EVALUATION**			
A	Verify the load forecast Report used in the development of the plan			
B	Evaluate sources and validity of data and any assumptions			
C	Evaluate the approach and methodology adopted in the analysis, and confirm it is based on least cost principles			
E	Verify cost estimates and evaluate the investment schedule			
F	Evaluate Results /Output			
	TOTAL SCORE			
	RECOMMENDATION			
	ASSESSMENT BY: NAME:……..DESIGNATION……			

NAME OF PARTICIPANT:				
S/N	**OBJECT**	**SCORE**	**Y/N**	**REMARKS**
	SIGN:……DATE:…… ….			
A	REVIEWED BY: NAME:……DESIGNATION:…… SIGN:……..DATE:…… …			
B	APPROVED BY: NAME:…….DESIGNATION:…… . SIGN:……...DATE:……. .			

Narratives on Generation Maintenance Plan by Gencos

- Name of Participant: The Generation Maintenance Plan is prepared by the Brown Field Generators (Gencos) for the maintenance of the plants. This plan is submitted to the Commission for review and subsequent approval. In the above template, the name of the participant (Genco) should be clearly indicated.
- Responsiveness requirements: This is a check for the completeness of the documentations in the submission. It is a check for the promptness in the submission, and for the correctness of the format in which the submission is made. It is also a check for the adequacy of the outlook period for the plan. It is a check to ensure that the submission is consistent with the process flow. Absence of any document/item or presence in the wrong format, attracts a NO, while availability in the correct format attracts a YES score.
- Check validity of the objectives: In reviewing the generation maintenance plan, check on the validity of the objectives of the Participant for preparing the plan. Such objectives may include to have knowledge of the types of maintenance the plants can be subjected to and the capacity that can be made available through the maintenance program. Another objective may be to have a knowledge of the expenditure on the plants during the period for the purpose of financial management and tariff determination.
- Evaluation:
    - Verify the Generation forecast used in developing the plan.
    - Verify application of the least cost principle.

- Evaluate compliance with the relevant conditions of the Power Purchase Agreement
- Verify Cost Estimates and Investment Plan.
- Evaluate the results and outputs of the plan

All the above conditions are rated and scores allocated, according to agreed criteria. If satisfactory, approval is granted by NERC for further necessary action.

8.5. Review Template for Generation Projection Report by System Operator

NAME OF PARTICIPANT:				
S/N	**OBJECT**	**SCORE**	**Y/N**	**REMARKS**
A	**RESPONSIVENESS REQUIREMENTS**			
A	Completeness of submitted documents			
B	Promptness of Submission date			
C	Adequacy of the forecast outlook period			
D	Documents submitted in the proper format or template issued by the Commission			
E	Complies with the planning process flow			
B	**CHECK VALIDITY OF OBJECTIVES**			
	Assess the objectives of the participant for performing the forecast, and evaluate its validity			
	EVALUATION			
A	Confirm Generation Forecast from the Brown Field Generators for conducting the projection			
B	Verify and evaluate the key Government policies on power considered in the projection,			
I	Renewable energy generation			
Ii	Energy efficiency and conservation policies			
5	Evaluate any potential contracts for power			
6	Evaluate the impacts of the new capacities on the retail tariff for power			
7	Evaluate the approach and methodology adopted in the projection			

NAME OF PARTICIPANT:				
S/N	**OBJECT**	**SCORE**	**Y/N**	**REMARKS**
8	Verify and evaluate the model and assumptions employed			
9	Evaluate the Results and Outputs of the projection			
	TOTAL SCORE			
	RECOMMENDATION			
A	**ASSESSMENT BY:** Name:……DESIGNATION…… SIGN:……DATE…….			
	REVIEWED BY: NAME: ……..DESIGNATION:…… SIGN: ……DATE:……..			
B	**APPROVED BY:** NAME:……..DESIGNATION:…….. SIGN:……DATE:……			

Narratives on Generation Projection by System Operator (SO)

- Name of Participant: The generation projection is performed by the System Operator, and this is submitted to NERC for review and subsequent approval. In the above Template, the name of the Participant, ie the SO should be clearly indicated.
- Responsiveness Requirements: This is a check for the completeness of the documentations in the submission, as the generation projection Report. It is a check for the promptness in the submission, and for the correctness of the format in which the submission is made. It is also a check for the adequacy of the outlook period for the projection. It is also a check to ensure that the submission is consistent with the process flow. Absence of any document/item or presence in the wrong format, attracts a NO, while availability in the correct format attracts a YES score.
- Confirm validity of the objectives: In reviewing generation projection report produced by the SO check on the validity of objectives of the Participant for performing the

projection. Such objectives may include to determine the generation capacity estimate for the country, including the technology mix, over the outlook years.

- Evaluation:
    - Generation forecast from the Gencos is part of the input required in developing the projection. This is confirmed and evaluated in the review process of the projection.
    - There are some key government policies considered capable of generally affecting generation capacity e.g. renewable energy policies, energy efficiency and conservation program, revocation of generation license and possible shut downs. These government policies affect generation capacity in the projection. These policies are verified and the extent to which they affected the projection is evaluated in the review process.
    - There are some licensed green field power plant projects expected to be in operation that are considered in the generation projection report. Contracts for the expected power plants are verified and evaluated.
    - The impacts of the expected generation capacities on the retail tariff regime is checked and evaluated.
    - The approach, methodology, model and assumptions employed in the generation projection analysis are evaluated.
    - The results and outputs are evaluated

All the above conditions are rated and scores allocated, according to agreed criteria. If satisfactory, approval is granted by NERC for further necessary action.

8.6. Review Template for Transmission Expansion Plan by TCN and Associated Comments by NESI Stakeholders

NAME OF PARTICIPANT:				
S/N	**OBJECT**	**SCORE**	**Y/N**	**REMARKS**
A	**RESPONSIVENESS REQUIREMENTS**			
A	Submission Date in line with the provision of the Grid Code and Market Rules			
B	Documents are submitted in the proper formats or templates issued by the Commission			
C	Expansion Plan Study Horizon complied with			
D	Approved Software used			
E	Simulation Report submitted			

NAME OF PARTICIPANT:				
S/N	**OBJECT**	**SCORE**	**Y/N**	**REMARKS**
F	Confirm consistency with the integrated system planning process flow			
B	**CHECK VALIDITY OF OBJECTIVES**			
	Assess the objectives of the participant for performing the forecast, and evaluate its validity			
C	**EVALUATION**			
A	Verify and evaluate the load projection and generation projection used in the Generation Adequacy Report considered for the Transmission Expansion Plan			
B	Check for compliance with any government policies on the power system			
C	Verify and evaluate sources and validity of data and assumptions			
D	Verify and evaluate the base case network data			
E	Evaluate the approach and methodology adopted in the analysis, and confirm it based on least cost principles and considers environmental factors			
F	Evaluate the model employed in the analysis			
G	Verify the cost estimates and evaluate the investment plan			
H	Verify and evaluate stakeholder engagement in the planning process			
I	Evaluate validity of Results/Outputs			
	TOTAL SCORE			
	RECOMMENDATION			
	ASSESSMENT BY: NAME:……DESIGNATION…….			

NAME OF PARTICIPANT:				
S/N	**OBJECT**	**SCORE**	**Y/N**	**REMARKS**
	SIGN:……DATE……			
	REVIEWED BY: NAME:……..DESIGNATION:…….. SIGN:…….DATE:……..			
	APPROVED BY: NAME:…….DESIGNATION:……. SIGN:……DATE:……			

Narratives on Transmission Expansion Plan by the System Operator and Associated Comments by NESI Stakeholders

- Name of Participant: The Transmission Expansion Plan is prepared by System Operator with the cooperation of the Transmission Service Provider. This plan is submitted to NERC for review and subsequent approval. In the above Template, the name of the Participant should be clearly indicated.
- Responsiveness Requirements: This is a check for the completeness of the documentations in the submission. It is a check for the promptness in the submission, and for the correctness of the format in which the submission is made. It is also a check for the adequacy of the outlook period for the plan, as well as a check for compliance with the requirements of the integrated system planning process flow. Absence of any document/item or presence in the wrong format, attracts a NO, while availability in the correct format attracts a YES score.
- Check validity of Objectives: In reviewing the Transmission Expansion Plan, check on the objectives of the Participants in preparing the plan is conducted and evaluated. Essentially, one of the objectives of Transmission planning is to seek to determine the minimum investment required to integrate new generation into the Grid and evacuate the power to bulk load centres, while maintaining the integrity of the Grid. Other objectives may be to ensure that the proposed transmission infrastructure is provided at the minimum possible cost, with minimum losses and with adequate considerations for the impacts on the environment.
- Evaluation:

- Part of the main input in developing Transmission Expansion Plan is the approved Generation Adequacy Report (GAR) developed from load projection and generation projection reports. The input GAR is verified and evaluated.
- Evaluate compliance with government policies on the power system. For example, one of the policies of government could be to ensure that every state in the country is provided with a 330/132KV transmission substation. Such policies are checked and evaluated in the review process.
- Simulations are performed in developing the transmission plan requiring network data and necessary assumptions. The sources and validity of these data and associated assumptions are verified and evaluated in the review process.
- The suitability of approach and methodology in the Least – Cost analysis with consideration of environmental factors, in the planning process is verified and evaluated.
- There are key software modules available in developing the Transmission plan e.g. Load flow, Short Circuit, Stability and Reliability Analysis. The model/modules employed in the analysis are verified and evaluated.
- The cost of transmission assets is estimated to produce an investment plan. Many cost models are available for estimation. For example, the cost of new transmission lines could be estimated on the basis of cost per unit length of the lines. Also assumptions based on recent trends in capital transmission project costs could be employed. The cost estimates are verified and the investment plan is evaluated.
- The transmission expansion plan prepared by the SO based on the approved generation adequacy report is presented to stakeholders for comments. The engagement of the Stakeholders in the planning process should be assessed and impacts on the plan evaluated.
- Evaluate the results and outputs of the plan

All the above conditions are rated and scores allocated, according to agreed criteria. If satisfactory, approval is granted by NERC for further necessary action

8.7. Review Template for Distribution Expansion Plan by DisCos and Associated Comments by NESI Stakeholders

NAME OF PARTICIPANT:				
S/N	**OBJECT**	**SCORE**	**Y/N**	**REMARKS**

A.	RESPONSIVENESS REQUIREMENTS			
i.	Distribution Expansion Plan Report			
ii.	Submission Date in line with the provision of the Distribution Code			
iii.	Documents are submitted in the proper formats or templates issued by the Commission			
Iv	Compliance: Planning Process Flow Diagram			
V	Expansion Plan Study Horizon			
Vi	Approved Software			
Vii	Simulation Report			
Viii	Availability of Energy and Demand Study Report			
B	**CHECK VALIDITY OF OBJECTIVES**			
	Such Objectives of Distribution expansion plan may be:			
a	To enable the planning, design and construction of the Distribution System for Reliability and affordability			
b	To facilitate connection by distribution network Users.			
C	To set technical standards for use at all relevant interfaces.			
d	To achieve coordination in the development, maintenance and operation of the Distribution System.			
e	To ascertain compliance with the Least Cost – Best Fit Principles and environmental factors			
C	**EVALUATION**			
a	Load Demand Forecast (LDF) for Consistency.			
b	Single Line Diagram			
c	Simulation for The Horizon Period			
d	Summary of Simulation Result			

e	Analysis of Result			
f	Suitability of approach and methodology adopted in the study			
g	Compare Investment Plan With The Result of The Analysis			
h	Least Costs and Best Fit Consideration, and environmental factors			
i	Verify cost estimate and evaluate investment plan			
	TOTAL SCORE			
	RECOMMENDATION			
	ASSESSMENT DONE BY: NAME: …… DESIGNATION:…… SIGN: …… DATE:……			
	REVIEWED BY: NAME: …… DESIGNATION:…… SIGN: …… DATE:……			
	APPROVED BY: NAME: …… DESIGNATION:…… SIGN: …… DATE:……			

Narratives on Distribution Expansion Plan by Discos

- Name of Participant: The Distribution expansion plan is prepared by Discos, and submitted to NERC for review and subsequent approval. In the above Template, the name of the participant (Disco) should be clearly indicated.
- Check for Responsiveness:
    - This is a check for the completeness of the documentations in the submission, as the Distribution Expansion Plan.
    - It is a check for the promptness in the submission, and for the correctness of the format in which the submission is made.
    - It is also a check for the adequacy of the plan period.

- Checks are carried out on the submission of single line drawings showing existing and new network studied.
- There are works on other key components in the capital investment drivers (such as metering, rehabilitation works, standardization of substations, billing, etc) required as part of the Expansion Plan by the Discos, in addition to the items generated from the system studies. Checks on the completeness of these key components are carried out.
- Absence of any document/item or presence in the wrong format, attracts a NO, while availability in the correct format attracts a YES score.

- Check validity of Objectives:
  - In reviewing the Distribution Expansion Plan, a check is conducted to confirm the validity of the objectives for developing the plan by the participant.
  - Essentially, such objectives may include a study of the existing load situation, identification of areas where any form of network violation exists and where network reinforcement or expansion is required.
  - The objective can also include to prepare the cost implication of proposed expansion program. Compliance with least Cost – Best Fit principles and the environmental requirements are confirmed
- Evaluation:
  - Evaluations are carried out on the load forecast report, and the single line diagram, including the line characteristics, used in developing the network model.
  - The sources of data and the validity of the associated assumptions are verified and evaluated.
  - Evaluations are also carried out on the network modeling, system studies performed for the expansion plan. The tool (eg NEPLAN or PSS/E or DigSiLent) employed for simulation is evaluated, the results of the simulation and the analysis of the simulation results are also evaluated.
  - Works on the other key components in the capital investment drivers are evaluated.
  - The suitability of approach and methodology adopted in the Least – Cost analysis, along with consideration of environmental factors is evaluated.
  - Cost Estimates and Investment Plan: The cost of distribution assets is estimated to produce an investment plan. Many cost models are available for estimation. For example, the cost of new distribution lines could be estimated on the basis of cost per unit length of the lines. Also assumptions based on recent trends in capital distribution project costs could be employed.

Verifications of the cost estimates and evaluation of the investment plan are carried out in the review process.

- Stakeholder Comments: The distribution expansion plan prepared by the Discos based on the approved generation adequacy and load projection reports is presented to stakeholders for comments. All the comments are sort, collated, checked for correctness, acceptability, appropriateness and others during the review process.
- Modify relevant subject areas of distribution expansion plan for approval: the Stakeholder Comments are captured and the relevant areas of the plan are modified accordingly for approval.

All the above conditions are rated and scores allocated. If satisfactory, approval is granted by NERC for further necessary action.

8.8. Review Template for Power Procurement Plan by NBET

NAME OF PARTICIPANT:				
S/N	**OBJECT**	**SCORE**	**Y/N**	**REMARKS**
A	**RESPONSIVENES REQUIREMENTS**			
A	Completeness of submitted documents			
B	Promptness of Submission date			
C	Adequacy of the forecast outlook period			
D	Documents submitted in the proper format or template issued by the Commission			
E	Complies with the planning process flow			
B	**CHECK VALIDITY OF OBJECTIVES**			
	Assess the objectives of the participant for performing the forecast, and evaluate its validity			
C	**EVALUATION**			
A	Sources and validity of any data and Assumptions			
B	The cost estimate and Investment Plan			
C	Compliance of the procurement plan with the procurement statues			
	TOTAL SCORE			
	RECOMMENDATION			
	ASSESSMENT BY: NAME:……..DESIGNATION:……			

NAME OF PARTICIPANT:				
S/N	**OBJECT**	**SCORE**	**Y/N**	**REMARKS**
	SIGN:……DATE: …….			
	REVIEWED BY: NAME:…….DESIGNATION SIGN:……DATE…….			
	APPROVED BY: NAME:……..DESIGNATION…….. SIGN:……. DATE……			

Narratives on Power Procurement Plan by NBET

- Name of Participant: The Power procurement plan is prepared by NBET, and this is submitted to NERC for review and subsequent approval. In the above Template, the name of the Participant (NBET) should be clearly indicated.
- Responsiveness Requirements: this requires that all the information needed in the submission are complete and in the correct format. There is also the requirement that the plan should be submitted promptly. These requirements should be checked.
- Check validity of objectives: In reviewing the power procurement plan, a check is conducted to confirm the validity of the objectives for developing the plan, by the participant. Such objective may include to determine the generation capacity requirements, in terms of capacity, technology and location to close any gap in the supply-demand balance for the sector.

- Evaluation:
    - One of the major inputs in developing the procurement plan by NBET is the approved generation adequacy report. This and other data required by NBET in developing the plan and any associated assumptions should be verified and evaluated.
    - There are some guiding principles and rules provided in the procurement statutes/act (BPP) that require strict compliance. Also, the procurement guideline provided by the Commission should be complied with in developing the plan. These compliances should be verified and evaluated in the review process.

- Evaluate the results and outputs of the plan

All the above conditions are rated and scores allocated, in line with the agreed criteria. If satisfactory, approval is granted by NERC for further necessary action.

8.9. Review Template for Generation Adequacy Analysis by Market Operator

NAME OF PARTICIPANT				
S/N	**OBJECT**	**SCORE**	**Y/N**	**REMARKS**
A	**RESPONSIVENESS REQUIREMENTS**			
A	Check availability and use of the AGPR and ALPR in the analysis			
B	Check to confirm submission is prompt			
C	Confirm compliance with the system planning process flow			
B	**CHECK VALIDITY OF OBJECTIVES**			
	Check to confirm the validity of the objectives of the participant in conducting the analysis			
C	**EVALUATION**			
A	Review the divergence between AGPR and ALPR established by the MO in a generation adequacy report. The methodology adopted in establishing the gap is evaluated.			
B	Evaluate the Results/Outputs of the Generation Adequacy Analysis			
	TOTAL SCORE			
	RECOMMENDATION			
	ASSESSMENT BY: NAME:……DESIGNATION…….. SIGN:……..DATE:……..			
	REVIEWED BY: NAME:……DESIGNATION:…… … SIGN:……DATE:…… ….			
	APPROVED BY: NAME:……DESIGNATION:……			

NAME OF PARTICIPANT				
S/N	**OBJECT**	**SCORE**	**Y/N**	**REMARKS**
	SIGN:……DATE:……..			

Narratives on Generation Adequacy Analysis/Report by Market Operator (MO)

- Name of Participant: The Generation Adequacy Analysis/Report is prepared by Market Operator (MO), and it is submitted to NERC for review and subsequent approval. In the above Template, the name of the Participant (the MO) should be clearly indicated.
- Responsiveness Requirements: This is a check to ensure that all the requirement to enable adequate analysis of the approved Load and Generation Projections for Generation Adequacy, are provided and utilized. Such requirements include, the Load Projection Report, Generation Projection Report. This is also a check for the promptness of the submission, as well as a check to ensure that the required outlook period is complied with.
- Check validity of the objectives for generation adequacy analysis: In reviewing the generation adequacy analysis, there should be a check to confirm the validity of the objectives of the participant in conducting the analysis. Essentially the objective of the generation adequacy report may be to review any approved generation projection to determine whether total generation in the projection report satisfies the total demand reliably, assuming no transmission or distribution constraints, while at the same time providing requisite operating reserve to ensure system stability. If there is no balance between projected generation and the projected load, the actual capacity gap established is checked.
- Evaluation:
    - The divergence between AGPR and ALPR is established by the MO in a generation adequacy report. The methodology adopted in establishing the gap is evaluated.
    - Checks are conducted on the processes, and the results and outputs are evaluated

All the above conditions are rated and scores allocated, according to agreed criteria. If satisfactory, approval is granted by NERC for further necessary action.

8.10. Review Template for Transmission Adequacy Analysis by Market Operator

NAME OF PARTICIPANT:				
S/N	**OBJECT**	**SCORE**	**Y/N**	**REMARKS**
A	**RESPONSIVENESS REQUIREMENTS**			
A	Check to ensure that submission of the report is prompt			
B	Check to ensure that transmission expansion plan, generation expansion plan and the load projection report were available and used for the analysis			
C	Confirm compliance with the system planning process flow			
B	**CHECK VALIDITY OF OBJECTIVES**			
A	Check to confirm the validity of the objectives of the participant in conducting the analysis			
	EVALUTION			
A	Evaluate the adequacy of the transmission infrastructure to evacuate the projected generation capacity as well as to supply the projected loads, in magnitude, time and location			
B	Evaluate the methodology adopted in conducting the analysis			
C	Evaluate the Results/Outputs of the Transmission Adequacy Analysis			
	TOTAL SCORE			
	RECOMMENDATION			
	ASSESSMENT BY: NAME:……DESIGNATION:…….. SIGN:……..DATE:……			
	REVIEWED BY: NAME:……DESIGNATION:…….. SIGN:……DATE:……			
B	APPROVED BY: NAME:……..DESIGNATION:……			

NAME OF PARTICIPANT:				
S/N	**OBJECT**	**SCORE**	**Y/N**	**REMARKS**
	SIGN:……....DATE:…… …..			

Narratives on Transmission Adequacy Analysis/Report by Market Operator (MO)

- Name of Participant: The Transmission Adequacy Analysis/Report is prepared by Market Operator (MO), and submitted to NERC for review and subsequent approval. In the above Template, the name of the Participant (the MO) should be clearly indicated.
- Responsiveness Requirements: This is a check to ensure that all the requirement to enable adequate analysis of the transmission expansion plan for Transmission Adequacy, are provided and utilized. Such requirements include, the Transmission Expansion Plan, Generation Expansion Plan and Load Projection Report. This is also a check for the promptness of the submission, as well as a check to ensure that the required outlook period is complied with.
- Check validity of Objectives: In reviewing the transmission adequacy analysis, check on the objectives of the Market Operator in preparing the adequacy report is conducted. Essentially the objective of the transmission adequacy report may be to determine adequacy and capability of the transmission system to reliably transmit electrical power from the generation stations to the loads centres, throughout the grid.
- Evaluation:
    - The adequacy of the transmission network to evacuate the projected generation capacity as well as to supply the projected loads, in magnitude, time and location in evaluated
    - The divergence between the ATEP and AGEP with respect to the projected load demand in the transmission adequacy analysis is evaluated. The model adopted in the analysis is also evaluated.
    - Checks are conducted on the processes, and the results and outputs are evaluated

All the above conditions are rated and scores allocated, according to agreed criteria. If satisfactory, approval is granted by NERC for further necessary action.

8.11. Review Template for System Adequacy Analysis by Market Operator

NAME OF PARTICIPANT:				
S/N	**OBJECT**	**SCORE**	**Y/N**	**REMARKS**
A	**RESPONSIVENESS REQUIREMENTS**			
A	Check to ensure that submission of the report is prompt			
B	Check to ensure that transmission expansion plan, generation expansion plan, distribution expansion plan and the load projection report were available and used for the analysis			
C	Confirm compliance with the system planning process flow			
B	**CHECK VALIDITY OF OBJECTIVES**			
	Check to confirm the validity of the objectives of the participant in conducting the analysis			
C	**EVALUATION**			
A	Verify and evaluate the key government and sectoral policies considered by the MO in preparing the System Adequacy Report			
B	Verify and evaluate sources and validity of data and assumptions used in the analysis			
C	Verify and evaluate the approach and methodology adopted in the analysis. Evaluate compliance with the integrated planning concepts			
D	Review the process and evaluate the results/outputs			
	TOTAL SCORE			
	RECOMMENDATION			
	ASSESSMENT BY: NAME:…….DESIGNATION……. SIGN:…….DATE…….			
A	REVIEWED BY: NAME:…….DESIGNATION:…… . SIGN:……DATE:……..			
B	APPROVED BY: NAME:……DESIGNATION:……. .			

NAME OF PARTICIPANT:				
S/N	**OBJECT**	**SCORE**	**Y/N**	**REMARKS**
	SIGN:……DATE:……			

Narratives on System Adequacy Analysis/Report by Market Operator (MO)

- Name of Participant::The System Adequacy Analysis/Report is prepared by the Market Operator (MO), and submitted to NERC for review and subsequent approval. In the above Template, the name of the Participant (the MO) should be clearly indicated.
- Responsiveness Requirements: This is a check to ensure that all the requirement to enable adequate analysis of the relevant variables for System Adequacy, are provided and utilized. Such requirements include, the Transmission Expansion Plan, Generation Expansion Plan, Distribution Expansion Plan and Load Projection Report. This is also a check for the promptness of the submission, as well as a check to ensure that the required outlook period is complied with.
- Check validity of the Objectives: In reviewing the system adequacy analysis, a check on the validity of the objectives of the Participant in preparing the report is conducted. Such objectives may include the determination of the adequacy and capability of the overall system infrastructure to reliably evacuate the projected electrical power from the generation stations to the loads centres, as well as to distribute the power from the load centres to the serve the projected loads, throughout the grid.
- Evaluation:
    - The main inputs into the development of the System Adequacy Report by MO are the approved Distribution, Transmission and Generation expansion plans. There are key government and sectoral policies that should be considered in the development of system adequacy analysis. Such policies are verified and their inclusion in the analysis evaluated.
    - plans. Other relevant data required by MO in developing System Adequacy Report and any associated assumptions are verified in the review process.
    - There is need for an integrated system adequacy analysis encompassing all the main sectors (load/distribution, generation, and transmission) of the electric power supply chain. The System Adequacy Analysis should be based on this vital need for system integration. The approach, methodology adopted in the analysis and confirmation of system integration are verified and evaluated in the review process.
    - The results/outputs of the analysis are evaluated

All the above conditions are rated and scores allocated, according to an agreed criteria. If satisfactory, approval is granted by NERC for further necessary action.

8.12. Template for Key Components in Generation Expansion Plan Review

For GenCos, the following table contains the key components reviewed for approval:

NAME AND TYPE OF PLANT:								
		Planning Horizon						
Capital Investment Drivers	Project Areas	Unit	Year 1	Year 2	Year ……	Year 9	Year 10	Remarks
GREEN/BROWNFIELD POWER PLANTS	Generator							
	Steam turbine							
	Gas turbine							
	Hydro turbine							
	Wind turbine							
	Boiler							
	Compressor							
	Pumps							
	Gas handling system							
	Dam							
	PV cells							
	Balance of plant							
	Building/structures							
	Land							
	Eia/resettlement/wayleave							
EVACUATION SCHEME	Substations (extension/reinforcement)							
	New transmission line							
	Transmission line reinforcement							
RENOVATION & MODERNISATION WORKS (R&M)	Generator							
	SYSTEM CONTROL							
INFORMATION & COMMUNICATION SYSTEM	SCADA EMS							
GENERAL SERVICES	WORKING TOOLS SPARES							

8.13. Template for Key Components in Transmission Expansion Plan Review

For the Transmission Expansion Plan, the following table contains the key components reviewed for approval:

NAME OF PARTICIPANT:									
				Planning Horizon					
Capital Investment Drivers	Project Areas	Regions	Unit	Year 1	Year 2	Year …	Year 24	Year 25	Remarks
New Capacity Expansion	330KV Lines (DC/SC) 132KV Lines (DC/SC) 330/132KV S/S 132/33KV S/S Reactive power Compensation								
Reinforcement/Rehabilitation Projects	330/132KV S/S (Rien.) 132/33KV S/S (Rein.) S/S Upgrade 330KV Line reconductoring 132KV Line reconductoring System Control Rein. System Control Repl.								
Information & Communication System	Optical fibres SCADA EMS								
General Services	Consultancy Services Working Tools Spares								

8.14. Template for Key Components in Distribution Expansion Plan Review

For the Distribution Expansion Plan, the following table contains the key components reviewed for approval:

NAME OF PARTICIPANT:									
				Planning Horizon					
CAPITAL INVESTMENT DRIVERS	**S/No.**	**PROJECT AREAS**	**UNIT**	**YEAR 1**	**YEAR 2**	**YEAR 3**	**YEAR 4**	**YEAR 5**	**Remarks**
ACCESS	1	New Connections	No.						
	2	Metering (customer, feeders, interfaces etc)	No.						
	3	Customer Enumeration	No.						
	4	Reliability including Distribution Automation	%						

NEW CAPACITY EXPANSION PROJECTS	5	New Distribution Lines: 33kv; 11kv; 0.415kv	KM						
	6	New Distribution Transformers: All Types	MVA						
	7	New Injection Transformers: All Types	MVA						
	8	Voltage compensation projects	MVAr						
	9	System optimization projects	Lot						
	10	GIS Mapping projects	Lot						
	11	Loss reduction initiatives	Lot						
	12	Energy Efficiency projects	Lot						
	13	HSE projects	Lot						
	14	Security projects	Lot						
	15	New LV Infrastructure system control projects	Lot						
	16	New HV Infrastructure system control projects	Lot						
REINFORCEMENT/ REHABILITATION PROJECTS	17	Distribution lines rehabilitation projects – Emergency repairs (33kv; 11kv; 0.415kv)	KM						
	18	Distribution/injection sub-stations rehabilitation projects – Emergency repairs	No.						
	19	Planned replacement of overhead lines and assets	KM						
	20	Planned replacement of underground cables and assets	KM						
	21	Planned and emergency replacement of protection and control lines (33kv, 11kv and 0.415kv) and sub-stations (distribution and injection) assets	Lot						
	22	Reinforcement of existing system control infrastructure	Lot						
GENERAL SERVICES	23	Customer service, Billing and collection Infrastructure	Lot						
	24	Information and communication eg SCADA, EMS, DMS, etc	Lot						
	25	Standardization of distribution sub-stations (fencing, earthing, fusing of feeder pillars etc)	Lot						
	26	Building and facilities	Lot						
	27	Working Tools	Lot						
	28	Fleet/Logistics	Lot						
	29	Spare Parts	Lot						

The table above shows the components for the Distribution Expansion Plan Review Template. The Capital Investment Drivers in the Template are explained as follows:

Access – There is a statutory obligation of Discos to connect customers within the coverage areas to the supply network, as well as to know the customers being served, by enumeration. This part of the template provides the interface link between Discos and their customers requiring projections for service delivery.

New Capacity Expansion Projects - As new customers are connected to the distribution network, there is the need for system expansion (new substations and lines) to accommodate these customers and ensure system reliability and efficiency for best services.

Reinforcement/Rehabilitation Projects – As customers load on the existing infrastructure increase, there is the need to reinforce these equipment to improve delivery capacity to the customers. Also required are the replacement of obsolete and ageing equipment which no longer meet current operating practice and standards.

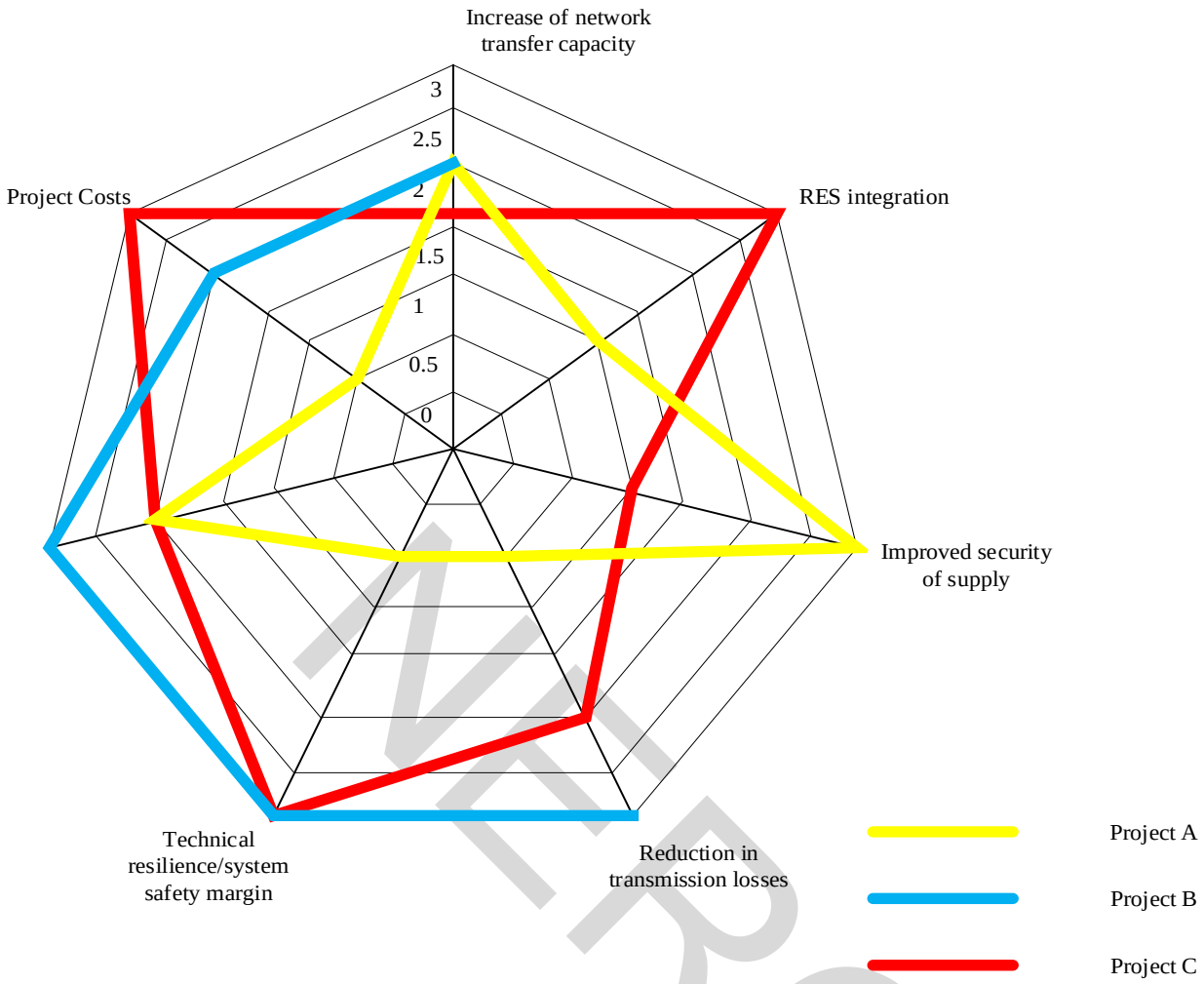
General Services – The utility companies require offices for its staff; vehicles for working crew; computer systems for customer services, Billing and collection management; information and communication systems; working tools and standardization of its substations for safety.

9. Prioritization of Investments

Apart from giving insight into the number and types of projects to be implemented during the horizon period, the Investment Plan contains the associated budget for the investments. As part of the preparation for project implementation, availability and sources of the necessary funds to meet the budget are determined. There is always the problem of funds limitation, due to which all projects cannot be implemented as in the plan. The only way out is to rank the projects for implementation according to priority.

The ENTSO-E Method, which is a cost-benefit Methodology which sets out the approach for measuring each of the seven benefit indicators of the electricity network elements, has been recommended for use in project ranking. The ENTSO-E Methodology has proved to be a very useful tool in system planning . It is used to:

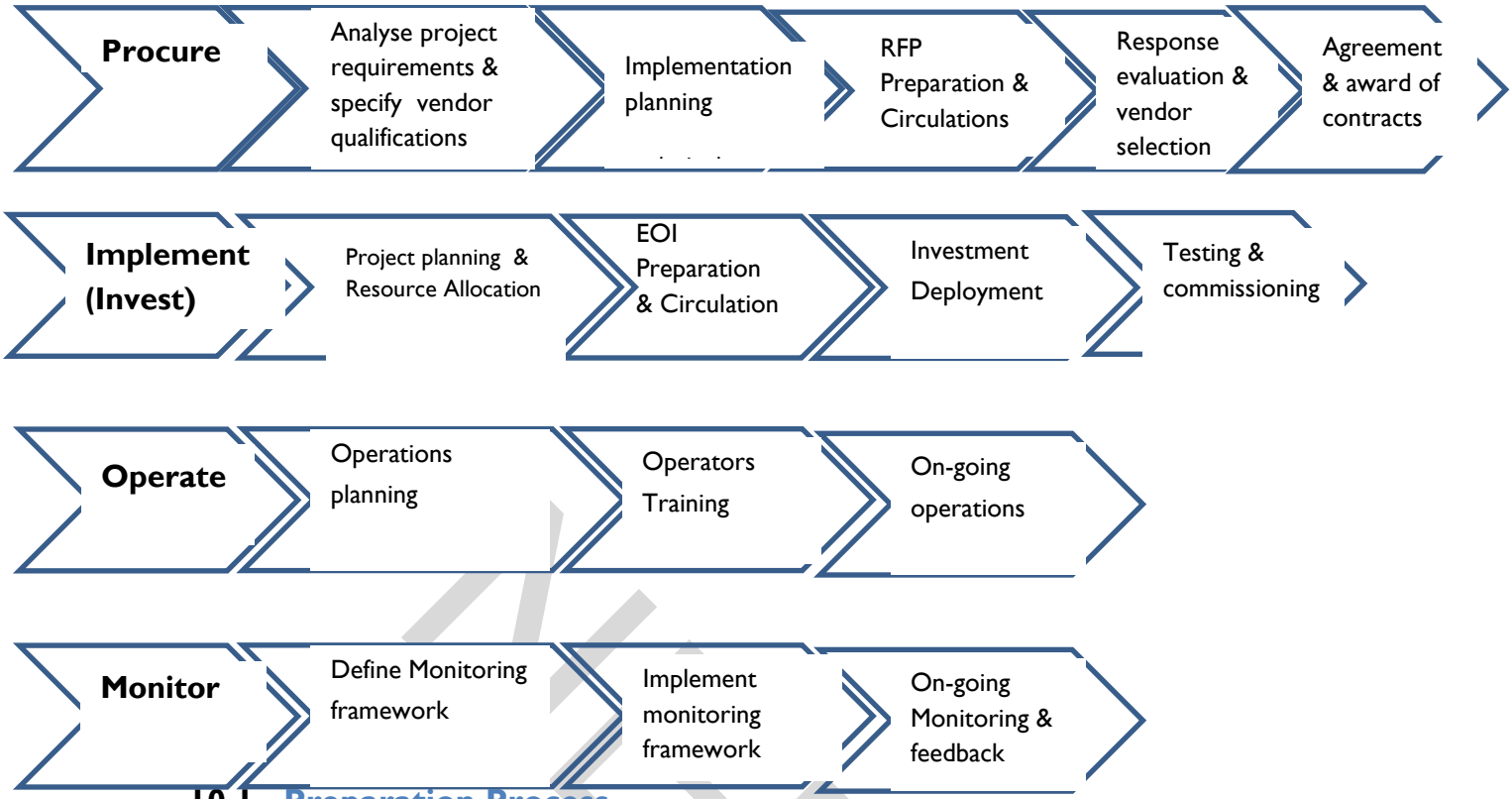
- Determine the effectiveness of the overall expansion plan (when most of the projects score high on the ENTSO-E map, the plan is effective), and
- Rank the individual projects for programmed implementation (when some of the projects score higher than others) in the usual event of funds limitation



The figure above is the Radar Format Graph of ENTSO-E Method of project ranking. The maximum score of any project on the Radar Format Graph is 21 points. The projects represented on the Graph (the bold lines) have scores of 9.5 points for project A, 13 points for B and 15.7 points for project C. Projects for implementation are chosen according to their scores on the Graph.

10. Framework for Procurement and Investments in the Nigerian Power Sector

After a system plan has been approved, the next to follow are implementation and operations by the **Operators**. These implementation and operations are to be monitored by the **Commission** to ensure consistency with the approved plans. For successful implementation of the plans and deployment of the relevant investments, in the Nigerian Electricity Industry, the generation, transmission or distribution companies {the Operators}, should follow a systematic procurement methodology to analyse, plan and invest in the infrastructure to achieve the objectives of the approved plans. The figure below illustrates the critical steps involved in procuring contracts for the implementation of the approved plans



10.1. Preparation Process

Preparation and planning are the key first steps in the successful procurement of any power system project. As part of the preparation work, and before any tender is advertised, the procurement agency requires a realistic estimate (based on good quality design & project specification, scoping & costing processes), of the cost structure with a breakdown of significant cost items. To prepare such an estimate, an Engineer of the agency should be selected and appointed to not only carry out this preliminary work, but continue to supervise the contractor and ensure all works are carried out according to the design and to the highest quality possible.

This estimate must be kept strictly confidential and there should be no links between personnel having this knowledge and the bidders. Underestimates from the bidders could lead to poor contract performance and the need for changes and variations as the contract proceeds, and overestimates may suggest overpricing.

Contracts for power projects are usually expensive, therefore pre-qualification of bidders is recommended. This pre-qualification should be based on professional competence (staff and equipment, relevant experience, financial capability, integrity, etc.).

The final outcomes of this process are the technical design with business cases, as well as the preparation of the RFP.

As a guide:

- The RFP should define the scope of the project and the expected deliverables

- The RFP should clearly mention the project timelines
- The RFP should provide detailed technical requirements and should cover all the technical and performance expectations
- The RFP should outline the compliance guidelines, including technical compliance of equipment and materials in the supply scope, and general compliance related to financial strength and experience
- The RFP should outline the evaluation approach and key aspects of the evaluation matrices
- The RFP should provide guidelines on preparing and submitting the responses to the RFP

10.2. Procurement Phase

In the procurement phase, the Operators (Procuring Agencies) need to clearly draft the requirement based on the outcome of the preparation phase and provide a precise scope for procurement and implementation. As an International best practice, there are three pillars that all procurements must conform to. These are:

- Integrity: this refers to the need for all parties involved in the procurement process to observe the highest standards of ethics during the process, and refrain from fraud and corruption
- Transparency: this refers to the need to make all relevant procurement information publicly available to all interested parties, consistently and in a timely manner
- Accountability : this refers to the need for effective, efficient and economic use of resources, as well as adequate communication with the relevant parties

Also, there are procurement Rules for the country, enforced by the Bureau of Public Procurement (BPP), which must be followed in every public procurement. The International financial agencies, like the WB, EU, etc, have their own specific procurement Rules, which must be followed in every procurement involving their funds.

These Rules are designed to encourage true and open competition in tendering and contract awards. They also promote effective monitoring and auditing of all processes and implementation activities.

The key activities of the procurement process, are as follows:

i. Vendor Specification and advertisement for Expression of Interest (EOI)

The agency needs to specify the vendors in order to ensure suitable vendors are invited for the RFP process. This is followed by the advertisement for the expression of interest, essentially to reduce on the number of RFPs to be circulated. The responses to the request for EOI are evaluated, vendors are pre-qualified for the RFP process

ii. RFP Circulation

The agency also needs to circulate the RFP to all the pre-qualified vendors to seek for their responses as per the guidelines in the RFP document. The RFPs are usually in two parts – the Technical and Financial Proposals

iii. Response Submission by the Vendors

The vendors need to analyse and understand the scope and requirements of the RFP and prepare their responses accordingly. The vendors may seek clarifications for better understanding of the technical and general requirements of the RFP, therefore there may be need for a bidders' conference to enable vendors ask the questions and understand the requirements of the project and the RFP

iv. Response Evaluation and Vendor Selection

The Procuring Agencies need to Evaluate responses to the RFP based on the set criteria. The evaluation process include weeding out the non-responsive bids before the main evaluation. The Technical Proposals for the responsive bids are evaluated first. The vendors whose Technical bids score the set minimum and above are short-listed for the evaluation of the Financial bids, while those whose Technical bids did not make the required marks have their Financial bids returned.

The Financial evaluation, which is usually less tedious than the Technical evaluation, involves the allocation of scores to the proposals in line with the set criteria. The weighted average scores for the Technical and Financial proposals of the bidders are calculated and organized in a descending order. Depending on the number of vendors required, discussions are initiated with vendors according to their positions in the above ranking. Vendors are finally selected based on evaluation and discussion. The output of this is the selected vendor(s).

v. Agreement & Award of Contract

Once the response evaluation and vendor selection is done, the agency and the vendor need to comply with the terms and sign the contract agreement. The agreement should:

a. Define scope of contract
b. Define conditions of contract
c. Define service level agreement, including provision for penalty for deviation from the terms

The output is the contract signed with the vendor(s)

10.3. Implementation (Investment) Process

The next step after signing the procurement contract is to commence implementation. The implementation process is the most crucial process and involves activities such as, resource allocation, implementation planning with time lines, development of sub-contracts for equipment supplies and support works, actual investment deployment and monitoring of the project execution by regular status checks and review of progress.

In the implementation phase, the procuring agency and the Vendor need to agree on a project implementation schedule, with clear milestones. Both the Regulator and the procuring agency need to allocate resources to monitor and support project execution. The implementation must focus on scope, schedule and costs to achieve the project.

For the smooth execution of the project, the Regulator and the agency need to monitor the overall project progress, and:

- A specific timeline has to be agreed between parties
- Regular project meetings need to be conducted to track progress
- Site visits on regular basis has to be done to ensure deliverables
- An acceptance test has to be done based on equipment specification, functionality and expected performance, as part of the project implementation process

10.4. Operations and Monitoring Process

Following the investment deployment, the procuring agency need to plan and implement an operational and monitoring framework, in order to successfully operate and monitor the infrastructure. The monitoring framework will consist of:

- Defining the key elements to monitor
- Defining the performance matrices
- Defining the feedback and corrections plan

The implemented project should be handed over to the procurement agency for operations, maintenance and monitoring. The developed monitoring framework should be operationalized accordingly

11. Monitoring Practices and Procedures for the Generation, Transmission, and Distribution System Plans

Firstly, the System Participants (GenCos, TSP, DisCos, and NBET) submit their individual expansion plans, ie Generation Expansion Plan (GEP), Transmission Expansion Plan (TEP), Distribution Expansion Plan (DEP), and Power Procurement Plan (PPP), respectively, to the Commission for review and approval. The Review Procedures are described in section 7, while the Review and Approval Templates are described in section 8.

After scaling the review process successfully, the system expansion plans submitted by the System Participants become Approved Generation Expansion Plan (AGEP), Approved Transmission Expansion Plan (ATEP), Approved Distribution Expansion Plan (ADEP), and Approved Power Procurement Plan (APPP), respectively. After approval, the plans are dispatched by the Commission to the respective Participants for implementation. The Participants will procure the items, works, and services contained in the approved expansion plans following the framework described in section 9.

The summary of the expansion plans, with the financial implications, are the associated investment plans. Because these investment plans form the bedrock of the tariff burden born by the electricity consumers, the Commission need to ensure that the actual investments incurred by the Participants follow and comply with the approved expansion plans faithfully. Accordingly, the Commission should follow the procedures, as well as the Template below to monitor the implementation of projects by the Operators to ensure strict compliance with the approved plans.

The procedures for monitoring the implementation of the Approved Transmission Expansion Plan (ATEP), for example, are as follows:

a. Check the validity of the objectives for the project implementation
b. Verify that projects being implemented are in the ATEP
c. Check main contractors for conflict of interest and technical competence
d. Verify that design complies with relevant statutes, standards, and specifications (the S3 Criterion)
e. Check costs of major elements of the assets being installed
f. Check quality of materials and workmanship
g. Verify that the works comply with HSE stipulations and that approved mitigation plan is implemented fully
h. Check work schedule and progress against agreed timelines
i. Verify that all key aspects of the implementation plan comply with international best practice
j. Confirm the outcome of the project implementation met the established objectives,

The same monitoring procedures apply to the Approved Plant Maintenance Plan (APMP) and the Approved Distribution Expansion Plan (ADEP). For the procurement of bulk power under the Approved Generation Expansion Plan (AGEP), the Bulk Power Procurement Regulation should also apply

The items of power infrastructure are complex and may need specialist expertise for the evaluation of the items themselves and their associated installation. The Commission may therefore need to engage the services of requisite Consultants in the review of the processes and plans, as well as in the monitoring of project implementation, if the required expertise are not available in-house.

Firstly, the project monitored must be on the relevant approved plan (AGEP, ATEP, ADEP, APMP and APPP). The monitoring schedule of the project, which should be aligned with the construction plan, will be agreed with the affected Participant (GenCos, TCN, DisCos, etc.) and the EPC Contractor.

The Monitoring Template below, adapted from Approved Transmission Expansion Plan (ATEP) monitoring procedures is applicable to all the System Participants.

In monitoring generally, the Commission will confirm the quality of design, materials, and construction (the 3-Q Check) against the S3 Criterion (compliance with relevant statutes, standards, and specifications). Periodic checks on impact of project implementation on Health, Safety, and Environment (HSE) will be conducted. Full implementation of the Environmental and Social Impact Assessment (ESIA) mitigation plan must be ensured, especially where resettlement of populations is involved. Resettlement must include provision of the means of livelihood and not just housing accommodation. Careful watch over budget and timelines is kept to avoid overruns and slippages in project implementation.

A **No-Objection Certificate** will be triggered once the monitoring score for a project or project key component hits a predetermined threshold. The Commission may need to develop an in-house grading formula to be incorporated into the Monitoring Template in order to minimize subjectivity and personal biases. It may also, be necessary to check the main contractors for conflict of interest to avoid insider dealings

The generic Template for monitoring the implementation of projects (on project – by - project basis) is as shown below.

11.1. Project Implementation Monitoring Template

S/N	OBJECT	SCORE	Y/N	REMARKS
A	NAME OF PARTICIPANT:			
B	PROJECT TITLE:			
C	COMPONENT/ITEM MONITORED:			
D	NAME OF CONTRACTOR:			
1	S3 CRITERION			
1.1	Statutes			
1.2	Standards			
1.3	Specifications			
2	3-Q CHECK			
2.1	Quality of design			
2.2	Quality of material			

S/N	OBJECT	SCORE	Y/N	REMARKS
2.3	Quality of works			
3	COST OF COMPONENT			
4	**COMPLIANCE**			
4.1	HSE Compliance			
4.2	ESIA Mitigation measures			
4.3	Work Schedule and Timelines			
4.4	International Best Practice			
	TOTAL SCORE			
	RECOMMENDATION			
I	SITE ENGINEER – EPC CONTRACTOR: NAME:…….DESIGNATION:…….. SIGN:……...DATE:……..			
II	PROJECT MANAGER – EPC CONTRACTOR: NAME:……DESIGNATION:……. SIGN:…….DATE:……..			
III	PROJECT MANAGER – MARKET PARTICIPANT (Operator): NAME:…….DESIGNATION:…….. SIGN:……..DATE:…….			
IV	NERC MONITORING OFFICER: NAME:…….DESIGNATION:…….. SIGN:……DATE:…….			
V	NERC APPROVING OFFICER: NAME:…….DESIGNATION:…….. SIGN:……..DATE:…….			

It should be observed that the Guide is focused on the Review and Monitoring processes and methods of Power System Plans, by the Regulator. It should be noted that knowledge of these Review and Monitoring processes is important to the Operators because it guides them in the development of their System Plans

12. Approval of the Guide by the Commission